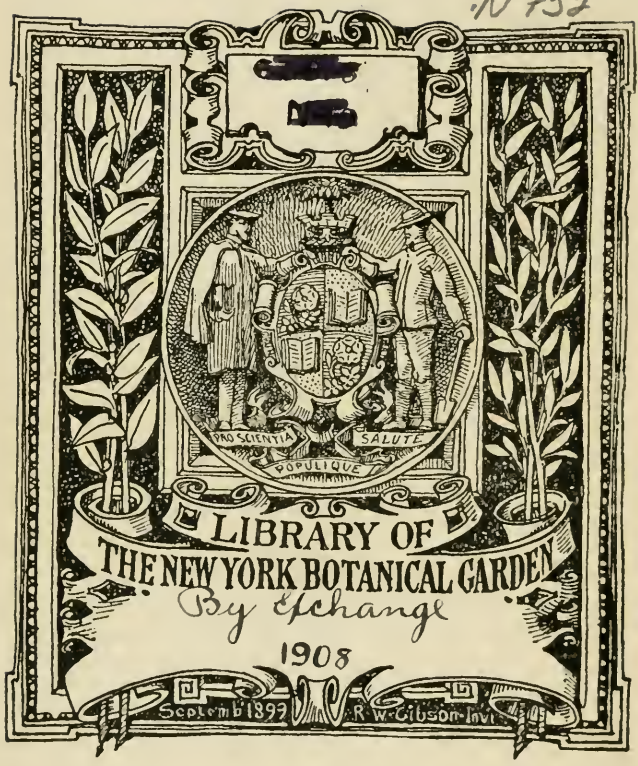


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NINETEENTH ANNUAL REPORT

OF THE

CORNELL UNIVERSITY

Agricultural Experiment Station

ITHACA, N. Y.

1906

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NINETEENTH ANNUAL REPORT

OF THE

Agricultural Experiment Station of Cornell University.

STATE OF NEW YORK:

DEPARTMENT OF AGRICULTURE,

ALBANY, *January 14, 1907.*

To the Honorable the Legislature of the State of New York:

In accordance with the provisions of the statutes relating thereto, I have the honor to herewith transmit the Nineteenth Annual Report of the Agricultural Experiment Station at Cornell University.

CHARLES E. WIETING,

Commissioner of Agriculture.

XA
N 753
1906

ORGANIZATION

OF THE CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT
STATION.

BOARD OF CONTROL
THE TRUSTEES OF THE UNIVERSITY.

THE AGRICULTURAL COLLEGE AND STATION COUNCIL

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THOMAS F. HUNT, Professor of Agronomy.

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JOHN W. GILMORE, Agronomy.
HERBERT H. WHETZEL, Plant Pathology.
SAMUEL FRASER, Agronomy.
JAMES A. BIZZELL, Chemistry.
ELMER O. FIPPIN, Soil Investigation.
CHARLES E. HUNN, Horticulture.

Office of the Director, 17 Morrill Hall.

The regular bulletins of the Station are sent free to persons residing in
New York State who request them.

December 1, 1906.

The Governor of the State of New York, Albany, N. Y.,
The Secretary of the Treasury, Washington, D. C.,
The Secretary of Agriculture, Washington, D. C.,
The Commissioner of Agriculture, Albany, N. Y.:

The Act of Congress, approved March 2, 1887, establishing Agricultural Experiment Stations in connection with the Land Grant Colleges, contains the following provision: "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 commissioner of agriculture, and to the secretary of the treasury of the United States."

And the Act of the Legislature of the State of New York, approved April 12, 1906, providing for the administration of the New York State College of Agriculture at Cornell University, contains the following provision: "The said University shall expend such moneys and use such property of the State in administering said College of Agriculture as above provided, and shall report to the commissioner of agriculture in each year on or before the first day of December, a detailed statement of such expenditures and of the general operations of the said College of Agriculture for the year ending the thirtieth day of September then next preceding."

In conformity with these mandates I have the honor to submit on behalf of Cornell University the following report:

The law quoted above calls for an annual report on the State College of Agriculture for the year ending the thirtieth day of September. By chapter 655 of the Laws of 1904, the State appropriated \$250,000 for the purpose of constructing and equipping buildings for the State College of Agriculture at Cornell University. But funds for the maintenance of the College were not provided until 1906 when the above mentioned law for the administration of the College was also enacted. The clause in the Appropriation Act of 1906 is as follows:

"For the State College of Agriculture at Cornell University for the promotion of agricultural knowledge throughout the State as provided by chapter four hundred and thirty of the laws of eighteen hundred and ninety-nine, and for the maintenance, equipment and necessary material to conduct the College of Agriculture, one

hundred thousand dollars (\$100,000), payable to the treasurer of Cornell University on the warrant of the comptroller."

As this money did not become available until October 1st, and the present report covers the year ending September 30th, it is obvious that no account can be given of its expenditure. For several years, however, the State had appropriated to Cornell University funds for extension work in agriculture, and the results of this work have been reported annually to the Commissioner of Agriculture for the year ending September 30th. The present report therefore properly concerns itself only with that extension work. As, however, during the last two years Cornell University has had charge of the erection of the buildings for the State College of Agriculture and has constantly been planning for the inauguration of the State College which went into operation on October 1st, it seems proper that this report should contain a full account of all the agricultural activities at Cornell University, of the plans for their improvement and enlargement, and of the funds by which they have been supported. In this way there will be a record of the condition of things when the New York State College of Agriculture first went into operation, which will undoubtedly be useful for future reference.

It is natural to begin with the buildings for the New York State College of Agriculture, for which the Legislature in 1904 appropriated \$250,000. They comprise four members — a main building, a dairy building, an agronomy building, and an animal husbandry building. Of these the dairy building is now in use, and it is hoped the agronomy building may be fit for use before the close of the year. The main building is very nearly completed, and it seems safe to predict, in spite of many delays in the past, that all the buildings will be completed by the spring. It is important to call attention to the fact that they have been constructed within the appropriation, which will also serve to equip the buildings so as to make them usable. The residue of the appropriation, however, is not large enough to furnish the buildings with equipment to make them as efficient as they might and should be made. The first need, therefore, of the College is additional equipment. It will be seen also from the reports of the Director and the heads of several departments herewith annexed, that the College needs a new barn, new glass houses, more land and stock, besides other facilities to give to the work of instruction and research its maximum efficiency.

The primary object of the New York State College of Agriculture is to increase the productiveness and profitableness of farming. To

that end the Administration Act (chapter 218 of the Laws of 1906) authorized it to give instruction, to conduct research, and to disseminate agricultural knowledge throughout the State by publications, lectures, demonstrations, "and in such other ways as may be deemed advisable." The entire control of the College is vested in the Board of Trustees of Cornell University. But it is specifically provided that "said University shall receive no income, profit or compensation therefor, but all moneys received from state appropriations for said college of agriculture or derived from other sources in the course of the administration thereof, shall be credited by said University to a separate fund, and shall be used exclusively for said New York State College of Agriculture."

With the enlarged staff of instruction which the State appropriation has made it possible to appoint, the College is now conducting extensive and thorough courses of instruction for students in agriculture who come to Ithaca and also disseminating agricultural knowledge throughout the State in a manner which is commanding not only the favorable comment of the people of New York but also attracting the attention of other States and countries.

The Act (chapter 655 of the Laws of 1904) appropriating \$250,000 for buildings for the New York State College of Agriculture at Cornell University contains the following provision: "Nothing in this act shall be construed to relieve Cornell University of any of its obligations to the State to provide for instruction in agriculture or otherwise and the provisions of this act are intended to provide additional facilities therefor." This clause forbids Cornell University to shift to the State any obligations that may be imposed upon it by law to provide for instruction in agriculture. That is to say, the University must in the future, as a matter of good faith with the State which now co-operates with it, continue to do not less than it has done in the past for the maintenance and support of instruction in agriculture. The clause just cited makes no reference to research, and properly so because the work of research in agriculture at Cornell University is conducted by an Experiment Station maintained by Federal appropriations. But whatever the University has in the past done to support instruction in agriculture it must continue to do in the future.

Recognizing this obligation, the Trustees of Cornell University called on the Treasurer to make a report upon the regular appropriations and moneys expended for the College of Agriculture for the year 1903-4, the year of the passage of the Act in question, and also for the seven preceding years, together with the sources thereof. That report is as follows:—

REGULAR EXPENDITURES.

	1896-7	1897-8	1898-9	1899-0	1900-1	1901-2	1902-3	1903-4
Salaries.....	\$ 5,250 00	\$ 3,500 00	\$ 4,500 00	\$ 4,850 00	\$ 5,000 00	\$ 5,000 00	\$ 5,200 00	\$ 11,200 00
Agricultural appropriation.....	7,200 00	7,600 00	7,500 00	7,500 00	7,000 00	8,000 00	7,000 00	8,624 00
Horticultural appropriation.....	900 00	1,200 00	1,200 00	1,200 00	1,300 00	1,300 00	1,300 00	
Congressional Industrial Fund for facilities.....	3,000 00	3,000 00	3,000 00	3,000 00	3,000 00	3,000 00	3,000 00	3,000 00
	\$16,440 00	\$15,300 00	\$16,200 00	\$16,550 00	\$17,200 00	\$17,300 00	\$16,500 00	\$22,824 00
The funds for these expenses were provided as follows:								
Departmental receipts.....	\$ 6,273 72	\$ 5,957 44	\$ 5,493 15	\$ 4,085 98	\$ 5,911 16	\$ 5,700 60	\$ 6,187 22	\$ 4,911 49
Fees.....	1,000 00	1,757 50	1,810 00	1,927 50	2,227 77	1,840 40	900 00	1,215 00
Dairy Laboratory.....	19 55	30 20	24 15	35 55				
Congressional Industrial Fund.....	5,750 00	5,750 00	5,750 00	5,750 00	5,750 00	5,750 00	5,750 00	10,000 00
General University funds.....	2,796 73	1,804 86	3,122 70	3,850 97	3,311 07	4,003 00	3,002 78	6,697 51
	\$16,440 00	\$15,300 00	\$16,200 00	\$16,550 00	\$17,200 00	\$17,300 00	\$16,500 00	\$22,824 00

From the payment from the General University Funds deduct \$1,000 formerly paid from Experiment Station on Prof. Atkinson's salary and assumed by the University in the reorganization.

It appears from this report that, apart from departmental receipts, fees, and Congressional funds the highest contribution from the University treasury to the maintenance of agricultural instruction was in 1903-4 when it amounted to \$5,697.51.

But these appropriations do not exhaust the service which the University has rendered to the cause of agricultural instruction. It was permitted students in agriculture to take work in other Colleges of the University free of charge to such extent as the Faculty of Agriculture deem advisable. The Registrar was accordingly instructed to ascertain the amount of such free instruction given to agricultural students during the period covered by the Treasurer's report, which closed with 1904, the year of the passage of the Act in question. As this investigation demanded the compilation of a vast number of figures, the Registrar was instructed to report for the first, the last, and the middle years covered by the Treasurer's report. The Registrar's report is as follows:

REGISTRAR'S REPORT.

YEAR	Total number of students taking Agr. work	Number of hours of instruction in Agr. subjects	Per cent	Number of hours of instruction in Vet. subjects	Per cent	Number of hours of instruction in Forestry subjects	Per cent	Number of hours of instruction in all other subjects	Per cent
1896-7.....	86	1350	60	24	1	..	..	865	39
1900-1.....	117	1760	60	109	4	80	3	975	33
1903-4.....	161	2349	57	66	2	..	..	1669	41
Average.....	121	1820	59	66	2	27	1	1170	38

It will be seen from the foregoing statement that the largest amount of instruction by Cornell University to students of agriculture in subjects outside the College of Agriculture (and other State colleges) was in the year 1903-4, when it aggregated 1,669 hours. As a student in order to graduate must take thirty hours a year, and is permitted to take thirty-six hours a year, on the basis of thirty-three hours per year, 1,669 hours would represent almost exactly the total instruction given to fifty students or half the instruction given to 100 students for one year.

After consideration of these reports of the Treasurer and of the Registrar at meetings held on October 2, 1906, and November 27, 1906, the Executive Committee of the Board of Trustees of Cornell University appropriated for the support of the State College of Agriculture \$5,700 from the University treasury and \$10,000 from the Congressional Industrial Fund, and voted also that the receipts from the University farms, plant, etc., and agricultural fees hitherto turned into the University treasury, be credited direct to the State College of Agriculture, and that the University assume the obligation of furnishing to students in Agriculture, free of charge, instruction in other Colleges of the University, if there be a demand therefor, up to an aggregate of 1,669 hours.

As has been already explained, the principal object of the New York State College of Agriculture is to improve the agricultural methods of the State; to develop the agricultural resources of the State in the production of crops of all kinds, in the rearing and breeding of live stock, in the manufacture of dairy and other products, in determining better methods of handling and marketing such products, and in other ways; and to increase intelligence and elevate the standards of living in the rural districts. But the law organizing the College does not exclude investigation and research. On the contrary the College is authorized "to make researches in the physical, chemical, biological and other problems of agriculture, the application of such investigations to the agriculture of New York, and the publication of the results thereof." Nevertheless, it is planned that the College shall devote itself, if not exclusively, at least pre-eminently, to giving instruction to students who come to Ithaca in the arts and sciences of agriculture and to the diffusion of agricultural knowledge throughout the State. The work of investigation and research is, in the meantime, delegated to the Federal Experiment Station. And men who engage in research are to do no teaching whatever, their time and energy being devoted solely to the

discovery of new truths in the field of agricultural science. Already two full professors have been appointed in the Experiment Station whose sole duty is research. One is to work in the field of plant physiology and the other is grappling with some of the numerous problems that arise in soil physics and soil chemistry with special reference to the problems of different kinds of soil under different treatment.

The expansion of the work in the Federal Experiment Station has been made possible by the Act of Congress approved March 6, 1906, providing for an increased annual appropriation for Federal Experiment Stations and by the concurrent resolutions relative to this Act of Congress adopted by the Senate and Assembly of the State of New York on April 19, 1906. The annual increase to the appropriation for Experiment Stations made by this Act is \$5,000 for the first year and a further increase of \$2,000 a year for the next five years, making the annual amount to be paid to each State and Territory \$30,000 instead of \$15,000 as heretofore. By the concurrent resolutions above mentioned it is provided that in New York State nine-tenths of the increase shall be assigned to the Federal Experiment Station at Cornell University and the other one-tenth to the State Experiment Station at Geneva, this being the proportion in which the original appropriation of \$15,000 annually, as provided by the Experiment Station or Hatch Act of March 2, 1887, was divided between the two stations. The Act provides that the Federal appropriation for experiment stations shall be applied "only to paying the necessary expenses of conducting original researches or experiments bearing directly on the agricultural industry of the United States, having due regard to the varying conditions and needs of the respective States and Territories."

The work of the Experiment Station and of the College of Agriculture is very varied and extensive. For a complete description of it I beg to refer to the accompanying reports of the Director and heads of the several departments, which are to be regarded as an integral part of this report. Instruction and research in agriculture are necessarily expensive. The Federal Government holds the Stations to strict accountability for all their expenditures, which are regularly reported with expenditures itemized. This report includes a statement of the expenditure of State funds, which are all carefully guarded by the State Commissioner of Agriculture. The list of the staff of instruction in the New York State College of Agriculture and of the Federal Experiment Station on September

30, 1906, is also given. And for further information there are appended the series of bulletins of the Agricultural Experiment Station, Nos. 233 to 241 inclusive, the Junior Naturalist Monthly, new series, vol. 2, Nos. 1 to 8 inclusive with supplements, the Cornell Reading Course for Farmers leaflets, Series VI, Nos. 26 to 30 inclusive, the Cornell Reading Course for Farmers' Wives leaflets, Series IV, Nos. 16 to 20 inclusive, and the Home Nature-Study Course leaflets, new series, vol. II, Nos. 1 to 4 inclusive.

The report of the Director is chiefly devoted to the question of the proper organization of a College of Agriculture. It is a timely discussion, in view of the action of the Legislature establishing a State College of Agriculture at Cornell University in 1904 and providing for its administration in 1905. The aim of a College of Agriculture is on the one hand to increase the productiveness and profitableness of farming and on the other to educate the people of the country for country life, to enlarge their horizon, to elevate their ideals, and to make them more efficient producers and better citizens. And the College addresses itself not only to students present in its halls, but to farmers all over the State; and it is not only a teaching institution but also an institution of research and experiment. College teaching in agriculture at Ithaca, the diffusion of agricultural knowledge throughout the State of New York, and original investigations and experiments with a view to new discoveries in agricultural science—these are the threefold functions of the New York State College of Agriculture at Cornell University.

As to the teaching of students in the College it may be pointed out that the attendance is steadily increasing. In 1904-5 there were 508 students enrolled. About half of these were students in the winter school, and the others students in the four-year course, special or graduate students. The subjects of study, apart from the fundamental arts and sciences, are divided by the Director into the crop-growing group and the animal-growing group. The former includes the fertility of the land, the breeding of plants, the diseases of plants, and methods of growing and handling different kinds of crops. The latter includes the feeding of animals, the breeding of animals, the diseases of animals, and methods of rearing and handling different kinds of animals. Besides these central and fundamental agricultural subjects there are also courses on farm mechanics and machinery, rural engineering, technology and manufacture, rural art, etc.

The second function of the College is extension work. This work, says the Director, comprises all those teaching enterprises that aim to reach the farmers of the State and their problems in the places where the problems are. No agricultural teaching is at present more needful or capable of accomplishing more good in the State. It is not, indeed, the scholarly work of the College; but it is the bureau of publicity of agricultural knowledge. The extension enterprises fall into several categories among which may be mentioned reading-courses, experiments and demonstrations on farms, tests and inspections, orchard and other surveys, lectures and schools, correspondence, popular publications, etc. This variety of work is conducted by a special staff, which is largely differentiated from the teaching faculty of the College.

There is a still more complete differentiation in regard to the third function of the New York State College of Agriculture — the function of research and experiment. In 1904-5 the Federal appropriation available for the object was \$13,500, and with an annual augmentation it will, four years hence, be \$27,000 annually. Already two able scientists in the field of agriculture have been secured as investigators, and others of the same standing will be secured in the future. For just as the College is to engage in teaching students and the extension department is to carry knowledge and help to the farmers, so the Experiment Station must be manned with scientists competent to conduct genuine investigations and original experiments.

The remainder of the full report is divided into eleven main heads as follows:—

I. In the department of Agronomy the teaching reached during the year under consideration 523 students. An attempt has been made to correlate the instruction in soils with that in agronomy and an innovation has been introduced in securing Dr. J. G. Lipman as a non-resident lecturer on soil bacteriology. The needs of this department are for new barns and new glass houses in which to conduct instruction and experiment.

The Federal Experiment Station work has been carried on in a series of twenty-five experiments at Cornell. Especial attention has been paid to experiments relative to agricultural chemistry. A small temporary bungalow has been constructed on the Mitchell farm for the use of the directors of the field experiments.

The report on State Extension Work in Agronomy shows 508 experiments conducted with the aid of about 300 co-operators in

fifty-five different counties. There have been two objects in view: (a) to gain information in regard to the soil and crops under experiment and (b) to extend the educational influence of the experiments to the farmers who are doing the work and to their neighbors who observe them.

The personnel of the department has been changed by the addition of Professors Lyon, Warren and Fippin and Mr. C. F. Clark.

II. In Animal Husbandry instruction has been given to more than 300 students during the year 1905-1906. The increased demands make an addition to the teaching staff imperative. The State extension work has been carried on by means of lectures before farmers' meetings and by supervision of the records of cattle. Cattle have been examined for over 100 owners in New York State. The Federal Experiment Station work has been concerned chiefly with beef, mutton and pork production.

Instruction in the sub-department of Poultry Husbandry (maintained by special State appropriations) was offered to 152 students in seven courses last year. Work in investigation resulted in thirty-nine separate experiments on such subjects as incubation, feeding fowls, breeding poultry, etc. Correspondence has been answered to the extent of more than 2,500 letters and the tendency toward increase is marked. The extension work in Poultry Husbandry is conducted through reading-courses, co-operative experiments, lectures, exhibits and personal exchange of views.

III. The report of the department of Horticulture shows that experimental work has been carried on with both State and Federal funds. The former has included experiments on the comparative value of garden vegetables, spraying investigations, cultural experiments, orchard surveys and studies of the "little peach" disease. The latter has consisted of investigations into the characteristics of garden beans and of the effect of acetylene, sulphur, ether and of lime upon certain plants. The department of Horticulture has done effective extension work through lectures, visitations and correspondence. The demand for this aid seems to be increasing. The remainder of the report on Horticulture deals with the equipment of that department and explains the need of new forcing houses and experiment facilities.

IV. The department of Dairy Industry has been in a very unsettled condition pending the completion of the new State dairy building and its work has been handicapped on that account. Instruction has been given to 108 regular and special students as compared

with seventy-four in 1904-5. Ninety-one students were registered in the Winter Dairy course (State Extension work). The class was unusually regular in attendance and attentive to work. The demand for the men who have taken this winter dairy course exceeds the supply. Correspondence amounting to over 5,000 letters was conducted by this department in 1905-1906. Seventy-five visits have been made by Mr. Hall and his assistants to establishments where former students are employed. Investigation has been hampered by the unsettled conditions before mentioned but a study of the bacteria of freshly drawn milk has been begun.

V. The department of Rural Art has been in existence since 1904-1905 only. Its second year has been encouraging. The number of courses offered has been increased from one to four. The courses now being given are Theory and Aesthetics of Landscape Design, Work with Plans and Drafting, Plant Materials for Landscape Effect, and Advanced Work in General Landscape Design.

VI. The department of Entomology has published two bulletins in the Federal Experiment Station work. Bulletin No. 233 dealt with saw-fly miners on European elms and alders. Bulletin No. 234 discussed the bronze birch borer.

The Extension Work with State funds has been carried on under three divisions. (a) The regular teaching work consisted of a course on injurious insects given to thirty-eight students in the short winter course in agriculture. (b) The experimental work resulted in the issuance of Bulletin No. 235 on Co-operative Spraying experiments. (c) The co-operative experiments have dealt largely with insecticides and their effectiveness in killing the plum curculio, rose-chafer and San José scale. The experiments prove that these pests can be controlled by proper spraying.

VII. The work of the Federal Division of the department of Agricultural Chemistry has consisted of analyses of green corn (30 samples), of root crops (182 samples), of soil (48 samples) and of soil solutions (96 samples). The Extension Work has been carried on chiefly in connection with analyses at the request of farmers, the principal subjects of analysis being insecticides and fertilizers. This department is now attempting to solve the problems relating to soil fertility on the Mitchell farm.

VIII. A final and summary report is submitted by the department of Botany in the Federal Experiment Station. The adoption of the policy of separating the work of the Experiment Station from that of teaching and research will necessarily make this the final

report of the professor in charge. An extended account is given of the experiments of the department since 1892. It is shown that the subjects treated have been physiological investigations, diseases of plants and studies in the higher fungi.

The State Extension work in Botany has been continued by means of lectures at farmers' institutes, by horticultural meetings, by farmers' field meetings and by exhibits at fairs and by teaching in the winter courses. The exhibits made at the fairs were certain cultivated plants of New York State, showing some of the more common diseases. Co-operative experiments and correspondence work also took a prominent part in the department of Botany. The report earnestly recommends a continuance and expansion of the extension work, especially that which relates to plant diseases. The following are some of the investigations conducted by the department in 1905-6: The prevention of the pod spot on beans, the alternaria blight of ginseng, the fire blight of pears and apples, spraying experiments on septoria leaf blight of the tomato, experiments on the control of rust on hollyhocks and investigations into the nature of root rot of peas.

IX. The farmers' reading-course (maintained by State appropriation) enrolled 9,654 members during the past year, 2,271 of whom were new members within the year. Two thousand five hundred and forty-six of these farmers were organized into 125 reading-course clubs. An attempt has been made to extend the work so that farmers who desire to secure the bulletins but are unable to fill out the discussion papers may still be placed on the mailing list.

X. The report of the farmers' wives' reading-course (maintained by State appropriations) shows an enrollment at the end of the year of 20,284. During the year 2,077 discussion papers were returned. The Winter-course in Home Economics, which is a natural outgrowth of the reading-course, enrolled forty during the winter of 1906.

XI. The Bureau of Nature Study (maintained by State appropriations) reports that their latest records show a total of 1,506 clubs for junior naturalists with a membership of 30,083. The total number of letters received from the children was 20,806. The children wrote on thirty-one different topics, such as "tracks in the snow," "evergreens," "snowflakes," etc. This bureau also enrolled 33,476 children in the children's gardening and junior agricultural course.

Nature-study for the home has also been attempted by this department and over 10,000 lessons on birds, trees, insects, plants and fish have been sent to the farm homes of the State.

Such is the outline of the work carried on in the numerous departments of the College of Agriculture. The farmers of the State are manifesting an increasing interest in this work, as is shown by the larger demand for bulletins, leaflets and personal advice, by the influx of new students, and by the hearty co-operation which is given to all enterprises in experiment and research. The growing and successful work of the College makes necessary an increase in the provisions for its maintenance and support. Undoubtedly, the Legislature in the foundation of the New York State College of Agriculture contemplated an institution worthy of the Empire State and commensurate with its agricultural interests. For buildings and equipment the Legislature appropriated \$250,000 to which was added by Cornell University \$40,000 as required by the law authorizing the University to appropriate the former dairy building. This sum of \$290,000 has been spent largely on the buildings, leaving only a comparatively small amount for equipment. While this equipment will enable the buildings to be used, it will not draw from them their maximum efficiency, or make an exhibition worthy of the agricultural interests of the State of New York. An appropriation for the adequate equipment of the College should be made as a direct investment in the interest of the people of the State. And in the next place the College should be supplied with barns, stock and farms that might serve on the one hand as models to the farmer and on the other as means for the conduct of the instruction, experiment and research to which the College is dedicated. As agents of the State in the administration of this College, Cornell University calls the attention of the Legislature to these needs.

Respectfully submitted,

J. G. SCHURMAN,

President of Cornell University.

REPORT OF THE DIRECTOR OF THE NEW YORK STATE COLLEGE OF AGRICULTURE.

The demands of the College of Agriculture have grown greatly in the past year, but there has been no growth in the staff or equipment. The expected completion of the new buildings within the next year and the hope of maintenance funds from the State, support the enthusiasm of the staff and the student body and make it possible to hold the College together. The College of Agriculture is a most complex institution, touching very many public questions and prosecuting its work all over the State as well as at Ithaca. No other college at Cornell University has such diverse interests.

The undergraduate student body has made an increase over last year of 22 per cent. The students pursuing agricultural work in 1905-6 (not counting students registered in arts and other colleges and taking work in the College of Agriculture) are as follows:

Regular four-year students.....	128	
Specials	102	
	230	
WINTER-COURSES.		
General Agriculture	71	
Dairy	90	
Poultry	35	
Horticulture	15	
Home Economics	40	
	251	
	481	
Counted twice	5	
	476	
Students in graduate department pursuing work in Agriculture:		
In residence	28	
In absentia	4	
	32	
Total students in Agriculture alone.....	508	

There have been two innovations in the College in the past year: a lecture course in home economics, and the projecting of a traveling summer school.

The lecture-course in home economics covered a period of ten weeks. More than twenty women, expert in various subjects, gave the lectures; about forty registered students completed the full course, and many others attended as visitors. The purpose of the course was to awaken an interest in education for women along the line of home-making, and to enable us to study the entire field and to judge the questions involved. This survey has enabled us to arrive at conclusions as to the scope and nature of courses in home economics; and it confirms us all in the feeling that such a course should be a regular part of our work.

The traveling summer school of agriculture (which, so far as I know, is the first of its kind) is to consist of a body of students in charge of Professor Hunt, the members of which are to study agricultural practices that are not common to New York State. The party expects to have its own train. It plans to leave Ithaca late in June or early in July, extending the tour to Colorado, Texas, Louisiana, Mississippi, and the Atlantic coast States. Special attention will be given to ranching, stock-feeding, irrigation, rice, sugar-cane, cotton and tobacco. The trip is planned to occupy about eight weeks, and a credit of six hours may be given for the course.

The awakening interest in the College on the part of the people of the State is shown in the offering of scholarships. There are at present seven Grange scholarships, as explained in a later part of this report; and Mr. Harrison L. Beatty, of Bainbridge, Chenango county, also offers a scholarship of \$75.00 for the Winter-course to a properly qualified student from the town of Bainbridge.

REORGANIZATION OF THE COLLEGE.

The action of the Legislature in passing an act providing for the administration of the College of Agriculture and in making an appropriation for maintenance, raises the question of the proper organization of the College. At present the College is essentially unorganized, there being no well-marked subdivision of its varied and complex activities among its various officers.

It is first necessary to determine what the functions of a modern agricultural college are conceived to be. At first these institutions stood chiefly for education in the technical or occupational agricul-

tural subjects—concretely, with the problems of increasing the productiveness and profitableness of farming. Gradually, however, they have enlarged their scope to cover all the activities that are peculiar or applicable to the open country as distinguished from those that center mostly in the city, and to use these subjects broadly as a means of training men for life and for general citizenship. Not only must the productiveness of land be increased, but the ideals of living must be elevated and all rural institutions must be quickened. The modern agricultural college concerns itself with large public questions of education, trade, transportation, and general betterment, standing for all agencies that will aid in making the farmer a more efficient producer of wealth and a more effective citizen. In shorter words, the agricultural college stands for education for country life. It is not a professional college. These purposes are expressed in the Administration Act of our own College of Agriculture, signed by the Governor on the 12th of April, 1906:

“The object of said college of agriculture shall be to improve the agricultural methods of the state; to develop the agricultural resources of the state in the production of crops of all kinds, in the rearing and breeding of live-stock, in the manufacture of dairy and other products, in determining better methods of handling and marketing such products, and in other ways; and to increase intelligence and elevate the standards of living in the rural districts. For the attainment of these objects the college is authorized to give instruction in the sciences, arts and practices relating thereto, in such courses and in such manner as shall best serve the interests of the state; to conduct extensive work in disseminating agricultural knowledge throughout the state by means of experiments and demonstrations on farms and gardens, investigations of the economic and social status of agriculture, lectures, publication of bulletins and reports, and in such other ways as may be deemed advisable in the furtherance of the aforesaid objects; to make researches in the physical, chemical, biological and other problems of agriculture, the application of such investigations to the agriculture of New York, and the publication of the results thereof.”

In organizing such a college the keynote should be quality. It is gratifying to have a large number of students, for this indicates the public estimate of the work; but it is more important that every kind of work be unexcelled for truthfulness and effectiveness. We need several departments that are yet practically untouched; but there is greater need that all departments now established and projected be thoroughly officered and equipped.

The second step is to segregate the different fields of work, each field with its own organization. These fields are three: (1) college and university teaching; (2) extension work; (3) research and experiment. Each of these departments should have its own staff, devoting itself directly and consecutively to the problems within its field.

I. TEACHING.

So far as entrance requirements and other statutory matters go, the four years' course in the College of Agriculture is fully equivalent to that offered in the College of Arts and Sciences. It is expected that the equipment will soon be adequate to the working out of these ideals in the most thorough-going way in every department. In order to accomplish these ends, however, all students pursuing the regular courses must be of standard academic grade. This means that students who are unprepared to pursue any course of instruction must be cared for otherwise. Such students may enter as specials.

In all the great agricultural departments, as agronomy, horticulture, animal husbandry, in which mature judgment of affairs is needed, it should be the policy to place no class in full charge of an officer of the grade of instructor. Assistants and instructors should aid the professors, not have charge of classes on their own responsibility and in their own name. All these great departments, therefore, must be supplied with more than one professor—with as many professors, in fact, as the growth of the work demands; and every effort should be made to secure men strong enough to occupy full professorships. Every department should be strengthened with men until each man can devote his best energies to his own special work and until the department itself stands unexcelled.

High-grade collegiate work and high-class equipment lead naturally to postgraduate studies. In these studies the College of Agriculture at Cornell University should excel. Even at present, the number of students pursuing postgraduate and special advanced work exceeds forty, which is itself a larger body of students than is present in some agricultural institutions in all departments. About 15 per cent. of the students in the Graduate Department of Cornell University are prosecuting agricultural work. There is every reason why this work should be encouraged. In a short time, some of the officers must give practically all their time to postgraduate students;

and eventually it may be necessary to establish such work as a separate field or entity. It is for Cornell University to establish a standard for postgraduate study in agriculture, for there seems to be little understanding of what such work should be.

It may be useful to display the kinds of academic teaching which a really vital agricultural college should cover. While it is the purpose of such an institution to train men and women rather than to develop subjects, yet the subject-matter is the means of training, and the pursuit of it should have direct effect on the business of farming itself and on the meaning of country life. The primary or fundamental field in which a college of agriculture should operate, so far as subject-matter is concerned, is in increasing production. Before pursuing the special agricultural subjects, however, the student should be well grounded in fundamental subjects. Aside from studies developing self-expression (as language and drawing) the student should have training in such sciences as physics, chemistry, geology, biology, physiology, meteorology, climatology. Leaving out of count, in this discussion, the fundamental arts and sciences, the special classes of subjects that are related directly to production are as follows:

A—The crop-growing group; including:

- (1) Fertility of the land (agricultural chemistry, "Soils").
- (2) The breeding of plants.
- (3) The diseases and disabilities of plants.
- (4) Plans and practices in the growing and handling of kinds of crops (applications of agronomy, horticulture, and forestry).

B—The animal-growing group; including:

- (1) The feeding of animals.
- (2) The breeding of animals.
- (3) The diseases and ailments of animals.
- (4) Plans and practices in the rearing and handling of kinds of animals (including applications of collegiate departments known as animal husbandry, poultry husbandry, and the like).

Aside from these central and more or less technical agricultural subjects, there are other departments corollary to them or essential to an institution that stands for agriculture and country life in the broadest way. These other lines of teaching are as follows:

1. *Farm Mechanics and Machinery*.—The use of machinery has now come to be a permanent part of the equipment for good agriculture, and the kinds of machines are legion. The principles that are involved in farm machinery, and the practice, cannot be ade-

quately discussed in most colleges of mechanic arts or engineering, for such colleges have another and special point of view. Several of the colleges of agriculture are now developing departments of farm machinery. The subject needs emphasis in the East as well as in the West. In fact, it needs greater emphasis here; machinery has been developed mostly for easy conditions and large areas. It now needs to be developed for the more difficult and complex Eastern conditions. For the present, however, our own College of Agriculture cannot establish such a department, as the existing departments must first be fully equipped.

2. *Rural Engineering*.—Under this term are included such field engineering problems as have to do specially with agricultural enterprises, as surveying with reference to land measure, drainage, irrigation, road-making, water-supplies, and many of the lesser problems of bridge-building, traction development, and other construction. Nearly all the land of the country is to be in farms (using the word farm to include organized and managed forests), and the complete utilization of this land will demand the expenditure of much engineering skill. The engineer will probably contribute as much as any other man to the making of the ideal country life. Professional engineering subjects must be left to the technical engineering schools; but training must also be provided from the agricultural point of view and in connection with other agricultural studies. These agricultural engineering subjects are bound to multiply. Irrigation, for example, is not to be confined to arid regions; it must be added to humid regions not only to overcome the effect of drought but to cause the land to produce to its utmost. Irrigation for humid climates presents a special set of problems, for it must be intimately associated with drainage, and these problems are not yet thoroughly understood. The name "rural engineering" now appears in the curricula of some agricultural colleges. We cannot yet develop this range of work at Cornell.

3. *Rural Art*.—Almost from the first, the agricultural colleges have included landscape gardening in their curricula. In fact, they are the only institutions that have taught it. The subject is considered to be their special province. To this day there is only one professional school covering this field and that is recently organized at Harvard. At least twenty-two of the land-grant institutions are now giving instruction in these subjects.

As a country life and agricultural subject, landscape gardening (or landscape architecture) has to do primarily with the making of

the farm property (both the home and the farm) attractive and artistic. In a larger way, it has to do with the preserving and improving of natural scenery, with village improvement, and with the general elevation of taste. The artistic handling of ordinary farm properties must be left largely to the agricultural schools and colleges, because it cannot pay sufficient fees to warrant a professional man to undertake it; moreover, the desire for such handling must be aroused and fostered by educating the man who lives on the land. A good beginning in this outdoor art field has already been made at Cornell and the work should by all means be continued and extended. The entire farm area of the University should be laid out with reference to good taste, making it practically a rural park without in any way interfering with its agricultural utilization—in fact, such lay-out should increase its agricultural utility. This farm area should be organically a part of the entire University domain, campus and farm developing harmoniously and consistently along broad and correct artistic lines; and all this, in turn, should harmonize with the development of Ithaca and the adjoining country.

4. *Rural Architecture*.—Rural architecture is for the most part hopelessly inefficient and therefore hopelessly inartistic. Real farm architecture will not be handled by professional architects because there are no fees in it; and, as in the case of rural art in general, the public sense must be quickened. Moreover, the problems in farm architecture are essentially agricultural problems. This is particularly true of barns and stables. Practically, all barn buildings must be rebuilt on fundamentally new lines if farming is to be an efficient business. In the past, barns and stables have been built merely to house and protect produce and animals, rather than to accomplish certain definite progressive ends. The modern ideas of sanitation, whereby dust is to be eliminated, are revolutionizing stable construction, to say nothing of means of securing cleanliness in other ways, of ventilation, of sunlight, water-supplies, and other necessities. Probably the best ventilated buildings now constructed are the modern cow-stables.

5. *Technology and Manufacture*.—Several great departments or kinds of work will develop in this field. Dairy manufacture has already reached a very high degree of development in several agricultural colleges, including our own, and is completely established in the public confidence, although it was a doubtful innovation only a few years ago. This intelligent dairy manufacture has had an unmeasurable effect on dairy production and products. Therefore it

is not too much to expect that comparable results will follow in other lines of agricultural manufacture, particularly in the making of commercial products and the utilization of waste in the great fruit industries.

6. *Domestic and Personal Questions.*—The home as well as the land must be reached. The home questions are of two categories: the internal, comprising housekeeping and householding subjects; the external, in which the home is considered as part of the community in its relation to school, church, organizations, and various social questions. The farm home should be the ideal place in which to train boys and girls. It should be comfortable, attractive and sanitary. Human food should receive as much scientific attention as food for the farm animals. Woman's work should be alleviated and elevated. The work needs reorganization. Mechanical appliances must be brought to its aid. The miscellaneous activities that center about the home have been assembled into courses of study. These courses have received various collective names, none of which is good, because the subjects are miscellaneous and not capable of being closely welded. Of these names, I like "Home Economics" best. After giving much study to the general subject, I have come to the conclusion that we must have a course in home economics in the College of Agriculture (a beginning has already been made), but I doubt whether we should have a department of home economics. By this I mean to say that the different subjects comprising such a course should be taught by the various specialists in the University, the special home-making subjects now unprovided for to be handled by one or more special teachers, at least one of whom should preferably be a woman and have charge of the assembling of the instruction. This woman should be a specialist and should teach only in her specialty. All the work should be of positive collegiate or university grade, strictly comparable in every way with other college work, and be founded on good preparation in the fundamental sciences and arts.

7. *Economic and Social Subjects.*—The farm is a part of the community and commonwealth. The farmer is a part of society. These economic and social relations must be studied from the farm point of view. These subjects are practically untouched, although the terms "rural economics" and "rural sociology" are coming into the curricula of colleges of agriculture. We are establishing such work at Cornell, but it greatly needs extension. I am "professor of rural economy:" my assistant does the teaching. A large body of thought

and philosophy has been developed in these lines in Europe, particularly in Germany. These subjects are in many ways the most important that fall to the field of a college of agriculture. Economic and social questions are proper subjects to be taught in a college of agriculture, so far as they bear on rural questions. They must be founded, of course, on the study of sound principles as taught regularly in arts colleges. The application of them to country-life conditions is founded on agricultural thought and practice; and many of the questions are purely agricultural. Rural economics is as logically a part of our agricultural curriculum as is agricultural chemistry. The entire effort of a college of agriculture is devoted to the elevation of country living: that is, it eventuates into social and economic studies.

8. *Normal Department.*—It is devolving largely on the colleges of agriculture to revive and redirect the rural school. The schools must be made effective in their localities. We do not need new subjects in the schools so much as reorganization. Teachers must be trained for the new school, and a good part of the responsibility of training them must rest with the agricultural colleges, because these colleges are near the problem. The recent report of the Commission on Industrial and Technical Education for Massachusetts, under the chairmanship of Carroll D. Wright, proposes that a normal department be established in the Massachusetts Agricultural College to train teachers for the rural schools of that state; and a bill embodying this recommendation is now before the Massachusetts legislature. In our own case we already have the beginnings of normal work in the two-year special course in nature-study for teachers; the need of reorganizing and extending this department I consider to be urgent.

II. EXTENSION WORK.

The extension work comprises all those teaching enterprises that are not of academic kind and that aim to reach the people and their problems in the places where the problems are. It is capable of accomplishing great good. In fact, it is a question whether it is not the most needful just now of any agricultural teaching. It should be clearly separated from college work, with its own staff of experts trained especially for it. In this way it is not at all inconsistent with college efforts, but rather a supplement to them; and it need in no way detract from the efficiency and standing of academic teaching.

The extension department becomes a bureau of publicity. The extension enterprises fall into several categories, the leading ones of which are as follows:

1. *Special-Course Instruction.*—Here may perhaps be included various special courses in a college of agriculture, not founded on full entrance requirements and probably not of full college grade, designed for persons who have not had adequate school advantages or have not the time or opportunity for a full course and who want the work for its bona fide agricultural value. At Cornell, we allow such persons to enter the regular classes in the College of Agriculture; but this practice needs to be carefully re-studied both in the interest of the regular four-year student and of the special student himself. Whether the special student work, in our case, should be considered an extension enterprise will develop with the progress of the extension enterprise itself.

2. *Winter-Courses.*—In the present stage of our educational development and in the absence of any secondary schools that are prepared to do agricultural teaching, winter-courses or other very brief courses are a practical necessity. At Cornell we now provide five winter-courses: (1) general agriculture; (2) dairying; (3) poultry; (4) horticulture; (5) home economics. We need to make the winter-course work progressive so that a student may return for one or more winters. This will probably come about by equipping the general agriculture winter-course for all undifferentiated students, and advising students to return to pursue one of the special winter-courses, or possibly to enter the special-course.

3. *Extension Work by Students.*—Certain kinds of helpfulness can be carried into various parts of the State by students, particularly in the organizing of societies, reading-clubs, holding of meetings, and the like. Students may constitute very good advance agents if they are carefully chosen and are well guided. The students in the College of Agriculture are now engaged in this work in Tompkins County, which for the time being may be regarded as a laboratory and proving ground for certain extension enterprises. This movement may well be spread, and become a part of college extension work. New York State is the proper laboratory for the College of Agriculture.

4. *Reading-Courses.*—The chief object of a reading-course is to increase the reading habit to the end that the correspondent may read not only more reading-course literature but more good periodicals and books. A recent study of our own reading-course work

shows that such result is secured. Aside from this, a reading-course should set the reader straight on principles and should give him reliable information. It should not deal in news or discussion of events. A reading-course enterprise should also include the subject of travelling libraries.

Our own reading-courses are two, each with its special publication or bulletins. Five bulletins have been published in each course in the year 1905-6. It is expected that these bulletins (now numbering thirty in the Farmers' Course and twenty in the Women's Course) will conclude the regular serial publication of new issues of a bulletin character. It is the plan to keep these bulletins in stock for use in starting off new readers.

At May 1, 1906, the statistics of the reading-courses stand as follows:

1. Readers in Farmers' Reading-Course.....	6,593
Number of Clubs.....	44
2. Readers in Farmers' Wives' Reading-Course.....	20,237
Number of Clubs.....	46

5. *School Work*.—The rural schools must look largely to the colleges of agriculture for help and guidance. The normal department of such a college should have its extension bureau. The greatest problem in extension work at present is with the public schools. This is particularly true in New York State, following the adoption of the State syllabi for nature-study and agriculture. This College should aid in working out the syllabi in the schools of the State.

The present nature-study enterprise of the College of Agriculture falls under three heads, in the hands of three persons: gardens, by John W. Spencer; Junior Naturalist work, by Miss McCloskey; correspondence instruction for teachers, by Mrs. Comstock. Following are the statistics of this work, May 1, 1906:

1. Number of children registered as desiring to make gardens.....	28,168
Number of teachers registered.....	1,782
2. Children enrolled in Junior Naturalist Clubs.....	25,111
Number of Clubs.....	1,217
Number of children's letters read.....	15,064
3. Rural school teachers of New York State enrolled in correspondence on nature-study.....	849
Pupils enrolled in Clubs.....	129
Colleges and libraries enrolled.....	144

6. *Experiments and Demonstrations on Farms.*—It is now an accepted part of the work of an agricultural college to make demonstrations and tests on farms and in gardens. There are three purposes in this extension experiment work: (1) To illustrate or teach,—to instruct the co-operator in methods, to set him at the working out of his own problems, to bring him into touch with the latest discoveries and points of view. (2) To demonstrate or determine in various parts of the State the value or the inefficiency of various new theories and discoveries,—to determine how far these newer ideas are applicable to local conditions. (3) To discover new truth, which may be worthy of record in bulletins: this is usually the least of the results that follow from such experiments, because the experiments are not under perfect control nor continuously under the eye of a trained observer. This kind of teaching provides laboratory work for the farmer on his own farm.

In our own case the general plan of work is mutual or co-operative,—the farmer to provide land and labor and to have the crop, the expert to give advice and supervision and, so far as possible, to inspect the work. In some cases the College furnishes seeds and other materials. It does not furnish fertilizers. The benefit of the experiment or demonstration is expected to accrue mostly to the person on whose place the work is done.

We are rapidly approaching a turning-point in this demonstration work; we should either extend and deepen it, or consider a fundamental modification in the plan. This kind of work is no longer in its initiate stage.

The statistics of co-operative or demonstration experiments for 1905-06 are as follows:

Number of experiments in charge of department of agronomy.....	501
Number of persons experimenting, about.....	400
Number of experimental plats, about.....	1,150
Number of counties in which work was done.....	45
Number of experiments in charge of department of horticulture....	30
Number of experiments in charge of department of entomology....	15
Number of co-operative record-tests by poultry sub-department.....	125

There were also experiments of a similar kind conducted by the departments of agricultural chemistry and botany.

7. *Tests and Inspections.*—Various kinds of tests and inspections fall to the colleges of agriculture. One of the leading groups is the testing of milk for butter-fat in order to determine whether the cow is entitled to be recorded in the official registry of the breed. These tests are paid for by the breeders, or their associations, but the work

is performed by persons employed by the College of Agriculture. At the close of the official year last August, the department of animal husbandry had made 180 tests in the State of Holstein cows, for 85 owners. Tests were also made of Guernseys. At one time the department had 24 men employed in this work. The work for the present year will not be less.

As a part of its extension work, the department of dairy industry endeavors to come in close contact with a large number of butter-makers, cheese-makers, milk-shippers, and milk-producers. Last summer an officer of the department spent most of his time traveling in the State visiting persons engaged in dairy work, showing them where improvements might be made and frequently remaining with them long enough to put the suggestions into operation. This summer probably twice as much work will be done. We have many requests from former winter-course students and others to assist them when in difficulty with their dairy work. Sometimes the difficulty is bacterial infection, the source of which must be removed; sometimes it is inability to produce the particular kind of product required by the market; sometimes it is need of advice as to new building operations or repairs. A few of these requests are answered by a personal visit, but in most cases a detailed letter is sufficient. With the enlargement of facilities and personnel, we propose to undertake the thorough study of certain important problems in the State. One of these is the richness of milk as it is sold in different parts of the State. We are arranging to have a large number of samples sent from cities, towns, farms, restaurants, to be tested for fat-content. Information gathered in this way will be useful in studying the best method for sale of market milk, a question on which there is great diversity of opinion, yet one of great importance to the dairy interests as well as to the consuming public.

Gradually, similar work will develop in horticultural and other fields.

8. *Surveys*.—Certain industries and certain regions need to be studied as they actually present themselves, for the purpose of discovering their status and needs, to the end that suggestions may be made for betterment. Much of the first extension work of the College of Agriculture was of this kind, and several expository bulletins were published, as "Apricot Growing in Western New York" (No. 71); "Impressions of the Peach Industry in Western New York" (No. 74); "Some Grape Troubles of Western New York" (No. 76); "A Plum Scale in Western New York" (No. 83); "The

Recent Apple Failures of Western New York" (No. 84). Probably no publications of the College ever have been more in demand, and practically all these bulletins are now out of print.

At present, however, the greatest need is for a detailed survey of the condition of an industry in some special geographical region. Two publications have recently been made of such pieces of work; Bulletin 226, "An Apple Orchard Survey of Wayne County;" Bulletin 229, "An Apple Orchard Survey of Orleans County." A similar survey of Niagara County is in progress. We are now undertaking a general survey of the agricultural status of Tompkins County. This county is representative of a large area of hill country in the State, and the recommendations that result from the study are likely to have wide application. For this year, the inquiry will probably be confined to certain townships representing important soil types. A survey is also projected of the condition of certain stock interests in the central part of the State. The entire State needs detailed study in this spirit, the inquiries being closely correlated with studies of surface geology, climate, soil types, and with economic and social conditions.

9. *Inquiries in Economic and Social Questions.*—A natural corollary of an academic department of rural economy is the methodical study of the actual economic status of agriculture in the State and the social status of the agriculturist. A mailing-list should be more than a lot of names to which publications are to be sent. Every person who is the recipient of the publications of the College of Agriculture should give personal information that the College may use in studies of the agricultural status. A mailing-list, in other words, should carry certain specific information. It is necessary that we completely reorganize not only our mailing-lists themselves but the methods of making and handling them; with this reorganization it is intended that the cards contain facts that will be of service to the College. I expect to employ at least one person whose entire time shall be given to the mailing department and the collecting of data by means of it.

The mailing-list is only one of the agencies for the collecting of data bearing on economic and social questions. In time, colleges will make surveys expressly for the purpose of studying these phases.

10. *Co-operation with Organizations.*—Every organized agricultural interest should contribute to the general welfare in an edu-

ational way. Without in the least interfering with any organized effort (but rather aiding it), the College of Agriculture can be useful in co-operation. The College should have relation with every agricultural society and club, that it may study the educational features and spread them. This College now has such relation with the granges of the state (the membership of the State Grange is above 70,000 and is growing rapidly) and many other organizations; but lack of men and means seriously limits the work. The State Grange now provides six scholarships in the College of Agriculture. Stafford Grange (Genesee county) provides one scholarship. The fairs are, or should be, educational institutions. At some of the county and local fairs, as well as at the State fair, we are now interested in securing exhibits of children's work, and otherwise. The rural churches and the colleges of agriculture also should co-operate in many ways. Village improvement societies, women's clubs in villages and the open country, experiment clubs, and other organized bodies are all within the field of a college extension department.

11. *Organization of Extension Interests.*—A natural consequence of extension work will be some kind of an organization of the participants to concrete and forward it. In several states and in the province of Ontario, organizations have already been perfected, but so far they devote themselves to experiment work.

At Cornell, the Experimenters' League is a similar institution. The Agricultural Experimenters' League of New York was organized March 3, 1903, by students in the College of Agriculture. The constitution states that "The object of this League shall be: for the promotion of co-operative experiments in the various departments of farm husbandry; for the promotion of intercourse among those studying farm problems; for the advancement of agricultural education; for the collection and dissemination of data relating to country life; and for the purpose of supporting legislation favorable to the promotion of these objects." There are two classes of members, active and associate. Active membership (for which the fee is one dollar) is open to those who are residents of New York State who have been enrolled as students in Cornell University, or in any college or school of agriculture, or those professionally engaged in agricultural science. Associate membership (for which the annual fee is fifty cents) is open to others who desire to co-operate in the work of the League. Associate members have all the privileges of active members except holding office and voting for officers.

The membership of the League has been as follows:

	Active	Associate
1903	54	21
1904	44	10
1905	44	5
1906	53	24

This membership includes all those who have paid their dues each year. There have been 134 different men connected with the organization as active members and 50 as associate members. Several meetings were held in the winter of 1903 for the purpose of organization. Since that time three annual meetings have been held at the College. In addition to business, reports of experiments and addresses by agricultural workers have been given at these annual meetings. In time this League will no doubt find itself taking a field broader than its name. In fact, it should develop into an agricultural organization of the first magnitude and importance, meeting once each year at the College of Agriculture; and it should be a part of the extension work of the College.

12. *Lectures and Itinerant Schools.*— From the extension department of a college of agriculture should proceed lectures, institutes, conventions, and travelling schools that carry the educational impulse and the latest knowledge to the people, all in charge of persons who are specially trained for the work. The demand on teachers and experimenters for such work as this consumes much of their energy, makes serious inroads on time that is supposed to be devoted to other purposes, and often sacrifices the interests of students. On the other hand, a college of agriculture can not withdraw from the people and still be able to serve them. The travelling lecture work belongs to the extension department rather than to the academic department. When specially trained men are provided, the demand on other teachers and experimenters will not be felt seriously.

13. *Correspondence.*— As a result of all this effort in many fields, the correspondence assumes great proportions and becomes of unusual importance. The College of Agriculture now sends out about 60,000 letters a year. The College has ten type-writing machines, and as many operators; and extra help is employed when correspondence is very heavy.

14. *Publication.*— The publications of the New York State College of Agriculture in the extension department are of five kinds:

1. Junior Naturalist Monthly. For the year 1905-6, nine numbers have been issued (monthly for nine months), together with six supplements on gardens.

2. Four quarterly issues of the Home Nature-study Course, with seventeen supplements during the year.

3. Bulletins of the Farmers' Reading-Course (monthly from November to March):

- No. 26—Tasteful Farm Buildings.
- 27—Tasteful Farm Yards.
- 28—The Plan of the Farmhouse.
- 29—Water Supplies for Farm Residences.
- 30—Barns and Outbuildings.

4. Bulletins of the Farmers' Wives' Reading-Course (monthly from November to March):

- No. 16—Programs and Evenings with Farmers' Wives' Reading Clubs.
- 17—Flour and Bread.
- 18—Dust as Related to Food.
- 19—The Selection of Food.
- 20—Canning and Preserving.

5. Bulletins of the Experiment Station, recording the publishable data of the demonstrations and tests, as follows to May 1, from the beginning of the fiscal year, October 1, 1905 (other bulletins are prepared):

- No. 235—Co-operative Spraying Experiments.
- 236—The Blight Canker of Apple Trees.
- 237—Alfalfa.
- 238—Buckwheat.
- 239—Some Diseases of Beans.

III. RESEARCH.

In March, 1887, President Cleveland approved the Hatch Act, establishing an agricultural experiment station in every State and appropriating \$15,000 for the purpose. Nine-tenths of this fund, by the terms of the State law, comes to Cornell University for the establishing and maintaining of an experiment station. One-tenth is received by the New York State Experiment Station at Geneva, to enable that Station to secure the franking privilege on its publications. On March 16, 1906, President Roosevelt approved the Adams Bill, which, at the expiration of five years, will duplicate the amount received by each State for its experiment station. By concurrent resolution, the present legislature distributes this new fund on the same basis as the first fund.

In five years the fund accruing to the State College of Agriculture from the Federal government for experiment and investigation will amount to \$27,000 annually. This fund should be set aside sacredly for research on fundamental questions. The making of "tests" and "trials," the publication of mere advice and information, do not constitute research; these efforts belong to the extension work. The Experiment Station should have its own distinct organization. The academic department can do the teaching; the extension department can handle the daily problems and perform the educational work throughout the State; the Experiment Station can devote itself wholly to real investigation.

The sum of \$27,000 will not maintain a large experiment station; but the station can be thoroughly good as far as it goes. Either of two policies may be pursued: (1) several assistants may be employed as subordinate officers to the regular college departments, but devoting their time to the experiment station; or (2) a few mature men capable of occupying full chairs or departments, may be secured. I decidedly prefer the latter. At least half of the entire fund should be set aside for maintenance and publication, allowing perhaps four or five strong men to devote their lives to research. In the technical subject-matter, these men may be associated with the corresponding department in the college department. To one of these officers, I hope to delegate the responsibility of looking after, assembling, co-ordinating and publishing all research, experiment and demonstration work in the College, in whatever department it may be performed.

The investigational work is not now organized as an entity, though several lines of research are in progress. Three bulletins have been published so far from the federal funds within the fiscal year as follows (and others are in preparation):

No. 232 — Experiments on the Influence of Fertilizers upon the Yield of Timothy.

233 — Two New Shade-tree Pests.

234 — The Bronze Birch Borer.

An experiment station is not only directly valuable of itself, but it is essential to a modern college of agriculture. The discovery of knowledge affords the example and provides for the impetus that all teaching needs. Research can not be dissociated from teaching of a college and university grade. Only one of all the land-grant colleges lacks an experiment station, although in two or three others the

station is geographically removed. Of necessity, every teacher in a college of agriculture who keeps alive is an investigator; this investigation should be organized and the results published. The student catches the spirit of it, and develops a scientific habit of mind, taking nothing on authority but everything on evidence.

IV. THE MOST URGENT NEEDS OF THE COLLEGE OF AGRICULTURE.

The completion and equipment of the buildings of the College of Agriculture will by no means provide all the facilities that the College must have if it is to do its part in placing the agricultural interests of New York State where they ought to be. The complete equipment of a College of Agriculture is a direct investment in the interest of the people. It is not a gift to any institution or to any occupation. If the New York State College of Agriculture does not need more buildings and equipment, it will be because the College does not grow; and if it does not grow it will have small usefulness. At the very least, the College must be put on its feet, and the new buildings, large as they are, will not accomplish this. They will not accommodate all the students that will probably come the first year that they are ready for occupancy. The large auditorium will seat less than 600 persons. The laboratories will be over-crowded with 500 and more students pursuing many kinds of work. The College has not nearly reached its full growth; it is yet scarcely under way. I mention a few of the most urgent present needs.

The first need is for more land. The farm area is now approximately as follows:

Arable land	92 acres
Pasture land	94 "
Wood and waste land.....	50 "
Land about buildings, etc.....	4 "

240

This is not sufficient land, especially not sufficient tillage land, to support good herds, let alone the crops and experiment grounds that are essential. One farm should be devoted to research, free from encroachment of ordinary farm operations. Another should be devoted to orchards, of which we have practically none at present.

There must be barns. The best modern barn construction should be represented here. The present barn is wholly unsuited to the needs. It could very well be utilized, with remodeling, as an addi-

tional laboratory for mechanics and machinery. At least the following barn structures are needed: a central or administration barn; horse barn; dairy barns and other cattle barns; pig barn; sheep barns. The animal husbandry, which is of commanding importance to the State, cannot be developed until land and barns are provided.

A new set of poultry buildings should be provided.

Glass houses for the horticultural department, for investigations in agronomy and in entomology, are essential.

Live-stock must be secured if the College is to represent the State. Additional teaching force must be provided if we are to meet the needs and demands of the State. The College should have a summer session for teachers in the rural schools.

It must be remembered that we are now dealing with the problem of establishing an up-to-date college of agriculture from the ground up, not with merely supplementing or extending one that is already housed and equipped. In saying this I do not forget the good work of our predecessors, for if they had not persisted the present growth would be impossible. It is because of the good foundations they laid that the present superstructure can be erected, in a day when popular education is coming to its own.

I wish to express the sentiment of the members of the staff, and also my own, in appreciation of the way in which the people of the State and the officers who control the policy of the University have seconded our efforts to further the cause of agricultural education in New York State.

Respectfully submitted,

L. H. BAILEY,

Director of the College of Agriculture.

I. AGRONOMY

For the federal year ending June 30th and for the state year ending September 30, 1906, I have the honor to submit the following report:

I. TEACHING WORK.

The courses of study and the students pursuing them in the Department of Agronomy, including the allied courses in Soils and Field Engineering during the year 1905-6, have been as follows:

Soils 1, first term	98
Soils 2, second term	47
Soils 3, second term	24
Soils 5, first term	5
Agronomy 11, first term.....	53
Agronomy 12, second term.....	48
Agronomy 13, first term	12
Agronomy 14, second term.....	12
Agronomy 15, first term	15
Agronomy 15, second term.....	16
Agronomy 19, first term	25
Agronomy 19, second term.....	17
Field engineering 51, second term.....	64
Agronomy, Winter-Course	69
Post Graduates, first term (in residence).....	10
Post Graduates, second term (in residence).....	8

523

During the year the instruction in soils has been brought into more definite relation to the Department of Agronomy. Additional teaching force has enabled the addition and revision of the courses of study.

In order to make the laboratories accommodate a larger number of students, to make the schedule more elastic and to make the instruction more effective for both regular and special students, arrangements have been made to add some parallel courses; for example, Agronomy 1, 11 and 12 have been paralleled by Agronomy 101, 111 and 112. The regular four-year course students and the special students come to agronomy with somewhat different preparation and somewhat different aims. This differentiation in courses of study makes it possible to meet more effectively the needs of both classes of students.

Agronomy 16, Tropical Agriculture, has been added to the courses offered by the Department.

The aim has been also to make more useful and vital the course in Farm Practice. There are so many necessary limitations in a course of this sort that it has been impossible to realize our ideal, but it is believed that some progress is being made.

A rather important departure has been made in the selection of a non-resident lecturer to give a special and continuous course of lectures. Dr. Jacob G. Lipman, Soil Chemist and Bacteriologist of the New Jersey Agricultural Experiment Station, New Brunswick, N. J., has been engaged to give a series of ten lectures on soil bacteriology to students of the Department of Agronomy.

In my last report I discussed at some length the aims, facilities and needs of the Department of Agronomy and the relation of the several farms in connection therewith, which need not be repeated here. At this time, however, I wish to refer to the present need for barns for the work of the College of Agriculture, especially for the development of work in Animal Husbandry. I have already placed in your hands a sketch for a set of farm buildings comprising administration barn, which would include the horses; and cattle barn, which would make provision for milch cows, breeding stock and beef cattle, and contain storage for hay, grain, roots and silage; a sheep barn; and a piggery. The plan contemplates placing the administration barn, the cattle barn and the sheep barn in rather close proximity, so arranged that the manure can be conveyed readily to a manure shed, while the piggery would be placed some distance from the other buildings. It is recommended that this set of buildings be placed south and east of the University filtration plant.

A pressing need of the Department of Agronomy at this time is a set of glass houses for the purpose of carrying on instruction and experiments with growing plants during the college year. From the first of November to the first of April there is very little outdoor growth at Ithaca, and, therefore, very little instruction can be given or experiments made upon the growth of plants except under cover. The present demand for space has entirely outgrown the small house connected with the insectary. It is recommended that three glass houses be built, each 60 x 20 feet; one for experiment station work, one for advanced and post graduate students, and one for the elementary instruction. These three could be placed side by side and connected at one end with a potting shed about 30 x 40 feet. It is recommended that these houses be placed north of the new agronomy

building at sufficient distance to allow the addition of a wing to the agronomy building at some future time and not have this interfere with the light in the glass houses. It is also recommended that that portion of the area north of the model rural school building which is not needed for school garden work be suitably fenced and assigned to the Department of Agronomy for some special research work which Professor Lyon desires to conduct. The Department of Agronomy also wishes to use all of the land lying between the dairy and judging pavilion and the filtration plant, and between the poultry yard and the new athletic field for the growing of various crops for student instruction and for use by students in carrying out their thesis work. This area should be strongly and suitably fenced.

During the year I placed in your hands an estimate for the reshingling and repainting of what is known as the North University barn. This building is greatly in need of repairs indicated in the estimate submitted and are only such as are essential to its preservation.

II. FEDERAL EXPERIMENT STATION WORK.

As outlined in a former report, the policy of the Department of Agronomy during the past three years has been to direct its investigations towards (1) the improvement of the grasses and forage crops and the determination of the best methods of culture and fertilizing in the climate and soils of New York State, and (2) the investigation of the best and most economical forms of concentrates with which to supplement the grasses and other forage crops which this State raises in relative abundance. In the carrying out of this policy the following experiments have been conducted during the past year, a number of them every year during the past three years and most of them will be continued or repeated next year.

	Year begun
Timothy, individual plants.....	1903
Root Crops, 1904.	
Clover, individual plants.....	1906
Root crops, early planted, 1905.	
Alfalfa and timothy, soil solution.....	1906
Soil fertility, poor spots.....	1906
Alfalfa inoculation	1906
Weeds affecting corn.....	1906
Root crops, field trials.....	1905
Student corn.....	1904
Potato rotation.....	1905
Potato varieties.	
Grasses, varieties.....	1904

	Year begun
Timothy, rate of seeding.....	1904
Timothy, fertilizer treatment.....	1904
Timothy, size of seed.....	1904
Alfalfa, lime and inoculation.....	1904
Timothy selection	1905
Timothy selected for vigor question.....	1904
Root crops, selection of mother cabbages.....	1906
Do, mangel.	1906
Root crops.	1906
Root crops, late planted.....	1905
Alfalfa inoculated and fertilization.....	1905
Corn, varieties	1905

As you well know the field expenses of these investigations have been paid for principally out of appropriations made by the Board of Trustees from their general funds, the appropriation available from the Federal fund being entirely inadequate for this purpose. Unless otherwise directed it will be the policy of this Department to pay the field expenses of these experiments largely out of State funds set aside for the maintenance of the Department of Agronomy.

During the past three years certain investigations have been in progress in the Department of Agronomy in connection with the Department of Agricultural Chemistry, which have sought to determine what are the differences in the essential factors of plant growth, under normal field conditions caused by different methods of fertilization and different cultural methods. Last winter the Department also had the assistance of the U. S. Bureau of Soils through a detail of men who worked upon certain phases of this problem. The investigations thus far made have led to some important suggestions. It is now the purpose of Dr. Lyon to conduct a series of field and laboratory researches upon these fundamental questions. The nature of these investigations is indicated in the following titles, viz.: (1) to study methods for determining the fertilizer requirements of soils; (2) an examination of soil solutions under different methods of soil treatment; (3) inquiry into certain soil conditions detrimental to crop production. At present Dr. Lyon has no laboratory in which to conduct the laboratory side of these investigations. It is proposed as soon as the new agronomy building is ready, to use \$500 to \$800 of the \$1,500 set aside from the Federal fund for the maintenance of the investigations in agronomy in equipping a laboratory and conducting the experiments outlined by Dr. Lyon.

During the year there has been constructed on the experimental grounds at the Mitchell farm a small bungalow for the use of those having charge of field experiments. This structure is looked upon only as a temporary affair. As soon as the policy is settled as to the place of field experiments an adequate field laboratory should be constructed for those in charge of the field work. This should be a plain brick structure, two stories high, the first story having cement floor and containing apparatus for the threshing and weighing of seeds, grains and other products of the experiment plats; suitable accommodation for such tools as may be necessary for the daily prosecution of the field work; and a suitable place where the field men can write up their daily notes: while the second floor should be arranged for the storage of experimental materials that it is necessary to keep from year to year.

The following bulletins have been prepared by the Department of Agronomy during the year:

Bulletin 237, Alfalfa, Report of Progress.

Bulletin 238, Buckwheat.

Bulletin 241, Second Report on the Influence of Fertilizers on the Yield of Timothy Hay.

Farmer's Reading-Course Bul. Series VI, 30, Barns and Outbuildings.

III. THE EXTENSION WORK.

The co-operative experiments in agronomy have been carried on during the past year along the lines heretofore announced. It is never possible at this time of the year to summarize fully the results of the year immediately preceding. The co-operative work with alfalfa for the year 1905 has been summarized and published in Bulletin No. 237 of the Cornell Experiment Station. A few of the features of the present year may be mentioned. The new liquid method of preparing and distributing cultures by the United States Department of Agriculture has been compared with soil. Liquid cultures for alfalfa were sent to 59 experimenters, for soy beans and other legumes to 21; alfalfa soil was sent to 20 experimenters and soy bean soil to 7. The reports from these experimenters indicate briefly that in a few instances cultures seem to have produced an increase in the abundance of nodules and in still fewer cases in the vigor of the plants, but usually no result whatever was obtained from the use of cultures. Dressings of soil uniformly produced an abundance of nodules and almost always increased vigor of plants.

The following table shows the character of the co-operative experiments and the number of experiments arranged by Professor Stone during 1906:

Alfalfa	75
Oats	45
Fertilizers	11
Potatoes	157
Potato cultures	6
Sunflowers	14
Soy beans and other legumes	30
Beans	34
Buckwheat	16
Vetch	7
Weeds	66
Lime	8
Meadows	16
Dwarf milo	13
Millet	10
Total	508

About 300 different persons located in 55 different counties co-operated in these experiments.

Two important objects in the co-operative experiments have been (1) to gain information in regard to the soil and crops under experiment, and (2) to extend the educational influence of the experiments to the farmers who are doing the work or to their neighbors who observe them. Heretofore the second of these objects has received the greatest emphasis. It is now believed that the time has come when more emphasis should be placed upon the research rather than the educational aspect of the work. This does not mean that a less number of experiments of the ordinary co-operative type should be conducted, but that more experiments should be conducted in different parts of the State which are directly under the supervision of the College of Agriculture. Many problems will require a thorough investigation which cannot be carried out here at the Experiment Station because of local conditions. In making up the list of suggested experiments for the coming year, Dr. Warren has divided them into two categories, viz., investigations and co-operative experiments. The list of experiments to be conducted under each head is given below.

A. INVESTIGATIONS:

1. A study in the growth of clovers and alfalfa on volusia loam.
2. The influence of fertilizers and manure on the economic production of timothy hay.

B. CO-OPERATIVE EXPERIMENTS :

3. Renewal of pastures without plowing
4. Meadows, same as 3.
5. Similar to 2.
6. Trial of meadow fescue.
7. Alfalfa, use soil and manure on all.
 - (a) Lime and no lime.
 - (b) Inoculation.
 - (c) And clover mixed.
 - (d) Seed in grain and after grain and after tillage only.
8. Vetch and rye.
9. Vetch in corn.
10. Soy beans in corn.
11. Soy beans alone.
12. Peas and oats for hay and soiling.
13. Oat variety test.
14. Wheat variety test.
15. Field bean variety test.
16. Potato variety test.
17. Buckwheat variety test.
18. Buckwheat mixed variety test.
19. Buckwheat cultural test.
20. Potato cultural test.
21. Value of sunflower in silage.
22. Spraying for wild mustard.
23. Test of soil with litmus and lime.
24. Fertilizer trial any crop.
25. Profit or loss in growing any crop.
26. Farm labor.
27. Use of more horse power on farms and other labor saving devices.
28. Corn breeding.
29. Potato breeding.
30. Breeding any other farm crop.

IV. PERSONNEL.

On May 1, 1906, Professor Samuel Fraser, Assistant Agronomist, resigned to accept a position of greater responsibility. Professor Fraser is a man of wide knowledge, a careful observer, and a thorough investigator. Mr. Charles F. Clark, a graduate of the University of Vermont, and a post graduate student with his major in agronomy at Cornell, has been elected to succeed him.

Professor T. L. Lyon was elected Professor of Experimental Agronomy and entered upon his duties the first of September, 1906.

Professor Elmer O. Pippin, who had heretofore been detailed by the Bureau of Soils to give instruction at Cornell, was elected Assist-

ant Professor of Agronomy with special reference to Soils, and entered upon his duties under the new arrangement October 1st.

Professor George F. Warren, Horticulturist of the New Jersey Experiment Station, was elected Assistant Professor of Agronomy and began his duties on October 1st.

These additions to the Department of Agronomy have made it possible to readjust the work of the Department. Professor Lyon is to devote his time to research work and is to have general supervision of the work in soils. He is not to teach classes, but may receive post graduate students. Professor Fippin is to have immediate charge of the undergraduate instruction in soils. Professor John W. Gilmore, who has been promoted from the position of Instructor in Agronomy to that of Assistant Professor of Agronomy, is to continue in charge of the experimental work along the line of crop improvement and has been placed in immediate charge of some of the undergraduate classes in the Department. In order that Professor Gilmore may give more time to the work of instruction and research, he has been relieved of the business management of the farm, which has been placed in charge of Professor Stone. Professor Stone has been placed in charge of the instruction in Farm Practice, has been definitely assigned to the care of the students in the Winter-Course in General Agriculture, and will continue to give the instruction in agronomy to the Winter-Course students. In order that he may have time for these new duties he has been relieved of the extension work which has been placed in the hands of Professor Warren, whose recommendations I have incorporated in this report.

I am glad of this opportunity to testify again to the energy and devotion to duty as well as the personal co-operation received from every member of the staff of the Department of Agronomy.

THOMAS F. HUNT,

Professor of Agronomy.

II. ANIMAL HUSBANDRY.

I submit herewith a report of the Department of Animal Husbandry for the year from July 1, 1905, to June 30, 1906.

I. TEACHING.

During the College year 1905-1906, instruction in Animal Husbandry was offered in five distinct courses and in Poultry Husbandry in seven courses. The details of the latter will be found in the accompanying report of Professor Rice. In the courses in Animal Husbandry proper, the registration was as follows:

	First term.	Second term.
Course 31, General course in animal husbandry.....	63	52
Course 32, Advanced course in animal husbandry.....	14	8
Course 34, Advanced course in animal mechanics.....		35
Course 35, Practice course in feeding and stable management		4
Course 36, Elementary animal husbandry, given only to students in the Veterinary College.....	16	
	93	99
Total		

In addition, instruction was given to Winter-Course students, as follows:

In breeds and breeding.....	49
In feeds and feeding.....	149
In special lectures to poultry course.....	23
	221
Total	

Making a grand total of 313 students for one term.

The work of instruction was carried on fairly successfully, and the records made by the students were exceptionally good when it is considered that the work was very much hampered by enforced removal from the old dairy building at the end of the Easter Recess. On account of being unable to secure any accommodation elsewhere, a part of the work usually given to students in Course 31 was necessarily omitted.

With the growing numbers in courses in Animal Husbandry, the need of additions to the teaching force is more and more felt, and an additional instructor is necessary if the work is to be maintained at its present grade, to say nothing of development. The courses offered in Animal Husbandry should be amplified and extended so as to give opportunity not only for a larger amount of work in this subject, but for specialization in various directions. Aside from the teaching force, additional equipment in the way of class room material and particularly in the line of additional live stock must also be provided in the near future, and this calls for additional land, and particularly for new and modern barns and stables. With the larger number of students coming to us from a wide range of territory, it becomes imperative to have at hand a much wider variety of live stock for illustrative and educational purposes than we have ever had. We should at least double the number of breeds now represented in our cattle, sheep and swine, before the equipment can be considered at all adequate, and the number of representatives of each breed should also be largely increased. An adequate equipment in live stock would call for the maintenance of at least 150 cattle, an equal number of sheep, and from 30 to 50 breeding swine. The College should also have good representative specimens of the various types of horses, not only for the sake of performing the necessary labor upon the farm, but for class room use with the students. It is hardly necessary to mention that this branch of the live stock has been entirely neglected for a good many years, and not only is the present stock of horses entirely useless, from an instructional standpoint, but is entirely inadequate to perform the necessary labor upon the farm. The College could profitably use at least 20 horses.

II. EXTENSION WORK.

While a few lectures have been given before farmers' meetings, the greater part of the effort along the line of agricultural extension has been in the supervision of the records of pure bred cattle for owners of several of the leading dairy breeds. This work, beginning in 1894 when only two records were supervised, has steadily grown in amount and in appreciation of its usefulness by owners and breeders. During the year, records of cows belonging to five breeds, namely, Holstein, Jersey, Guernsey, Brown Swiss and Ayrshire, were supervised by representatives of the College. The amount of this work is indicated by the following tabulation;

For breeders of Holstein-Friesian cattle.

Records of 866 cows for 7 days.

Records of 54 cows for 14 days.

Records of 8 cows for 21 days.

Records of 63 cows for 30 days.

Records of 2 cows for 60 days.

Records of 1 cow for 182½ days.

These cows were owned by about 100 different individuals and firms, nearly all of which were in the State of New York.

For breeders of Jersey cattle.

Records of 3 cows for 7 days.

Periodical supervision of 5 cows once each month for 2 days at a time.

These cows belonged to 3 different breeders.

For breeders of Brown Swiss cattle.

Records of 1 cow for 7 days.

Records of 1 cow for 30 days.

Periodical supervision of 2 cows once each month for 1 day at a time.

These cows belonged to one breeder.

For breeders of Guernsey cattle.

Periodical supervision of 64 cows once each month for 1 day at a time.

These cows belonged to 12 different breeders.

For breeders of Ayrshire cattle.

Records of 2 cows for 7 days.

These cows belonged to one breeder.

The expense of this work is largely borne by the breeders, they paying all traveling expenses and per diem of the representatives of the College. During the past year the constant services of about a dozen men were required, except during the months of July and August, while at the height of the season, in the late winter and early spring, as many as twenty-five men were employed. The supervision of these men in the field and the checking of their reports entails considerable work upon the office force of the Department. The College also furnishes the necessary equipment, which, where so many men are employed, is considerable. But the usefulness of the work in stimulating greater interest in selecting, breeding and developing cattle, and its appreciation by the breeders during the past twelve years, leads us to believe that it is probably as useful a form of extension work as could demand our attention and activities.

III. EXPERIMENTATION.

During the year, investigations that have been carried on for several years along the line of beef, mutton and pork production, have been continued as opportunity offered, and a mass of data is being accumulated which will warrant publication some time in the future. In the meantime, every available opportunity is utilized to make additions to the general mass. But the demands upon the time of the staff of the Department for teaching and extension work, have been so great as to preclude very much attention being given toward experimentation.

H. H. WING,
Professor of Animal Husbandry.

IIa. SUB-DEPARTMENT OF POULTRY HUSBANDRY.

I submit the following report of the work of the sub-department of poultry husbandry for the year estimated as ending December 1st.

The activities of this department are five-fold. They have to do with: First, administration; second, instruction; third, investigation; fourth, correspondence; fifth, extension.

I. ADMINISTRATION.

During the past year the stock, buildings, and equipment of the Poultry Department have been materially increased. There has been expended for scientific apparatus, primarily for investigational purposes, approximately \$300. For equipments for instructional purposes, approximately \$300. For permanent improvements, approximately \$500. The latter includes nine New York State gasoline heated colony houses, three summer houses, and a laying house. Many important improvements to existing buildings have also been made.

The plant, as now arranged, comprises forty-nine pens and the main poultry building, having a total capacity for wintering 1,000 head of poultry and for rearing 2,000 chickens annually. With this capacity we can give instruction in pen practice to thirty students at one time without interfering with the regular experiments now under way. We can also provide instruction to thirty students at one time in incubator practice, although in doing this they are much crowded. This increase in capacity for giving instruction, however, is not sufficient to meet the demands of the present year.

In order thoroughly to systematize the business end of the poultry department and to thereby give an accurate and comprehensive account each week and month of the expenditures and incomes, a system of records has been worked out and is now in active use. A copy of each of these forms is here appended, which show at the end of each day the condition of the cash transactions and of the inventory, and gives an account of all stock bought, sold, or which has died, all feed purchased or fed, all eggs used for market or incubators, all equipments purchased or destroyed, etc. The successful

working out of this system entails much careful attention to detail but it is worth while and has never, until this year, been possible to accomplish.

The gross sales during the past twelve months were \$1,330.50.

The present estimated value of the poultry plant and equipment are: stock, 1,291 head, value, \$1,500; equipments, value, \$2,500; buildings, etc., value, \$1,500; total value, \$5,550.

II. INSTRUCTION.

Seven courses of instruction are now offered in poultry husbandry. The first, second, third and fourth courses (see courses 37, 33a, 33b, 33c, general announcement 1906-07) are given to regular and special students throughout the college year. The fifth is a special winter course of twelve weeks, covering practically the same field as courses one, two, three and four. The sixth is an advanced course for students who have completed courses one, two, three and four, or course five, and is intended to give students an opportunity to specialize in poultry husbandry and to do original research work in order to fit themselves for positions of responsibility in charge of large commercial poultry plants or poultry departments at the Agricultural Colleges and Experiment Stations. The seventh is a special course of twenty-four lectures given to students who elect poultry husbandry from the various winter-courses.

The lecture course, 37 (two hours per week), should be made a three hour course in order to better cover the subject and to give opportunity for recitation periods now not given.

The afternoon practice course, 33a, now given two afternoons per week up to December 6th and after February 27th (credit one hour per term), should be continued during the entire year and should be made a two hour course. The present arrangement is unsatisfactory and unfair but is made necessary because of lack of help, laboratory room, and equipments to carry on the course while the winter poultry course is in progress.

A practice course of one afternoon per week should be given in connection with the lecture course (No. 7) to the winter-course students, not in the poultry course, who elect poultry husbandry, not now provided because of lack of facilities, etc., as above.

The following table shows the number of students who have elected poultry husbandry each year, the courses which they have taken, and the total number of hours of instruction given:

REGISTRATION IN POULTRY HUSBANDRY IN CORNELL UNIVERSITY.

	1903-4 1st year	1904-5 2nd year	1905-6 3rd year	1906-7 1st half year *
Total number of students registered,				
Course 37	27	53	55	77*
Afternoon practice, 38a.	22	31	42	28*
Morning, Noon and Night, 38b.	3	16	29	14*
Seminary (Advance Course) 39.	0	7	14	17*
Post graduates for M. S. degree minor subject	0	0	1	0*
Seniors—Thesis	0	0	2	3*
One year specials in poultry husbandry.	0	0	3	1*
Total number of students registered in the one year courses	27	60	71	93*
Total number of hours University credit in the one year courses.	79	173	229	251*
Winter-course.	0	17	35	†
Electing poultry husbandry from the other Winter-courses	30	30	41	not avail.
Total number of students taking some form of poultry instruction at one time.	57	107	152	not avail.

There are to date, November 22, 1906, 52 signed applications for the winter poultry course to be compared with 18 which had been received last year on the same date. It is certain that we will be unable to accommodate all who apply.

The large increase in attendance is due to three contributory causes. First, the scarcity and the newness of schools where instruction in poultry husbandry can be obtained. Second, to the exceptionally attractive opportunities offered to persons who complete a thorough poultry course. Third, to the high regard in which Cornell University and the New York State College of Agriculture are held, throughout the country. The wide range of residence of the students who take the winter poultry course, confirms the accuracy of the above statement. Of the students who have taken the winter-course or who have signed applications for the present year, there were, in 1905, 13 from New York State, 4 from other states. In 1906, 25 from New York State, 10 from other states. In 1907, 37 signed applications to date from New York State, 15 from other states. The different states represented above are: Conn., 1; D. C., 1; Ind., 1; Ia., 1; Mass., 5; Md., 3; Me., 1; Minn., 3; Miss., 2; N. J., 3; Ohio, 1; Pa., 3; Utah, 1; Va., 1; Wis., 2.

† Not available. 52 signed applications.

We are unable to meet the demand for students to fill positions of responsibility. Since January 1, 1906, there have been 65 requests for men to accept positions as poultrymen, many of which are now on the waiting list. Many of the requests for poultrymen came from agricultural colleges and experiment stations, thus showing the awakening interest in the subject of instruction and investigation in poultry husbandry throughout the country.

During the past year the following Cornell men have accepted positions in poultry departments in connection with colleges or experiment stations:

J. G. Halpin, B. S. A., 1905, Instructor in Poultry Husbandry, Michigan Agricultural College.

H. C. Pierce, 1907, Instructor in Poultry Husbandry, Iowa Agricultural College.

C. L. Opperman, Special 1905, Assistant in Poultry Husbandry, Iowa Agricultural College.

F. G. Thayer, Special 1905, Assistant in Poultry Husbandry, Sub-Experiment Station, Minn.

R. R. Slocum, 1906, Poultryman in Bureau of Animal Industry, Washington, D. C. (Civil Service appointment).

R. C. Lawry, Special 1905, Instructor in Poultry Husbandry, Cornell University.

C. A. Rogers, 1905, Assistant in Poultry Husbandry, Cornell University.

II. INVESTIGATION.

During the years 1904-05-06, thirty-nine separate investigations have been conducted or are now in progress, which may be classified as follows:

7 incubation, 13 feeding fowls, 6 breeding poultry, 4 fattening poultry, 5 poultry buildings, and 4 rearing chickens.

The work of investigation has been completely separated recently, from the work of instruction, in order that both might be made more effective and efficient. In order to bring this about, the investigational work is divided into two classes. First, the investigation intended for student instruction, and second, the investigation not intended for student instruction. Each are of equal importance and both are absolutely necessary to an efficient poultry department. The former is necessary for student inspiration and development and may also be made to furnish accurate data worthy of publication. The latter is necessary in order to insure absolute accuracy and to

carry out investigations requiring close application. Persons engaged in instruction and in student investigation have absolutely nothing to do with regular experiments in progress, and the persons responsible for the latter, have nothing to do with instruction or student investigation.

An attempt has been made to bring about uniformity, completeness, and accuracy in all experiment work and instructional work. To this end a blank form has been devised and adopted which is used alike by all persons in pen practice, student investigation, or regular experiment. It will be seen that this system provides for once a week reports and continuous posting of results on a single sheet. Posting and reports are rigidly required of all persons. By this system, the instructor, the students, or a visitor can tell at a glance the results accomplished at any particular time. As a necessary accompaniment of the above system, zinc plates are being prepared to be placed on each of the 49 pens, each giving the number of the pen, kind of fowl, nature of experiment, and person in charge. For example:

Pen No. 3.
Student investigation No. 29 C.
"Forcing versus Retarding Pullets."
This pen forced. Wet mash.
In charge of Clara Nixon.

By this means any person will be enabled to know the nature of the experiment in progress. The person in charge will have the added incentive to greater neatness and accuracy owing to the fact that either responsibility for carelessness or credit for good work will be publicly and specifically placed on the person in charge.

III. CORRESPONDENCE.

The correspondence is large and rapidly increasing. A record of the letters answered from this office from April 12, 1905, to April 12, 1906, shows that 2,336 letters were received and answered, an average of 6.4 letters per day for the year. A record kept for five weeks from April 7th to May 12, 1906, shows that 298 letters were received and answered, an average of 8.5 per day. The relative average increase per day for the five weeks above as compared with the daily average per year would be 2.1 letters per day. The correspondence from October 29, 1906, to November 22, 1906, shows 245 letters written, or an average of 11 letters per day, an increase of $2\frac{1}{2}$ letters per day since May 12, 1906. 43% of all the correspondence is with persons outside of the State and 41% of the

requests for information or publications are from outside New York State. This, like the large proportion of students from other states coming to us for instruction, is due to the dearth of information on poultry husbandry available in other state agricultural colleges. With the publication of several poultry bulletins which will soon be ready for the press, the correspondence will necessarily be materially increased. It is interesting to note the nature of the correspondence. Of the 298 letters above mentioned, 97 asked for specific information, 46 were in regard to positions, 21 were of a business nature, 21 requested poultry publications, 18 had to do with co-operative experiments in poultry husbandry, 16 sought information about the poultry courses, 79 were of a general miscellaneous nature on a large variety of subjects, difficult to classify.

IV. EXTENSION WORK.

The extension work is carried on through several avenues of reaching the people as follows:

(a) The reading courses, although under the direct charge of the extension department, calls for frequent and sometimes lengthy interviews from that officer in order that he may meet the inquiries for technical information.

(b) Co-operative experiments. 152 persons in New York State have kept some form of record of their "incubators" or "feed and production" records of their flocks or "mortality records" of their chickens. This work is capable of indefinite extension and should result in much good, but with the present force it has been impossible to do justice to the persons who have co-operated with us.

(c) By lectures at poultry institutes, farmers' institutes, meetings of poultry associations, granges, etc. The demand for this outside teaching is increasing far more rapidly than we are able to meet it. Eight requests from outside this State, several from within the State, for the months of November and December, 1906, have had to be declined owing to press of work at the College. Fifteen meetings were attended last year in this State. We should not only be able to send a speaker to meet all these requests from within the State, but should arrange a definite schedule of lectures providing at least one lecture each year before every poultry association within the State.

(d) By educational exhibits at the State and county fairs. The first attempt was made last year and repeated this year at the Tompkins county fair and last year at the New York State Breeders' Association, and also this year at the New York State fair. The

good results which followed from the exhibit of models, charts, etc., are apparent from the interest shown by visitors at the fairs and the number of persons who gave their names for publications and the correspondence which followed. They would abundantly justify a continuation of this means of reaching the poultrymen of the State. Approximately, 212 persons signed cards requesting the publications at the New York State Breeders' Association, 159 at the New York State fair, and 50 at the Tompkins County fair.

(c) Receiving visitors. A large number of visitors from this and other states and countries do us the honor each year of inspecting the poultry plant. To give them cheerful, painstaking attention is our privilege and our duty, and it is also a most fruitful source of consumption of time which some one must supply.

GENERAL RECOMMENDATIONS.

If the poultry department is to continue to grow as it has in the past, it will be necessary to provide more land, more help, more buildings and more equipments. The growing demand for instruction in poultry husbandry, both in the long and short courses, and the pressing need for experiment and research to solve the many perplexing problems confronting poultrymen, will justify the expense. If the demand is met, it will be giving to the large poultry interests of the State only what already has been too long withheld. In view of the above I would recommend the following improvements to be made in the near future:

1. In order to separate more completely the instructional from the investigational work, a separate poultry plant should be established on land easily accessible to the University. The present plant should then be used wholly for instructional purposes. For the experiment plant there should be not less than 20 acres and buildings to accommodate not less than 1,000 fowls and provide a general feed and supply room with dormitory facilities.

2. It is apparent that the three laying houses now south of the road, will have to be removed. I would recommend that they, together with the three old poultry buildings north of the road, be torn down and the materials, in so far as possible, be used in reconstructing the poultry plant.

3. A new building consisting of 28 pens, each 12 x 12, should be constructed, connecting the main building with the new poultry house now in process of erection and shown on accompanying plans, which also show an arrangement of walks, roadway, etc. This

house should be built primarily for instructional purposes. It could be built, including fences, for approximately \$2,000, including labor. This would accommodate 30 students at one time. Another building similar to this and extending parallel to it should be located at the north end of the present poultry yards.

4. A large winter brooder house should be built. At present we have no means for giving the winter-course students instruction in brooding. The New York State gasoline type of colony brooder house with which we now rear our chickens is not adapted to mid-winter use, therefore there should be built a modern brooder house, heated by hot water and fitted with not less than 50 individual brooders. This would cost in the neighborhood of \$2,000. The need for this building is made more urgent on account of the earlier opening of the winter-course which makes it necessary to rear chickens under mid-winter conditions.

5. All of the poultry buildings should be painted to match and harmonize with the new College of Agriculture, and plantings made to harmonize artistically with the surroundings.

6. We have outgrown every room in the poultry building.

A lecture room large enough to seat at least 100 students, and a laboratory room large enough to accommodate from 50 to 60 students, should be provided in some of the buildings in the New York State College of Agriculture or elsewhere. The old judging pavilion, if properly fitted, could be used for the above purpose temporarily, by putting in a floor and heating by steam from the college heating plant and also lighting by electricity.

The poultry building should be fitted with electric lights and also steam heat from the college system. The present method of lighting by many lamps and heating by five stoves, increases fire risks, causes dirt, extra expense, and inconvenience. An entrance with porch should be built on the west end of this building, permitting entrance to the basement and to the first floor in order to relieve congestion at the south entrance.

It would take approximately \$10,000 to construct the buildings and make the other improvements to meet the immediate needs of the sub-department of poultry husbandry.

Heartly appreciation is felt by all who are connected with the sub-department of poultry husbandry and poultrymen generally, for the personal interest shown and cordial support given by the Dean of the College of Agriculture and others who are in authority.

JAMES E. RICE,

Assistant Professor of Poultry Husbandry.

III. HORTICULTURE.

I present a report of the progress of work in the Department of Horticulture, covering educational and investigational efforts for the year just closed:

I. GENERAL REMARKS.

The year's work in the Department of Horticulture may be regarded as expressing a satisfactory amount of growth along investigational and educational lines under existing conditions. An important addition to the teaching staff of the Department has been made by the appointment of Mr. L. B. Judson as Assistant Professor of Horticulture. Professor Judson takes charge of two important courses, practical and sub-tropical pomology, in addition to several others of minor importance. There has long been a demand for instruction in the culture of citrus and southern fruits by students in the graduate school and by students from the South American countries and our own southern states. The opportunities for investigation are considerably limited by reason of inadequate field and laboratory equipment, and also by reason of the increasing demands upon the time of the staff of the Department by students in class-room and practicum. The number of students electing horticulture this year is larger than ever before in both graduate and undergraduate classes. It has been necessary to divide the beginning class into two sections in order to carry on the work in a satisfactory manner.

II. EXPERIMENTS.

Under Federal Funds: The following studies have been conducted under federal appropriation during the present year:

1. An exhaustive examination of the characteristics of garden beans with special reference to their uses and adaptations, together with a system of classification based upon the characters of seed. In preparation for publication.

2. Investigations on the influence of acetylene light on crops grown under glass. These studies have covered a period of two University years, and are being continued the present year.

3. Studies of the influence of sulphurous ether upon plants grown under glass. The ether is applied to the plant while in a dormant condition and the plant is then brought under the influence of conditions favoring growth. The investigation covers one year and is in progress at this writing.

4. The influence of ether and acetylene in combination as agents in stimulating growth of forced plants. The investigation has covered one year and is in progress.

5. Influence of lime upon rhododendrons and members of the heath family. The work has covered one year and is in progress.

Preliminary reports on all these studies are being prepared and will be submitted for publication at the earliest moment possible.

UNDER STATE FUNDS :

I. Variety studies; comparative values of garden vegetables.

(a) Cucurbits.

1. Cucumbers under glass.

2. Squashes in field.

(b) Garden peas in field.

(c) Radishes in field.

(d) Beans in field.

(e) Tomatoes under glass.

II. Spraying investigations.

(a) A study of injury caused by sprays. Two field experiments.

(b) Experiments for the prevention of black rot of the grape. Three co-operative vineyard experiments.

III. Cultural experiments. The growing of plants under shade in the greenhouse and in the field.

Reports of the spraying experiments are being prepared for publication. Notes on other work recorded above under state funds will be held till additional investigations make it worth publishing them.

IV. Orchard survey. For the past two years a determined effort has been put forth to make such an examination of actual fruit-growing conditions in Niagara county as would allow us to present the results with proper deductions in bulletin form. Lack of means has prevented the prosecution of this important work. The reports on orchard conditions in Wayne and Orleans counties, published as Bulletins 226 and 229, have attracted widespread attention, and the edition of these bulletins is already exhausted. This has caused us to lay considerable stress upon the importance of studying fruit conditions in other important fruit-producing counties. The work in Niagara county was commenced in 1905 and continued this summer; and although all the ground we would like to have examined has not been covered, nevertheless sufficient data has been obtained on the

- peach and apple-growing of the county to enable us to make a preliminary report. This report is in the process of preparation.
- V. Little peach disease. This obscure disease has obtained a serious foothold in Niagara county, New York. In co-operation with the Division of Plant Pathology of the Bureau of Plant Industry, Department of Agriculture, Washington, an examination of peach orchards in the river section of Niagara county was undertaken last summer, first, for the purpose of discovering the extent of the disease, and second, of ascertaining whether it could be stamped out by applying the extermination method. This means the prompt destruction of all infested trees. A definite area was covered twice by the agents of the Department, the trees marked and the owners requested to destroy them as promptly as possible. The success of the method will probably be measured by the thoroughness with which the owners of the infested trees root out and destroy these individuals. This work will be continued next season.

III. EXTENSION TEACHING.

1. *Lectures.*—The members of the staff of the Department of Horticulture have been called upon frequently during the past year to speak before such organizations as the following and have in each case responded whenever it was possible to leave University duties:

- State Fruit Growers' Associations.
- County Fruit Growers' Organizations.
- Farmers' Clubs.
- State Farmers' Institutes (to which each member of the staff gave approximately two weeks of his time).
- Pomona and subordinate Granges.

In addition to this, the head of the Department has spoken several times before Village Improvement Societies and Civic Associations on the general topic of civic improvement.

2. *Visitations.*—From time to time, requests have come to the Department for the services of an expert to study local orchard troubles caused by soil, climate or parasites. Whenever such requests affected a considerable area, and where the interests were sufficiently large to warrant, a special visitation was made, the conditions carefully studied and, when possible, a meeting of the farmers called for the purpose of discussing the whole matter with them. This is a personal and valuable type of extension effort.

3. *Correspondence.*—The volume and scope of the correspondence of the Department continues to grow each year; and with the

extension of our efforts and the addition of new members to the staff, this phase of our work will assume a very important relation to the efficiency of the Department's work as a whole. The increase in the volume of our correspondence expresses a healthy desire on the part of our horticultural constituents to learn and know more about the affairs of the orchard and garden.

DEPARTMENTAL EQUIPMENT.

The teaching staff of the Department has been materially strengthened. The number of courses has been greatly increased. But though men are the mainsprings of good instruction and sound investigation, the quality of these is seriously impaired by inadequate equipment. The suite of rooms assigned to the Department of Horticulture in the new Hall of Agriculture may be expected to satisfy the needs of classroom and laboratory only temporarily. A building for horticulture, closely connected with a set of glass ranges, is one of the desiderata in the near future. This leads me to make some observations upon the material equipment of the Department of Horticulture in the past and as it stands to-day.

Character of Experimental Grounds.

The field equipment originally set apart for the Department of Horticulture comprised about ten acres of rolling land with a striking admixture of sand, loam and joint clay distributed in irregular patches throughout. This variation in make-up is so great as to make it impossible to secure perhaps more than half an acre of uniform soil in any one place. As the University has grown, this area (being central) has been invaded by other departments from time to time. Moreover, experiments involving the harvesting of fruits — and, to some extent, this is true of flowers — are quite impossible on this area, as it is in the direct path of the student to or from the athletic field; and fruits are looked upon as the legitimate prey of the average student as he comes from or goes to his exercise. The area will serve a very useful purpose in growing illustration material.

For experiments in fruit-breeding, orchard-culture and all experiments involving the harvesting of fruit-crops, land somewhat removed from University activities must be secured. This is one of the urgent needs of the Department. Considering the great fruit interests of the State of New York, this defect is serious and should receive immediate attention.

Forcing-Houses.

This small group of cheap, mostly frame, houses has grown up gradually in response to the urgent needs of the Department and the energy of the former head. In the beginning, they were used for the growing of winter vegetables and the forcing of flowers. In this connection, the bulletins of the Department of Horticulture bear excellent testimony to the efficiency of the buildings and the industry of those who had charge of them. These are now used almost exclusively in meeting the needs of the graduate students pursuing advanced work in horticulture and in providing facilities for laboratory exercises in greenhouse management and nursery and orchard practice for the beginner. This they do very inadequately. The older houses being of wood and in use fifteen or sixteen years, are now in a bad condition, and the annual bill for repairs grows larger each year. The heating plant is not only inadequate to the requirements made upon it, but the limit of growth has been passed. The houses themselves are unsuited for the purposes to which they are put and utterly unfit to represent the modern glass house and equipment of an up-to-date college of agriculture.

Allow me to summarize briefly some of the more urgent requirements of the Department of Horticulture for the carrying on of instruction and the conducting of investigations.

IMMEDIATE AND PRESSING NEEDS OF THE DEPARTMENT OF HORTICULTURE.

i. A glass house equipment comprising (a) a winter garden for laboratory use especially designed to meet the needs of the class in elementary horticulture and the students in the special winter-courses.

(b) A glass house especially designed for research work for graduate students. The facilities for work of this kind in our present group are utterly inadequate.

(c) A glass house for the forcing of tree fruits in which specimens of the citrus fruits may also be cultivated for the use of students interested in sub-tropical horticulture.

(d) A series of ranges for the growing of the leading commercial crops of flowers and vegetables. We are badly in need of houses where crops of carnations, roses, chrysanthemums, violets and stove plants may be handled in the manner practiced by the commercial florist.

Such an equipment is urgently needed at once. The houses should be modern in all respects, should be of the best material, and an equipment of this kind will cost not less than \$25,000.

2. Additional class-room and laboratory requisites. The following are needed to assist in giving the kind of instruction that we hope to offer when we equip our quarters in the new agricultural compound:

Lantern slides for sub-tropical horticulture.....	\$100
Charts, maps, prints, etc.....	100
Models of fruit.....	200

3. Experiment grounds and field equipment. An area of fifty acres is needed for permanent orchard experiments and for the carrying on of market gardening and trucking experiments. It is exceedingly important in the interests of Tompkins county and the central counties of the State that the College of Agriculture should demonstrate the feasibility of fruit-growing in this section. A simple illustrative experiment, aside from all other considerations, would be of great value. A certain part of this area should be set aside for that purpose.

4. The Department of Horticulture should have an annual appropriation of not less than \$10,000 aside from salaries, for the carrying on of its various enterprises. Orchard survey work alone would absorb two to three thousand dollars of this sum if prosecuted as vigorously as it should be. The development of the new orchard tract, the equipment of class-room and laboratory with apparatus for instruction and research will use a considerable portion of this sum. The horticultural interests of the State demand that more attention should be given them, especially along educational lines, than has been done in the past.

5. Manufacturing. The thorough utilization of horticultural products calls for the establishment of a canning and manufacturing laboratory in connection with the Horticultural Department of the College of Agriculture. There is an immediate demand for information in this department, and the whole subject will have to be taken up in the near future. The modern college of agriculture should be equipped with an evaporator, cannery and other features for the utilization of the by-products of the orchard. Instruction should be given in the arts which enable the grower to prevent waste of orchard products during years of over-production.

While this report comprises more of wants than accomplishments, yet it seems proper at this juncture where we are entering a new epoch in the life of the College to look our defects squarely in the face and plan for their improvement.

JOHN CRAIG,

Professor of Horticulture.

IV. DAIRY INDUSTRY.

I submit herewith my third annual report of the work of the Department of Dairy Industry. This is for the year ending September 30, 1906.

The first six months of the year were spent in the old State dairy building, which had been used for dairy instruction since its erection by the State in 1893. In the latter part of March the Department was moved into temporary quarters to allow contractors to remodel the building as the north wing of the Goldwin Smith Hall of Humanities. At the suggestion of the president and with the generous consent of the Medical College, the office of the Department was temporarily located in the faculty room of Stimson Hall. The manufacturing work was established and carried on under exceedingly great difficulties, in two or three rooms of the small frame building west of the barn, on Reservoir Avenue. Class rooms were used in Stimson and White Halls and in the stock judging pavilion. Laboratory work was suspended. It was confidently expected that the temporary quarters would be needed only a few weeks when the new dairy building would be occupied. But construction work in the latter proceeded so slowly that it did not become available until after the close of the year, hence the second half of the year was spent in places not well adapted for our work.

The unusual difficulties surrounding the Department and the fact that the writer felt compelled to give a large amount of his time to looking after the construction of the new dairy building, assisting in planning details which had not been planned previously or called for revision, and arranging for equipment for the building, made it impossible to undertake much new work. Most of the regular activities of the Department, however, were carried forward. These included the following:

I. TEACHING REGULAR AND SPECIAL STUDENTS.

The numbers of students in the different classes and the number in the corresponding classes of the previous year were as follows:

	1905-6.	1904-5
Course 41 Milk and Butter making.....	53	25
42 Cheese making	17	25
43 Market Milk	29	15
44 Advanced work	9	19

It is believed that some students wanting to take work in dairy industry avoided doing so because of the unsatisfactory and unsettled facilities for instruction in the spring term.

II. THE WINTER DAIRY-COURSE.

Ninety-one students were registered in this course. It was an exceptionally good class, and it is worthy of note that a large proportion of the class remained throughout the term of eleven weeks. Ninety per cent of all registered were present at roll call, the afternoon of the closing day. So far as known, every student who wanted a position at the close of the course and who was capable of doing good work, readily found one. Some took charge of factories, while others with less experience became helpers. A few students secured places on certified and ordinary milk farms. Some returned to their own factories and farms. Individual cases could be cited to show just how the winter dairy-course helps the students, the University and the State. During the year we were requested to recommend men for two hundred and three dairy positions. This must show that students of the winter-courses in previous years, have given good account of themselves. The salaries attached to positions most often available to these men varies from ordinary farm wages to about \$1,200 per year. At the present time we find it difficult to find competent men available for managerships of dairy farms. Some of these places call for a high grade of skill and offer to pay accordingly.

There are about 2,000 plants in New York State where milk is received from farmers, to be made into cheese or butter or to be shipped to the city. There should be always a good demand in this State for our Winter Dairy-Course students.

III. CORRESPONDENCE.

The Department has received and answered about 5,000 letters during the year. A large proportion of these were in reference to difficulties in dairy work and improvements of dairy establishments.

IV. FIELD WORK.

Mr. Hall visited former students as usual during the summer season. Some visits were made also by Mr. Griffith, Mr. Ayres and the writer. The total number of visits was 75. This is a most important part of the work of the Department. It should be ex-

tended. It keeps our former students closer to their instruction than anything else could do. On these visiting trips other establishments than those in which students are employed are included wherever possible. Under this head might be mentioned educational dairy exhibits at the State and county fairs.

V. INVESTIGATION.

On account of the unsettled condition of the Department as explained above, it was impossible to carry on any extensive investigation. With the assistance of W. H. Boynton of the Veterinary College, a study of the bacteria and leucocyte content of freshly drawn milk was begun. It was intended to carry on this study in connection with milking machines, but the latter were discontinued. The study will be resumed when opportunity offers. The Department received no Federal funds until the close of the year.

The Department expects soon to be in full possession of the new building provided by the State, and for which ground was broken May 1, 1905. It will provide about two and one-half times the space heretofore used, and it is well arranged for teaching and investigating. Good progress is being made toward a permanent milk supply which is deemed essential.

The amounts of fat received by the manufacturing division in the three summer months were

June	13,341.44 pounds fat
July	11,773.84 " "
August	10,677.23 " "

The Sage skimming plant, six miles north of the Campus, received more milk this season than a year ago. The farmers appear to be well satisfied and disposed to increase their herds, which we encourage them to do. Until a permanent patronage is secured the procurement of milk for our classes will be always difficult and costly.

Inasmuch as the Department is expected to give especial attention to the production of clean milk, the need of a sanitary stable and equipment where clean milk can be produced, is keenly felt. This is our greatest need at the present time.

Other additional needs include an artificial refrigeration plant which, installed and with proper insulation of refrigeration rooms, would cost about \$5,000; at least twelve compound microscopes which, with attachments needed for dairy bacteriology work, would cost about \$1,000; certain machines and other apparatus for the man-

ufacturing work, to replace part of those loaned to us, and to extend our equipment so as to permit work in fancy cheese making and other lines not now undertaken, worth not less than \$2,500; a pressure sterilizer for the market milk work which, installed, would cost about \$800; provision for more field work — at least \$500 could be used to great advantage in this direction.

This opportunity is taken cordially to thank the Director and officers of the University for the support given to the Department of Dairy Industry.

R. A. PEARSON,
Professor of Dairy Industry.

V. RURAL ART.

Work has been given in general landscape design since the fall of 1904, the work being at first designated as a course in Outdoor Art, this term being considered as more general and comprehensive in its character, and meeting better the needs of the College of Agriculture, the idea of the course being not only to give, in a preliminary way, instruction to students who wish to become landscape designers, but also to help the farmer toward a better understanding and appreciation of his surroundings.

During the college year of 1904-1905, a somewhat preliminary course of instruction was started under the general guidance of the College of Agriculture, Mr. Warren H. Manning, the well known landscape architect of Boston, lending his name and occasional services to the work, and Mr. Bryant Fleming conducting a series of lectures covering in a broad, general way the theory and aesthetics of outdoor art, together with its history. Ten students registered for the course, the work being open only to juniors, seniors, and special students in the College of Agriculture. No special certificates were offered for the completion of the work, the students merely electing the work, supplementary to their general work in the College of Agriculture.

During the college year of 1905-1906, the work was continued under the same general direction, one additional instructor, Mr. Taylor, a graduate student in the Department of Agriculture, being engaged to help with the work. Some modifications and improvements were made in the course, principally toward its better arrangement. The work was divided into several distinct courses, as compared with the one very general course offered the year before, these courses being termed as follows: Theory and Aesthetics of Landscape Design; Work with Plans and Drafting; Plant Materials for Landscape Effect; and Advanced Work in General Landscape Design. The work was also designated in the College Announcement of courses as a two-year course in Outdoor Art, supplementary to the general work in Agriculture, open only to juniors and seniors. Preliminary requirements were also raised somewhat, various other courses in the College of Agriculture, Arts, Engineering, and Architecture being required to have been taken before registration in the work given in Outdoor Art.

The registration was about equal to that of the preceding year, and in addition to the undergraduate work, two advanced students were given instruction, largely in the nature of working out problems for civic betterment in and about the University. The two advanced students finished their work in a most satisfactory manner, but no special mention or certificates were given them for completing the course. One is now actively engaged in the profession of landscape architecture, and the other is incorporating what he obtained from the course with his teaching in a western college.

During the year the work proved itself a necessity and was established on a rather firm foundation.

The work was again continued at the beginning of the present College year, 1906-1907, with a most satisfactory registration of fourteen students, some new to the work, and others continuing their work begun last year. The courses are being given much the same as last year, with the exception that constant improvements are being made. They are being attended not only by the students registered in the work, but by many visitors from other colleges in the University, principally from the Departments of Arts and Architecture.

The greatest needs of the course at present are better drafting-room facilities, the present accommodations being quite inadequate to properly accommodate the work of the students, and sufficient funds to equip the course as we would like to have it. These difficulties will no doubt be shortly overcome, particularly the need for greater space, which will be obtainable immediately upon the completion of the new Agricultural buildings. In regard to finances, however, it remains for some interested person to come forward and properly endow what can be made one of the most interesting and profitable courses in the University.

BRYANT FLEMING,

Lecturer in Rural Art.

VI. ENTOMOLOGY.

I herewith transmit a report of the entomological work of the Station during the past year. The report has been prepared by the assistant Entomologist at my request, as nearly all the entomological work has been done by him.

J. H. COMSTOCK,
Professor of Entomology.

Report of Assistant Professor Slingerland.

The work of the Entomological Division of the Station during the past year has been along similar lines as in previous years. Some work begun in previous years was finished, and considerable new work is now in progress. Several co-operative experiments were made with fruit-growers, and some very interesting and valuable results were obtained. The time consumed in teaching and correspondence work increases each year, and now requires a considerable portion of the Entomologist's time.

I. FEDERAL EXPERIMENT STATION WORK.

Two bulletins were published during the past year from this Division, giving the results of research work under the auspices of the Federal Funds.

Bulletin No. 233 dealt with two new shade tree pests: Saw-fly miners on European elms and alder.

Bulletin No. 234 discussed the bronze birch borer: An insect destroying white birches.

Work is being continued by this Division on other insect pests of shade trees and ornamental plants, and a thorough study of the insect enemies of timothy has been begun.

II. EXTENSION WORK WITH STATE FUNDS.

Teaching.—During the winter a course of lectures on injurious insects was given to 38 students in the short Winter Course in Agriculture.

Experimental work.—Under the auspices of the State Funds there was issued from this Division:

Bulletin No. 235. Co-operative Spraying Experiments:

I. Experiments Against the Plum and Quince Curculios.

II. Final Demonstration of Efficiency of a Poison Spray for the Grape Root-worm.

III. Making Bordeaux Mixture with "New Process" or Prepared Lime.

Co-operative experiments.—Co-operative experiments were continued by this Division this year against the plum curculio and the rose-chaffer. Twenty pounds of arsenate of lead were sent to each of four prominent fruit-growers with directions for its use against the plum curculio. During the summer I saw most of these experiments, and reports at the end of the season were very favorable for this method of controlling this pest of stone fruits.

An extensive rose grower on Long Island, who co-operated with us last year in an experiment against the rose chafer reports that: "The results of these experiments so far appear to be that the arsenate of lead can be used in perfect safety on roses in the proportion of 1 pound in 5 gallons of water, so far as the foliage is concerned, and that the rose bugs will certainly keep away from it when applied at that strength." A vineyardist who used this poison at the same rate on grape vines, making but one application, reports that a sprayed row which for two or three years had been stripped of the fruit by the rose bugs had, he feared, too many grapes this year for the good of the vines. Where he used the poison only half as strong the grapes were not so good or numerous, and the men did not find as many dead rose bugs. I think our work during the past two or three years has demonstrated that the rose-chaffer can be controlled with the arsenate of lead poison, but it must be used in very heavy doses.

The San José scale continues to increase its depredations in the fruit-growing sections of the State and is constantly appearing in new localities. While the lime-sulphur spray continues to be the cheapest and one of the most effective insecticides yet discovered for this pest, many fruit-growers, and especially owners of fruit trees or shrubs in yards, desire something easier to make and more agreeable to apply. The new so-called soluble or miscible oil preparations seem to offer the solution of this difficulty, as they are easy to make and not very disagreeable to apply. One of our most prominent fruit-growers discovered the San José scale in one of his orchards last fall, and would have cut and burned the trees immediately, but was finally persuaded to let me make a thorough test of one of these

oils. The proprietary article, known as "Scalecide," was selected for this test. One hundred and twenty gallons of it was purchased for use in this orchard and in making a similar test on a smaller scale in another section of the State. The infested orchard consisted of 600 six-year-old pear trees, and two or three hundred large plum and peach trees. Not all of the trees were infested with the scale, but 200 or more of them were encrusted with it in many places. It was decided to make the first application early in October before the leaves were off. About half of the trees were sprayed at this time with Scalecide, at the rate of one gallon of the oil in 12½ gallons of water, after some preliminary tests on a few trees with different strengths of the material had been made. An examination a little later showed that 90% or more of the scales had been killed, and while some of the leaves were burned, apparently no injury had been done to the fruit buds or bark. The whole orchard was again sprayed in November after the leaves had dropped with the oil, at the rate of one gallon in fifteen gallons of water. A third application was made early in the spring before growth began with the insecticide at the same strength as in the second application. The work was most thoroughly done under the eye of the owner with a gasoline engine sprayer, carrying a pressure of 125 pounds. The orchard was watched with interest during the past summer, and it was soon evident that most, if not all of the scales, had been killed. So confident did the owner become that he finally offered one dollar each for every living scale found upon the treated trees. I examined the trees carefully two or three times during the summer and in September, and other entomologists and horticulturists did the same. Although every effort was made to find living scales, the owner reports that no one claimed any dollars. It is a curious and interesting fact, that the scales all came off from the bark of the Japan plum trees, whereas large numbers of the dead scales remained on the pear trees during the season. These results are certainly remarkable, carried on as they were as a business proposition, by a fruit-grower himself. I fully realized that the experiment was in good hands, and that my directions would be faithfully and thoroughly carried out. The success of this experiment is due, I think, to the thoroughness with which the material was applied, the pressure that was used, and the number of applications. I believe it is practically impossible to kill all the scales with one application of any insecticide yet recommended for this pest, and I believe this is the explanation of many of the reported unsatisfactory results for spray-

ing for the San José scale. I think it is very important to make one application in the fall, as the insect is then to be found in all stages from those recently hatched to the full-grown insects, and most of them have not yet reached the less vulnerable hibernating condition. I think there is a good deal in the strong pressure used to force the spray into the cracks and crevices of the bark and help it to soak under the scales where it can reach the living insect. It is interesting to note here that two rows of trees in the same orchard were sprayed by a State inspector with the lime-sulphur wash, one application was made in the fall and another in the spring. The results were equally as good as those obtained from the use of Scalecide.

I obtained equally as good results on a single pear tree in my back yard with two applications of Scalecide, one in the fall and one in the spring, but another fruit-grower who used the material in the same way, but not quite so strong, reports that there are quite a number of living scales on his trees this fall. He thinks he obtained better results with the lime-sulphur mixture. Scalecide at the rate of one part in fifteen of water costs twice as much as the lime-sulphur spray, but it is so much easier to make and agreeable to apply, that if fruit-growers can get practically as good results with it, many of them will gladly go to the extra expense.

M. V. SLINGERLAND,

Assistant Professor of Economic Entomology

VII. AGRICULTURAL CHEMISTRY.

The following report of the work of the chemical division of the Experiment Station has been rendered by Dr. J. A. Bizzell, the assistant chemist of the Station.

GEO. W. CAVANAGH,
*Assistant Professor of Chemistry
in its Relations with Agriculture.*

I. WORK OF THE FEDERAL DIVISION.

On September 27, 1905, the Assistant Chemist was requested to take samples of sweet corn from the farm of N. B. Keeney & Son at LeRoy, N. Y. Selections of seed had been made with a view to increasing the sugar content of the grain as mentioned in previous reports of this Department. The green crop and the dry seed had been examined for sugar content the preceding year. On the data indicated above, thirty samples of green ears were taken and the grain examined for sugar. The grower has made no further requests for analyses for seed or crop.

The experiments with the root crops as outlined in the last annual report have been continued during the present year. In this connection 182 samples have been examined.

At the request of the department of agronomy forty-eight samples of soil were examined for moisture content.

During the spring of 1905 soil and inoculation experiments with alfalfa were begun, the object being to determine the best methods of soil treatment for this crop. This Department undertook analyses of soil solutions from each of the experimental plots, in order to determine whether the differences in growth could be traced to differences in the plant food solution. The results, including the analyses of 96 soil samples, show that liming at the rate of 2,000 lbs. per acre on Dunkirk clay loam, increased very decidedly the amount of water soluble nitrates in the soil. The crop was also decidedly benefited by the liming.

II. EXTENSION WORK.

As in previous years the work under the extension fund has been of a miscellaneous character. In response to various requests from farmers, analyses have been made of the following:

	Samples.
Dried apples	1
Insecticides	12
Fertilizers	3
Feeds	1
Limestone	1
Preservatives	1
Quartz	1
Water	1

At the request of the Poultry Department analyses were made of the following:

	Samples.
Chick feed	19
Litter	4
Grit.	1
Oyster shells	1

III. WORK IN PROGRESS.

Several problems pertaining to soil fertility have arisen during the present year. This Department is now undertaking work, which it is hoped will bring to light facts of fundamental nature in regard to this much discussed question. During the season of 1905 certain small areas on the Mitchell farm were noticed to be decidedly unproductive, while the surrounding soil although of the same type and possessing the same properties as far as could be determined, was productive. Analyses of the soil solutions from the two areas showed no differences except that the unproductive soil contained a much larger quantity of soluble nitrates. A chemical study of the soil solutions has been begun and will be continued throughout the growing season. Analyses of thirty-four samples have already been made.

A series of trials with alfalfa and timothy with special reference to the effect of liming and the accumulation of nitrogen in the soil, have been begun and will be continued during the present season. Thirty-six samples have been examined for nitrates, and analyses will be made at short intervals throughout the season. Eight samples of soil have been analyzed in connection with the timothy fertilizer experiments. The results seem to warrant a further study of the

composition of the crop, in order to learn something of the recovery and loss of nitrogen applied as nitrate of soda.

Other experiments not yet definitely outlined, but bearing on the problem of soil fertility will be studied during the coming year.

J. A. BIZZELL,
*Assistant Chemist of the Experiment
Station.*

VIII. BOTANY IN THE EXPERIMENT STATION.

I present the following report, being a brief resumé of the work of the Division of Botany from September, 1892, to the present time.

Since the policy recently adopted by Cornell University of clearly separating the work of the Experiment Station from that of teaching and research in the University has lately gone into effect, I take this opportunity of making my final report from the Division of Botany since my work henceforth will be devoted entirely to the educational and research work in botany for the University. It seems appropriate also that I should give at this time a brief resumé of the principal work undertaken by the Division of Botany during my connection with the Experiment Station.

My connection with the Cornell University Agricultural Experiment Station dates from September, 1892. During this period my position at Cornell University has been a dual one, as Professor of Botany at Cornell University, and as Botanist of the Experiment Station. Two-thirds of my time has been devoted to educational and research work in botany on the University side, and one-third of my time during this period has been devoted to investigation work in botany for the Experiment Station. This report, therefore, so far as it relates to my own work is confined to the results of investigations for one-third of the time during the period from September, 1892, to the present.

During my connection with the Experiment Station, the work in the Botanical Division has been chiefly confined to plant diseases caused by fungi, or of a physiological nature, and to studies of mushrooms and wood destroying fungi. The greater part of this work has been the investigation of new and little known diseases of plants. At the same time the botanist has been called upon to determine and name plant diseases or fungi which have been sent in for this purpose. This with the correspondence entailed has consumed a great deal of time, since it was necessary to indicate remedial treatment to check or obviate the trouble in the future in the case of diseases. Besides, many weeds, flowers, grasses, etc., have been communicated to the Botanist for determination.

Investigations in the Federal Division.

PHYSIOLOGICAL INVESTIGATIONS.

Investigations in the Federal Division have been carried on by myself and were begun in the autumn of 1892.

The three chief subjects of a physiological nature which have been investigated may be referred to first. One of these the "Oedema of Tomatoes" or "Dropsy" of Tomatoes, was published as Bulletin No. 53, May, 1893. This trouble was characterized by numerous intumescences upon the succulent stems and the veins on the under-side of the leaves. The cells of the tissue in these regions became greatly enlarged, the walls thin, and finally the endosmotic pressure became so great that the cells collapsed. Experiments demonstrated that the trouble was due to excessive root absorption while the conditions of the greenhouse were such as to check transpiration and favor the accumulation of osmotically active substances in the tissues. Suggestions were made as to how this trouble could be corrected by proper lighting and ventilation of the houses.

The second physiological trouble was a similar one on apple trees, and was published in Bulletin No. 61, December, 1893.

The third physiological investigation was an inquiry into the food value of mushrooms for higher plants and was published as Bulletin No. 240, June, 1906. The results obtained showed that a portion of the substance of the common mushroom, and probably of all Basidiomycetes, becomes available as food for autotrophic green plants, just as was anticipated in the case of the decay of these plants. They showed also that the common mushroom contains a nearly perfect food for the higher plants, and indicate that the higher plants can make use of simple ammonium compounds. This opens an interesting field for investigation and will perhaps aid in throwing light on the symbiotic relation between fungus mycelium and autotrophic green plants growing in various degrees of association.

DISEASES OF PLANTS.

The investigations on the diseases of plants have been carried on with special reference to the determination of the cause of unknown diseases, studies of the morphology of the fungi causing them and especially studies of development in order to learn the life history of the parasite as far as possible. In connection with this work progress has been made in the improvement of devices for photographing of the fungi, methods of culture, etc. The chief one of

these devices perhaps is that for photographing cultures of fungi and bacteria by transmitted light and for which the Botanist was awarded a diploma and given a gold medal at the Universal Exposition at St Louis in 1904.

The diseases of plants investigated, the results of which have been published in bulletins, are as follows: A new Anthracnose of the Privet, and the Cercospora of Celery Blight, both in bulletin No. 49, December 1892. After the article on the anthracnose of the privet was published the perfect stage, or ascus stage, appeared in the cultures. This was the first discovery by exact methods of the connection of an ascus stage with one of the anthracnoses*. In Bulletin No. 61, December, 1893, were published two sundry articles on plant diseases caused by fungi, Artificial Cultures of *Melanconium fuliginum* and Powdery mildews of Crucifers. An extended study of Carnation diseases was also made, but the results were published in the American Florist, 1893.

In 1894 an extended investigation was made of the fungi which cause leaf curl and plum pockets. This was a morphological, structural, and taxonomic study, and included illustrations by photographs, microscopic structure and descriptions of the species then known to occur on the genus *Prunus* in the United States. It was published as Bulletin No. 73, September, 1894.

The question of the damping off of seedlings was investigated during the same and following year. The results of this investigation were published in Bulletin 94, May, 1895. It included a study of development and parasitism of *Pythium debaryanum* on seedlings. *Pythium intermedium* on fern prothallia, and *Complectoria complens*, the rare member of the Entomophthorales on fern prothallia which was here noted for the first time in America. A new cutting bed fungus (*Volutella leucotricha*) was described, and some notes were published on a sterile damping off fungus (*Rhizoctonia*) and it was shown here, as the writer has shown formerly,† that a large percentage of damping off of seedlings which previously had been attributed to *Pythium debaryanum* was caused by this fungus.

For the past year and at the present time investigations are being made into the life history of the pear and quince leaf spot (*Entomo-*

*See Bot. Gaz., 26, 101, 1898.

†Some diseases of Cotton, Bull. 41, Ala. Agr. Exp. Sta., Dec. 1892. Diseases of Cotton, in the Cotton Plant, Bull. 33, U. S. Dept. Agr. Office Experiment Station, 292, 1896.

sporium maculatum), and it was shown by the writer as early as 1897* that the perfect stage of this fungus was a *Fabraca*.

STUDIES OF THE HIGHER FUNGI.

The third subject for investigation has been the study of the higher fungi, with special reference to the edible and poisonous mushrooms, the wood and timber destroying fungi, and the members of this group which are parasitic.

The first studies were published as Studies and Illustrations of Mushrooms I & II, in Bulletins 138, 1897, and 168, 1899, the former containing an account of *Agaricus campestris*, *Lepiota naucina*, and the poisonous *Amanita phalloides*, and the second giving an account of *Coprinus atramentarius*, *comatus* and *micaceus*. These bulletins are profusely illustrated with life size photographs. Some of the studies of wood destroying fungi appear in Bulletin 193. Studies of some Shade Tree and Timber destroying Fungi, June, 1901. These investigations describe the mode of entrance of these wound parasites into the trees, their progress in the tree, special characteristics in the decay of the timber for each species, a comparison of the fruit structures, and the result of a study to show that the sheets of "punk" so abundant in old coniferous logs, and sometimes found between the boards in a lumber pile are formed of the mycelium of *Polyporus pinicola* so common on all conifers. Suggestions are also made as to the necessity of care in forestry operations and in the pruning of shade and fruit trees to prevent the entrance of these injurious fungi.

Some investigations have also been made in the cultivation of mushrooms to acquire sufficient experience to give directions for the growing of mushrooms on a small scale with little expense for family use. The results of this study were published in Bulletin 227, Mushroom Growing for Amateurs, March, 1905.

A large number of other studies have been made and are still in progress on the development, structure, taxonomy and economic relations of the higher fungi as well as upon the parasitic fungi, and a great number of photographs have been accumulated. Some of these studies were published in book form,† and others have been published in leading botanical journals of the United States and

*Leaf Spot of Pear, Garden & Forest, 10, 73, 74, 1897.

†Studies of American Fungi, Mushrooms, Edible, Poisonous, etc., Henry Holt & Co., New York.

Europe, and material is accruing for further studies on development and for monographic work, but as these studies have been largely made on the University side of the work they will not be more fully reported here.

Investigations on the Nixon Fund.

The State Fund given to the Experiment Station under provision of chapter 437 of the Laws of 1896 resulted in establishing a position for an assistant in the Division of Botany in 1896, whose special duty should be the investigation of diseases of plants caused by parasitic fungi, and who should also take part in the educational extension work among the farmers and horticulturists of the State. This position has been held by several young men in succession.

The first, Dr. E. J. Durand, was appointed in 1896. As a result of his investigations an account of a serious disease of Currant Canes was published as Bulletin No. 125, February, 1897, in which the general and botanical characters of the disease are described and illustrated, and remedial measures are recommended.

Dr. B. M. Duggar was appointed assistant in the year 1896-97. His first work was published in Bulletin No. 132, as joint author with Professor L. H. Bailey, Notes on Celery, March, 1897. The investigations of Dr. Duggar here related to Two Destructive Celery Blights, the early blight (*Cercospora apii*) and late blight (*Septoria petroselini* var. *apii*). The botanical and structural characters of these parasites are described and illustrated, and remedies suggested to prevent the trouble in the field and in storage where the late blight is sometimes especially injurious.

In 1898 the results of his studies on pear diseases were published in Bulletin No. 145, Some Important Pear Diseases, February, 1898. Four diseases were treated of here.—Leaf Spot (*Septoria piricola* Desm.), Leaf Blight (*Entomosporium maculatum*), Pear Scab (*Fusicladium pirinum* (Lib., Fehl.), and Pear Blight (*Bacillus amylovorus* Burrill). This was followed by Bulletin No. 163, Three Important Fungous Diseases of the Sugar Beet, February, 1899. These are as follows: Root-Rot of Beets (*Rhizoctonia betae* Kühn), Leaf Spot of the Beet (*Cercospora beticola* Sacc.) and Beet Scab (*Oospora scabics* Thaxter). This was a timely bulletin on the diseases of this new crop for the State. The symptoms and characters of the diseases are described and illustrated, and suggestions are made for treatment.

Bulletin No. 164, Peach Leaf Curl, and notes on the shot-hole

effect of Peaches and Plums, February, 1899, was the result of some investigations during 1898. Dr. Duggar showed that a weak Bordeaux mixture was effective in preventing or greatly lessening the peach leaf curl (*Eroasacus deformans*). He also brought out the interesting fact that leaves of peach and plum were both injured by improper spraying in such a way as to produce small circular holes in them resembling the effect of the shot-hole fungus.

This work on The Prevention of Peach Leaf Curl was continued by Dr. W. A. Merrill, who was appointed assistant for the year 1899-1900 during Dr. Duggar's absence in Europe, and his results, which confirmed and extended the earlier ones, were published in Bulletin No. 180, March, 1900. Dr. Merrill began a study of the injuries to shade trees in cities from various causes during his connection with the Experiment Station. This work was continued by him afterward during a stay in Europe, and in 1902 a Bulletin, No. 205, Shade Trees, was published. Many devices for protecting trees are illustrated.

The injuries to a great variety of plants due to the soil fungus Rhizoctonia were found to be so great from gradual accumulation of material that a special Bulletin, No. 186, was published upon this subject in January, 1901, The Sterile Fungus Rhizoctonia as a Cause of Plant Diseases in America. This was a joint bulletin by Dr. Duggar and Mr. F. C. Stewart of the Geneva New York Experiment Station. The disease is described on about twenty different hosts in America, and a short history of its occurrence in Europe and America is given.

Dr. Duggar resigned in 1901 to enter Government work; Mr. Clayton O. Smith was assistant, 1901-02, and Mr. J. M. Van Hook was assistant 1902-03. Mr. Van Hook gave especial attention to the "wilt disease" of ginseng, and this work led to the study of other diseases of this new and important crop, which were found to be surprisingly large for a plant so recently brought into cultivation, and which has so few fungus enemies in a state of nature. Bulletin No. 219, Diseases of Ginseng, June, 1904, was the result of this work.

In 1903, Mr. H. H. Whetzel was appointed assistant in this work, and he has prosecuted the investigations with great vigor and success. His first bulletin was No. 218, Onion Blight, April, 1904, which deals with a serious disease of the onion crop caused by *Peronospora schleidcniana*. A study was made of the conditions favoring the infection and spread of the disease and recommenda-

tions made for preventing it. The most important contribution as a result of his investigations thus far is the Blight Canker of Apple Trees, Bulletin No. 236, February, 1906. This is a widespread and very serious disease, especially in certain parts of the State. Mr. Whetzel demonstrated the identity of this disease with the Fire Blight of Apples and Pears and gives a history of it, a full discussion of its characters, and its method of attack, with suggestions as to its control. The bulletin is illustrated with a large number of photographs showing the injuries caused by the disease.

Bulletin No. 239, Some Diseases of Beans, is largely a compilation prepared as an emergency bulletin to meet the demand for information on this subject from bean growers in the State.

Professor Whetzel has now in progress studies on a large number of diseases of plants. Among these is a leaf spot disease of ginseng, caused by a species of *Alternaria*. This is the most serious and widespread disease of ginseng in this State. Material is nearly ready for a bulletin on this subject.

Professor Whetzel himself will make a fuller report on work which he has in progress.

GEO. F. ATKINSON,

Botanist.

IX. BOTANY IN THE EXTENSION WORK.

I. THE REPORT ON THE TEACHING ENTERPRISES OF THE YEAR.

Winter course students.—During the winter-course session of 1906 this Department offered a course in Farm Botany and Plant Diseases, which consisted of one lecture and one laboratory period each week. The work was given in the laboratory of the Botanical Department of the University, the apparatus and supplies being furnished chiefly by that Department and to which Department I believe all the laboratory fees were credited. Fifty students made requests to take this work. Provision, however, had been made for only twenty-five so that it was necessary to limit the number of those entering. The original limit was increased to forty by making an extra effort and giving some of the work on Saturday afternoon. This number was finally reduced in various ways to twenty-nine, most of which number successfully completed the work.

Extension teaching among the farmers of the State.—This work consisted of several distinct lines: first, Farmers' Institutes. Four Farmers' Institutes were attended during the year 1906 and 1907, two or three lectures being delivered at each meeting. The subjects discussed were Fire Blight, Apple Tree Cankers, Bean Diseases, Brown Rot of Peaches, Cucumber, Onion and Celery Diseases. The structure and nature of the leguminous tubercles were also explained. Besides these other miscellaneous diseases were taken up upon special request of those present at the meetings. I have made it a practice during the past year to carry a compound microscope with me, together with such specimens as were necessary to demonstrate the talk in hand. I found a microscope a most excellent adjunct to the work. The fact that a man might by looking through the microscope, see the fungus or bacterium under discussion made a great deal of difference in getting his attention and arousing his interest.

Horticultural meetings.—Two horticultural meetings were attended during the year,—the Western New York State Horticultural Society and the New York State Fruit Growers' Association. At the former a paper was presented on the Blight Canker of Apple Trees. At the latter an exhibit of plant diseases was made.

Farmers' field meetings.— Under this heading I have included all meetings of farmers' associations aside from Institutes and Horticultural Meetings. A Farmers' Field Meet was held at Le Roy under the auspices of a Farmers' Reading Club. Another meeting of a similar nature was held at Jacksonville in connection with the Farmers' Reading-course work in the Jacksonville Grange. A lecture on the diseases of beans was given before the Byron Grange, Byron, N. Y., and another before the Association of Farmers' Reading Clubs at Batavia, N. Y. A talk was also given before the Business Men's Club at Newark, N. Y. The work at these meetings consisted of lantern slide lectures, talks and demonstrations with the microscope. Two of them were all day meetings.

Fairs.— Plant disease exhibits were made at three of the fairs in the State this year extending throughout the time that the fairs were in session. The first was at the State Fair, Syracuse, N. Y. From there the exhibit was taken to the Oneonta Fair, Oneonta, N. Y., and was again set up at the Tompkins County Fair, Ithaca, N. Y. The exhibit consisted of specimens of the cultivated plants of the State, showing some of the more common diseases. Charts were prepared showing photographs of these diseases, the nature of the organism causing them and the results of treatment. Either myself or an assistant was always present with the exhibit to answer questions, explain the nature of these diseases and show with the microscope the organism causing them. Directions for the treatment of some of the diseases were passed out to those who cared to have them. The name and address of the plant pathologist was also distributed to a large number of persons who expressed a desire to write later in the year for information on different diseases.

Co-operative experiments.— An outline of 6 co-operative experiments was prepared and published and sent out by the College of Agriculture for the year 1906. Detailed outlines for carrying on these experiments were prepared and mailed to about twelve persons. These were chiefly winter-course students.

Correspondence.— The correspondence during the past year increased remarkably. During the previous year about 400 letters were written by this Department in reply to inquiries of various kinds along the lines of plant diseases. During the year just ended, however, this number has more than doubled itself so that we have written during the past year in the neighborhood of 1,000 letters. The letters received were for the most part inquiries in regard to diseases of different sorts and often entailed an extended examina-

tion of diseased material. Such correspondence naturally requires considerable time and careful work in order that it be properly done.

II. PLANS AND RECOMMENDATIONS FOR THE ENSUING YEAR ALONG THESE LINES.

Teaching work with students in the college.—As already planned and outlined in the catalogue of the College of Agriculture, this work for the coming year is to be greatly enlarged and extended. The removal of the Department from its present quarters in the Botanical Laboratory of the University to the new building of the College of Agriculture will necessitate a new and complete equipment. In order that the work outlined may be presented in the most efficient manner, sufficient money should be set aside to provide for the necessary equipment and the maintenance of the teaching work. Since botany, presented from an agricultural point of view, is a fundamental subject in a general agricultural course, the sum set aside ought to be sufficiently large to make the work as valuable as possible. The sum necessary this year will, for reasons indicated above, be larger than would probably be necessary hereafter for the maintenance of the Department.

The work as planned for next year contemplates two courses for winter-course students,—one course in elementary agricultural botany for specials, an advanced course in plant diseases open to both specials and regulars, and a course for graduate students in which the technique of plant pathology will be taken up along with special lines of investigation. All of these courses include much laboratory work and the necessity for a regular assistant in the Department seems evident.

Farmers' Institutes.—It seems very desirable that some work be done in Farmers' Institutes along the lines of plant diseases. I think that the most good can be accomplished by discussing diseases of those crops, in which the farmers of any given locality are especially interested. To make this valuable the speaker should have notice some considerable time beforehand as to the localities he would be expected to visit. He should also be furnished with information in regard to the crops grown in those sections. The talks should I believe be illustrated with as great an abundance of material as possible and the use of a microscope. During the work of last winter I found the microscope of most valuable assistance.

Horticultural meetings.— Experience with the plant disease exhibit at Lockport last winter convinced me that this should be a permanent part of the work of the Department. The growers of the State showed the greatest interest in the exhibit and kept me busy at nearly all hours of the day answering questions and showing the organisms of the disease under the microscope. The exhibition of the different diseases of fruit trees accurately named and labeled and the distribution of literature to those persons who are especially interested will I am sure become one of the most valuable features of the Horticultural meetings.

Farmers' field meeting and Grange lectures.— The work along these lines also offers great opportunities in teaching the farmers of the State in regard to the nature and treatment of the fungus diseases of their crops. These lectures and talks should be well illustrated with specimens, lantern slides, photographs and the microscope.

The Fairs.— The apparent success of the Plant Disease exhibit at the fairs this year indicates that this also ought to be a permanent feature of the work of the botanical Department. In order to make this most valuable complete sets of specimens, photographs, etc., should be prepared illustrating the life history and treatment of the more common fungus and bacterial diseases that occur in this State. This will call for considerable expenditures as the preparation of such material is expensive. Moreover, if many fairs are to be attended these sets will have to be duplicated. To be effective these exhibits must be in charge of some one competent to carefully explain the nature of the diseases represented and to answer the questions of parties interested.

Co-operative experiments.— Judging from the reports on these experiments during the past year would say that I think them of questionable value so far at least as results are concerned. The chief benefit derived I believe is to the person who is carrying on the experiment, and from this point of view the work no doubt well repays the effort put upon it.

Correspondence.— The increased correspondence has taken a great deal of the time of the pathologist. The indications are that the correspondence for next year will be much heavier. The correspondence entails not only the work of determining the material sent in and the answering of the letters, but it also necessitates the careful preservation of much of the material for future reference and illustration and the preparation and the recording of extensive notes in

a great many cases. Besides this it is often necessary to carry on a more or less extended investigation requiring much laboratory and clerical work. It, therefore, seems very desirable that the Department should have its own stenographer who might give all her time to the work. At the present time the arrangement with Professor Atkinson for stenographic work is satisfactory to neither of us, as one interferes more or less with the plans and work of the other. For this reason it frequently happens that correspondence must go unanswered for several days, while the careful keeping of notes, etc., is practically out of the question.

The increase along all the lines of work as outlined above would seem to make it desirable that more money be appropriated for the regular work of the Department. The \$300 at present appropriated to this Department for all of its work, both teaching and investigation, is entirely inadequate. This is especially true since the removal of the Department to the new building will necessitate the buying of almost complete equipment in the way of apparatus and furniture. This manifestly cannot be made with the \$300, but aside from that the \$300 is not sufficient for the running expenses of the Department, especially when the stenographer must be paid out of this fund. Not only does it seem that the appropriation should be increased for running expenses, but if the work outlined for the Farmers' Institutes, Horticultural Meetings and Fairs is to be carried out and enlarged more assistance will be necessary. I would respectfully recommend the establishment of an assistantship paying at least \$500 and tuition, to be given to a young man well grounded in botanical work, the assistant to devote half of his time to the Department throughout the year, the other half to be available for the continuation of his studies as a student in the College. Such an assistantship would greatly relieve the pressure of work in the Department during the teaching period and would also provide for a continuation of the investigation work during the vacation of the man in charge.

III. INVESTIGATION ENTERPRISES.

The work of investigation during the past year has been devoted to the following problems. First, a careful investigation into the methods of preventing the anthracnose or pod spot of beans. The work was undertaken to determine if the recommendations usually given for the treatment of this disease and as outlined in our Bulletin 239 were practical when applied to field operations. If such recommendations were not practical, to determine if possible some means

by which the ravages of this disease throughout the State might be reduced. Thanks to the kindness of two large canning companies at Rome and Oneida, N. Y., excellent opportunities were afforded for testing the spraying of beans on large areas and with the most modern apparatus. Moreover, these companies stood all expenses in the way of materials and paid our traveling expenses. The result of the summer's work seems to indicate that spraying for this disease is not efficient at least so far as large field operations are concerned. It is thought that we must look to other means for the control of this disease. Repeated tests of seed in the laboratory have shown that practically all of the seed offered in the markets is badly diseased. During the next year it is planned to carry on extensive tests of bean seed offered in the market and it is hoped we may be able to devise a plan for the growing of clean beans for seed. I believe that the solution of the problem lies in the obtaining of seed entirely free from the disease.

Second, the work on the *Alternaria* Blight of Ginseng was continued throughout the past season and the solution of the control of this disease finally worked out. We were able to establish beyond a doubt that thorough and systematic spraying would grow plants perfectly free from the disease.

Third, work on the fire blight of pears and apples was also carried on to some extent in continuation of the work begun last year. It is hoped that this work may be continued again next year.

Fourth, spraying experiments on the *Septoria* Leaf Blight of tomato were repeated again the past year with results that seemed to indicate that this disease may be entirely controlled if the spraying is properly done and the removal of the diseased leaves as fast as they appear is systematically attended to.

Fifth, some preliminary spraying experiments were also made for the control of the rust of hollyhocks. Two sprayings with Bordeaux mixture gave remarkable results in the control of this disease. It is planned to complete the work on this problem next year.

Sixth, some investigations were also made on the nature of the root rot of peas. This disease caused considerable loss in the pea fields of the State. The work was of a preliminary nature, and it is expected that it may be carried on during the coming season.

Three bulletins are now in preparation and it is hoped that at least one of these may be ready for publication during the early part of the coming year. These bulletins will be *The Alternaria Blight of Ginseng*, *The Fire Blight of Apples and Pears*, and *The Septoria Leaf Blight of Tomatoes*.

In connection with the United States Department of Agriculture a plant disease survey of the State is being made. This is done largely through correspondence with farmers in different parts of the State, and an annual report is made and submitted to the Department of Agriculture. This report is based on materials received through correspondence and from the observations and collections made by the pathologist during the year.

H. H. WHETZEL,
Assistant Professor of Botany.

X. REPORT OF THE FARMERS' READING-COURSE FOR THE YEAR 1905-1906.

Progress of the Farmers' Reading-Course work during the past year has been in the direction of more intimate contact with the readers rather than in securing more readers.

On October 1, 1905, the reports of the Department showed a total enrollment of 9,654, of which 2,271 were newly enrolled during the twelve months preceding and 2,546 of whom were organized into 125 Reading-Course Clubs. During the year, 3,014 Discussion-Papers had been returned. By comparing the number of Discussion-Papers returned with the total number of readers it is readily seen that a large proportion of them returned no Discussion-Papers. The average is one Discussion-Paper for 3.2 readers. Since the second Bulletin of any series was not sent to a reader unless he returned the Discussion-Paper, there were a great many readers who received only one Bulletin during the year.

It seemed to those directing the work that there must be a great many of our readers who really wanted the Bulletins but found it impossible to fill out the Discussion-Papers and return them. Accordingly, after sending the next Bulletin in series to each of the old readers and waiting about two weeks, we sent a circular letter to each man, a part of which read as follows: "We feel that you can obtain the most value from this by returning the Discussion-Papers with answers to the questions or with questions for us to answer. Still if you do not feel that you can do this and yet want the lessons, we will put your name on a permanent mailing list and send you one Bulletin each month through the winter. If you wish to avail yourself of this offer, kindly fill in the blank space on the enclosed card, with your name, address, and the subject you would like to study." One gratifying result of this circular letter was that it brought back a large number of Discussion-Papers. The readers would say that they had intended to answer but the Bulletin had been laid aside and the Discussion-Paper forgotten. Besides those who returned the card sent for that purpose, all those who returned the Discussion-Papers and all new readers were put on the permanent mailing list. Practically every one, therefore, whose name is found on the list, has himself

requested the Bulletins during the year. On the 15th or 16th of each of the five months of the Reading-Course term we sent the next Bulletin to every reader on this list unless he had returned a Discussion-Paper and received a Bulletin since the first of the month. With the exception of the few who enrolled late in the winter or during the summer, practically all our readers have received under this arrangement a complete series of five Bulletins. The new Bulletins were sent to those who returned Discussion-Papers and a special effort was made to answer all questions found on the Discussion-Papers within a few days of the time the Discussion-Papers reached this office.

On August 1, 1906, the reports of the Department show an enrollment of 6,700, of whom 3,498 were newly enrolled during the ten months preceding, and 911 of whom were organized into 45 Reading-Course Clubs. During the ten months 6,092 Discussion-Papers have been returned.

In round numbers we have 2,000 readers who are corresponding with us. The remaining 4,700 have simply requested that the Bulletins be sent to them. Of those returning Discussion-Papers

1140 have been answering fully
 383 have been answering in part
 138 have written very little
 291 have written nothing except their name
 44 have said they had no experience and therefore could not answer
 800 have asked questions for us to answer

In answer to requests for information we have sent 3,109 letters. These were sent under two cent stamp. Besides these, about 16,000 circular letters were sent under one cent stamp.

We have received many requests for information on such general subjects that we could not answer fully in a letter. In such cases after answering as fully as possible we have referred the reader to Bulletins from the Experiment Station here or at Geneva, or to the Farmers' Bulletins from Washington. Lists of the available Bulletins from these places are kept on hand at all times. If no Bulletins touching the subject were available, books were recommended. We know that many of the readers have received and read the literature recommended in this way; but we do not know how many. The case of those who apply for correspondence work is a good example. They fill out a card asking for literature on a certain subject. We recommend certain books which they may purchase. We always ask them to correspond with us freely so that we can help them on

any points not understood. It is only occasionally, however, that we hear from these parties. We have no way of knowing whether the books are used or not. For the full development of this end of the work it seems almost necessary that the books be sent from the College. If there were a way whereby the parties interested could secure the books through the College and either pay the publisher's rates or regard them as loaned for a short time, it would be possible to get the farmers interested in this kind of literature. After becoming interested, many would buy the books who would not have done so if they had been obliged to buy them before having an opportunity to read them. Possibly a small circulating library of the best books on each subject could be sent to each applicant with the understanding that he was to return them within a certain time, unless he wished to purchase them.

Another part of the work which should be developed is the Club work. We have tried to develop this through correspondence with the members and officers of the Clubs. We find it hard to keep in touch with them in this way. At the beginning of the year all the old Clubs were invited to organize new Reading-Course Clubs. The Secretaries were asked to procure as far as possible the literature recommended at the end of many of the Bulletins for supplementary reading. If some method could be found whereby the Clubs could be furnished or could be induced to procure books on the subject they are studying, the work could be made much more valuable. No doubt this could be brought about more readily if the Supervisor could visit the Clubs once or twice each year. We have found it hard to do much of this work without neglecting the correspondence. During the fall months when the correspondence is not heavy, a man could help the old Clubs and start many new ones by visiting the places which have the largest number of active readers. In many places, doctors and pastors of rural churches will lend enthusiastic support to this work. Several Clubs were formed this year by men in these professions.

An encouraging phase of the Club work has developed in Genesee county where an organization has been formed for the purpose of promoting Reading-Course work in that county. The local Clubs meet once every two weeks at the houses of the members. It was planned to have a meeting of the members of all the Clubs at some central point once a month. These meetings were held in the day time and when possible a speaker from the College of Agriculture was provided. Experiments and demonstrations illustrating the

work and also field meetings were found very helpful in stimulating interest in the work. The work of this organization has been very successful during the year and will no doubt be continued during the coming year.

During the year another Series has been added to the Reading-Course, making in all six Series and thirty Bulletins. The Bulletins now available are as follows:

I. *The Soil and the Plant*.—The Bulletins in this Series are (1) The Soil: What It Is; (2) Tillage and Under-Drainage; (3) Fertility of the Soil; (4) How the Plant Gets its Food from the Soil; (5) How the Plant Gets its Food from the Air.

II. *Stock-Feeding*.—The five Bulletins in this Series are (1) Balanced Rations for Stock; (2) The Computing of Balanced Rations; (3) Sample Rations for Milch Cows; (4) Soiling Crops, Silage and Roots; (5) Pastures and Meadows.

III. *Orcharding*.—The five Bulletins in this Series are (1) How a Fruit Tree Grows; (2) Planting the Orchard; (3) Tilling and Fertilizing the Orchard; (4) Pruning and Spraying; (5) Picking, Storing and Marketing Fruit.

IV. *Poultry*.—The five Bulletins in this Series are: (1) Building Poultry-Houses; (2) Feeding of Laying Hens: The Principles; (3) Rations for Poultry; (4) Raising Chickens; (5) Marketing Poultry Products.

V. *Dairying*.—The five Bulletins of this Series are: (1) The Care of Milk on the Farm; (2) The Composition of Milk and Cream and their By-Products; (3) Construction of Sanitary Dairy Stables; (4) Farm Butter-Making; (5) The Dairy Herd.

VI. *Buildings and Yards*.—The five Bulletins of this Series are: (1) Tasteful Farm Buildings; (2) Tasteful Farm Yards; (3) The Plan of the Farmhouse; (4) Water Supplies for Farm Residences; (5) Barns and Outbuildings.

The popularity and use of the various Series may be judged by the following table:

	Number either starting or finishing.	Number of new readers starting.	Number Discussion Papers returned.
Series I The Soil and the Plant.....	3338	1303	1476
Series II Stock-Feeding.....	2098	294	990
Series III Orchardng.	1523	485	1171
Series IV Poultry.	2836	1157	1663
Series V Dairying.	1202	179	510
Series VI Buildings and Yards.....	410	80	282

It must be borne in mind that new readers are advised to start with Series I and that a great many never finish more than that one Series. The Series of Bulletins first published seem to be more widely known and more in demand than the recent Series.

GEO. W. HORSFORD,
Supervisor Farmers' Reading-Course.

XI. FARMERS' WIVES' READING-COURSE.

The extension work among farm women in the College of Agriculture for the year 1905-06 has been in relation to Bulletins which are sent each month from November to March; in the organization and promotion of clubs among farm women; and a course in home economics established for three months of the winter in the University for the benefit of farm women who have been able to attend.

October 1, 1906, there was the following membership in the Reading-Course:

Series 1.	2040
Series 2.	6860
Series 3.	4459
Series 4.	6925
Total.	<hr/> 20284

The Discussion-Papers returned were:

Series 1.	999
Series 2.	550
Series 3.	323
Series 4.	205
Total.	<hr/> 2077

An effort has been made to determine why more women did not answer the discussion-paper and letters are at hand to show that a lack of time, a diffidence about offering ideas and the lack of practice in writing leads many women to omit the return of the discussion-paper and at the same time to ask to have the Bulletins continued. In general where discussion-papers are returned much information is obtained which keeps the Department in touch with the farm home, establishing a better acquaintance and making it possible to furnish a more efficient Reading-Course.

Farmers' Wives' Clubs have been established in the Grange and in separate organizations where the members have made the Reading-Course a basis of work with the addition of some literary topics. Most excellent results have followed from the establishment of the clubs in rural districts. The club idea is growing and bids fair to be a prominent feature in social and intellectual rural life. It keeps

the women in a community in sympathy with each other in their general interests. It prevents isolation of women in farm homes and is inspiring those interested to grow intellectually. By means of the Reading-Course inquiries have been made to determine what literature is read in the farm home. It has been gratifying to know that the Bulletins have stimulated further reading.

It is observed that the farm women both in Grange, Farmers' Institutes and other meetings show a deeper interest and better knowledge of the scientific side of home making than is evidenced among the village women.

The Winter-Course in Home Economics in the winter of 1906 had a membership of 40 and the constant attendance of many outside of those registered. Lectures were given by women holding prominent positions in the field of Home Economics from the best institutions of the country. Assistance was also rendered by men and women connected with the University. This course is a natural outgrowth of the Reading-Course which has by printed bulletin gone into the farm home. If that becomes efficient it must necessarily follow that the more extended knowledge of home matters will be desired by the home makers.

MARTHA VAN RENSSELAER,
Supervisor Farmers' Wives' Reading-Course.

XII. NATURE-STUDY.

The Bureau of Nature-Study, during the school year of 1905-06, has maintained its usual field of work in the same manner and efficiency as since its installation, ten years ago. Through the teachers, children were organized into clubs called Junior Naturalist Clubs. The members elected a president and secretary. Many teachers took the occasion when the election of officers took place to give a lesson in civics. A number of teachers also had the clubs hold meetings under parliamentary rules.

These clubs were under the able management of Miss Alice G. McCloskey, who edited the monthly publication known as the Junior Naturalist Monthly and every club member was considered a subscriber. These publications were remarkable for the fine English, apt and free illustrations and subjects germane to the season of the issue. Each number contained several topics. The pupils were asked — not required — to write letters to the Bureau of Nature-Study telling what they had observed under the inspiration of these leaflets. These letters were written during the language period of school.

The record of these clubs closed on July 2, 1906.

The number of clubs in the State of New York.....	1,506
Total membership of clubs.....	30,083
Total number of letters received from children during 1905-06.	20,896

Under the suggestions of the publication, children wrote on 31 different topics as follows:

Tracks in Snow.....	295
Evergreens.	51
Snowflakes	160
Home-making.....	90
Pigeons.	87
Cocoons.	449
Mice.	660
Corn.	1,132
Toads	329
Poultry.	1,043
Teasel.	502
Apples.	1,132
Pigweed.	73

Puzzle.	850
Terrarium.	27
Vegetables.	1,220
Seeds.	8
Silo.	939
Berries.	32
Indian Pipe.	52
Length of root.	50
Jack O'Lantern	41
Blue Jay.	437
Growth of plant.	156
Birds.	1,340
Cats.	165
Schoolhouse	306
Chicken hammock.	50
Landscape.	199
Home library	90

The 140,000 pages of the Junior Naturalist Monthly were distributed through the following months:

October, 1905.	40,000 pages
November, 1905.	64,000 pages
December, 1905.	120,000 pages
January, 1906.	120,000 pages
February, 1906.	60,000 pages
March, 1906.	144,000 pages
April, 1906.	72,000 pages
May, 1906.	120,000 pages

It is with pleasure that I call attention to the results of our special effort made to give instruction in children's gardens and junior agriculture in the public schools of the State of New York, during the year of 1905-06.

At the opening of the public schools of the State in September of 1905, we did not have a single pupil enrolled. At the close of the school year, June, 1906, the total number enrolled was 33,476. The enrollment and instruction given were by means of leaflets and correspondence through the teachers. Six supplemental leaflets were published for small children on gardening topics, bearing date and topics as follows:

- November, Children's Plants and How They Grow.
- December, How to Help Plants to Grow.
- January, Uncle John's Talk with Gardeners.
- February, Contest Between Beans and Potatoes.
- March, Billy Boy and His Garden.
- April, Pepperpod's Berry-box Garden.

Circular letters were sent with five of the above issues for the purpose of awakening interest. Several thousand letters were written answering children who asked information concerning problems that came in their garden experience. In writing, an effort was made to encourage and instruct from a child's point of view.

The cost of the above work was four cents per child per school year.

JNO. W. SPENCER,
Supervisor Bureau Nature-Study.

HOME NATURE-STUDY.

A special effort was made last September to reach the teachers in the rural schools. We concluded to send out fewer leaflets; therefore, they were sent to those outside of the rural schools only upon special request. It was difficult to get the names and addresses of the rural teachers, for the lists given in the previous year's report did not give the correct address. The Granges were asked to assist us in getting the names of the rural teachers. The following letter was sent to the secretaries of the six hundred Granges of New York State:

"We are trusting in your interest as a patron to assist us in an effort to reach the children of the rural districts, and get them interested in nature-study as a direct aid to farming.

"If the young people are to stay on the farm it will be because they find that life most attractive. They should get to know the problems of the farm and get interested in solving them. They should know not only the names, but the value of the trees, plants, insects, birds and all the living things which are sure to occupy their farms with them to their benefit or detriment. Such studies if properly introduced in the district school will not crowd out the regular studies, but will, on the contrary, be a help in making reading, geography, drawing, composition and even arithmetic more interesting.

"Will you please to help us by mailing the enclosed postal cards to the teachers of your own and adjoining districts? And will you kindly bring this matter before the next meeting of your Grange, hoping that we may thus gain the direct influence of the members in this work of educating the children toward the farm instead of away from it."

In each of these letters were sent three postal cards like the enclosed.

ITHACA, N. Y., SEPT. 15, 1905.

TO THE TEACHER:

You know the life in your schoolroom; would you like to know something of the life just outside your school house, and use this knowledge to give your pupils a new interest in the school and the farm? If so, we will help you in any two of the following lines:

The Birds, their names, food habits and relations to agriculture.

The Wild Flowers, their names, methods of growth and seed distribution, especial attention being given to weeds.

The Trees, their names, characteristics, their flowers and fruits, and their special uses.

The Insects, a study of the insect friends and foes of the farmer, how to deal with them; also the life habits of common butterflies and moths.

The Fishes, a study of the names, habits, foods and uses of those common to our streams.

Suggestions will be given as to how these subjects may aid the school work in language, drawing and geography. The course is free of all expense to all teachers in New York State, and is conducted by correspondence. Send a postal card giving your name and address.

ANNA BOTSFORD COMSTOCK,
Home Nature-Study Course,
Bureau of Nature-Study,
Cornell University,
Ithaca, N. Y.

Although we received but a limited number of answers from the secretaries, yet in many instances they sent the postals to the rural teachers of the neighborhood without replying to us directly. As a result we had 849 rural school teachers in the Home Nature-Study Course. A smaller proportion of these teachers wrote out the answers than was the case with teachers in cities and villages, who composed our previous classes. However, the answers were of special excellence containing very little superficial work, and, on the whole, it seemed that our efforts have met with fair success.

We sent the leaflets only to those training classes where the teacher requested them specially.

Our plan was carried out of publishing with each issue a special leaflet on each of the following subjects: birds, trees, plants, insects, fishes. We suggested to the pupils that each take two of these subjects and specialize in them rather than try to cover the whole ground.

Lessons sent out for the year:

Birds.	2,830
Trees.	2,515
Plants.	2,226
Insects.	1,576
Fish.	1,081
	<hr/>
	10,228

These lessons were sent out in the aggregate as follows:

October–November.	2,196
December–January.	2,428
February–March.	2,730
April–May.	2,874
	<hr/>
	10,228

It will be seen that there was a steady increase in the numbers sent out in each succeeding issue, this increase being due to special requests for the lessons.

Lessons received:

October–November.	471
December–January.	199
February–March.	162
April–May	117

949

Letters received:

Letters.	862
Postal Cards.	420

1,282

Letters sent out:

Letters.	2,500
Circular Letters.	2,500
Postal Cards	2,000

7,000

ANNA BOTSFORD COMSTOCK.

Lecturer in Nature-Study.

JUNIOR NATURALIST WORK, AND UNIVERSITY TEACHING.

The work under my supervision in the College of Agriculture is twofold: Instruction in Nature-Study in the College and Extension Teaching.

In the Extension Teaching I have carried on the following lines of work during the past year. First, the Junior Naturalist Clubs, which during the year numbered 28,000 children. These clubs are organized as follows:

Public school teachers in New York State are requested to organize the children into clubs for correspondence work in Nature Study. The members of the clubs are known as Junior Naturalists.

Each Junior Naturalist receives an illustrated leaflet, issued monthly during the school year. The purpose of this leaflet is to interest him in his natural environment: the birds, the trees, the wild flowers, the crops, etc.

To every child who is an active Junior Naturalist for four months, sending to Uncle John one letter each month concerning some subject mentioned in the leaflets, we send a picture.

To the teacher who co-operates with us in this work, we send a picture suitable for hanging in the schoolroom.

During the past year the Junior Naturalist work has been more satisfactory than in any previous year. The letters from the children have shown more thought and more actual observation. From the children 20,896 letters were received on the following subjects: *Poultry, Teasel, Apple, Potato Bug, Weed Seeds, Terrarium, Pumpkin, Soil, Seeds, Berries, Indian Pipes, Study of Roots, Jack O'Lantern, Growth of Plant, Bird, Schoolhouse, Country Scenes, Nature-Study Library, Tracks, Evergreens, Snow Flakes, Home Making, Pigeons, Cocoons, Mice, Corn, Toads, Bluejays, Cats, A Little Chick's Hammock.* That some subjects are more popular with the children than others will be shown by the following report of letters by subjects as received from the children: Poultry, 1043; Teasel, 502; Apple, 1,132; Potato Bug, 73; Puzzle, 850; Vegetable, 1,220; Terrarium, 27; Pumpkin, 86; Soil, 939; Seeds, 8; Berries, 52; Indian Pipes, 52; Length of Roots, 50; Jack O'Lantern, 41; Growth of Plant, 156; Bird, 1,340; Schoolhouse, 306; View, 199; Library,

90; Tracks, 295; Evergreen, 51; Snow Flakes, 160; Home Making, 90; Pigeons, 87; Cocoons, 449; Mice, 660; Corn, 1,132; Toads, 329; Bluejay, 437; Cats, 165; Hammock, 50.

In the final issue of the Junior Naturalist Monthly a plan suggesting summer study relating to country life was published. Prizes were offered for the best compositions on these subjects. Following are a few of the letters that will illustrate observation along these lines:

1. *Prize offered for the best letter on birds.*

"Dear Uncle John:

"Last term our teacher started a Junior Naturalist Club and the last little paper I got there was offered prizes for the best composition on outdoor life.

"I have tried the best I could to write, I hope I will get a book. This is the first time I ever wrote to the Junior Naturalist Club.

"The History of Two Families of Birds in Our Orchard.

"In our orchard there is an old apple tree. The tree has been there about 25 years and blossoms about the middle of May. The blossoms are quite pink. The apples are good when they are ripe.

"This summer a family of robins built in this tree and also up in the other end of the orchard the family of black-birds built their nest. They went up to the very top up in the thick branches and built a nest of sticks and straws.

"The robins built their nest about 12 inches from the ground, in the crotch of the tree.

"The old birds brought straw and dry grass and strings. It took them about two days to do this, then the mother bird lined it with soft, dry grass and a few feathers. In about 5 days after I first saw them start to build the nest there was one egg in the nest. In three days there was three eggs in it.

"Then the mother bird began to set. She set about nine days and then there was one baby robin in it. The old ones fed it and worked to get enough for them and their baby bird. The other two eggs did not hatch and I took them out of the nest.

"One day I came home from school and found the baby bird had grown too big for the nest and had to sit on the edge of it.

"But meanwhile the other family of birds had hatched and the black-birds tried to get the little baby robin away from its parents.

"One night I was washing dishes and heard such a noise out in the orchard I ran out to see what it was. When I got there one of the black-birds had the little baby robin in its mouth and was flying away with it. I picked up a stone and threw it at it and hit it on the wing but it did not drop it so I had to let it go.

"I really think that the black-birds ought to be banished to the woods

like the crows. They do so much harm robbing song-birds' nests and eating the young birds.

"I am disgusted with them. I think they ought to be shot. This is not the only case I know of. They have often killed old birds on their nest while defending their little birds.

"I have no sympathy for them at all. They are thieves and robbers.

"Hoping my letter is not too long, I will close.

"From EDITH L. WRIGHT,

"Ogdensburg, N. Y."

Age 12 years.

2. Prize for best letter on country roadsides.

"Dear Uncle John:

"I have been studying the country roadside this summer and I thought I would tell you about it.

"The dandelions come about the first here. The flowers are of a yellow color. They grow very thick all over the hillsides and pastures and the roadsides. The next flowers that bloom, I think, were the buttercups and daisies. The buttercups grow quite tall and the flowers are yellow. The daisies grow quite tall also. They are yellow in the centre with a white frill around the edge.

"Then violets, strawberry, bloodroot and mandrake blossom. The violet is dark blue. These flowers are cousins to the pansy and look very much like it. The flowers of the strawberry plant are quite small and white. The plant is a sort of a vine that runs on the ground a short distance and roots start out along the vine. The berry is red and the seeds grow quite different from most plants. They are on the outside of the berry.

"The bloodroot is a white blossom but it grows a little higher than the strawberry. The reason it is called bloodroot is because when you break the stem there is a sort of juice that comes out and the color of the juice is reddish orange. The mandrake has a pretty flower.

"The thistle grows in pastures and roads. The leaves to it are a little different from most plants. There is sort of thorns on the edge of the leaves. The thistle has two different colors. They are purple or white.

"The clover is very common all over around here and the plant grows all the year.

"Forget-me-nots, wild roses and wild bluebells come about next. The forget-me-nots grow along in the little brooks that flow by the road. These flowers are very small and they are light blue.

"The wild rose is a pink or red flower. This flower has little thorns something like the thistle only this is woodlike.

"Bluebells grow in quite swampy places. The flower is described very well by its name for it is really a blue bell.

"The 'flower de luce' blossoms in the same place as the bluebell. It wants swampy ground.

"Then last of all come the goldenrod, Jacob's ladder or butter and eggs. The goldenrod is yellow. It grows taller than most plants.

"From your niece

"RUTH KIDDER

"Jamestown, N. Y."

Age 10 years.

3. *Prize for best letter on gardens.*

"My garden is located at the southwest corner of our house. It is about 3 by 14 feet in size.

"I planted it about the middle of May and sowed cosmos, asters, pansies, mignonette, bachelor buttons, petunias, dianthus, nasturtiums, and a wild garden. Also there is a queer little flower, that I do not know the name of and another strange flower.

"Then I had my gourd seeds to plant. There is a story connected with them.

"I put them in a little room in the rear of our house and left them there till I was ready to plant them. When it came time to plant them I picked up the envelope and saw it was all kerosene oil.

"Mother said this would kill the seeds and I felt very bad about it because I had never had any before, but I planted them in one corner of my garden. Then father came along and planted two rhubarb plants and the seeds were all mixed around for about a square foot.

"I had not looked at my garden for a couple of days and so I thought I would see the plants and also water them. So I went around and what did I see but two little shoots poking their heads above the ground. I watched them for a few days and when the leaves were large mother said they were gourds.

"They are now very large plants and three more have come up. My bachelor buttons are just blossoming and my garden is going to be a very pretty one.

"About a week ago my uncle came and my garden was not in very good condition then. He said, 'Come on and fix this garden up.' He said to get a spade and a basket. We did not have the right kind of a spade, and so I got the axe and asked if that would do, and uncle saying yes, we went to work. First I took the axe and trimmed it all around by cutting the sod off in a straight line, and doing this all around. Then I took all the grass and dirt and put it into the basket and carried it away. Then we weeded it all out and the most troublesome weed of all was the chickweed, next came the pigweed and the rest did not trouble me very much.

"There are lots and lots of butterflies around our house and they visit the flowers a good deal and the bees too. They come to get the honey out of the nasturtiums and other flowers. The plant lice trouble me a good deal by coming mostly on my poppies and swarming on the stems.

"When they do this I pick off the stem and put it into the fire so destroying the flower but getting rid of the pests. Another funny experience I had was this. I had picked off the stem to a weed and saw a very fat, green stem about one inch long and taking hold of it I was astonished to feel it move in my hands. Dropping it on the sidewalk I examined it and it proved to be a worm very fat indeed. I then stepped on it.

"No birds have yet visited my garden that I have seen. I expect to see the bluebirds again this fall. These birds come every fall and hopping on our clothesposts bid us goodbye with a song.

"DONALD HOMER TYLER."

4. *Prize for best letter on farm crops.*

"Dear Uncle John:

"As I have some spare time I will write a composition on the 'Farm Crops' to help in the work of Plant Life.

"The corn crop is the most interesting to me. We endeavor to top dress it in the winter and plow it in the spring. As soon as we get the sod plowed we fix it for the corn to be planted by the use of spring tooth harrow and roller.

"We roll the piece over once and then go over the field two times with a pee tooth harrow, then we roll it again.

"When we want a very good growth of corn and not such a growth of fodder, we plant it with a planter, and when we want a very large growth of fodder we plant it with a drill, the rows being three feet apart.

"We have a very good crop for our soil and climate. We sowed half yellow corn and half early white corn until mixed and still have continued to sow it.

"When it is up about four inches we commence cultivating it and we cultivate it about every three weeks until it is about thirty-four inches high.

"When the corn is ripe we go in with a corn binder and cut it, then we go along behind the binder and set the corn up in shocks containing bundles. We draw it down to the barn in three or four weeks.

"As soon as it is fit we husk it or shred it. It is not a very good plan to shred it unless you have a silo, for it will mold.

"Corn is raised chiefly in the central part of United States but there is some raised in the eastern part. Corn is used in fattening stock for market.

"E. CURRY WEATHERBY."

5. *Prize for best letter on brook.*

"Dear Uncle John:

"In the brook by my home there are many different fish. They are minnows. They are about three inches long. There are lots of tad-poles in the pond and poly-wogs are a plenty too. There are frogs and toads too. The frogs have green eyes and a brown back. The toads are all brown.

"There are crabs in the brook too. These crabs are very strong. When they get a hold of your finger you think they will never let go. They are a brown color. Some of them are black. Forget-me-nots grow all along the bank of the creek and wild sun flowers grow there too. All these fish, crabs, and flowers died because the brook dried up.

"Yours truly

"JOSEPH GARFIELD."

"This brook was called 'Swift Brook' by the Indians.

"It is about four miles long and twelve or fifteen feet wide in the widest place. The deepest place that I have found is not more than four feet deep.

"In the Spring it is so high that it washes the bridge away sometimes. Where the brook is widest there are falls different from any I have ever seen and difficult to describe. The water falls over rocks that resemble a broad staircase of the tiniest steps.

"The source is a spring. The bed is mostly smooth rock, too slippery to stand on. In lots of places the bank is steep and rocky with water trickling down the rocks.

"The trees near the brook are hemlock, beach, birch and maple. In one place a hemlock grew out over the water. It is dead now and another has grown out over the first.

"I have seen minnows in this brook and little water flies darting back and forth in the water.

"What I have written so far is about the brook in summer when the water is lowest. Now I will tell what I have seen in time of a flood.

"The water was muddy and roaring, at least four times as high as it usually is. It came over the road and washed one bridge away. The rain of a night and a day caused this.

"There is a lovely ravine that we drive through often. The road follows the brook for half a mile with the brook on one side of the road. A steep hill on the other side of the brook is covered with trees, shrubs and berry bushes. These hills are so steep and high that the sun only gets in at noon. There are several springs in this ravine, one of them a small one at the base of the rocks near the road where mamma used to drink when she was a little girl and went to school in the 'little white schoolhouse' at the other end of the ravine.

"Swift Brook empties into the Chenango River two miles south of Norwich.

"HELEN BURR."

6. *Prize for best letter on the potato.*

"The farm crop that interested me more than any other is potatoes. We planted eighteen acres.

"When the frost went out of the ground, we plowed the rest of the ground that we did not have time to plow in the fall. We dragged the ground three or four times. We marked the ground up and down the hill first. Then we marked the ground crossways. We dropped the potatoes from two and one half to three feet apart. We did not cut much seed. A man and two horses followed the man who dropped the seed and covered the potatoes. We had a few above the ground when the frost came. We recovered them. We started to cultivate our potatoes as soon as they became big enough so that we could see them. It rained almost all the time. When they got big enough we took the shovel plows and killed all the weeds that were in the hills. We went over them with a hiller killing all the weeds that the shovel plows did not kill.

"We began to spray potatoes July fifth. We sprayed until August twenty-first. The vines were almost dead by September first. We used three gallons of blue vitrol, seven pounds of lime, one quart of arsenic and salsoda to kill the bugs to fifty gallons of water. We commenced digging September twenty-first. The potatoes go from one hundred fifty to one hundred seventy-five bushels to the acre.

"DONALD TOX."

In order that the children might be encouraged to write to Uncle John, a small picture was offered to each Junior Naturalist who would study four selections from the *Junior Naturalist Monthly* and write an account of his observation on them.

During the past year I have had an opportunity, following lectures at Teachers' Assemblies and at Teachers' Institutes to learn much regarding Junior Naturalist work as it is followed in the schoolroom. It has been very gratifying to find that the teachers find it furnishes simple practical lines that can be followed by the teachers in public schools. I have found a large number of rural teachers who are able to use the leaflets and who have found them helpful.

During the past spring and summer some experimental work was done in school gardens under the direction of the Cornell University College of Agriculture. The movement was undertaken for two purposes: first, to give opportunity for practice work to the classes registered in the University in school gardening; secondly, to experiment in gardening for the benefit of the children organized throughout the State as Junior Naturalists and Gardeners.

The main effort in school gardens was expended in a garden supported by the City Improvement Society, the public schools and the University. There were on this plot of ground one hundred forty-four gardens, a few of which were planted by the teachers in the practice class, the remainder by the children in the public schools. The gardens were planned with the purpose in view of teaching simple principles of landscape gardening as well as giving instruction in planting and harvesting crops. It was hoped that the children would take a delight in the beauty of the place as well as in the growing of plants.

The important features of the garden were as follows:

1. An artistic sign-post built along architectural lines, painted in forest green with a touch of red, black and gold. This was much appreciated by the children and was in itself educational.

2. A building constructed for the purpose of having a vine-covered bower in which the children might find rest and shelter. It was furnished with seats and here the instruction in school gardening was given. The tools were kept in a piano box in the building and the top of the slanting cover of the piano box formed a place for a black-board.

3. In the centre of the lot a pool was made with a galvanized tank. It was surrounded by a circular seat. In the tank native water plants were grown and all aquatic animal life that the children found and cared to watch.

Each child had a plot of ground five by fifteen feet in which five kinds of vegetables and five kinds of flowers were grown. A second crop of radishes and lettuce was planted. The peas were followed by beans, radishes and lettuce by cabbages. There were three types of garden; the first and fourth garden being alike, etc.

Another garden managed by the College of Agriculture was taken up in connection with some mission work in the city. The garden was in one of the slum districts. It was laid out much on the same plan as the first described. To this garden, however, a playground was added which proved to be valuable in attracting the children to the garden. Once on the ground it was an easy matter to encourage them to work.

TWO-YEAR SPECIAL COURSE IN NATURE-STUDY.

This course is designed to help persons who expect to teach nature-study and county-life subjects in the public schools. Persons actually engaged in teaching and also all persons in the University who signify their intention to teach are eligible. A certificate will be given on the completion of 60 hours in the courses prescribed below, together with such other work in the College of Agriculture as may be approved by the Director.

(a) SUBJECT-MATTER COURSES.

- Botany 1, 2, 3 hours, throughout the year.
- Botany 5, 2 hours, second half-year.
- Invertebrate Zoology 1, 2 hours, first half of first half-year.
- Entomology 3, 3 hours, second half-year.
- Entomology 15.
- Systematic and Economic Vertebrate Zoology 6, 3 hours, throughout the year.
- Physical Geography 1, 3 hours, throughout the year.
- Soils 1, 3 hours, first half-year.
- The Homestead 61, 2 hours, first half-year.

(b) LABORATORY PRACTICE IN NATURE STUDY.

- 91. *Nature-Study*. Lectures and discussion of methods. Second half-year. Credit, 3 hours. M., W., F., 12, *Insectary*. Mrs. COMSTOCK.
- 92. *Home Nature-Study Work*. Work in the training classes in the Ithaca schools in which students are also to take part. Second half-year. Credit, 1 hour. By appointment. Mrs. COMSTOCK.
- 93. *Practice Work in Nature-Study* in the public schools of Ithaca, com-

prising school room work, excursions, and other exercises with children. First half-year. Credit, 2 hours. By appointment. Miss McCLOSKEY.

94. *School Gardens*, comprising actual garden making with children on school grounds and in the University school gardens. In winter the work will be conducted in the forcing houses where plant growing subjects will be taken up in such a way as to adapt them to elementary school conditions. Second half-year. Credit, 2 hours.

99. *Nature-Study*. Advanced course. Individual work on special problems. Registration only after consultation. Mrs. COMSTOCK and Miss McCLOSKEY.

Students are requested to attend Professor DEGARMO'S "Philosophy of Education," Course I. Attention is also called to the summer work in entomology.

For the past two years courses 93 and 94 have been given in the College of Agriculture. These courses give the Nature-Study students an opportunity for practice work with school children. The Superintendent of City Schools has co-operated in this movement and opened the public schools as laboratories. Thus far the work has been satisfactory.

In Course 94 all students have an opportunity to become familiar with garden practice. They grow the common flowers and vegetables in gardens of their own and assist the children in the school gardens.

ALICE G. McCLOSKEY,
Assistant Supervisor in Extension Department.

Statement of the Scheme of Expenditures under the State Appropriation for the Extension of Agricultural Knowledge for the Year ending September 30, 1906.

Salaries.....	\$20,430
Office, Printing and Special Investigations.....	5,000
Nature-study.....	2,800
Home Nature-study.....	1,000
Farmers' Reading-Course.....	1,500
Farmers' Wives' Reading-Course.....	1,500
Entomology.....	500
Animal Husbandry.....	600
Agriculture and Chemistry.....	1,000
Botany.....	300
Horticulture.....	800
Dairy Industry and School.....	3,000
Poultry.....	1,020
Survey of Tompkins County.....	350
Reserve.....	200
	<hr/>
	\$40,000

Appropriation of \$10,000, made in 1905, "to aid in extending the Reading-Courses and the Free Winter-Courses for Farmers' Sons and Daughters."

Extension of Reading-Courses.....	\$2,036 93
Extension of Winter-Courses.....	215 02
Home Economics.....	2,408 50
Dairy Industry.....	999 45
Animal Husbandry.....	399 97
Horticulture.....	224 37
Poultry Husbandry.....	996 60
Agronomy.....	25 55
Office.....	106 04
Balance remaining October 1, 1906.....	2,587 48
	<hr/>
	\$10,000 00

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CORNELL UNIVERSITY
AGRICULTURAL EXPERIMENT STATION OF
THE COLLEGE OF AGRICULTURE
Department of Entomology

TWO NEW SHADE-TREE PESTS:

SAWFLY LEAF-MINERS ON EUROPEAN
ELMS AND ALDER



By **M. V. SLINGERLAND**

ITHACA, N. Y.

PUBLISHED BY THE UNIVERSITY

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The regular bulletins of the Station are sent free to persons residing in New York State who request them.

I. A EUROPEAN ELM SAWFLY LEAF-MINER

Kaliosysphinga ulmi Sundeval

The American elm often develops into the most beautiful, majestic and graceful of shade-trees. It usually suffers less from insect foes than most other shade-trees. The English and Scotch elms and their varieties also have been largely planted for shade-trees in many parts of this country, and for a long time they were equally as free from insect deprecations as the American elms. In comparatively recent years, however, several of the insect enemies of the European elms in their native home have become established in America.

The European elm leaf-beetle (*Galerucella luteola*) has been ravaging elms, mostly the European species, for nearly 70 years, and is doubtless now the most serious elm pest in New York and neighboring States (Fig. 22). Since 1884, European elms in widely scattered localities in the United States, and especially in New York, have suffered from the European elm bark-scale (*Gossyparia ulmi*). In 1896, my attention was called to little case-bearing caterpillars (shown in



FIG. 22.—Elm leaf-beetle larvæ at work. Natural size.

Fig. 23) working on European elms in Brooklyn parks. The insect is apparently another importation, the European elm case-bearer (*Colcophora limosipennela*), and it is spreading and increasing its injuries.

I must now add to this list another serious insect enemy which has followed the European elms to America. This new elm pest is a near relative of the alder sawfly also discussed in this bulletin. It "blisters" and kills the leaves and thus far works almost entirely on English elms (*Ulmus campestris*), and Scotch elms (*Ulmus scabra* or *montana*), including the "Camperdown" variety.

Historical.—Apparently the first and only record of this new elm pest in America is the following brief note by Dr. Felt in 1898 (Bull. 17, U. S. Div. of Ent., p. 21; 14th Rept. of State Ent., 237): "An elm leaf-miner. This insect has been unusually destructive in Albany and Troy the present season. For the past three years the Camperdown elms in Washington Park, Albany, have suffered rather severely from this species.



FIG. 23.—A European elm case-bearer at work on an elm-leaf from Brooklyn parks. Natural size.

The present season the miner not only seriously injured the Camperdown elms but extended its ravages to the English, Scotch and American species. From half to two-thirds of the leaves on certain English elms in Troy were nearly destroyed by this insect, and many others presented a sorry appearance on account of the numerous mines."

In July, 1899, I received from New Brighton, N. Y., "blistered" leaves from a Camperdown elm, which had been nearly defoliated. Only the dried remains of a few larvæ remained in the "blisters" and it was not until 1901 that I got living specimens of the depredator. It was then found that a group of Scotch elms on the Cornell University Campus had been seriously infested for several years by a similar insect. The adult insect was not found and attempts to breed it in 1903 failed, and it was

not until May 27th, 1904, that I first saw the adult insect which was then present on the elm leaves in large numbers. The pest is evidently the common elm sawfly leaf-miner of Europe, *Kaliosysphinga ulmi*, Sundeval.* I have found the insect working on the European elms scattered through the city of Ithaca, and it is apparently on the increase. It doubtless occurs in most localities in New York, and perhaps in other States, where European elms are planted. The insect must have been in this country at least ten or fifteen years.

In England and Scotland, this elm pest is common but apparently rarely does noticeable injury. It is also widely distributed through Sweden, Germany, France, and Russia.

The insect.—The adult insect (Fig. 27) is a small, shining-black sawfly measuring about three millimeters in length, with its wings projecting beyond the body a little. The wings expand to about eight millimeters across. The antennæ and femora are black and the remainder of the legs are light brown with a blackish tinge. The wings are considerably clearer than those of the alder sawfly (Figs. 27 and 28). The saw-like ovipositor of the female is shown in Fig. 27.† The eggs are stuck into the elm leaves (Fig. 25), and the tiny whitish larvæ which hatch therefrom begin life at once as miners, finally consuming practically all of the interior tissues of the leaf over an area about half an inch in diameter. Full-grown larvæ measure about seven millimeters in length, and several are shown in Fig. 24. I found no striking characters for distinguishing them from their near relatives working in alder leaves.‡

* This species was described in 1847 by Sundeval (Forhandl. red de Skand. Naturforsk. Christiana, pp. 240, 241). For other European references see Dalla Torre's *Catalogus Hymenopterorum*, Vol. 1, p. 158, and Cameron's *Mon. British Phyt. Hym.*, Vol. 1, p. 295. This species is easily separated from the others in the same genus by the position of the radial cross-vein as given in Konow's Table on p. 59, and which can be readily seen by comparing the wing venation in Figs. 3 and 8.

† It is an interesting fact that every specimen of over 125 of the sawflies collected one day on elm leaves at Ithaca, N. Y., were females. Further collections gave similar results; I have seen no males during two seasons' observations. Cameron says the males are "similar, but with thicker and longer antennæ, the joints from the fourth being perceptibly thicker than the basal ones." Brischke says (Beob. Arten der Blatt und Holzwespen, 1883, p. 261, as *intermedia*) in his brief account that he knew only the females.

‡ The very young larvæ are said (Healy in *The Entomologist*, for 1896, p. 298) to have a large dark spot on the venter of the first thoracic segment, with two small brown dots on each side and a small black dot on the venter of the remaining body segments, except the last. But at the first moult these decorative markings are all thrown off. The full-grown larva is distinctly segmented and of a whitish color with the green food particles giving it a greenish tinge. The much flattened head is light brown with mandibles darker. The six true legs are slightly brownish and are little used, the larvæ moving about in their mines with a wiggling motion of the whole body. Rudimentary pro-legs are present on segments 5 to 12.

The full-grown larvæ eat through the epidermal floor or roof of their mines and drop to the ground where, about an inch below the surface, they make small, thin, elongate, cylindrical, brown, papery cocoons in which they transform early in May, through tender, whitish pupæ into the black adults or sawflies.

Food plants.— In Europe this insect is recorded as feeding on English and Scotch elms. In this country, Dr. Felt reports it on these trees and on American elms also. On the Cornell Campus there is a case where American and Scotch elms grow so near that their branches often mingle, and although the sawflies are often seen on the leaves of both trees, yet not a leaf on the native trees are "blistered" by the insect while the foreign trees are badly infested. In this locality the American elm seems to be almost entirely exempt from the pest. The Camperdown variety of Scotch elms is often infested.

Work and destructiveness of the insect.— Its work is quite conspicuous, as is shown in Fig. 26. Twenty or more of the larvæ often mine in a single elm leaf, and their mines soon coalesce forming a large "blister" often involving the whole leaf. Many mines just begun are shown in the leaf in lower left-hand corner of Fig. 26, and larvæ can be seen at work in larger mines in the leaf in the right-hand corner of this figure. Oftentimes a mine begun near the midrib of the leaf is confined to the area between two large veins until it gets nearer the outer edge where it extends under the smaller veins or into neighboring mines. The whole interior of the leaf is eaten, leaving only the outer epidermis which soon turns brown. The "blisters" are nearly as conspicuous from the lower as from the upper side of the leaf. The mines of its near relative in alder (Fig. 29), scarcely show from the underside of the leaf, possibly because the alder leaf seems thicker than the elm.

In July, after the larvæ leave the "blisters" on the elm leaves, the mined areas bleach out to a dirty whitish color, shrivel and curl. The picture of an infested branch in Fig. 26 was taken at this stage. Unless the leaves are wholly mined out, most of them remain on the tree a considerable time longer, the mines often becoming holes. Infested trees present the worst appearance about July 1st, or soon after the larvæ disappear. As many of the leaves drop off as the new growth comes on, and as no other broods of the insect appear, the infested trees begin to recover by the end of July, and by September 1st, trees which were badly infested in July often show but little signs of the insect's work to the casual observer.

I have seen small trees almost defoliated, and thus stunted and rendered unsightly by this sawfly miner, and from one-half to two-thirds of the leaves on several large trees on the Cornell Campus have been badly infested for several years. These large trees present a very ragged

and unsightly appearance about July 1st, but in two months have nearly recovered their beauty. The insect is thus capable of defoliating and checking the growth of young trees, and of rendering large trees unsightly for a time in midsummer.

Its life-history and habits.—In 1869, Healy recorded (The Entomologist, Vol. IV, p. 297) many interesting details of the life of this sawfly, and the European literature contains but few additional notes.

After July 15th, I have not found the insect on the trees again until the next May. In July the larvæ which mined the leaves go into the ground beneath the trees for a short distance, an inch or less. There they

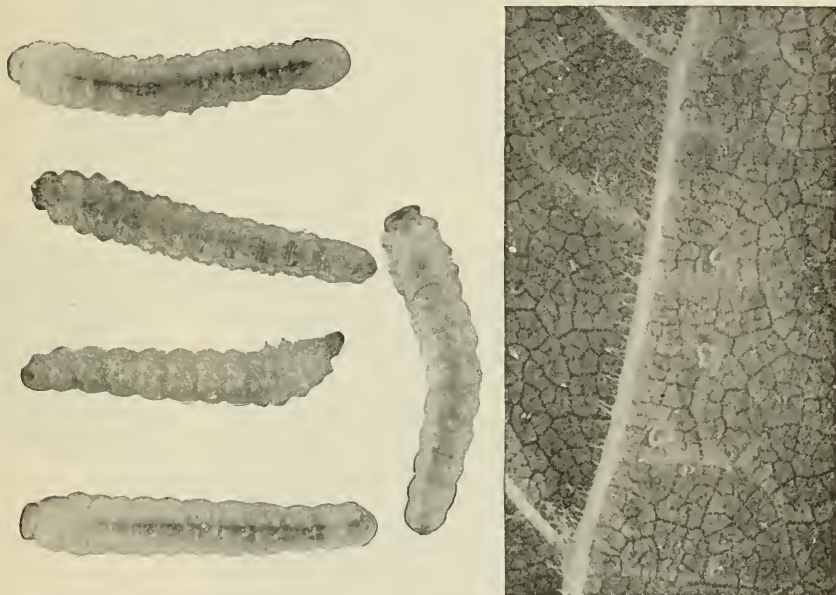


FIG. 24.—Larvæ of elm sawfly leaf-miner, much enlarged. This figure also serves for the alder sawfly larvæ, as the two species are much alike in this stage.

FIG. 25.—Three eggs of elm sawfly leaf-miner stuck in leaf. Much enlarged.

make small, thin, brown, elongate, papery cocoons in which they remain as larvæ for nearly ten months, or until late in April. About May 1st, they transform through tender pale-yellowish pupæ, apparently in about a week, into the black adults or sawflies which begin to emerge about the middle of May. Many had emerged by May 10th, in 1905.

On May 27th, 1904, I found hundreds of the flies on the elm leaves. About 1:30 P. M. only a few of the flies were seen, but at 3:00 P. M. when it was more sunny, they were very numerous. The flies are almost invariably on the upper surfaces of the leaves and are so "tame" that



FIG. 27.—*The European elm sawfly.* The saw-like ovipositor projects from the abdomen of the lower sawfly. The flies are shown much enlarged, as they measure only 3 millimeters in length.

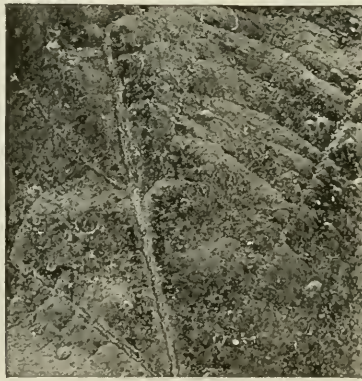


FIG. 28.—*The European alder sawfly and its eggs stuck in leaf (above), both much enlarged; the fly measures only 3 millimeters in length.*



FIG. 26.—Work of the European elm sawfly leaf-miner. The branch was taken from a badly infested tree in mid-summer after the miners had left; it well illustrates the destructive work of the insect (about half natural size). The leaf in lower left-hand corner shows many mines just begun in it, and the leaf in the opposite corner shows nearly full-grown larvae at work in their mines (both leaves slightly reduced.)

one can often pick them up with the fingers and easily collect them in cyanide bottles. None have been seen mating and I have found no males. When disturbed, they fly but a short distance, so that the insect spreads slowly.

The round, thin-shelled, milky-whitish eggs about .3 mm. in diameter are stuck into the leaves, often near the midrib, through slits cut with the female's saw-like ovipositor (Fig. 27). The location of the eggs is more readily determined from the under side of the leaf where pimple-like elevations of the epidermis appear in two or three days over the eggs, as shown in Fig. 25. But the eggs are stuck into the leaves from the upper side, as I observed repeatedly, the ovipositor evidently reaching nearly to the lower epidermis. It requires from forty to sixty seconds to lay an egg. The eggs hatch in about a week. Many larvæ had begun their mines by May 18th in 1905. I have found forty-three unhatched eggs and at least twenty-five mines just begun in a single large elm leaf (Fig. 26).* I have not found any characters which will readily separate the nearly-grown larva of this elm sawfly from those of the alder sawfly discussed on page 134.

On May 27th, 1904, I found on the Scotch elms on the Cornell Campus many of the sawflies, many recently laid eggs and many larval mines just begun in the leaves. By June 1st, some of the larvæ were nearly grown, and on July 4th practically all had left the leaves, no stage

* The following interesting details of the larval stages are quoted from Healy's account (*The Entomologist*, IV, 298). "The larva has a white body, and is in possession of 22 legs, the first six of which are annulated with dark brown; the claws are also dark brown; the head is tinged with pale brown of a darker tone at the sides, mouth reddish brown, eyespots brown, and its dorsal vessel is dull green; the under side of the second segment has a dark, oblong-shaped plate down its center, and on either side of this there are two brownish dots; on running our eyes down the remaining segments we observe that, excepting the anal segment, all are furnished with a small black-colored dot; the fifth segment has no organs of progression. At the first moult the decorative markings of the larva are all thrown off, and if at that time we closely inspect the under surface of the body we perceive a slight remnant or pigmentary deposit on the segments situated as the exact spots where the black ventral dots were located previous to the moult; these dusky marks, however, soon fade away, and leave the segments entirely spotless; the head and eyes slowly resume their original color, and the six thoracic legs regain their annulations. When full-fed it ceases to feed, and lies in its mine in a state of repose, and throws off its skin for the last time; by and by a faint yellowish tinge spreads itself over the body of the larva. At the appointed time the larva liberates itself from its mine by biting a hole in it. At the last moult the brown-colored bands on its six anterior organs of locomotion are thrown off entirely. Escaping from its mined abode, the little creature drops to the ground, and now, every time it is touched, it instantly partially curls its body up, remaining in that position only for a moment or two."

of the insect being found on the trees. The larvæ (Fig. 24) apparently live as miners in the leaves for about three weeks when they moult for the last time, bite through the roof or floor of their home and drop to the ground. Burrowing in an inch or less, they soon make the thin, brown, papery cocoon in which they remain in hibernation as larvæ for about ten months, or until the next May.

There is thus but one brood of this elm sawfly in a year, its destructive period being the month of June, but many of the "blistered" and unsightly leaves remain on the trees as mementoes of its work until autumn.* It is a fortunate provision of Nature that there is but a single brood of this pest in a season, otherwise it would certainly defoliate badly infested elm trees, which now have a chance to largely recuperate and regain their beauty before autumn. The single-brooded habit of this elm sawfly is in striking contrast to the three or more broods of its very near relative, the alder sawfly miner, discussed on page 134, which continues to work on the alder leaves from May until October.

Remedial suggestions.—The suggestions given on page 135 for controlling the closely allied alder sawfly will also apply to this elm sawfly miner.

Last autumn a treatment that doubtless materially reduced the numbers of these sawflies was unwittingly applied to some of the worst infested elm trees on the Cornell Campus. In grading, several inches of new soil was spread over the ground beneath the infested trees. Apparently many of the little sawflies failed to emerge through this layer of soil in the spring. As practically all of the sawflies transform within an inch of the surface immediately beneath the infested trees, it would be practicable in some cases to apply a layer of soil several inches thick under the trees in autumn and remove it about June 1st, or after the time for emergence of the sawflies. Whenever practicable, however, I would advise the removal or spading under and packing down of the sod from beneath the trees as described on page 135, for I think this method is more effectual.

Last spring other peculiar conditions occurred in the clump of badly infested European elms on the University Campus. It was the fruiting season for several of the trees and they bloomed and fruited profusely. This process delayed the appearance of the leaves until after most of the

*Healy states (The Entomologist, IV, 298) that in England there is only one brood during the season, and that by the end of June they are all under ground. Cameron states, however, that he has captured the flies in August in England (Mon. British Phyt. Hym., Vol. I, p. 296), and intimates that there is probably an autumnal as well as a spring brood, but Cameron's experience must be very exceptional.

sawflies had emerged and laid their eggs, which they were thus forced to do in the leaves of the few non-fruiting trees. Had many of the worst infested branches on the larger trees and the smaller crowded and stunted trees been removed early in June, and their hordes of sawfly larvæ left to dry up and die in the leaves, the infestation could have been still further checked, but it was delayed and finally never done. Whenever practicable and advisable, this pruning of infested branches early in June should be done, as it will materially aid in controlling the pest. As a result of the earth-mulch or earth-smothering treatment and the delay in appearance of the foliage due to the fruiting of several of the trees, the infestation in 1905 was concentrated on fewer trees and was not so severe as during the previous year.

II. A EUROPEAN ALDER SAWFLY LEAF-MINER

Kaliosysphinga dohrnii Tischbein

The European alder (*Alnus glutinosa*) and its cut-leaved varieties are often planted as ornamental trees in America where they have become naturalized in some localities. In Europe the leaves of this alder are preyed upon by several insects, and at least one of these enemies has been injuring these trees in America for several years.

In June, 1891, a nurseryman at Newark, N. J., sent me several leaves of European alder with large brown patches or "blisters" on the upper side, as shown in Fig. 29. I soon found that a large tree on the Cornell



FIG. 29.—Work of the European alder sawfly leaf-miner. Several larvæ lived in the brown blisters or mines. Nearly natural size.

University Campus, and one tree of the cut-leaved variety near the Campus also bore many of these "blistered" leaves. There were several small larvæ living in each large "blister" which they had caused by mining in the leaf just under the upper epidermis. The half dozen European alders planted on the Campus in later years were soon infested by the insects, and during the past season many of the leaves on these trees were so badly "blistered" that the ground beneath was strewn with the brown, dead leaves, and the trees presented a very ragged appearance from July till autumn. Thus the insect is capable of seriously injuring these desirable ornamental trees. A study of the life and habits of this alder pest was begun in 1891, but was interrupted for several years, and finally completed during the past year.

The insect.— Within the brown mines or “blisters” on the leaves may be found in summer from one to a dozen or more slender, whitish larvæ or “worms” (Fig. 24), varying from 2 to 7 or 8 millimeters in length. When full grown, these larvæ leave their mines and drop to the ground. An inch or less below the surface of the soil they make a small, thin, brown, papery cocoon to which particles of soil adhere. In this cocoon the insect transforms through a tender, white pupa into the small, black four-winged sawfly shown much enlarged in Fig. 28. In this adult form the insect’s body and head are shining black, and measure about 3 millimeters in length; when the wings are folded they extend about a millimeter beyond the tip of the abdomen. When expanded, the front wings measure about 8 millimeters across. The antennæ and femora are black and the tibiæ and tarsi are light brownish with blackish tinge, especially on the hind legs. The wings are quite dusky, considerably more so than those of the elm species herein described. These two species are easily distinguished by the position of the radial cross-vein (compare Figs. 27 and 28) as indicated in the table* for separating the species of

*The following table for separating the species of the genus *Kaliosysphinga* is given by Konow, the European expert in this group of insects (Wien. Ent. Zeitung, Vol. V, p. 269, 1886):

- A. The radial cross-vein meets the second cubital cell just before the second cubital cross-vein — 1. *ulmi* Sundeval (= *intermedia* Thoms).
 AA. The radial cross-vein lies behind the second cubital cross-vein.
 B. Third antennal joint twice as long as the fourth which is distinctly shorter and thinner than the second — 2. *pumila* Klg.
 BB. Third antennal joint only about a half longer than the fourth.
 C. Fourth antennal joint scarcely longer and a little thinner than the second, the third a good half longer than the fourth; wings clear — 3. *dohrnii* Tischb.
 CC. Fourth antennal joint plainly longer and thicker than the second, the third scarcely a half longer than the fourth; wings very dark — 4. *melanopoda* Cam. (= *nigricans* Thoms).

In a foot-note Konow says: “*Dohrnii* is very nearly related to *melanopoda* and only by a close observation of the characters given can it be separated; moreover, it is always somewhat smaller, hardly 3 mm. long, while *melanopoda* is somewhat longer.”

But in his description of *melanopoda* and in his table for separating it from its allies (Mon. of British Phyt. Hym., Vol. 1, p. 292, 1882) Cameron states that the third antennal joint is “more than double the length of the fourth” which would put it in B instead of BB in Konow’s table. Cameron mentions *dohrnii* only in a foot-note (l. c. p. 291) saying that the description of it, so far as it goes, agrees with either *pumila* or *melanopoda*.

The sawflies I bred on European alder in 1891 were determined by Konow (in 1896) as *Kaliosysphinga dohrynii* Tischbein (Stettin. Ent. Zeit., VII, 1846, p. 80). What is probably the same insect has been recorded several times in American literature under the names *melanopoda* Cameron (Can. Ent., XXIII, p. 252) and *varipes* St. Fargeau (Can. Ent., XXV, 59 and 247; Fletcher’s Rept. for 1892, p. 147).

this genus of sawflies. The females are provided with a saw-like ovipositor, shown in Fig. 27, with which their eggs are laid in the leaves.

Historical Notes.—This insect was first described in Germany in 1846, but it is apparently not a pest and has attracted very little attention in Europe.* Just when this sawfly miner was introduced into America is not known; but it was doubtless at least twenty years ago. For I found it in injurious numbers at Newark and Ithaca in New York in 1891, and the same year, Dr. James Fletcher, the Canadian entomologist, reported a serious outbreak of what was probably the same insect, which “for three years had entirely spoilt the appearance of the European alders upon the grounds of the Experimental Farm at Ottawa” (Can. Ent., XXIII, 252). The insect was also reported as working on native alders in a swamp near this Experimental Farm in 1893 (Can. Ent., XXV, 59, by Harrington); and the same year an American alder, *Alnus rugosa* (*scrrulata*), at Woods’ Holl, Mass., suffered seriously from this pest (Can. Ent., XXV, 247, by Dyar). I have found no other references to such an alder enemy in American literature. If it is the same species, which is quite probable, that has been working on both European and native alders in such widely separated localities from Massachusetts through New York into Canada for ten years or more, doubtless it is now widely distributed over this country. In Europe it is recorded as working on *Alnus glutinosa* and *incana*; the former species in its many varieties is now widely planted in America, and *incana* is the common native alder along our northern streams.

Its work.—The work of this alder sawfly is conspicuous and easily recognized. It is well shown in Fig. 29. Small brown spots first appear on the upper sides of the leaves where a single larva has begun its mine. As the larvæ feed and grow, the brown “blisters” increase in size and often several of them join and form one large “blister” which may involve nearly the whole leaf and contain 15 or 20 larvæ. The mines are just beneath the upper surface of the leaf which is thick enough so that the work of the insect scarcely shows on the undersides of the leaves.

Throughout the season, the infestation begins on the newest or youngest leaves. Badly infested or “blistered” leaves die and drop off, thus spoiling the ornamental effect of the trees, and checking their growth.

According to Dalla Torre’s Catalogue (1894), pp. 122 and 287, Lepeletier (Count of St. Fargeau) described two sawflies as *varipes*, now placed in the genera *Emphytus* and *Priophorus*. One of these is considered a variety of *E. tibialis* and the other an aberration of *P. padi*. As neither of these species work on alder, it is at least very doubtful if Harrington was correct in designating the species injuring alder in Canada as *Fenusa varipes* St. Fargeau (*melanopoda* Cameron).

*Apparently the only account in Europe of its life and habits is a paragraph by Brische in 1883. (Beobach. Arten der Blattund Holzwespen, 2nd Abth., 261 (as *Fenusa pumila*) in which the life and habits in late summer are briefly described,

The life-history and habits of the insect.—As late as October a few of the larvæ were making their characteristic mines and brown "blisters" on the leaves of the trees on the Cornell Campus. The winter is passed as larvæ tucked away in their little, brown, elliptical, papery cocoons mostly about half an inch below the surface of the soil beneath the infested trees. In May these hibernated larvæ transform, in about a week, through tender, pale yellowish pupæ with brownish-black eyes into the shining black adult insects or sawflies. The adults usually begin to emerge by May 15th, and begin laying eggs at once. On June 8th in 1904, I found many of them busy laying eggs in the younger leaves, and a few larvæ had already nearly completed their mines. I have never seen the flies mating, and have found no males. Thus the insect seems to breed parthenogenetically. A small, thrifty tree which was putting out much new growth in 1904, was severely attacked in June while older trees nearby suffered but little, until about a month later.

The egg is about .3 mm. in diameter, round, thin-shelled and of a delicate milky-white appearance. The female sawfly saws a slit in the leaf from the upper surface and tucks her egg in just under the upper epidermis of the leaf. Most of the eggs are laid in the central portion of the younger leaves between the larger veins. It requires about a minute to lay an egg. Over the egg the surface of the leaf is slightly elevated and turns yellowish, thus enabling one to easily locate the egg (Fig. 28); this is more distinctly seen from the upper surface of the leaf. Evidently the eggs hatch in a few days and the little larvæ begin their life as miners.

The greenish-white, slightly flattened, distinctly segmented larvæ with light brownish heads and short apparently useless legs are shown much enlarged in Fig. 24. The duration of the larval period I have not determined, but it is probably about three weeks.* One larva mines over an elongate area, about the size of a one cent coin, which is often bounded by two large veins for some distance before it merges into a neighbor's mine (Fig. 29). Frequently the rusty brown "blisters" or mines of ten to twenty larvæ coalesce and involve nearly the whole leaf, which soon

* Dyar has described in detail six larval stages (Can. Ent., XXV, 247). In the fifth or last feeding stage, the larva is translucent whitish with a greenish tinge from the food, and it measures 6 to 7 mm. The head is much flattened and of a light brown color with the mandibles and ocelli darker. The true legs, the ventral surface of the first thoracic segment, small spots on the venter of the other thoracic segments, and the cervical shield are brownish. The abdominal legs are rudimentary and present on joints 5 to 12. No tubercles or setæ are distinguishable. I have found no striking differences between these larvæ and those of the European elm sawfly leaf-miner, *Kaliosysphinga dohrnii*, therefore Fig. 24 may represent both species,

dies. The excrement and cast skins of the larvæ are left within the mines. When full grown the larvæ burst through the upper epidermis of the leaf or the roof of their home, and fall to the ground into which they work themselves for a short distance, usually about half an inch, sometimes an inch, and there make their thin, brown papery cocoons. In summer they soon transform in these cocoons, probably in a week or two, into the black sawflies.

Eggs are soon laid and another brood of larvæ begin their destructive work of "blistering" the leaves. I have not been able to determine definitely the number of broods of this sawfly which develop during the growing season, as the broods overlap, but there are at least two or three broods, perhaps more. Beginning in May, their work continues throughout the summer until October in this latitude. After about June 1st, I have found the insect in all stages on or under the infested trees almost any day until September. This is in striking contrast to the well defined, one-brooded life of its near relative, the elm sawfly, herein discussed.

The insect hibernates as a larva in the soil near the surface in its brown, papery cocoon, the transformation to the pupa occurring in May. Thirty-one cocoons were found in an area of only four square inches under a small tree last May.

Remedial suggestions.—During the past season I have tested a simple, practicable, and effective method for controlling this insect. Finding that it hibernates within an inch from the surface of the soil, I buried several cocoons at depths of two, four and six inches. But very few of the flies emerged from any of the buried cocoons. A thin layer of the sod beneath the infested trees was at once removed and should have been carried away promptly, but it was delayed until many of the flies emerged. Thus the infestation was not checked so completely as it should have been, but the trees are not nearly so badly injured this year as in 1904.

By promptly removing about one or two inches of the sod or soil from beneath trees infested by the insect about May 1st, and carrying it to a considerable distance or burying it, this insect can be easily and effectively controlled. By thus preventing the emergence of the spring brood of sawflies, the development of succeeding broods is stopped. In many cases, it would doubtless be practicable to simply spade under the sod to a depth of six or eight inches, and pack it down hard. Care should be taken to remove the sod over an area extending a foot or two beyond the circle bounding the points to which the longest limbs reach. Thorough and prompt burying of the cocoons in this manner about May 1st, will control this sawfly miner and preserve the beauty of this desirable European tree,

CORNELL UNIVERSITY
AGRICULTURAL EXPERIMENT STATION OF
THE COLLEGE OF AGRICULTURE
Department of Entomology

THE BRONZE BIRCH BORER:
AN INSECT DESTROYING THE WHITE BIRCH



An infested birch in one of the Buffalo Parks

By **M. V. SLINGERLAND**

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THE BRONZE BIRCH BORER

Agilus anxius Gory

Order COLEOPTERA; family BUPRESTIDÆ

The birch trees with their graceful habits, their slender, often pendulous branches, and their picturesque trunks are conspicuous features of any landscape. The European white birch in its various weeping and cut-leaved forms has been extensively planted in American city parks and private lawns. Its artistic beauty, with its silvery stemmed branches and fluttering leaves "floating at the discretion of the winds" makes the white birch a constant source of delight both in summer and winter. As compared with the elm or maple, the white birch is considered a short-lived tree, but they frequently survive to grace a landscape for thirty years or more.

It is with much regret, therefore, that this Experiment Station finds it necessary through this bulletin to announce to lovers of these beautiful white birches that a deadly insect enemy has recently appeared which is fast destroying these trees in city parks and on home grounds. Hundreds of the finest specimens of these graceful trees in Buffalo, (see frontispiece) Ithaca and other cities and towns of New York have succumbed to this enemy within the past eight years. About half of the score of white birches on the Cornell University Campus (Fig. 34), some of them over thirty years old, have been killed by the insect within three years; and several of the remaining trees are infested and will not survive more than a year or two. These facts demonstrate the seriousness of the situation, and demand that city authorities and private owners of these valuable trees acquaint themselves with the details of the work and life-habits of this insect so that remedial measures may be promptly and judiciously applied.

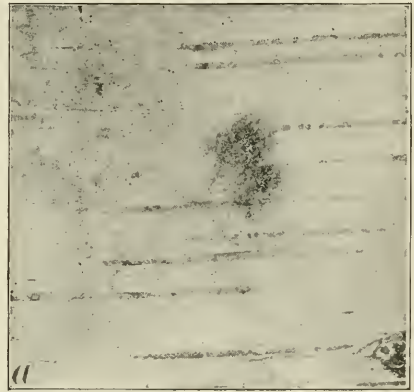


FIG. 30.—*a*, Characteristic rusty brown spots on bark over the borer in autumn, natural size; *b*, birch branch showing the peculiar ridged effect over the burrow of borer, reduced in size.

INDICATIONS OF THE INSECT'S PRESENCE

The presence of this insect in birch trees is not easily determined until it has been at work for a year or more. The first intimation one usually has of its presence is the dying of some of the top branches of the tree. This is well shown in the frontispiece and in Fig. 34. This dying of the tops of the trees has been very characteristic of the work of this pest wherever I have seen it in New York. The whole tree often succumbs in another year or two. Rarely the trees might begin to die at the top from a condition known as "stag head" caused by lack of moisture and food materials. A careful examination should readily locate the borer if it is the culprit. Some have tried to save a tree by pruning out the dead branches or top, but without avail, for by that time the whole tree usually is infested.

Sometimes one can determine in autumn whether a tree is infested by this insect, even before any branches have been killed. Characteristic reddish or rusty brown spots or discolorations, as shown at *a* in Fig. 30, often occur on the white bark of the trunk and larger branches at the point where the insect is preparing to hibernate and transform in the wood beneath. Usually the insect can be easily located by cutting through the bark and into the wood beneath these rather conspicuous spots.

Another peculiarity which characterizes the work of the insect is the ridge which often develops in the bark over the burrow on the branches, as shown at *b* in Fig. 30.

Thus, while the insect works in rather an obscure manner, it indicates its presence in the above described characteristic and sometimes conspicuous ways. Unfortunately, however, it is usually then too late to save the tree, but much can be done to prevent further infestation of other trees.

CHARACTERISTICS OF THE ENEMY

This destroyer of white birches is a small, slender, olive-bronze colored beetle nearly half an inch in length (7.5-11.5 mm.), as shown in Figs. 31 and 35. *Its general color and the fact that it works mostly in birch trees suggested the good popular name of Bronze Birch Borer for the insect. However, it is not in this adult or beetle stage that the insect is destructive. It is injurious only during its life as a larva or grub when it is a borer.

*Chittenden (Bull. 18, U. S. Div. of Entomology, p. 47) technically describes it as "of moderately robust form, subopaque, olivaceous bronze in color. The last ventral segment is oval at the apex; the punctuation of the prothorax is transversely strigoso-punctate, and its posterior angles are carinate in both sexes; the first ventral segment in the male is broadly grooved; the second more deeply, the groove being narrow and smooth (see *b* in Fig. 31). The serration of the antennal joints begins with the fourth joint. The elytra bear each a rather vague longitudinal costa and the scutellum is transversely carinate." The popular name of the insect was first suggested in this account by Chittenden.

The borer (Figs. 31 and 35) is a slender, flattened, footless, creamy white grub about three-fourths of an inch long when fully grown. Its small head with dark brown mouth-parts is retracted into the wide, flattened first thoracic segment giving it a flat-headed appearance. The other segments of the body are not so wide, the second and third thoracic being the narrowest. The caudal end of the body ends in two brown, horny, forceps-like processes with bidentate inner margins. It is this slender creature which is responsible for the killing of the trees. It may be found in autumn by cutting into the trees beneath the rusty-colored spots described on page 140 as occurring on the bark (Fig. 30, *a*). These grubs make tortuous or zigzag burrows in the sapwood around and across the trunk and branches of infested trees, as shown in Figs. 36, *a* and 32.

WORK OF THE INSECT

This borer attacks white birches of all sizes from nursery trees to stately monarchs more than a quarter of a century old. All parts of the tree, from branches a quarter of an inch in diameter to the main trunk, may be infested. The top branches are always first attacked and killed, then the infestation spreads into the other branches and trunk.



FIG. 32.—*Tee burrow of a single borer as it zigzagged around and through this 2-foot branch for a distance of over 5 feet. Much reduced.*

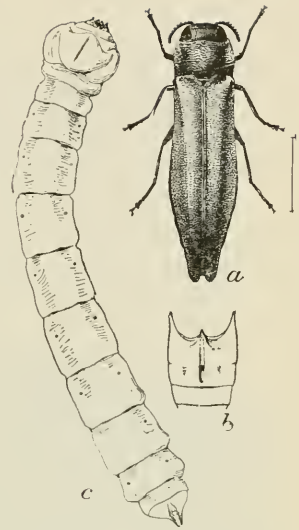


FIG. 31.—*The Bronze Birch Borer. a, female beetle; b, first abdominal segments of male from below; c, grub or borer. All enlarged about three and one-half times. (From Bull. 18, U. S. Bureau of Entomology).*

The burrow is extended in a tortuous or zigzag direction along the branch, getting wider as the borer grows, and running mostly in the sapwood just beneath the bark,

but sometimes going for a short distance deeper into the wood, even to the center of the branch. The borer packs the burrow behind it with its excrement and wood particles which turn dark brown in the first or smaller portion of the mine. The flattened grub makes a shallow burrow that gradually widens to an eighth of an inch. Many of these zigzag, packed burrows are shown at *a* in Fig. 36.

It is difficult to follow a burrow throughout its whole length. Larsen (Mich. Acad. Sci., 3rd Rept. 1902, p. 48) states that he followed one "through its winding course a distance of 1 foot and 7 inches in a length of branch of 4 inches, now near the bark, now deep down in the wood ;



FIG. 33.—Portion of trunk of infested white birch, showing no injury apparent until the bark is removed and the numerous burrows of the borer revealed. Natural size.

now running upwards in the branch, now running downwards. Neither the beginning nor the end of this burrow was found. The branch was somewhat less than an inch in diameter. Another burrow was traced upwards in a branch of about half an inch in diameter a distance of about 18 inches, then doubling upon itself ran downwards parallel to the upward course." I followed the burrow shown in Fig. 32, from the point where the grub had formed its hibernating and transforming cell in the wood back to the starting point on a branch about an inch in diameter and two feet long. The course of the burrow is shown in the figure, but one can get from the picture but a faint notion of the numerous



FIG. 34.—On the Cornell University Campus. The white birch tree in the foreground was killed by the bronze birch borer and the other birch tree across the road shows the characteristic work (top branches dying) of the insect.



FIG. 35.—a, The bronze birch borer beetle, natural size in lower corner; b, the grub or borer, natural size above.

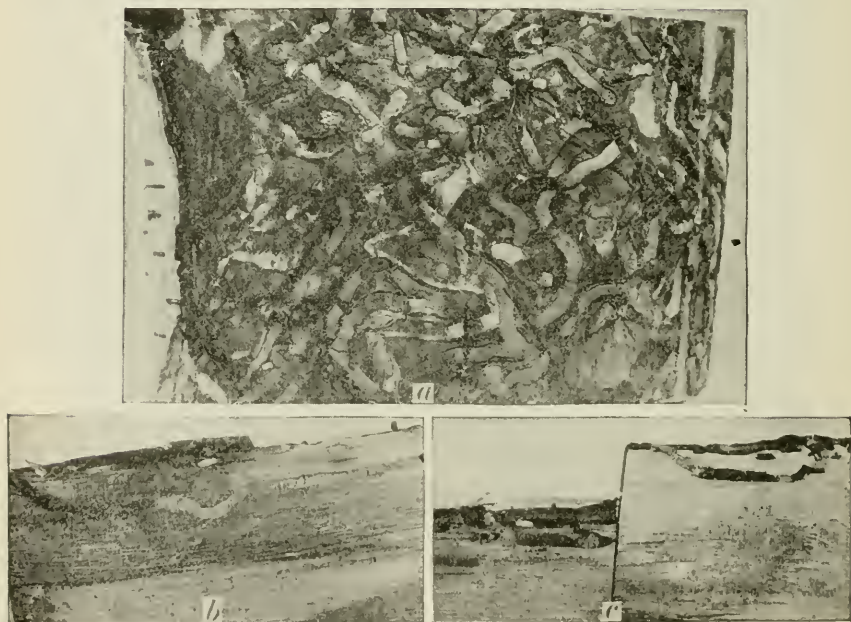


FIG. 36.—a, Portion of trunk of white birch with bark removed to show how the burrows of the borer sometimes zigzag across each other; b, shows a burrow extending through the wood; c, hibernating and transforming chambers in the wood a short distance beneath the bark. All figures reduced slightly.

turnings and zigzaggings of the burrow as it extended along and around the branch. Eight times the borer tunneled its way through the wood to the center of the branch or farther, once working along for about four inches near the center. This burrow, the work of a single borer, measured a little over five feet in length, and it was evidently all made between June 1st and October 1st. Surely this is a remarkable piece of work and must have kept the little creature chewing nearly every moment of the four months.

Oftentimes on the trunk and larger branches the burrows of several borers zigzag across each other in interminable confusion, as shown at *a* in Fig. 36. Yet it is a remarkable fact that even in this case where the infestation was very severe, there were no indications on the bark of the trunk of any injury beneath, or that the tree was infested by a borer; this fact is well shown in Fig. 33, where small portions of the bark were removed and the numerous burrows of the borer revealed. The burrows mostly extend through the growing wood just beneath the bark, and often the effort of the tree to repair the injury results in a woody growth over the burrow that causes corresponding ridges to appear on the bark (Fig. 30, *b*). Sometimes a burrow can be traced for several inches by these ridges on the bark. The next year's growth of the tree may cover an old burrow with wood, and burrows have been found thus buried under three annual rings of woody growth, showing that the tree might overcome some of the injury were it not for renewed attacks by the pest. Sometimes the burrowing of the borers weakens the limbs to such an extent that they break from their own weight.

HISTORICAL NOTES

Scientific name.—The first record in the literature of this Bronze Birch Borer concerned its scientific name. Like many other American insect pests, this borer was also named in Europe. One of the adults or beetles found its way into the collection of Dejean, a Frenchman, who published lists of the beetles he had. In the third edition of his *Catalogue des Coléoptères* (p. 63) issued in 1836, he listed this birch borer, giving it the name of *Agrilus anxius*. But the honor of naming the insect is now credited to Gory, another Frenchman, who first published in 1841 a description of it and courteously used Dejean's name (*Hist. Nat. des Coléoptères, Monog. des Buprestides, Vol. 4, p. 226*). Dejean recorded the insect from Boreal America.

In 1859, the insect was first recorded in American literature by Le Conte, and was then described under two different names as *Agrilus gravis*, from Lake Superior and New York, and *Agrilus torpidus* from Lake Superior and Illinois (*Trans. Am. Phil. Soc., XI, p. 247*); he recorded *Agrilus anxius* from Massachusetts. The former names fell as synonyms of Gory's earlier name of *anxius* when Dr. Horn monographed the genus *Agrilus* in 1891 (*Trans. Am. Ent. Soc., XVIII, p. 277-366*).

Early economic records.—Dr. Lintner was the first to record anything about the habits of the insect. In 1883, he collected 62 of the beetles "which were observed alighting from their flight in the bright sunshine, and running actively in jerking

motions, over the bark upon some cut poplars piled by the wayside" in the Adirondack region of New York. He suggested that the larva was probably a borer in poplar (37th Ann. Rep. N. Y. State Mus. Nat. Hist. p. 50; the same account occurs in Lintner's 5th Rept. p. 281). In 1884, Harrington took specimens of the beetles on willows in Quebec (Can. Ent., Vol. XVI, p. 101), and in 1889, Blanchard recorded it as occurring on the foliage of poplar sprouts in Massachusetts, and he took a few specimens on the summit of Mt. Washington, N. Hamp., "Whither they had flown from below" (Ent. Am., Vol. V, p. 32).

The first notice of this borer attacking birch appears to be that of Schwarz who mentioned the insect in 1890, in connection with the work of a Scolytid beetle, *Xyloterus politus* (Proc. Ent. Soc., Wash., Vol. II, p. 78) at Detroit, Mich., where two silver birches were killed. The same year Cook (3rd Ann. Rept. Mich. Expt. Sta., p. 119), bred the insect from galls which were quite common in Michigan on a willow (*Salix discolor*). Davis describes these galls (Insect Life, IV, p. 66) as an oval swelling of the live branch in which the borer tunnels "an oval gallery downward from the gall, sometimes in the pith, but oftener indiscriminately through the wood, and makes its exit often an inch and a half below." This work in willow is so different from that of *Agrilus anxius* in birch, that I was inclined to doubt the identity of the two borers, but an examination of one of Cook's specimens convinced me that they are probably the same insect, and Mr. E. A. Schwarz confirms this. As the specimen was a female, it was impossible to determine it definitely.

In 1896, Jack reported (Garden and Forest for 1896, p. 269), that "some of the foreign birches in the Arboretum and other localities about Boston have been killed by the attacks of boring larvæ" which were doubtless this Bronze Birch Borer. About the same time the white birches in the parks of Buffalo began to die from the attacks of this pest, and during the past six years the insect has killed hundreds of these beautiful trees in Buffalo, Rochester, Hornellsville, Ithaca and doubtless other cities in New York; and similar destructive work is reported from Detroit and Ann Arbor in Michigan, from Chicago, and from Guelph, London and Hamilton in Canada. It is still continuing its ravages in some of these cities, slowly spreading from tree to tree, as practically no well directed effort is being made to check it.

A good summary of previous records of the insect and an account of its work in Buffalo was given by Clittenden in 1898 and 1900 (Bull. No. 18, new series, U. S. Div. of Entomology, p. 44-51, and Bull. 22 of the same Division, p. 64-65). In a paper on "A Disease of the White Birch" read in March, 1901, before the Michigan Academy of Science (3rd Rept. of Mich. Acad. Sci. 1902, p. 46-49) John Larsen gave an excellent account of many original observations on the work and habits of this insect. Professor Lochhead well summarized the records in 1903 (28th Ann. Rep. Ontario Agr. Coll. & Exp. Farm for 1902, p. 22-23).

THE DISTRIBUTION AND DESTRUCTIVENESS OF THE INSECT

The bronze birch borer is an American insect and is widely distributed throughout the northern United States and Canada. It has been recorded from New Hampshire and Massachusetts westward through Connecticut, New Jersey, New York, Pennsylvania, Virginia, Quebec and Ontario in Canada, Michigan and Illinois to Colorado. Thus far it has been reported as injurious only in Massachusetts, New York, Michigan, Illinois and Ontario in Canada. But doubtless many white birches in other States have been killed by the insect, the real cause being unknown or unrecorded.

In New York State this borer now occurs in destructive numbers in St. Lawrence county, and in the following cities: Buffalo, Rochester, Ithaca, Hornellsville, and probably others. The beetles have been taken in other parts of the State, and it is liable to appear in destructive numbers wherever white birches are used as ornamental trees.

In Europe two similar borers (*Agrilus betuleti* Ratz, and *Agrilus viridis* L.) are destructive to birches.

The fact that the bronze birch borer often kills large trees in three or four years is sufficient evidence of its very destructive character. Within a few years many white birches in Chicago, Ann Arbor, Detroit, Buffalo, Ithaca and other cities have been killed by the insect. A tree usually succumbs within two or three years after the first top branches die.

In 1895, M. F. Adams, a keen observer of insect life, discovered that the common white birches in Buffalo's parks were injuriously infested by a borer. By 1898, several trees had been killed, the cut-leaved varieties also were being attacked, and the culprit was found to be the bronze birch borer. I saw in Delaware Avenue Park in Buffalo on May 11, 1899, at least one hundred magnificent white birches, some of them veritable monarchs nearly two feet in diameter at the base, all dying from the work of this borer. In August of the same year, Mr. Adams reported that from one spot in one of Buffalo's parks he could see fourteen black and yellow birches, but twelve of them were dead, all killed by this borer. Chamberlain reported in 1900 (*Scientific American*, Vol. 82, p. 42), that the result of the work of this insect is that "nine-tenths of Buffalo's white birches are either dead or dying and the rest will soon follow. Several hundred have died, including about 50 in Forest Lawn Cemetery the present season. Even the dead trees were not burned, and the pests were allowed to multiply at will."

I have seen over half of the white birches on the Cornell University Campus and many of those scattered about Ithaca's lawns killed by the insect within the past three or four years. And unless the vigorous, prompt, and judicious measures now being enforced on the Campus are carried out throughout the city, Ithaca's white birches will soon be dead monuments to the industry and destructiveness of this little enemy.

FOOD-PLANTS OR KINDS OF TREES ATTACKED.

This insect seems to confine its work almost entirely to birch trees. The only exception yet recorded is discussed on page 146 where it was found making gall-like swellings on a willow. The European white birch (*Betula alba*) and its cut-leaved weeping variety (*pendula laciniata*) have suffered most from its ravages. In the outbreak in Buffalo, the

former or *alba* was first attacked, the infestation then extending to the cut-leaved variety. But I have seen a case in Ithaca, where a cut-leaved birch was killed before a tree of the whole-leaved form only a rod or two distant showed any signs of being infested.

Several trees of the American black (*Betula lenta*) and the yellow (*Betula lutea*) birch have been killed by the insect in Buffalo, and it is also recorded as attacking the paper or canoe birch (*Betula papyrifera*).

However, there is no record of any kinds of birches having been killed by the insect in forests or woodlands. It seems to have confined its destructive work to the more valuable individuals and groups of these beautiful trees set in parks and private lawns.

The beetles have been taken on poplars cut and piled by the roadside, on poplar sprouts and trunks, and on willow, but there is no evidence that the insect was breeding in poplar. Larsen put a number of the beetles in a cage and supplied them with fresh leaves. "When only birch leaves were supplied they fed very sparingly. Some elm leaves were then put in with the birch and they fed greedily upon these. This led to further experiment and various sorts of leaves were used. They fed upon almost any leaf of soft texture. But their favorite food was willow, poplar and aspen leaves with preference strongly marked in the order given. It seems from this that the beetles upon leaving the birch feed on other trees until the time for reproduction."

THE LIFE AND HABITS OF THE INSECT

The chain of evidence regarding the life-story of this bronze birch borer is not yet quite complete, but from the records and from my observations and investigations most of the details can be supplied.

Hibernation.—All the evidence I have, shows that the insect always passes the winter as a full-grown grub or borer curled up in a long, narrow cell or chamber, which it makes in the wood not far from the bark. I have failed to find smaller borers in uncompleted burrows in autumn. One of these hibernating cells is shown at *c* in Fig. 36. Most of the borers may be found in these cells early in October; Adams reports finding some as early as July 14th. Some of them can be easily located by cutting into the tree beneath the characteristic rusty colored spots (Fig. 30, *a*). The grubs rest in the cells in a peculiar manner with the cephalic third of the body bent around lying close to the remainder. They are very sluggish when removed from the cells. Early in the spring these hibernated borers shorten up, straighten out in their cells, and thus prepare for transforming.

Transformation and habits in spring.—During the latter part of April or early in May, depending upon weather conditions, the grubs transform in their hibernating cells into adult insects or beetles (Figs.

31 and 35). A day or two before transforming the pupæ turn to the dark bronzy color of the beetle.

In making its hibernating and transforming chamber in the wood in early autumn, the borer also extends its burrow up to the bark, so that in the spring the newly transformed beetles only have to squeeze their way out of the cell and eat their way through the bark. Larsen records that the emergence of the beetles is rather a laborious process, as some were found "with the forward parts of their bodies protruding for hours making long rests between efforts to free themselves." Several of the

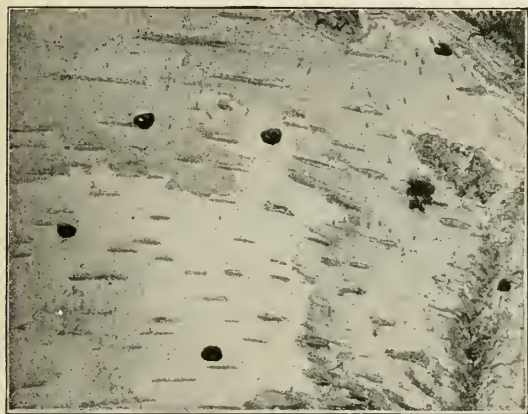


FIG. 37.—Exit holes of the bronze birch borer beetles in the bark. Natural size.

peculiar shaped *exit* holes of the beetles are shown in Fig. 37. Eleven exit holes have been counted in an area only two and a half inches in diameter.

The date of emergence of the beetles in the spring is of much importance in connection with methods for controlling it, and it varies somewhat with climatic and other conditions. Sometimes a few of them emerge as early as May 1st, but my observations and breeding notes in New York indicate that most of them do not appear until from May 15th to June 1st, or even later. In 1900 Adams reported that none of the beetles had emerged by June 3rd. The beetles feed on tender foliage, evidently preferring other trees like the willow and poplars, as Larsen has shown.

Egg-laying.—I have not seen the eggs of this bronze birch borer as I could not induce the beetles to lay eggs in my cages, but Larsen was more fortunate and obtained evidence that they were laid in crevices of the bark. He states that beetles "confined in a glass jar were found to be depositing eggs on June 8th, and for a week or more afterward. Pieces of fresh limbs were supplied, but the insects did not deposit their eggs upon these, but moved about feeling for crevices with their long prehensile ovipositor and having found a place, such as between the glass and the lower part of the cork or under a piece of wood, from five to ten or more eggs were put in one place. Copulation had gone on for some time before this. Great activity was exhibited during the copulation and egg-laying. No observations were made on the development of the eggs." It is unfortunate that the eggs were not described.

As further evidence that the eggs are laid several in a place in crevices or rough places on the bark, is the fact that the burrow I followed from end to end, as described on page 142 and shown in Fig. 32, began at a rough place where a twig had been broken off. And Larsen found that "in one place in a slight swelling on the bark were several small openings, less in diameter than a pin. From these openings burrows were traced. The burrows are at first very small and lie close under the bark and are filled with dark granules." Adams wrote me of a similar observation made in Buffalo early in June, 1899. He "detected the beginnings of the burrows by a slight circular discoloration on the outer bark."

Thus the evidence indicates that after feeding for a few days, the beetles mate and the eggs are laid early in June in rough places on the bark of the birches, first on the upper branches and later on the trunk.

Work of the borer.—The beginning of the newly-hatched borer's burrowings in the bark in June have just been described in the preceding paragraph. And its later work as it industriously tunnels its way, zig-zagging around and through the branches has been described on page 142. Beginning early in June, the borer must work almost incessantly to be able to dig such a tunnel in less than four months, or before October 1st.

Length of the life-cycle.—Although no one has followed this birch pest through its whole life, all the recorded evidence and all my observations indicate a yearly life-cycle.* I have just made a careful examination of much of the infested portion of a large white birch, and I found nothing but full-grown grubs or borers and exit holes of last year's generation. There were no indications of small or half-grown borers, as there would be if the insect required two seasons to develop.

NATURAL ENEMIES

Were it not for the ubiquitous English sparrow, doubtless the woodpeckers would help considerably in reducing the numbers of this bronze birch borer. The sparrows have largely driven the woodpeckers out of city parks and private grounds. During most of its life, or for about eleven months in a year, the borer is just under the bark where the birds could easily get at it. Adams observed one of the common woodpeckers, probably the hairy woodpecker, feeding quite extensively upon the grubs in Buffalo.

* Most of the species of *Agrilus*, both European and American, whose life-history has been fully worked out, require two years to complete a life-cycle or generation. This is true of *Agrilus viridis* and *Agrilus sinuatus*, both European species, the latter now an American pest also. But our native *Agrilus bilineatus* and *Agrilus ruficollis* seem to have a yearly life-cycle.

The pest does not escape from parasitic enemies. While examining some infested branches of birch in January, 1899, I found several borers that had been killed by parasitic grubs. The parasite had spun a tough, semi-transparent cocoon inside the skin of its host. Later the adult parasite was bred and it proved to be the interesting little creature shown much enlarged in Fig. 38. It is a Chalcid fly known to science as *Phasgonophora sulcata* Westwood (Griffith's Animal Kingdom, Insects, Vol. II, p. 432). Note the wonderful development of the hind legs, the purpose of which is unknown. Chittenden also reared the same parasite from this borer and from the flat-headed apple-borer infesting a Japanese redbud tree. The parasites issued about two weeks after the beetles. Dr. Howard writes me that the parasite has been taken in Texas, California, Washington, D. C., Illinois, South Carolina, Canada, Florida and Oregon, thus showing a very wide distribution. Doubtless this interesting little



FIG. 38.—*Phasgonophora sulcata*. The interesting little parasitic enemy of the bronze birch borer. Much enlarged.

enemy aids materially in holding this bronze birch borer in check. But in most localities it has not yet reached that point where it is numerous enough to cope with the pest to the extent that man need not employ artificial agencies to prevent the destruction of his beautiful white birches.

REMEDIAL SUGGESTIONS.

This bronze birch borer is practically invulnerable against man's usual insecticides. Nearly all of its life is spent as a borer under the bark out of reach of insecticides. The fact that the beetles feed for a few days on tender leaves would suggest spraying the trees in May with a poison, but apparently they do not eat the birch foliage to any extent, preferring that of willow, poplar, or elm. Thus it is very doubtful if it would materially check the insect to spray the birches with a poison.

On account of the possibility that the beetles might be prevented from emerging or from laying their eggs, several applications to the bark have been suggested, such as a poisoned whitewash, a mixture of hydraulic cement and skim milk, covering the trunks with a paper wrapping, and

a resin-oil wash. Adams treated about forty trees in Buffalo with a resin-oil wash (5 pounds resin dissolved and 1 gallon raw linseed oil poured in) with no satisfactory results. As the insect infests all parts of the tree, from branches half an inch in diameter to the trunk, it would be difficult to so cover the bark as to allow no place for egg-laying, or to put on such a coating as to prevent the exit of the beetles. I doubt the practicability and effectiveness of such methods against this birch borer.

Some have tried to save their trees by cutting out the top branches that were dead or dying, but in every case the trees finally succumbed. This pruning may sometimes delay the inevitable death of the tree for a year or more. *I doubt if a tree can be saved after it is once infested to the extent that the top branches are dying. Better sacrifice the whole tree at once and thus prevent the spread of the pest to neighboring trees.*

This brings me to the only practicable and effective method of dealing with this borer. That is the heroic one of cutting down and burning the infested tree, trunk and branches, before May 1st, thus destroying the whole crop or generation of borers in their hibernating quarters under the bark. As soon as the top branches are killed (as shown in the frontispiece and in Fig. 34), do not delay a moment, but cut and burn the tree, as its death is inevitable within a year or two.

But this is much more easily said than done, as any one can testify who has tried to persuade owners of private grounds or park authorities to apply the method in time. Sentiment and the forlorn hope that the tree may revive or last a few years more, often results in an infested tree remaining as a leafless eyesore on the landscape for a year or more after it is dead and all the beetles have been allowed to emerge and spread to other trees. It seems to be almost impossible in many cases to get individuals or city authorities to act promptly. Often after one succeeds in getting an infested tree cut down in time, it will not be burned promptly, but left where the beetles can readily emerge, so that practically nothing is accomplished in checking the pest.

A determined effort is now being made to save the remaining white birches on the University Campus. This autumn all the infested trees showing dying tops are being removed and promptly burned. In cities and towns where this insect is killing the white birches, there should be enacted an ordinance compelling the authorities to promptly cut and burn in autumn, winter, and surely before May 1st, the infested trees in the parks, and if possible requiring owners of private grounds to do the same. The mere enactment of such an ordinance will not often accomplish the desired result. Public opinion must be behind such a measure to enforce it. Ithaca, Buffalo, Rochester and other New York State cities are now face to face with the problem of checking this pest or of losing their white

birches. Civic Improvement Societies could render efficient aid in such work.

Briefly then, *there is no known way of preventing this bronze birch borer from attacking white birches, and the only practicable and effective method yet found for checking its ravages is to promptly cut and burn the infested trees in autumn, in winter, or before May 1st. There is no possibility of saving a tree when the top branches are dead, as shown in frontispiece and in Fig. 34. Cut and burn such trees at once and thus prevent the spread of the insect.*

CORNELL UNIVERSITY
AGRICULTURAL EXPERIMENT STATION OF
THE COLLEGE OF AGRICULTURE
Department of Entomology (Extension Work)

COÖPERATIVE SPRAYING EXPERIMENTS

- I. EXPERIMENTS AGAINST THE PLUM AND THE QUINCE CURCULIOS
- II. FINAL DEMONSTRATIONS OF EFFICIENCY OF A POISON SPRAY FOR THE GRAPE ROOT-WORM
- III. MAKING BORDEAUX MIXTURE WITH "NEW PROCESS" OR PREPARED LIME



By M. V. SLINGERLAND

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COLLEGE OF AGRICULTURE, CORNELL UNIVERSITY,

ITHACA, N. Y.

HON. CHARLES A. WIETING,

Commissioner of Agriculture, Albany:

Sir:— I am transmitting to you herewith the first installment of the reports of our coöperative experiment work for the season of 1905. This bulletin comprises a discussion of coöperative experiments in spraying against the plum and quince curculios, in which it appears that on cherries the curculio can be kept in check by spraying, that there is a probability that it can be controlled to some extent on plums and also that there is reason to hope that spraying will aid in controlling the quince curculio; the result of experiments in spraying for the grape root-worm in which it is shown that this method of fighting this pernicious insect is very effective; and also an account of the preparation of Bordeaux mixture with the prepared limes.

Respectfully submitted,

L. H. BAILEY,
Director.

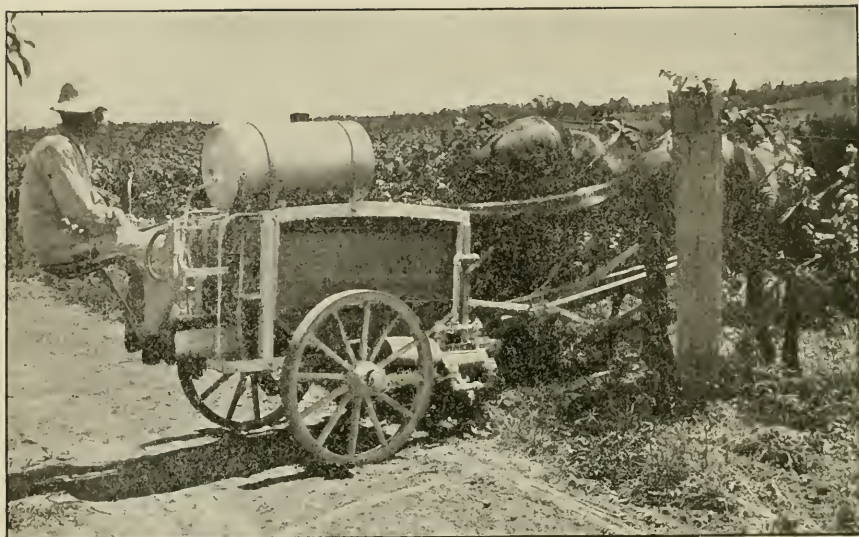


FIG. 44.—A vineyard sprayer in which the pressure is obtained from horse-power and compressed air.



FIG. 45.—The vineyard sprayer shown in Fig. 44 in operation. The nozzles should be farther apart.

I. SOME COÖPERATIVE SPRAYING EXPERIMENTS AGAINST THE PLUM AND QUINCE CURCULIOS

In my report as Chairman of the Committee on Entomology to the New York State Fruit-Growers' Association in January, 1904, I gave the details of some successful experiments made in 1903 by Mr. J. W. Spencer, Westfield, N. Y., and Mr. A. I. Loop, North East, Pa., in controlling the plum curculio with poison sprays. Mr. Loop used the arsenate of lead (3 pounds in 50 gallons Bordeaux) and the arsenite of lime (3 pints standard mixture in 50 gallons Bordeaux) and made two applications on several varieties of plums just after the fruit had set and two weeks later. The injury from the curculio on his sprayed trees was practically nothing, while on adjoining unsprayed trees from 80 to 85 per cent of the fruit dropped from curculio injury. His neighbors complained of considerable injury from the insect and they kept "curculio catchers" going and got many beetles, while Mr. Loop could get only one or two beetles per tree after the first spraying.



FIG. 39.—A "curculio-catcher" at work.

Mr. Spencer sprayed peaches, cherries and plums three times, soon after the petals fell and at intervals of six and ten days later. I examined the trees and there was much less of the work of the curculio on all the sprayed trees as compared with unsprayed trees left as checks.

These experiments aroused much interest among the members of the Fruit-Growers' Association and in consequence I concluded to try and interest several fruit-growers in coöperative experiments against this arch enemy of the stone fruits. My efforts met with much success and in 1904 more than twenty leading New York fruit-growers coöperated in spraying experiments against the plum curculio, and the plans were extended

to include also the quince curculio, the rose chafer, and the grape root-worm. Many of the experiments were also continued during the past year so that the results here recorded are often deduced from the experiences of two seasons.

I planned the experiments and in many cases visited the fruit-growers and inspected their orchards both before and after spraying. The spraying was done by the orchardists according to my directions as nearly as was practicable, but in the case of the grape root-worm most of the work was done by an expert student assistant. In all the experiments a poisonous insecticide known as arsenate of lead was used. Small quantities, varying from 10 to 40 pounds, of this poison were furnished to the experimenters free of charge. In 1904, 650 pounds of the arsenate of lead were purchased, 350 pounds being used in vineyards against the root-worm

beetles. Six hundred pounds were distributed during the past season, half of which was used against the grape root-worm.

While no new and startling facts have resulted from these co-operative experiments, they have often been excellent object lessons for neighboring fruit-growers and have served to bring the experimenters in touch with the Experiment Station and its methods. Each experiment has been a valuable teacher and



FIG. 40.—*Mr. Wood's sprayed plum tree. Note how the branches bend with their weight of fruit.*

illustrator in its neighborhood, no matter what the final results.

THE PLUM CURCULIO EXPERIMENTS

Spraying with a poison for the plum curculio is not a new notion. During the past thirty years there have been recorded many successes and some failures in combating this enemy of stone fruits with a poisoned spray. Many prominent fruit-growers feel sure that they can and do control this pest with such a spray, while others are thoroughly wedded

to the more laborious jarring process (Fig. 39). The reasonable theory of how the poison works was evolved from observations made nearly twenty years ago (Cornell Bulletin No. 3) on the feeding habits of the beetles. They feed more or less on the leaves, flowers and young fruits in the spring and may thus get some of the poison. Some have thought that the poison lodged in the crescent cut made by the curculios in egg-laying, and that the newly-hatched grub got some of the poison in its first meals, but this is not true, as the grub immediately tunnels into the fruit and does not get into the cut at all. Paris green has been the poison usually used in spraying for this pest, but in all my coöperative experi-

used stronger without danger of injuring the foliage.

In 1904, I sent 170 pounds of the arsenate of lead, in lots of from 10 to 30 pounds to 12 plum, cherry and peach growers in New York. They were requested to use the poison at the rate of 2 pounds in 50 gallons of water or Bordeaux and make two applications, one just after the blossoms dropped and another about a week later. The preceding severe winter killed the trees or buds in some instances and for other reasons several of the fruit-growers did not use the poison spray.

Largely owing to the fact that the curculio did not appear in injurious numbers, the following experimenters reported practically no difference between the sprayed and unsprayed trees:

Ira Pease, Oswego, on plums and prunes.

Freeman Pintler, Ontario, on peaches.



FIG. 41.—*Mr. Wood's unsprayed plum tree. Note much less fruit than on sprayed tree in Fig. 40. A fungous disease caused most of the leaves to drop.*

W. A. Bassett, Interlaken, on plums.

G. Schoenfeld, Westfield, on plums.

The beetles appeared in full force on peaches at E. Smith & Sons, Lodi, and it was thought necessary to use the jarring machines on all the trees, thus rendering it impossible to draw any definite conclusions from the spraying.

George H. Bostwick, Ripley, sprayed cherries three times with the poison on May 2d, May 14th, and June 2nd. He reported that "the curculios were very scarce, but I am well satisfied we did not have as many wormy cherries, as did our neighbors who did not use a poison spray." J. W. Spencer, Westfield, again used the poison spray on peaches, plums and cherries with results similar to those he obtained in 1903, as detailed on page 159.

Owing to the adverse conditions detailed above, the results from the coöperative experiments with a poison spray against the plum curculio in 1904, were far from conclusive but were sufficiently encouraging, especially on cherries, to warrant further experiments the next season.

In 1905, I sent 20 pounds of arsenate of lead to each of the following fruit-growers who desired to coöperate in spraying experiments against the plum curculio:

Freeman Pintler, Ontario.

Albert Wood, Carlton Station.

Geo. H. Bostwick, Ripley.

Ira Pease, Oswego.

I recommended that the poison be used at the rate of $2\frac{1}{2}$ pounds in 50 gallons, and that on part of the trees at least, three applications be made, once just before blooming, again just after the blossoms fell, and finally about a week later.

Mr. Pintler sprayed peaches on June 5th, 9th, and 15th, and in spite of several heavy rains during the spraying season, he reports that "it is very difficult to make a comparison, for the damage done by the curculios is very light. There were almost no peaches stung on the sprayed trees, while there were some on the unsprayed."

Mr. Wood sprayed one row of plums with the arsenate of lead three times as directed, using the Bordeaux mixture each time. An adjoining row was sprayed at the same time with Paris green at the rate of 1 pound in 50 gallons of Bordeaux, and a fourth application of whale oil soap was made after the other three with the poison. Two check trees were left unsprayed. Both sprayed rows bore a large crop of fine fruit. The check trees lost most of their foliage from the leaf blight fungus and they had much fewer fruits on them. Note how the branches on the sprayed tree in Fig. 40 are bending down with their load of fruit, and compare it with the unsprayed tree in Fig. 41. Thus Mr. Wood's results were quite striking and he is convinced that he can control the plum curculio with a poison spray.

Mr. Bassett reports curculio not numerous, and there was but little difference in favor of the sprayed trees. However, he has obtained sufficient results from his

experiments with a poison spray for two years to encourage him to believe that he can control the pest on plums by this method.

Mr. Bostwick reports that the poison spray has given more satisfactory results on cherries this year than in 1904. The curculio was less numerous than usual both years. He sprayed one row of cherries once (before blossoming) with the poison; another row was sprayed twice (once before and once after blossoming); two rows received no spray and one row was sprayed three times on May 2nd, 20th, and June 1st (the two last after the blossoms had dropped). He states that while the sprayed trees did not show an average yield of a large per cent in advance of the unsprayed trees, yet the quality of the sprayed fruit was far better and brought from 1 to 5 cents more per pound. There was but little difference between the trees receiving two and three applications, and the spraying before blossoming did not seem to help materially. The sprayed plum trees did not show an average yield of more than the unsprayed trees, but almost one-third of the fruit on the latter were "stung" by curculio and the sprayed fruit brought a little higher price than the unsprayed.

Mr. Pease sprayed prune trees and was forced to conclude that there was no difference between the treated and unsprayed trees.

Two other fruit-growers who used the arsenate of lead at my suggestion have sent in reports:

Mr. W. H. Hazlitt, Hector, writes, "I sprayed all my plums once very thoroughly with the arsenate of lead and Bordeaux mixture. I have a full crop of Bradshaws, Quackenbos and Lombards, and almost half a crop of Reine Claudes. I am firmly convinced that my spraying at the time I did is the only thing that saved the crop, as for three previous years my plums have set full and were stung badly and nearly all dropped."

Finally, Mr. J. W. Bell, Portland, reports, "we experimented with a poison spray for the curculio on cherries and plums, and with very satisfactory results to us. We used 4 pounds arsenate of lead (Disparene) in connection with 50 gallons of Bordeaux in the second spraying or just after the blossoms dropped, taking care to cover all the foliage. The result was we could hardly find a cherry or plum that was stung on the sprayed trees, while there were fully one-fourth stung on the unsprayed trees. We sprayed 400 trees, leaving one row in the center of the block unsprayed. The varieties were Red June and Burbank plums, and early Richmond and Montmorency cherries. We were so well pleased we shall use this spray on all our stone fruits another year."

Some general conclusions.—The general conclusion that we may draw from these experiments is that the plum curculio is readily controlled with a poison spray on cherries; that some fruit-growers are convinced it can be controlled on plums also, but most of the results are not conclusive; and there is need of further experiments on peaches as the evidence is very meagre. I would recommend the arsenate of lead in preference to other poisons for it adheres better, can be used stronger, and there is much less danger of injuring the foliage. I would use this poison at the rate of from 3 to 4 pounds in 50 gallons of water or Bordeaux mixture; the Bordeaux should contain only about half as much

of the copper sulfate as is usually used on apples, for the foliage of stone fruits is often easily injured by it. At least two applications should be made, one just after the blossoms drop and another about a week later, I have no conclusive data to indicate that spraying before the blossoms open will pay on the stone fruits.

Recent experiments in other States.— In the middle West, the plum curculio is a serious pest in apple orchards. In Bulletin No. 64, issued in 1904 from the Missouri Experiment Station, it is claimed that by spraying apple trees with the arsenate of lead twice before the blossoms opened and four times, at intervals of ten days, after the blossoms had fallen, the damage by curculio was greatly lessened. This treatment combined with the destruction of windfalls and thorough cultivation in July and August controlled the pest in apple orchards in Missouri.

As Bulletin No. 98, the Illinois Experiment Station issued in February, 1905, a very valuable and exhaustive account of "The Curculio and the Apple." The conclusion from the use of a poison spray on apples for the plum curculio after two years of careful experiments is that "under favorable conditions from 20 to 40 per cent of the fruit liable to puncture may be saved by five applications, and this treatment is regarded as profitable and practicable." For entirely satisfactory results in apple orchards, the spraying must be supplemented by attack from other directions, that is by the destruction of fallen fruit and especially by cultivation.

New York plum and peach growers usually pay little or no attention to the destruction of the fallen fruit and thus allow the pest to breed freely. The curculio is responsible for much of this fallen fruit and it would aid very materially in the warfare against the pest if the fruit were picked up and destroyed every few days.

Cultivation for the plum curculio.— In both the Missouri and Illinois Bulletins mentioned above, cultivation is strongly urged as a very effective method for helping to control the curculio in apple orchards. In Illinois they found that both the grubs and pupæ are very delicate and extremely sensitive to exposure to sunlight and air, and that short exposures to direct sunlight are fatal to the insect in these two stages; that over 90 per cent of the grubs which leave the fallen fruits do not go more than two inches into the soil to transform to the pupæ; and that nearly 90 per cent of the grubs and pupæ can be disturbed by cultivation within a period of thirty days from July 10. Therefore, they recommended superficial tillage of the apple orchards for a period of thirty or more days from July 10th.

After reading these facts, I wondered if the growers of stone fruits in New York had considered or had tried this cultivation method for the

plum curculio. I therefore stated the facts to several leading New York growers of these fruits and asked for their opinion of its practicability and its merits for their orchards.

Mr. C. K. Scoon, Geneva, replied that "it has been our custom to cultivate the plum and peach orchards during the dates mentioned (July 10 to Aug. 10), but the cherries are not cultivated after the last of June."

Mr. S. D. Willard, Geneva, stated that "it is possible the treatment may be a grand good thing, but it does not seem to me it would be a practical thing for us, for the reason that during the period you name we are very busily engaged in caring for our cherries and early plums, and it often requires all the help we have to handle them. There is one other feature that might be worthy of consideration, and that is whether it is wise to stir the soil and induce growth on the trees at this late date."

Mr. George T. Powell, Ghent, says that "as the plum is very greatly benefited by late culture, it is entirely practical to keep up the cultivation even up to the middle of July, after which the ground may be given a cover crop. I have been cultivating peaches and plums much later during the past few years, and find that we have had less trouble from the curculio. This late cultivation may be the explanation. With cherry trees, after they have gotten into full bearing, we are not continuing cultivation. We find they do not stand continued culture as well as other trees."

Thus the opinion seems to be that it is unwise to cultivate cherry orchards in New York late enough (July 10th to Aug. 10th) to reach the curculio in its tender grub and pupæ stages near the surface of the soil. But the evidence is not entirely against such late cultivation for plums and peaches. Theoretically, from what is known of the habits and vulnerability of the insect in the soil, this method of late and thorough superficial cultivation should prove very effective in controlling the plum curculio. It is unfortunate that New York cherry growers find it inadvisable to use the method in their orchards, but I hope our plum and peach growers can apply it. It is surely worthy of serious consideration, and I hope some one will give it a thorough trial in New York.

SPRAYING FOR THE QUINCE CURCULIO

The quince curculio (*Conotrachelus cratægi*) was discussed in detail in Cornell Bulletin No. 148, issued in May, 1898. As was stated therein, "theoretically the chances for poisoning the quince curculio are small." And it was then the universal testimony of quince growers who had thoroughly tested the poison sprays then in use (Paris green and London purple) that they could see little or no benefit from spraying for this pest. The insect differs considerably from its near relative, the plum curculio, in habits and life-history.

In the face of these facts, I had little hope that even a stronger poisonous application with the more adhesive arsenate of lead would reach this quince pest. But one extensive quince grower, Mr. H. L. Brown, Carlton, desired to try this poison, and in 1904 I sent him 20 pounds with directions to use it at the rate of $2\frac{1}{2}$ pounds in 50 gallons of water or Bordeaux mixture, making two applications, the first as soon as there were any signs of the beetles and the second about a week later. He sprayed a block of 100 quince trees with the poison according to directions on July 5th and 15th, making only one application on part of the trees.



FIG. 42—Jarring for quince curculio.

In September, Mr. Brown reported that "the evidence seems to be very much in favor of the two sprayings, and in comparing this block with the two others treated with Paris green, I will say that the arsenate of lead seems to be very much ahead." Several who saw Mr. Brown's orchard stated that the fruit on the trees sprayed with the latter poison was much superior to that on the other trees, as it was much freer from curculio injury.

The results obtained in the single experiment in 1904 were so encouraging that Mr. Brown and another large quince grower gladly co-operated with me in a similar experiment with the same poison during

the past season. The curculio was less numerous than usual in Mr. Brown's orchard and there was practically no difference between the sprayed and untreated trees, all bore good crops of fine quinces. In the other experiment, part of the orchard was sprayed with arsenite of lime and part with arsenate of lead, but no conclusions could be drawn, for a "curculio catcher" or jarring machine was also used on all the trees. Jarring is a very laborious process in this orchard as four men are required to run the machine, as shown in Fig. 42.

While the results of these two seasons' experiments are far from conclusive, they should at least encourage New York quince growers to thoroughly test a spray of arsenate of lead poison for this insect. It will be a great boon to quince growers if they can discard the laborious jarring process and control the pest with a poison spray.

II. FINAL DEMONSTRATION OF THE EFFICIENCY OF A POISON SPRAY FOR CONTROLLING THE GRAPE ROOT-WORM

During the past four years I have made extensive investigations on the insect pests of the grape in the vineyards of the Chautauqua grape belt. Each year the grape root-worm has received a large share of attention and success has crowned the efforts made to find a practicable and effective method for controlling it.

As the adult insects or beetles feed quite extensively on the grape foliage, theoretically they should succumb to a poison spray. Under my direction extensive experiments have been made in several vineyards with a poison spray each year since 1902, and other vineyardists have also coöperated in such experiments in their own vineyards. The results up to the present year have been recorded in Bulletins Nos. 208 and 224. In 1903 and 1904 the results were very striking and effective, but it was decided to make a further and final test of the poison spray method in 1905 in the same large vineyard that was sprayed the previous year. The vineyard was found to be considerably infested, as from 15 to 40 grubs and pupæ could be easily found in the soil near each vine examined.

Mr. R. S. Woglum, an expert student assistant, was placed in charge of the experiment, and the first application was made July 3rd. The spraying was done with a Niagara carbonic-acid gas sprayer, and arsenate of lead (Disparene) was used at the rate of 8 pounds in 100 gallons of water. One cylinder of the compressed carbonic-acid gas furnished sufficient power to throw out 500 gallons of this spray under a pressure of 80 pounds, thus making a very fine spray from each of the 8 nozzles. The machine in operation is shown in Fig. 43. A second application of the same spray was made on July 13th. It required 900 gallons of the mixture at each application on about $8\frac{1}{4}$ acres. The total expense was about \$3.25 an acre for each spraying.

The results were equally as satisfactory as those obtained in the previous years' work. On July 10th, I carefully examined 15 vines in different sections of the vineyard for eggs of the root-worm beetles. On the first 5 vines I found no eggs; on 5 other vines near the center of the vineyard, 2 egg-clusters were found; and on 5 vines in one corner, 17 egg-clusters were found; the 15 vines thus yielding only 19 egg-clusters. In another infested vineyard which has been well cared for but was not sprayed, I found 11 egg-clusters on the first vine examined at random.

There was also in our sprayed vineyard but very little of the characteristic "markings" on the leaves made by the beetles in feeding. Late in the season the vineyard was an instructive object lesson along a main road, as the foliage kept green and healthy long after neighboring vineyards began to look brown and drop their leaves.

A prominent vineyardist who has been spraying for the root-worm with the arsenate of lead for two or three seasons reported in October that this past season "excessive rains did much to counteract the effect of the first spraying and yet the results are not less striking than those of last year. On account of high winds



FIG. 43.—Carbonic-acid gas power sprayer at work in a vineyard. Spraying for the grape root-worm beetles.

I deferred and finally omitted the second spraying in part of one vineyard and I greatly regret the omission, for in this part the beetles came and kept coming until I realized I had made a very serious mistake. All parts of the vineyard sprayed twice are practically free from traces of harm."

"I think the time is near at hand when the efforts of your Experiment Station to protect the vineyardist from the root-worm enemy will receive far fuller recognition. It is no longer possible for those whose vineyards have been destroyed to deny or conceal the facts, and there is very little disposition to attribute the ruin to any other cause than the root-worm. Practically all whose vineyards have suffered are now anxiously seeking to know if it is really true that spraying will save their vines.

I have had the great pleasure of giving absolute assurance to a large number of neighbors and friends that they can stop this destruction just where it is. It now looks as if spraying would be very general in the Chautauqua grape belt next year. Some vineyardists who have been spraying for the last three years, but not systematically nor thoroughly, have not realized the convincing results they were looking for. This year, however, they were more thorough and successful and now say that they may neglect the cultivation hereafter, but will not neglect the spraying."

It is very gratifying to have such corroborative and appreciative evidence of the value of a poison spray for controlling the grape root-worm. The evidence accumulated by this Experiment Station during the past three years seems to me fully conclusive that this serious grape pest can be checked and kept below the danger limit with a poison spray. So conclusive is the evidence that it seems unnecessary for this Station to conduct further spraying experiments. It will require two thorough applications of a strong poison like the arsenate of lead, at the rate of 4 pounds in 50 gallons of water or Bordeaux mixture to obtain the most satisfactory results in controlling the grape root-worm. Spray first as soon as the beetles are first seen, which is usually about the last week in June, then spray again about a week or ten days later.

Having thus demonstrated beyond all reasonable doubt, as I believe, that the insect can be thus controlled, it only remains for the vineyardists in the infested region to equip themselves for thorough work along this line. Other insect pests and such fungous diseases as mildew and rot are liable to appear any season and vineyardists should be prepared to spray their vines thoroughly.

Notes on practical vineyard spraying.—I discussed vineyard spraying at some length in Bulletin No. 224, pages 69-71 and presented pictures of the best machinery then available. I have used for two seasons the machine shown in Fig. 43 which has a cylinder of compressed carbonic-acid gas for its power. The arrangement of nozzles on this machine is the best I have seen for the thorough work required to get satisfactory results in spraying. A vineyard sprayer should have at least three nozzles, and better four of them, on each side to do proper work, and to supply these nozzles properly with a fine spray requires a continuous pressure of from 80 to 100 pounds. A gas or steam engine or the compressed carbonic-acid gas will maintain such a pressure, and some pump manufacturers are devising such vineyard pumps. The pump shown in Figs. 44 and 45 (facing page 159) combines horse-power and compressed air. It did very good work, so far as developing sufficient power is concerned, in one vineyard the past season. With further improvements, especially in the way of more and better arranged nozzles, this type of vineyard spray pump should furnish the cheapest power and do good work.

A natural enemy of the grape root-worm.—While examining a vine for eggs of the root-worm in a vineyard near Ripley in July, 1905, I noticed that the eggs in several of the clusters were darker colored than usual. Closer examination revealed a minute parasitic fly developing inside each egg. The little parasites emerged from the eggs in about two weeks and proved to be one of the two kinds of these minute friends which did gallant work in Ohio vineyards several years ago. It is known to science as *Fidiobia flavipes*. As it lives in the eggs of the root-worm there is no danger of checking its goodly work with the cultivation or spraying treatments recommended for controlling this pest. I made no further observations to determine how widely or thoroughly this little parasitic enemy is distributed in the root-worm infested region, but I believe it will be an important factor in reducing the numbers of root-worms below the danger limit. But I would not advise any vineyardist to wait for its appearance or to let up a particle in their warfare of cultivation and spraying for the pest. Nature's insecticides are usually very effective in the long run, but oftentimes too slow for man dependent on annual crops.

III. MAKING BORDEAUX MIXTURE WITH "NEW PROCESS" OR PREPARED LIME

In addition to the stone lime commonly used in making Bordeaux mixture, there are on the market several "new-process" or prepared limes. All of these prepared limes are in the form of a fine powder, like lime that has air-slaked. Some of them are quick or stone lime that has been ground to a powder, while others are the quick-lime dry water-slaked, using only enough water to slake the lime, but not enough to leave it wet. Many New York fruit-growers and others who spray are using these prepared limes in making their Bordeaux mixture. For this reason, and on account of some dealers selling air-slaked lime for these prepared limes, there has been considerable discussion in the agricultural press on the merits of these limes, and many queries have come to me regarding them.

These facts led me to undertake a series of tests in making Bordeaux mixture with prepared limes. Some interesting and valuable results were obtained.

To make a good Bordeaux mixture, it is necessary that the lime be so constituted chemically as to combine with the copper sulfate and neutralize it; then it is equally as essential that the combination be made in such a way as to produce a very fine-grained or flocculent precipitate, which will settle very slowly so as not to require constant agitation in the spray pump. Such an ideal Bordeaux mixture can be easily made with any good stone lime, freshly slaked, provided both the lime and copper sulfate are much diluted before they are poured together. One correspondent has just described for me his method of making Bordeaux mixture, which is simple and easily accomplished, and one that will produce almost an ideal mixture. He says: "In making Bordeaux mixture as we do in batches of 150 gallons, we start with three barrels upon a platform elevated above the top of the sprayer tank, each barrel emptying into a trough common to all. Into one barrel we put 15 pounds of dissolved copper sulfate and fill the barrel with water; in another barrel from 18 to 20 pounds of "new-process" lime is poured and the barrel is then filled with water; the third barrel is filled with clear water. After thoroughly agitating the contents of the barrels we open the faucets of all three and let them flow together into a spray tank, and get good results, there being little sediment ever in the bottom of our tank, and the Bordeaux stands up well."

I secured four different brands of "new-process" limes, all of which were made from dolomitic or magnesium limestones. A chemical analy-

sis of these limes showed from 28 to 38 per cent of magnesia, and the quicklime varied from 40 to 60 per cent, the remainder being largely water. One sample was the "limoid," now recommended for making the kerosene-lime mixtures. Another sample was designated as "freshly-burned, fine-ground lime," which would not keep more than three or four weeks in this condition, as it would then begin to air-slake. Another sample, which was said to be five years old, had practically all air-slaked, and could not be used in making Bordeaux mixture, as will be shown later. All of these "new-process" limes were tested beside a good stone lime, and also with the best stone finishing lime I could get. The test consisted simply of making a Bordeaux mixture with the various limes according to the formula of five pounds of copper sulfate, five pounds of lime, and

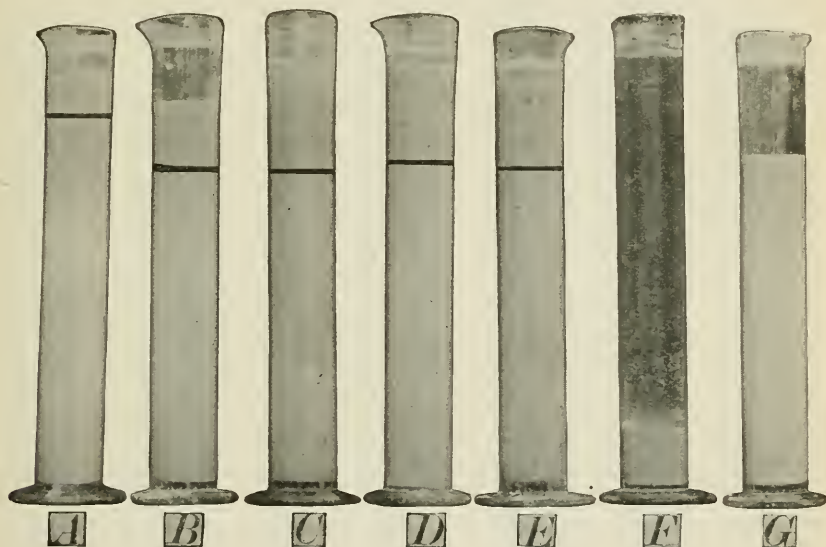


FIG. 46.—Cylinders of standard Bordeaux mixtures one hour after making. Detailed description in paragraph below. Black lines across the first five cylinders indicate levels to which the mixtures had settled after standing three hours.

fifty gallons of water. Small batches were made up and poured into tall glass cylinders and allowed to settle for various periods.

In Figs. 46 and 47 are shown the results of these tests after the mixtures had stood in the cylinders certain definite times. A was made with the best stone finishing lime (Canaan); B, with Seneca white, fine-ground, unslaked lime; C, with "limoid;" D, with a brand of prepared lime sold by a spray pump manufacturer; E, with Seneca white new-process hydrated lime, which was five years old and had all air-slaked; at G is shown Bordeaux wrongly made with a new-process lime in which

the dry lime was dumped into a *dilute* copper sulfate solution; G would have been a much poorer mixture had the dry lime been put into a *concentrated* sulfate solution. All the mixtures except G were properly made by pouring together dilute lime and copper sulfate mixtures. In Fig. 46 the mixture had stood one hour. The first five mixtures are about equal in value as the precipitate had settled but little in any of them. At this stage then, the Bordeaux made with the prepared limes is practically as good as that made with the best stone lime. Note how quickly the air-slaked lime in F settled to the bottom, and it did not neutralize the acid sulfate solution, hence did not make a Bordeaux mixture. After standing three hours, the precipitate had settled down to the points indicated by the black marks across the cylinders in Fig. 46. At this stage all the pre-

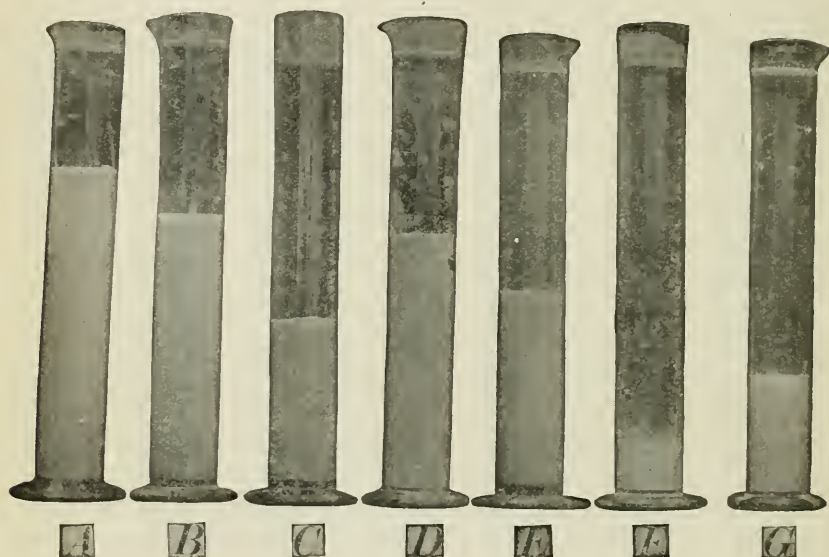


FIG. 47.—Cylinders of standard Bordeaux mixtures six and one-half hours after making. Detailed description on this page.

pared lime Bordeaux mixtures were about alike and still good mixtures, while that made with the best stone lime was holding up better.

In Fig. 47 is shown the same cylinders of Bordeaux after they had stood $6\frac{1}{2}$ hours. Here the stone lime mixture is slightly the best while those made with the prepared limes are varying. Note here how much better the precipitate in most of the properly prepared mixtures is holding up than in the wrongly made mixture at G. There is also a more striking difference in the quality of these two kinds of Bordeaux which is well brought out in Fig. 48. In this figure the cylinders have stood $6\frac{1}{2}$ hours and A is the same cylinder as G in Fig. 47. B and C in Fig. 48

are Bordeaux mixtures properly made with dilute mixtures of lime and sulfate of copper, the former having been made with a prepared lime and C with a good stone lime. Note the striking difference in the flocculency of the mixtures B and C as compared with the poorly made mixture at A. Mixtures B and C could be kept in suspension in the spray tank with less stirring and would not be so apt to clog the nozzles as the coarser and heavier mixture at A.

I was also interested to know whether it would take more "new-process" lime than stone lime to make a good Bordeaux mixture. I found that about one-half the quantity of stone lime, or about $2\frac{1}{2}$ pounds, was sufficient to thoroughly neutralize the five pounds of copper sulfate, but that an equal quantity of "new-process" lime was not quite enough to overcome the acidity of the copper sulfate. This result was rather surprising, because I had thought that the formula did not call for such an excess of lime over enough to neutralize the copper sulfate. This result shows that by the use of the ferro-cyanide test, by which one can readily determine when enough lime has been added, that much lime can be saved and thus the mixture cheapened. It is

always advisable, however, to add about as much more lime, especially during rainy seasons, when weather conditions act upon the spray after it is on the foliage, and unless there is plenty of lime considerable injury to the foliage may result. Doubtless the reason why it takes more "new-process" lime than stone lime to make a good Bordeaux mixture is because the former limes are about one-third magnesia, which does not enter chemically into the Bordeaux mixture. Fresh, "new-process" limes, except the one mentioned above, which was described as "freshly burned and finely ground," are limes which are water-slaked dry. The lime just mentioned is not slaked, however, and when put into water will finally slake, like stone lime. It is cheaper than the other "new-process" limes, but it will not keep so long in good condition, hence there would be a little more risk in getting it.

Some other results of the tests are that one should never attempt to make Bordeaux mixture with air-slaked lime. I am informed that some



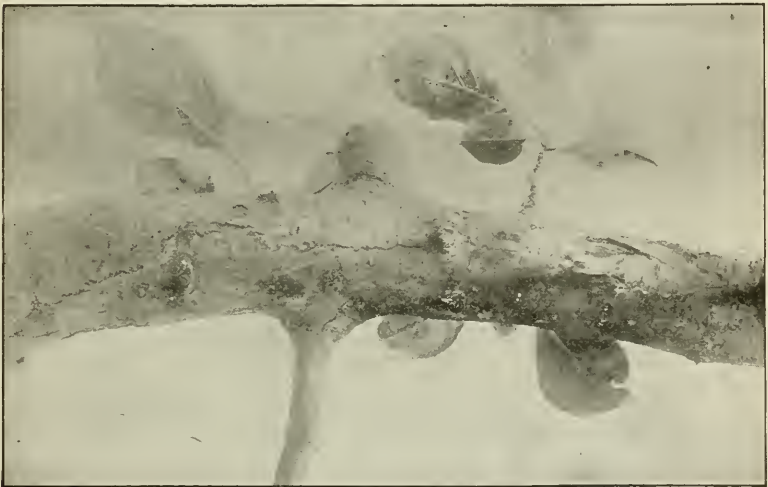
FIG. 48.—Bordeaux mixtures which have stood six and one-half hours. See page 174 for detailed description.

unscrupulous dealers have put on the market air-slaked lime as "new-process" lime. It is evident from the tests that practically as good a Bordeaux mixture, both chemically and mechanically, can be made with the "new-process" limes as with ordinary stone lime. But it is very essential that the "new-process" limes be fresh or newly made. Just how long these limes can stand before air-slaking I do not know, but I have tested some that have stood in barrels for four or five months, and they seemed to work all right. I would not recommend, however, that any of the "new-process" limes be used when more than a year old. One can easily make a simple test, which will soon determine whether the lime is good. Take a small quantity and make up a little Bordeaux mixture according to the formula given above, and use the ferro-cyanide test. Five cents' worth of these poison crystals dissolved in a pint of water will last a season or two for testing. If the test liquid turns a dark brown color as soon as a few drops touch the Bordeaux more lime must be added until the liquid does not change color. Litmus paper can be used for determining when the sulfate is neutralized. If the five pounds of lime considerably more than neutralizes the five pounds of copper sulfate, and the mixture does not settle very fast, it would be safe to purchase such lime in quantities for spraying. Another simple test for these prepared limes is to take a small amount of the lime, about one-half teaspoonful, drop it into a little hot vinegar, and if it effervesces or "sizzles" it contains carbonate of lime and will probably make good Bordeaux mixture. I would not buy any "new-process" limes without first making one of these simple tests, because, as shown above, they will all air-slake in time.

The prepared limes cost a little more than stone lime per barrel, but when you buy a barrel, all of the material can be used rather than one-half or two-thirds of it in the center of the barrel, as in the case of stone lime. Then it is much easier merely to dump the lime into water and stir it up without having to wait for it and watch it while slaking. Do not dump the dry lime into the copper sulfate solution, even when the latter is much diluted. I have received many inquiries regarding these limes, and have gained much information from the experiments described above. I hope the facts have been put in such a way that, by the aid of the illustrations, farmers will be able to get a better notion regarding the proper making of Bordeaux mixture, and that these comparative tests of "new-process" limes with stone lime may benefit the public.

CORNELL UNIVERSITY
AGRICULTURAL EXPERIMENT STATION OF
THE COLLEGE OF AGRICULTURE
Department of Botany (Extension Work)

THE BLIGHT CANKER OF APPLE-TREES



By H. H. WHETZEL

ITHACA, N. Y.

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FIG. 51.—Active canker showing the exuding milky drops. This sticky sap is made up almost entirely of the blight bacteria.

COLLEGE OF AGRICULTURE, CORNELL UNIVERSITY.

ITHACA, N. Y.

HON. CHAS. A. WIETING,

Commissioner of Agriculture.

Sir:— I hereby transmit a report of the investigations of the College of Agriculture on blight cankers that are coming to be very destructive of apple trees in many parts of the State.

This canker is found to be due to the same organism (a bacterium) that causes the blight of the pear. It is superinduced by over-rapid growth of the tree, and the points of inoculation are water-sprouts, wounds, and possibly the flowers. There is no cure, but further spread of the cankered areas may be prevented by careful treatment of the wounds as explained on page 119.

Many of the bulletins issued by this institution relate to the apple industry in New York State, and the following numbers are devoted exclusively to it:

- 48. Spraying Apple Orchards.
- 84. The Recent Apple Failures.
- 116. Dwarf Apples.
- 207. Pink Rot an Attendant of Apple Scab.
- 214. The Ribbed Cocoon-Maker of the Apple.
- 226. An Apple Orchard Survey of Wayne County, New York.
- 229. An Apple Orchard Survey of Orleans County, New York.

Respectfully submitted,

L. H. BAILEY,
Director.

THE BLIGHT CANKER OF APPLE TREES

I. CANKERS AND WHAT THEY ARE.

During recent years several kinds of cankers, occurring especially upon apple trees, have been described and figured in bulletins from different experiment stations in this country. A canker of fruit trees has long been known in Europe, due to the attacks of a fungus, *Nectria ditissima*.^{22*} This disease has also been reported from America.¹⁵ By careful inoculation experiments, these various cankers have been shown to be due to different species of either fungi or bacteria. Some of these canker diseases are peculiar to certain regions only. Others are more cosmopolitan and are likely to be found wherever apple trees are grown.

Notwithstanding the fact that these injuries to the bark of living trees have been, in the large majority of cases, absolutely proved to be due to the growth of parasitic fungi or bacteria, growers very generally even at the present time attribute them to "sun scald" or "winter injury." Lack of knowledge of the nature of fungous and bacterial growth, together with the ease with which responsibility may be shifted upon the weather, have made this opinion the common and natural one. Not only have experiment station workers shown that these injuries are usually due to the attacks of living organisms rather than to the results of unfavorable weather conditions, but they have demonstrated that the different forms of these cankers are due to distinctly different organisms.

The term "canker," then, has come to be a very general one and is applied to diseases which cause the death of definite areas of bark on the limbs and bodies of trees. The diseased area may be smooth and sunken or enlarged and roughened, depending on the nature of the organism causing it. Most "cankers," as the term is understood at the present time, are caused by the attacks of some parasitic plant, either a fungus or bacterium.

The following distinct canker diseases of apple trees have been described. Those marked with a † are known to occur in this State:

†European canker¹⁵ (*Nectria ditissima* Tul.).

†New York Apple Tree Canker¹⁶ (*Sphaeropsis malorum* Pk.).

Black Spot Canker¹⁴ (*Gloeosporium malicorticis* Cordley). First described by Cordley in 1900 as "Apple Tree Anthracnose"¹⁰. Also referred to as Pacific coast canker.

Illinois Apple Tree Canker¹² (*Nummularia discreta* Tul.).

Bitter Rot Canker⁸ (*Glomerella rufomaculans* (Berk.) Spal. & v. Schr.).

†Blight Canker of apple trees²⁰ (*Bacillus amylovorus* (Burr.) de Toni.).

It is to the last of these, the Blight Canker, that this bulletin is espe-

* These numbers refer to the bibliography at the end of this bulletin.

cially devoted. Although this particular kind of cankered spots on apple trees was probably first observed by horticultural writers as early as 1780¹¹ and has been repeatedly referred to in horticultural writings since that time, its true nature does not seem to have been suspected until 1880. In that



FIG. 49.—*Typical blight canker on main limb of young tree.*

year Professor T. J. Burrill, of the Illinois State Experiment Station, while working on the fire blight of pears and apples, came to the conclusion that the so-called "sun scald" spots on the bodies and larger limbs of apple trees are due to the same cause. At a meeting of the Illinois State Horticultural Society in 1881⁵ in answer to a query regarding the nature of "sun scald," he said: "The sun scald on apple tree is the same as pear blight." Similar statements of Professor Burrill upon the same subject are recorded in other places.⁶ Upon what experimental evidence, if any, this and other statements⁷ were based I have so far failed to discover. A number of writers² since that time have referred to these cankered patches as "body blight" due to attacks of *Bacillus amylovorus*,¹⁹ but none seem to have actually produced the cankers by the introduction of the bacteria into the bark of healthy trees.¹⁷

2. THE DISTINGUISHING CHARACTERS AND APPEARANCE OF THE CANKER

The blight canker (Fig. 49), while it may occur on trees of almost any age, is most destructive on young trees just coming into bearing, trees from 8 to 15 years old. In some sections of this State, notably the Upper Hudson River valley, at least 95 per cent of the trees of this age show canker on limbs or body. A very large percentage of the affected trees are dead and the remainder are fast succumbing. Very noticeable throughout this section also are the large number of trees with cankers in the crotches (Fig. 50) where the main limbs arise from the body. In this same region a good sized orchard, set out about three or four years ago, was observed to have suffered severely evidently from this same disease. In this orchard the disease usually involved the greater part of

the tree, often killing it to the ground. The cankers have also been observed in the upper crotches and on the sides of the large limbs in old trees. Spreading from these points of infection, the disease may gradually involve the entire limb, causing its death. Old trees weakened by age and neglect may suffer seriously from such attacks and the dead limbs protruding here and there from the green foliage in old orchards are often to be attributed to the ravages of this canker.

As already pointed out, it is on young trees that the canker is most dangerous, for unless promptly attended to the disease is almost certain to result in the death of the entire tree.



FIG. 50.—Baldwin tree killed by attack of blight canker in the crotches of the main limbs.



FIG. 52.—Typical canker showing the crack about the margin where the diseased bark has dried away from the healthy tissue.

In young trees with smooth bark the cankers are easily detected, even in their first stages. They appear as discolored and somewhat sunken areas, the margin along the advancing front being usually slightly raised or blistered. The tissue in actively spreading cankers is of a darker green than the healthy bark and is very watery or sappy. On damp cloudy days drops of a milky, sticky fluid (Fig. 51) exude from

the cankered tissues through the lenticels or pores in the bark. After a short time the diseased tissue begins to turn brown and dry out. Unless in a very active state of progress the margins are very distinct, marked by

a crack where, in drying, the diseased tissue has separated from the

healthy bark (Fig. 52). The older cankers are brown, somewhat darker than the healthy bark. They are distinctly sunken. The surface is smooth, never checked or roughened or beset with pustules or pimples, except in the old cankers, where, after a time, rot fungi gain entrance and, thriving in the already dead tissues, produce their fruit bodies on the surface. The progress of the spreading canker depends largely on the continuation of favorable weather conditions, which seem to be a humid atmosphere and cloudy days. With the return of bright sunny weather, the active spread of the canker is checked abruptly, often to be resumed again with the return of favorable conditions. This checking and renewing of activity sometimes result in large cankers with concentrically arranged cracks within the cankered area (Fig. 53). This renewal of activity may take place during the same season or the canker may partially heal over to spread anew the following year (Fig. 54). A large percentage of the cankers are active during but one season. There are



FIG. 53.—*Concentric cracks in the cankered area, indicating two periods of activity during the season due to abrupt changes in the weather conditions.*

always some, however, in which the disease is perennial, living through the winter to become active again the following spring, spreading and enlarging the original limits of the cankered area (Fig. 55). The diseased bark is usually killed by the wood, to which it clings tenaciously the first season. It gradually decays, however, and falls out, leaving the wood bare and exposed (Fig. 54). In small cankers the cone of diseased bark may be quickly forced out by the rapidly formed calluses, which heal and close the canker wound (Fig. 56). In some cases the canker is superficial, never reaching the cambium except, perhaps, in a limited area at the point of infection. Such wounds heal quickly beneath the dead bark, which clings to the tree as a sort of scab (Fig. 57).

The cankers vary in size from half an inch in diameter to as much as a foot or more in length and several inches across. On healthy, vigorous trees they are small and more or less circular in outline. They form funnel-shaped wounds with the small end toward the wood. These I have designated as "pit cankers" (Fig. 58). Often the dead bark remains as a sort of lid to the pit (Fig. 56), but it is easily removed with the finger or a knife blade. I have seen young trees with limbs and body literally covered with these pit cankers in all stages of



FIG. 55.—Canker spreading the second season, destroying callus of last season and enlarging area of cankered surface.



FIG. 54.—Cankers in body of tree resulting from the renewal of activity season after season. Observe that these started from small pit cankers which partially healed each season. The disease the following season destroyed all the bark growth, leaving only the little bit of wood formed in the callus. This still persists.

healing over. Aside from affording an entrance to rot fungi such cankers, unless they enlarge, do not seriously affect the health of the tree. In many cases these pit cankers do not heal properly or at all, and the disease, spreading the same or the following season, forms the large and dangerous "limb" or "body cankers" (Fig. 59).



FIG. 56.—*Pit canker. Rapidly forming callus closing the wound and forcing out the diseased bark.*

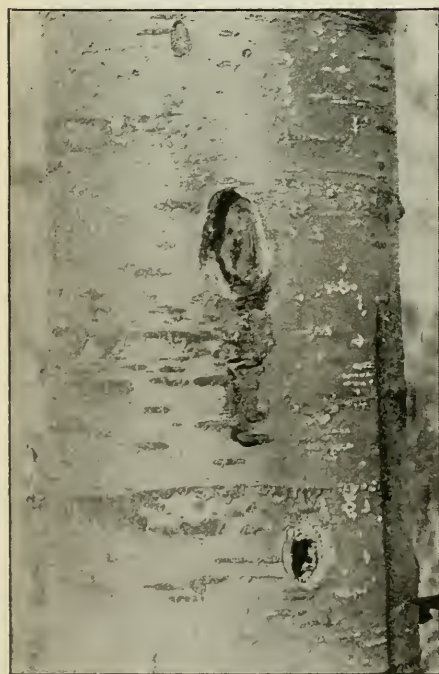


FIG. 58.—*Typical pit cankers in the body of a tree from which the diseased bark has dropped out. The upper one is exuding sap,—“bleeding.”*



FIG. 57.—*The wound healing beneath the cankered bark, which still clings to the tree as a sort of scab. This canker was more or less superficial.*

"Crotch cankers" (Fig. 60) usually appear in the crotches where the main limbs arise from the body, but may also appear in the secondary crotches well up in the tree. In general characters they are similar to the limb and body cankers. Owing to their peculiar position, water is retained more readily in the dead bark, thus affording the very best conditions for the entrance and growth of rot fungi. These find easier access to the heartwood at the crotch than on the limbs. It was observed that these crotch cankers heal much less readily and successfully than do the limb and body cankers. Crotch cankers, unless promptly attended to, mean the almost certain destruction of the trees.

The large cankers at the bases of young trees (Fig. 61), frequently referred to by growers as "collar



FIG. 60.—Typical crotch canker. Dead bark has been removed. Callus forming about the margin.



FIG. 59.—Large body canker resulting from successive seasonal attacks of the disease. Originated at the pruned stub.

rot," are in many cases very probably due to the same cause as that of the cankers on the upper parts of the tree. The well known "collar rot" of King trees may also be due to the same or a similar organism.

How this Canker Differs from the Well Known New York Apple Tree Canker

The New York apple tree canker (Fig. 62) described by Paddock¹⁶ in Bulletins No. 163 and No. 185 of the New York (Geneva) State Experiment Station, is very abundant and destructive in many orchards of the State. It is caused by a fungus and is in most respects very different from the blight canker with which, nevertheless, it is frequently confused. The chief differences between the two are set forth in the following parallel columns:

NEW YORK APPLE TREE CANKER	BLIGHT CANKER
Caused by a <i>fungus</i> .	Caused by <i>bacteria</i> .
Usually found on the main limbs of <i>old</i> trees.	Occurring most frequently on the body and limbs of <i>young</i> trees just coming into bearing.
Diseased portion more or less <i>swollen, cracked</i> and <i>roughened</i> . (Fig. 62.)	Diseased area <i>sunken</i> and <i>smooth</i> not cracked and checked. (Fig. 53.)
Cankered surface <i>black</i> .	Cankered surface <i>brown</i> .
Covered with <i>minute black pimples</i> —the fruit bodies of the fungus often not so evident in old cankers. (Fig. 62.)	<i>Not</i> showing any <i>pimples</i> or <i>fungus fruit bodies</i> , except in old cankers that have been invaded by saprophytic forms.
Freshly cankered tissue <i>dry</i> .	Freshly cankered tissue <i>watery</i> .
Cankers <i>perennial, i. e.</i> , living over and spreading from year to year.	<i>A large per cent</i> of the cankers <i>active but one season</i> .

3. HOW THE DISEASE AFFECTS THE TREE

The effect of the canker on the tree is to lower its vitality to a greater or less degree by cutting off the food supply to the roots, and thus indirectly reducing the flow of sap to the branches and leaves. In other words, it acts the same as partial or complete "girdling." The "collar rot" and "crotch cankers" seem to be the most fatal to the tree. The effects of the canker are first evidenced in the foliage. If there is a large body canker, the entire tree may show the effects of the trouble. More often the first symptom noted by the grower is the peculiar appearance of the foliage on one or more of the limbs. Either these branches fail to leaf out at all in the spring, or if they do the leaves never fully expand but remain undersized and curled or inrolled. They never take on the dark green color of healthy foliage, but remain pale and gray. Growers often refer to such trees as having "mouse ear" leaves. As the season advances and

the cankers spread, the leaves often die and dry up on the branches (Fig. 63). Sometimes badly affected trees will pull through until autumn or even live for two or three seasons. Such trees have scanty foliage, blossom profusely and frequently set a heavy crop of fruit. This fruit falls prematurely or is small and inferior in quality. Fig. 64 shows a large body canker at the base of one of the main limbs on an old tree. The canker had nearly girdled the limb. This spring the branch was loaded with blossoms to the exclusion of foliage, while the other limbs of the tree bore a normal quantity of flowers and leaves. Such affected limbs and trees, as if in anticipation of their approaching death, seem to devote their expiring energy in one grand and final effort to reproduce themselves.

As I have already pointed out, small cankers may not of themselves seriously affect the health of the trees. When the trees are strong and vigorous they frequently succeed in promptly healing the wounds. The dead bark of the canker, however, makes an excellent infection court for the entrance into the tree of "heart rot" and decay-inducing fungi. Moisture, so necessary to the germination and growth of the spores of fungi, is retained for a considerable time in the dead tissue. This is more especially true of crotch cankers. No doubt these rot fungi are often to blame for the final death of the tree. The heartwood of badly affected limbs and trees is commonly found to be soft and rotted, with only a thin rim of sound sapwood surrounding it.



FIG. 61.—Large body canker near base of tree, often referred to as "collar rot." The tree has made repeated attempts to heal this wound.

4. THE CAUSE OF THE CANKER

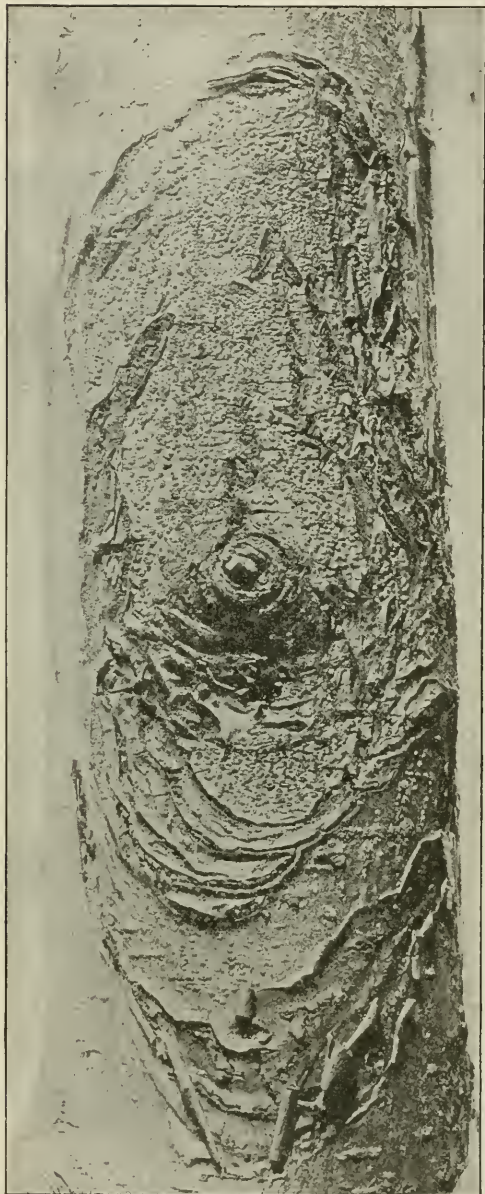


FIG. 62.—Typical New York apple tree canker, caused by the fungus *Sphaeropsis malorum*. Comparatively young canker. Observe the little pimples covering the diseased bark, —the sporecases of the fungus.

A microscopic examination of the viscid milky drops that exude from freshly cankered surfaces (Fig. 51) on moist cloudy days shows them to be composed almost entirely of minute rod-shaped bacteria. The diseased tissue within the bark is also found to be alive with these minute plants. By their rapid growth and multiplication within the cells of the bark, they cause its death. They are not carried along in the sap but slowly work their way from cell to cell. When the canker dries down they die and disappear, so that examination of the tissue of old cankers does not show them. That they are the direct cause of the disease was proved in the following way: Bacteria from the cankered tissue were introduced into the bark on the body of a healthy apple tree and also into the bark of a healthy pear tree, with the result that typical cankers appeared in both cases. (Figs. 65 and 66.) Blossoms and growing twigs of both pear and apples were also inoculated with bacteria from this same canker. These nearly all developed good cases of blight (Figs. 67, 68 and 69) in about ten days,

while twigs and blossoms punctured with a sterile needle gave no infection. This last experiment was twice repeated during the summer with pure cultures of the bacteria from the apple tree canker. The blight resulted in practically every case. Young fruits of both the pear and apple were also inoculated and gave well developed cases of the disease. (Fig. 70.)



FIG. 63.—*Badly cankered trees showing the dead leaves clinging to the branches.*

By a comparative study in various culture media of the bacteria from cankers, twigs and fruits of both pear and apple (Fig. 71) secured from different orchards about Ithaca, the organism of the canker was shown to be identical with that of the well known "fire blight" of the pear and "twig blight" of the apple.

5. HOW TREES BECOME INFECTED

Aside from the nature of the organism causing the malady, perhaps the most important question in taking up an investigation of a given plant disease is that of how the parasite gains entrance into the host. The answer to this question is the prime requisite for intelligent effort in combating the disease.

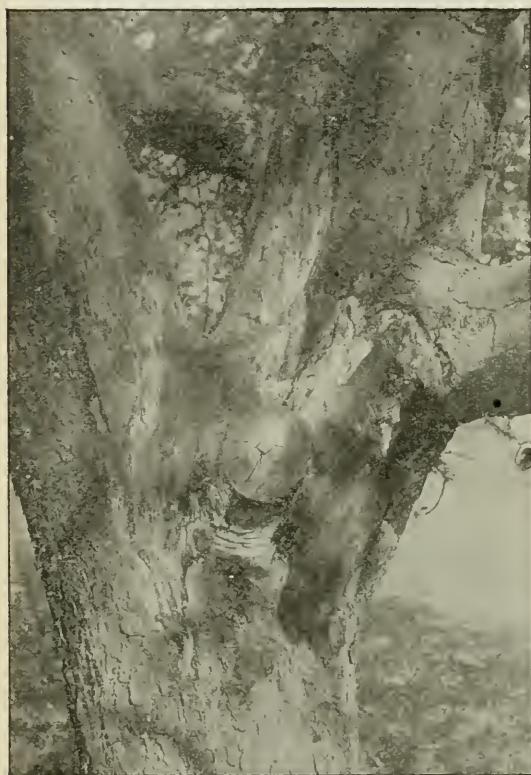


FIG. 64.—*Large body canker on the side of an old tree.*

Much of my attention while in the field during the past season has been directed to a solution of this problem. Only those ways of infection which personal observation has discovered are here recorded. No doubt the bacteria gain entrance to the bark in still other ways than those I have observed.

The bacteria frequently get into the bark of the limbs and body by way of short spurs and watersprouts. (Fig. 72.) Early in my investigations I came to this conclusion. The opinion was fully confirmed later in the season. Twig blight became very prevalent during July and August, especially in the region about Ithaca. It was then an easy matter to find blighted spurs and watersprouts with active cankers about their bases. (Fig. 73.) When these watersprouts grew out from the trunks, as is often the case in young trees, typical body cankers were formed. (Fig. 74.) The infection of the sprout itself is generally attributed to the work of insects, which after visiting freshly cankered sprouts or blighted twigs introduce the bacteria into the succulent tissues of the rapidly growing healthy shoots. The

blighted watersprout soon dries up and falls away, leaving often a very indefinite scar in the cankered area so that the following season it is usually impossible to tell with certainty the manner of infection. Observation on a large number of trees during the past season convinces me that the blighting of adventitious shoots on trunk and limb is responsible for most of the cankers in such locations. A number of cankers were produced in this way by artificial inoculation. (Fig. 68.)

Another source of infection was found to be the pruning knife. Along one side of an orchard of some 350 trees which was under observation throughout the season, it was early noticed that the pruned stubs of 1904 especially, showed collars of dead bark often two or three inches in width. (Fig. 75.) Instead of forming a callus and healing over the wound, as

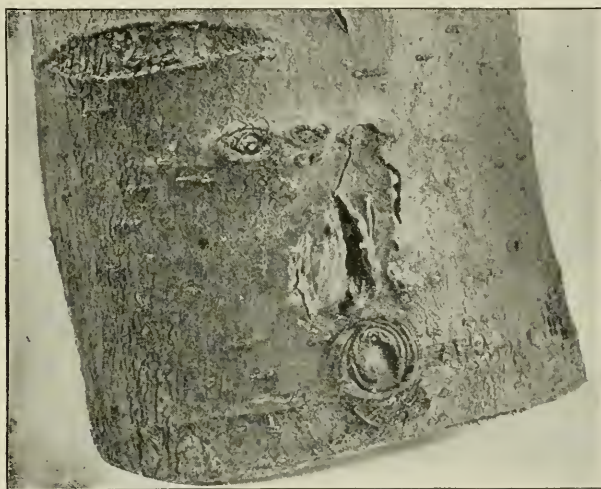


FIG. 65.—Canker near base of apple tree, resulting from artificial inoculation with bacteria direct from canker on another apple tree.

would normally occur, the tissue had died and shriveled up but still clung to the stub. In most cases the bacteria which had caused the death of the bark had died out the first season. In a few instances, however, the canker was observed to be active early in the spring, extending down the side of the adjoining limb. (Fig. 76.) Two badly diseased trees on this side of the orchard seem to have been the source of infection. Owing to their diseased condition, they had been severely pruned the previous season and very probably the knife or saw had carried the bacteria to the healthy trees. Flies which were observed constantly to follow the pruner to suck up exuding sap, may have been the direct agent in many cases in transferring the bacteria. The knife itself may convey the disease, as



FIG. 66.—Canker on pear tree resulting from inoculation with bacteria from active canker on apple tree.



FIG. 67.—Growing twig of apple blighted by artificial inoculation with bacteria from active canker on limb of apple tree.



FIG. 68.—Blossom and spur blight of apple resulting from artificial inoculation with bacteria from canker on limb of apple tree. Note the small cankers that have formed about the base of the spurs.

is shown by the following incident: While making inoculations into the body of an apple tree on the Station grounds, I had occasion to remove, from near the base, a large sprout of several years' growth. This I did with my knife which I had but shortly before used to cut bark from a fresh canker. A typical canker soon developed about this pruned stub. (Fig. 77.)

Of a similar nature are infections that occur through wounds or bruises on the limbs and bodies of trees. These wounds, commonly results of "barking," may be made by careless workmen when plowing or work-



FIG. 69.—Actively growing pear twigs blighted by artificial inoculation with bacteria from canker on limb of apple tree.

ing about the trees or from the gnawing of animals; one of the worst animals in New York is the woodchuck. A large percentage of such wounds heal over eventually, but frequently through the agency of insects or other means these wounds serve as infection courts for the canker bacillus. An interesting case of wound infection came under my observation last season. In cutting a cankered branch I accidentally "barked" a healthy limb with the cut end of the diseased branch. The tree was not again visited until some weeks later, when a large and actively spreading canker was found to have developed about the abrasion (see front cover). The bacteria were found in abundance in the diseased tissue and pure cultures were secured.



FIG. 70.—Half grown apple inoculated with pure culture of bacteria from canker on limb of apple tree. Note milky drops exuding from diseased tissue.

The wounds or punctures of insects seem to be directly responsible for some of the infections. Sometimes cankers on the bodies of trees cannot be attributed to infection through blighted shoots. In some cases these cankers have been traced directly to the wounds made by insects. Fig. 78 shows a hole made by a borer at the base of a tree and surrounding it is a well developed canker. It is very probable that many of the cankers at the base of young trees originate in wounds made by borers. The bacteria are probably carried to these wounds by flies or other insects which visit these places to feed on the exuding sap and excrement. The infecting agents in the case of crotch cankers have not as yet been definitely determined. It seems likely that insects again are here responsible. I have



FIG. 71.—Naturally infected apple. Infection probably took place in the spur at the base of the stem, through which it worked its way to the young fruit.

found them repeatedly hiding in the crevices of the dead bark that accumulates in the crotches, and one species seems to feed to some extent on the living tissue in such places. I have also observed this same species feeding on the exuding sap of cankered limbs and stubs. That it may carry the bacteria to the crotches seems obvious. Besides this, many of the crotches are of such a form that they readily retain moisture and thus afford the best of conditions for bacterial growth.

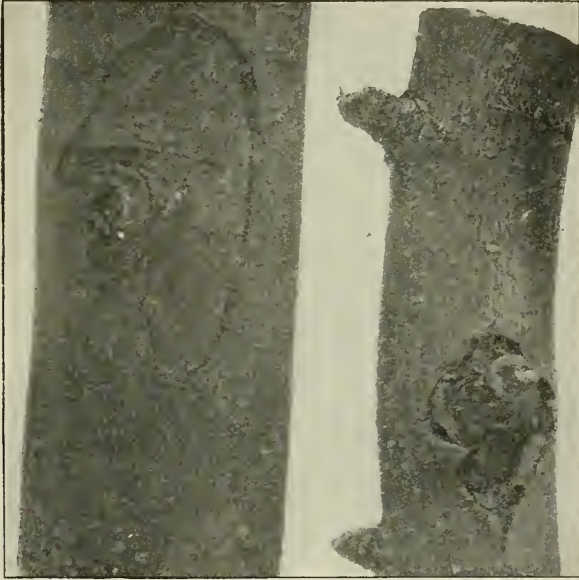


FIG. 72.—*Cankers on limbs of apple tree which originated through blighted spurs.*

At a general deduction, then, it may be stated that infection occurs only through a wound of some sort. Moreover, the infection court must be of such a nature that it will not dry out quickly. An abundance of moisture is known to be necessary to the rapid growth and development of the blight organism. This was repeatedly demonstrated in the large number of pure cultures which I had under observation during the summer. The growth was most abundant and vigorous in liquid media. This peculiarity accounts for the ease with which growing shoots are infected. When the diseased tissue of an active canker was at once cut out and the wound exposed to the drying heat of the sun without any other treatment, the canker ceased to spread and the place healed rapidly.

6. TREATMENT THAT PROMISES BEST RESULTS

Although the work of the past season has been devoted largely to a study of the various manifestations of the disease, its cause and distribution, still some attention has been given to the means of combating it. Through the kindness of several men, in different parts of the State, I have had the opportunity of carrying on some experiments along this line on their trees. PREVENTION rather than CURE is one of the axioms of plant pathology. In most cases the curing of a diseased plant is impossible, or its value does not warrant the effort required to save it. However,

in the case of trees just coming into bearing it seems that, if possible, some means of saving them should be worked out. Several things were accordingly tried, but the one that so far gives most promise of definite results is to *cut out the cankers* (Fig. 76). With a sharp knife remove all the diseased tissue (Fig. 79), swab out the wound with a weak solution of corrosive sublimate (one tablet to one pint of water), or with a three per cent solution of copper sulfate (1 ounce to 1 quart of water), and when dry, paint over thoroughly with some heavy lead paint. This should be done early in the season, as soon as the cankers are discovered, for two reasons: 1st,

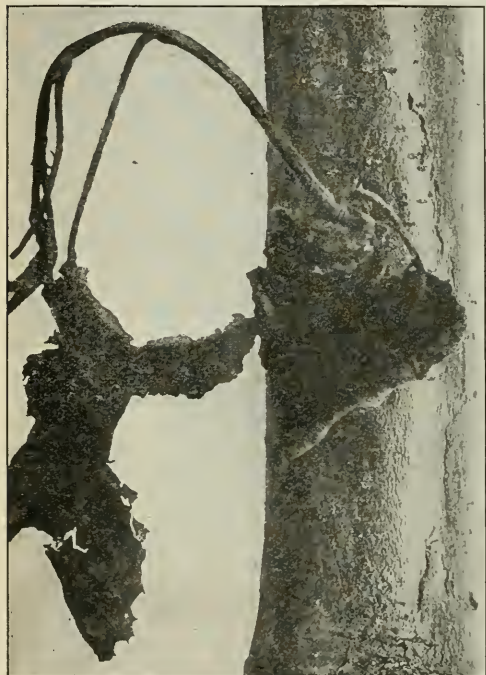


FIG. 73.—Recently blighted shoot on limb of Greening apple tree with well marked active canker about its base.

the spreading of the canker and its consequent damage to the tree is checked; 2d, the wound is thus given a long period in which to heal. The painting should be repeated again toward the close of the season and again the next year, or until the wound has completely healed. This prevents a second infection or the entrance of rot fungi. A twice-monthly inspection of every tree should be made and all cankers carefully cut out and treated as soon as they appear. Cankered trees so treated early in the spring of 1905 have formed good calluses and are fast healing the wounds (Figs. 80 and 81).

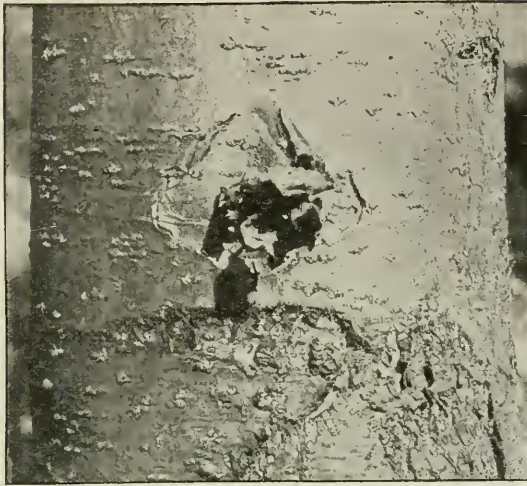


FIG. 74.—*Typical body canker in its first stage. Resulting from infection through blighted watersprouts.*



FIG. 75.—*Pruned stub canker. Infected at time of pruning, probably by the saw. Note the collar of dead bark.*



FIG. 76.—*Pruned stub canker. The bacteria did not die the first season, but continued throughout the winter slowly to work down the side of the limb. The diseased bark has all been cut away preparatory to treating and painting the wound.*

7. PREVENTIVE MEASURES.

It is scarcely necessary to point out that every precaution should be taken to prevent bruises or injuries of any sort, since these make excellent infection courts for the entrance of the bacteria.

All dead limbs and trees should be promptly removed from the orchard and BURNED. Old pear trees in the neighborhood of young apple orchards are often a constant source of infection, and, unless kept absolutely free of the blight, should be removed. A neighbor careless in respect to blight in his pear trees provides a dangerous source of infection.

Cut out and burn every trace of twig blight from both pear and apple trees as soon as it is detected.

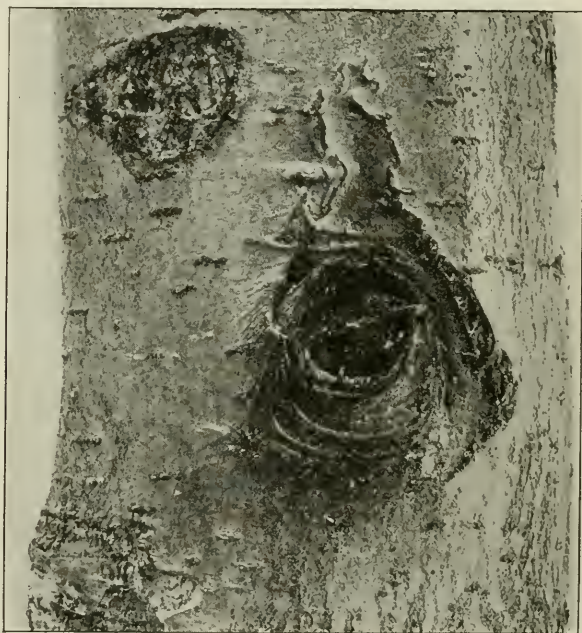


FIG. 77.—*Pruned stub canker resulting from cutting away a watersprout with a knife used shortly before to cut out an active canker and not disinfected.*

When pruning, treat all cut surfaces with the corrosive sublimate or copper sulfate solution and keep them painted until healed. Treat all accidental wounds in the same way.

Keep the body and main limbs of the tree free of watersprouts throughout the summer.

In planting, choose trees with open or spreading crotches.

Avoid excessive fertilizing with nitrogenous manures. Apply some form of phosphoric acid to ripen new growths.

The planting of varieties known to be more or less resistant to this disease is to be recommended. The Wolf River and Talman Sweet appear to be of this sort, while Baldwin and Ben Davis suffer most severely. Desirable non-resistant varieties may be top grafted on resistant stocks.

Mr. M. B. Wait, in a lecture at Lockport, N. Y., January 3, 1906, before the New York State Fruit Growers' Association, recommended the spraying of pear trees early in the spring with the Lime-Sulphur wash as



FIG. 78.—Canker formed about the mouth of the burrow of a borer near base of an apple tree.



FIG. 79.—Pruned stub canker, with diseased bark and stub removed, treated with corrosive sublimate and painted over. This is the same canker as Fig. 75, after treatment.

a means of covering up "hold over" cankers of the fire blight that had been overlooked in the "cutting out process." This treatment serves only to destroy any bacteria that may exude from trees already diseased, and thus prevent the cankers from serving as sources of infection. It will not protect healthy trees from infection. A similar treatment of cankered apple trees would certainly be of value.

8. DISTRIBUTION AND SEVERITY OF THE DISEASE



FIG. 80.—Pruned stub canker that had spread down side of limb during early spring of second year. Diseased tissue cleaned away, treated with corrosive sublimate and painted. Good calluses formed. Canker ceased to spread.

Since the first specimen of blight canker was received from the Upper Hudson River region early in the summer of 1904, evidence has been constantly accumulating that points to a very wide distribution of the disease. Numerous trips during the last two seasons have convinced me of its very general occurrence throughout this State. Practically no orchard of any size visited has been without some trace of it.

Certain sections have suffered much more severely than the rest of the State. The accompanying map (Fig. 82) shows the regions known to be most seriously affected. No doubt other localities have suffered as severely as those indicated, but limited time and funds at our disposal for this work have made a more extensive survey impossible. A careful and systematic examination of the orchards in all of the apple-growing sections of the State is very desirable, not only that the exact extent and severity of this disease may be determined but also that a comparative study of the distribution of other canker diseases may be made.

As already pointed out, the disease has been epidemic only in a few rather well marked and restricted sections of the State. In the Hudson River valley north of Albany the canker has destroyed nearly every young orchard. In the region about Schuylerville and Saratoga its ravages seem to have been most fatal. Throughout that section a number of orchards were set some ten to twelve years ago. These were just coming into bearing when the disease began to appear in alarming severity. At first only a few trees died here and there in an orchard, but by 1904 the loss had in many

cases reached more than 50 per cent, and a careful examination of several orchards showed that not less than 95 per cent of the trees were diseased. All along the line of the trolley north of Albany and about Saratoga, the dead and leafless branches of the young apple trees bear

witness to the destructiveness of the malady. The severe winters of 1902-3 and 1903-4 no doubt seriously affected the vitality of the trees, rendering them especially susceptible to attacks of the blight organism. The constant occurrence of the cankers indicate, however, that they were the chief factors in the death of the trees. No dead or dying trees in the young orchards were found that did not show cankers. Moreover, trees were observed here and there that bore no trace of canker and were apparently healthy and vigorous but showed upon examination the blackened cambium region due to freezing. In one orchard of originally some 400 trees (Fig. 83) which began to go out in 1903, less than 50 were still alive in June, 1905, and but a very few of these were entirely free from



FIG. 81.—Body canker cleaned out, treated and painted about eight weeks after treatment. Good, healthy calluses formed, which, with proper care, will completely heal this wound.

the canker. The old orchards in this section have also suffered considerably from this same malady, and pear trees have almost entirely gone out.

In the region about Kirkville and Chittenango in the northern part of Onondaga and Madison counties, a condition almost identical with that in the Hudson River region exists. The young orchards, while fewer in number, have suffered almost total destruction from this canker. The old trees in this section do not seem to have suffered to any considerable extent as yet. The disease appears to have become epidemic in this locality at about the same time as in the Hudson River region. In neither of these sections were many active cankers observed in 1905.

Practically all of them seem to have been formed during the seasons of 1902 and 1903. The summer of 1902 was a very rainy one in those regions, offering the very best of conditions for infection and development of the cankers. No doubt many of them appeared during that time but passed unnoticed by the ordinary grower until their baneful effects began to show in 1903. A few active cankers, however, were noted on trees here and there in these badly diseased orchards. The force of the

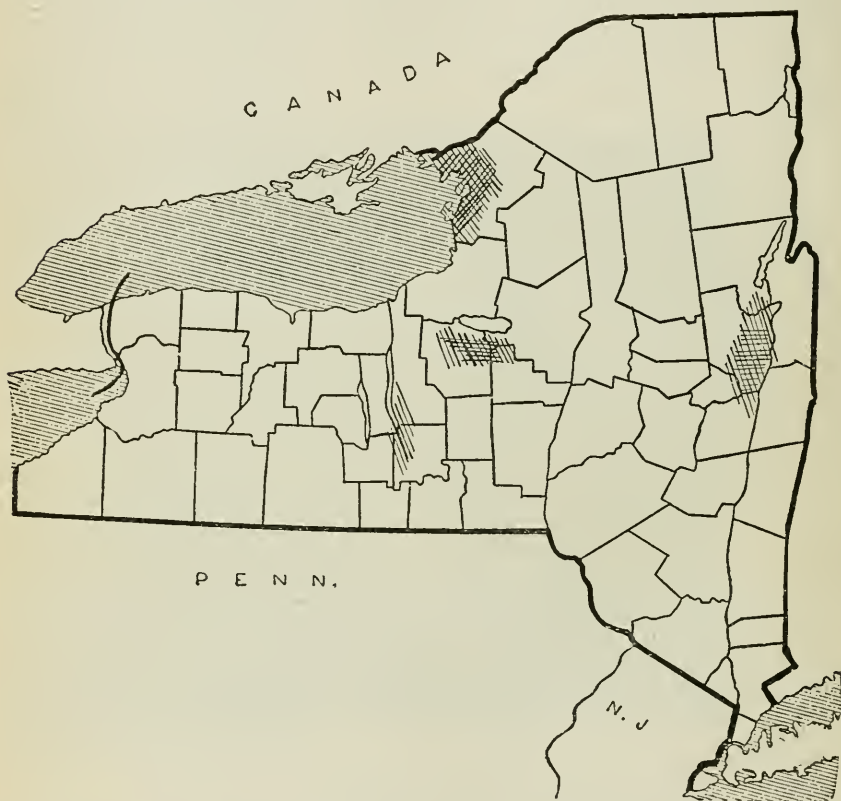


FIG. 82.—Map showing localities in the State where the disease is known to have been epidemic. The disease probably occurs throughout the orchards of the State, but is seldom severe.

epidemic seems to have spent itself by the end of 1903, the completion of the destruction being effected by the rot fungi that had gained entrance to the heartwood through the canker wounds.

In Jefferson county along the eastern end of Lake Ontario, especially in the neighborhood of Chaumont, the disease had completely wiped out many of the young orchards even before 1903. Farmers in this district assured me that their trees had been dying from this disease of trunks

and limbs for several years. Their statements were borne out by the advanced stage of decay of most of the cankered trees. The disease was active in trees which had not yet succumbed, and reports from that section showed that it was still at work in 1905.

The three sections already described are, so far as I know, the only places in which loss from the canker has been severe. An examination of the young orchards about Ithaca show a large percentage of affected trees, but as yet the disease has not occasioned serious losses. In an orchard of about 350 trees which has been under observation throughout the past season, about 85 per cent of the trees show cankers, while the actual number of dead trees resulting from its attacks has not exceeded five per cent. It is, on the other hand, a significant fact that a very large



FIG. 83.—Orchard of Mr. Henry Peck near Schuylerville, which originally contained some 400 trees. They began to go out in 1903 and in June, 1905, less than 50 trees were still alive. A very few of the 50 were entirely free from the canker.

proportion of this five per cent has died during the past summer. Reports of what appear to be the same disease have come from other sections of the State.

The canker is not confined to this State alone. Reports and specimens from different places indicate that it is more or less common in New Jersey, Delaware, Kentucky, Kansas, Iowa and Wisconsin. What is doubtless the same disease is also reported from Canada. In fact, it is safe to say that wherever the "twig blight" form of the disease occurs, the *canker form* on limbs and body is more or less common. A study of horticultural and agricultural literature shows that the disease has been destructive not only in nearly every apple-growing region of the United States and Canada, but probably also in England,²¹ as well.

9. THE BLIGHT CANKER IN ITS RELATIONS TO WEATHER CONDITIONS

It is well known that the "blight" in the twigs of pear and apple trees is most active and severe during a continued period of warm, muggy weather. The same is to be said of the cankers on the limbs and bodies of the trees. Considering that both are due to the activity of the same organisms, this is to be expected. It was repeatedly noticed during the past season that the active spread of the cankers was coincident with certain periods of rainy weather. The progress of the disease through the bark is always abruptly checked on the appearance of bright, sunny days. The recurrence of favorable weather may often cause a renewal of activity, the canker spreading and increasing its former extent. This usually results in concentric cracks within the cankered area. (Fig. 53.) This relation between the activity of the canker and the condition of the weather seems to be dependent on two factors: (1) The increased moisture content of the soil results in an increased amount of water in the bark and growing tissue of the tree, which, in connection with high temperature, causes the rapid growth of succulent tissue. This condition of the host is the most favorable for the growth and rapid multiplication of the bacteria. (2) The atmospheric humidity itself seems in some way directly to affect the activity of the parasite; for, although a heavy rain followed by bright, warm weather would seem to afford ideal conditions for the rapid growth of the tree, such weather was observed to be much less favorable to the activity of the cankers than damp, cloudy days. Smith has observed¹⁸ in his work on the asparagus rust that atmospheric conditions, aside from their indirect effects through the host, exercise a direct influence on the formation of æcidiospores by the parasite. The spores were observed to form only during periods of abundant atmospheric moisture,—conditions most favorable to their germination. The effect of cloudy weather on the canker organism seems to be of a similar nature. The rapid growth and multiplication of the bacteria result in their exudation in large drops (Fig. 51) from the diseased tissue, from which, through the agency of insects, they are carried to other trees. Bright, sunny weather would cause this viscid substance to dry and harden at once. But, as we have seen, the activity of the organism is checked by bright days, and consequently there is no exudation.

Humidity of the atmosphere is necessary not only for the best development of the bacteria, but is requisite also for the successful infection of healthy tissue by them. As has been stated before, infection can take place only through a wound of some sort. The moisture in the air prevents the rapid drying out of the infection court, thus affording the bacteria sufficient time, under favorable conditions, in which thoroughly

to establish themselves. The bacteria are quickly killed by the drying out of the wound before they have infected the living tissue.

As a general conclusion, then, we may say that those weather conditions most favorable to the activity of the disease in the tissues of the host are also the most favorable to the dissemination of the bacteria and the infection of healthy trees.

The disease generally manifests itself in the twigs only during the warmer seasons of the year. The cankers, although they grow most rapidly at this time, may be active at almost any season. I have observed them slowly extending along a limb during March and April (Fig. 76).

10. PROOFS OF THE BACTERIAL NATURE OF THE DISEASE

I stated in the early parts of this bulletin that the cankers are caused directly by bacteria. It remains to indicate more in detail the proofs of this assertion. These are as follows:

1. *Presence of the bacteria in the cankers.*—These are always to be found in abundance in actively spreading cankers and in milky, viscid drops which frequently exude from the diseased bark.

2. *Absence of fungi.*—Although diligent search with the microscope was made repeatedly, no trace of fungous mycelium was ever discovered in freshly cankered bark. The mycelium of common rot fungi is almost always to be found in the dry tissues of old cankers. In some cases, these saprophytic forms enter very soon after the bacteria have killed the bark.

3. *Production of cankers by inoculation.* (Figs. 65 and 66.) — Fortunately for my investigations, an active canker was discovered on an apple tree on the University grounds. Bacteria taken directly from this canker were introduced into the body of a healthy apple tree and also into that of a healthy pear tree. A sterile scalpel was used in making the incision into the bark, which had been washed with a solution of corrosive sublimate. A bit of the diseased tissue was carefully removed with a sterile scalpel and inserted into the wound, which was then sealed with grafting wax. A number of inoculations were made in each tree. Two typical cankers developed in each case. Those on the pear (Fig. 66) developed first and became more extensive. Those on the apple (Fig. 65) developed more slowly and never became so large. It was subsequently found that pure cultures of the organism could be regularly obtained by transferring with sterile scalpel bits of the diseased bark to potato bouillon. These inoculations may then be regarded as made from practically pure cultures. Two accidental inoculations (Figs. 77 and

cover) of the bacteria into healthy trees and limbs also resulted in well developed cankers. To these I have already referred (page 195).

4. *Production of twig blight with bacteria from canker* (Figs. 67 and 69).—At the same time that the inoculations into the bodies of the trees were made, bacteria from the same canker were introduced into blossoms and tips of growing twigs of both pears and apples. These were practically pure cultures, as a sterile needle was used to transfer the bacteria from the canker to the twigs and blossoms. Infection took place from nearly every inoculation, giving well developed cases of twig and blossom blight in 10 to 14 days (Fig. 68).

In the meantime, pure cultures were secured by dilution in agar plates and also by direct transfer from the diseased tissue of the canker into potato bouillon. A set of inoculations was now made from these pure cultures into twigs and green fruits of both pears and apples. These likewise resulted in nearly 100 per cent of infections.

5. *Observations on the formation of cankers*.—During the early part of July, twig blight became very common on the apple trees throughout the region about Ithaca. There was also a second severe attack of it during the latter part of the month and the early part of August. The blighting of watersprouts and short shoots on the bodies and main limbs of the trees resulted in the formation of many small cankers. Several of these I carefully observed and photographed at different stages in their development (Fig. 74). Pure cultures of the bacteria were also secured from these sources. There was absolutely no doubt as to the nature of the organism causing them.

II. THE IDENTITY OF THE CANKER ORGANISM WITH THAT OF THE FIRE BLIGHT OF PEARS

During the epidemics of twig blight just referred to, many of the fruits of both pears and apples were observed to be affected with the disease (Fig. 71). They showed on the surface watery spots which gradually turned brownish, and during cloudy days drops of viscous exudation appeared on the exterior. On cutting one of the fruits open the flesh was found to be tough and leathery with a milky sap collecting at the core. Gradually the flesh became brown and the fruit withered, finally turning black, especially in the case of the pear, drying up and falling to the ground.

Pure cultures were now secured from the following sources:

1. Active cankers on the limbs of apple trees (natural infection).
2. Blighted twigs of apple (natural infection).
3. Blighted twigs of pear (natural infection).

4. Blighted fruit of pear (natural infection).
5. Blighted fruit of apple (natural infection).
(Two cultures from widely separated localities.)
6. Blighted fruit of apple (artificially infected from canker on apple limb).

The pure cultures of bacteria from these different sources were each carried through 12 differentiating kinds of media (see page 210) and a careful record of growth, characters and reactions made. The comparative study showed the growth on a given medium to be the same for all the different cultures, thus establishing beyond a doubt the identity of the organisms causing the canker on the bodies and limbs of apple and pear trees and the fire- and twig-blight of these trees.

A third set of inoculations was made with the bacteria from certain of the above cultures. This was in August and the young shoots of the pear had ceased to grow. The fruits, however, were in just the right stage for infection. The shoots of the apple were still actively growing. Some 10-12 cross inoculations each were made as follows with the bacteria:

1. From canker to twigs of apples.
 2. From canker to fruit of pears.
 3. From twigs of pears to twigs of apples.
- All gave nearly 100 per cent of infections.

12. NOTES ON THE MORPHOLOGY AND CULTURAL CHARACTERS OF THE ORGANISM, *BACILLUS AMYLORORUS* (BUR.) DETONI

Morphology.—Direct from an active apple tree canker in hanging drop of sterile tap water. Short rods with rounded ends, single individuals nearly oval, 1.5-2 long, a little more than half as thick, occurring singly, in pairs, fours or even more, end to end. Many but not all motile.

The organism was also examined (in hanging drop of beef bouillon) from cultures on the following media: Beef bouillon, agar plate, agar slant, milk and potato plugs. All of these cultures were two days old except the agar plate and milk, which were several days older. The milk had thickened. The organisms varied little in these different media from the form and size observed in those direct from the diseased bark. They occurred singly or in pairs and frequently in short threads except on the potato plugs. There they were nearly all single. They were motile in all of the media examined but exceedingly so on potato plugs where they also appeared to be slightly larger.



FIG. 84.—*Bacteria directly from active canker on apple tree. Stained in carbol fuchsin. Showing various forms of the organism as they occur in the diseased bark.*

Cultural characters.—Pure cultures obtained from the sources already detailed on pages 208–209 were grown in the different media during July and August at ordinary room temperature. The media were all titrated to 1.5 acid unless otherwise noted. The work was done in the Bacteriological Laboratory of the State Veterinary College.

Gelatine plates.—Growth very slow, colonies becoming evident in about three to five days as tiny specks. Under the low power of the microscope they appear as small globose or lenticular growths, sharply outlined, yellowish. Surface colonies slowly liquifying the gelatin, forming little pits.

Agar plates.—Colonies evident by the second day, becoming characteristic by the fourth or fifth day. The surface colonies are then from two to three mm. in diameter in the form of a thin, white, finely granular or cloudy circular growth with a dense, sharply defined white center; margins even or slightly wavy. Deep colonies somewhat larger than the central mass of the surface colonies, globose or more often lens-shaped, dense opaque, yellowish. Under the microscope the central mass of the surface colonies and the entire deep colonies appear opaque, homogeneous and sharply defined, yellowish. The surface growth is coarsely granular or flocculent, whitish.

Potato bouillon.—Becomes uniformly and moderately clouded in 24 hours. When shaken shows waves or clouds from the surface into the lower liquid, indicating that growth is most active at the surface; with slight sediment and flocci, the flocci are easily dissipated on shaking; slightly acid to litmus paper. After about 48 hours the liquid becomes uniformly and heavily clouded. Flocci more abundant and more or less persistent. Alkaline. After about 20 days the liquid becomes clear above with abundant sediment and flocci at the bottom and strongly alkaline. No odor ever developed.

Beef bouillon.—Becomes faintly and uniformly clouded after 24 hours with flocci and sediment, slightly acid. After 48 hours cloudiness slightly increased. Flocci abundant and more or less persistent, neutral to litmus paper, becoming finally strongly alkaline and after 20 days showing tendency to clear. Odor not marked.

Sugar free bouillon.—Perfectly clear after 24 hours, the only evidence of growth being a slight sediment at the bottom. Neutral to litmus paper. After several days becoming faintly cloudy and alkaline. No indol produced.

Agar slant.—Growth in 24 hours, moderate, glistening white opalescent, thick but not spreading much, often in isolated circular colonies above, becoming more diffuse and spreading below toward the water at the base of the slant. Water of condensation turbid and with flocci. Growth not viscid. Increase of growth after this time very slight.

Gelatin stab.—Growth slow and at first feeble. Beaded or granular along line of needle. Surface growth spreading with irregular or erose margin, which is thick and white, the center thin and granulose; liquifaction very slow, becoming evident only after several days, crateriform to stratiform.

Potato plugs.—Growth feeble, becoming evident after a day or two as a thin moist pearly white coating over the surface of the potato, not viscid. No further change noted even after several days.

Glucose agar.—(Melted, inoculated, shaken and allowed to cool.)—No gas. Growth in 24 hours vigorous forming a thick white layer at the top, below granular from the minute buried colonies. Little change later except in increased thickness of this white surface layer.

Milk.—No change until about the third or fourth day when it begins to thicken, becoming very thick by the fifth or sixth day. The milk does not curdle but becomes subgelatinous. Finally after ten days or two weeks the thickened portion gradually settles leaving a clear watery liquid above. At first acid becoming strongly alkaline.

Litmus milk.—No change even after two weeks, never thickens.

Glucose bouillon.—Uniformly clouded at the end of 24 hours with abundant large flocci and frequently a weak pellicle. Little change in growth later. Remaining acid.

Lactose and saccharose bouillon.—No growth evident even after ten days.

Three descriptions of *Bacillus amylovorus* based on cultural characters seem to have appeared thus far in literature. The first of these is a part of the classical work on pear blight done by Arthur¹ in 1886. He grew the bacteria in various kinds of broths or liquid media and to a limited extent on solid media. The next description to appear was one by Chester (1900) based upon the study of a single pure culture from a blighted pear twig. The organism was grown in but a relatively small number of kinds of media and the reactions recorded differ strikingly from those obtained by Jones¹³ who published the third and most recent description (1902). The work of Jones was based upon a study of the organism from blighted twigs of both the pear and plum carried in parallel series through many kinds of media and extending over a period of eight months. Numerous successful inoculations were also made with bacteria from these cultures at different times throughout the period during which the cultures were under observation. My own cultural studies while not as extensive as those of Jones tally quite closely with the reactions which he obtained on similar media. It should be recalled in this connection that the bacteria which I had in culture were from the various forms of the disease on the apple tree as well as from the pear.

13. SECONDARY FACTORS IN THE DESTRUCTIVENESS OF THE DISEASE

I have already made casual references to certain things and conditions that may strongly aggravate the effects of canker attacks. My own observations along this line, while of a very general nature, indicate that this phase of the subject is one of extreme importance; for upon these secondary factors may depend not only the very general appearance of the disease in a given locality but also the subsequent effects of the same.

Those agents which seem most frequently to aggravate canker attacks are: winter injury of the trees, cultivation, fertilizing, and attacks of secondary organisms like rot fungi, etc. The first three of these result in a predisposition of the host to attacks of the bacteria, while the fourth, by taking advantage of the wounds made by the canker, may complete the destruction already begun. A summary of my observations on each of these factors follows:

Winter injury.—Anything that reduces the general vitality of the tree tends to render it more susceptible to attacks of the bacteria. I have already referred to the apparent effects of low temperature in relation to this disease in the Hudson River region. A long growing season during 1902, with excessive rains followed by a sudden and extreme fall of temperature early in December, is referred to by growers in that section as the beginning of the injury to their orchards. The winter that followed was a severe one with sudden and severe changes of temperature during the early days of the spring of 1903. Many trees failed to leaf out and large cankers were now observed on limbs and bodies of dead and dying trees. The general conclusion at once prevailed that these dead spots were the direct results of these weather conditions. Careful questioning, however, brought out the fact that previous to 1902 certain growers had observed these cankers on the bodies of their trees and some few trees had died, apparently from those injuries of the bark. It is also pertinent to point out at this place, that the rainy weather of 1902, which resulted in an excessive and long continued growth of tender tissues, afforded conditions most favorable to the infestation and development of the canker bacteria. It seems very reasonable to suppose that many of the cankers appeared during the summer and autumn of that year. That they were not generally observed by the grower until 1903 is probably explained by the fact that the effects of their attack did not become evident in the foliage of the trees until that season. My own observations on cankers with whose entire development from the beginning I have been acquainted, show that rarely do they cause the death of the affected limb or tree the first season. More than that, no evidence of their presence is to be detected in the appearance of the foliage. I am, therefore, of the

opinion that many of the trees in the Hudson River valley and about Kirkville were cankered prior to the winter of 1902-3. The severe weather no doubt weakened the trees yet free from the disease, thus rendering them more susceptible to attack during the summer of 1903. It also further weakened the trees already affected, rendering their destruction from further growth of the cankers certain. The appearance of a large number of the cankers in 1904 showed clearly that they had originated in 1903; others gave evidence that they had originated prior to that time (Fig. 54). The winter of 1903-4 was also a severe one and no doubt added to the sum of the injury already produced. To just what extent the winter injury in this section is responsible for the death of the trees is a question. In certain cases it was very evident that the tree had died from this cause. Such injuries were easily distinguished, however, from canker spots. That these dead spots on limbs and body and in the crotches resulted from freezing is, to say the least, exceedingly improbable. I base my opinion on the following facts:

- (1) The cankers may appear on any side of the body or main limbs;
- (2) The spots are usually more or less circular or oval with sharply defined margins;
- (3) The cankers are in practically every case formed about the base of a shoot or about a wound of some sort;
- (4) Every individual canker whose entire history is known was observed first to appear during the warm weather of spring or summer;
- (5) Typical cankers have been observed to form about the base of young sprouts which have been twig blighted;
- (6) Typical crotch cankers appeared during the past summer in trees which throughout the spring and early summer appeared to be perfectly healthy;
- (7) The bacteria of pear blight have been found repeatedly in the tissue of actively spreading cankers;
- (8) Spots, to every appearance exactly like typical cankers, were produced in the bark of healthy trees by inoculation with blight bacteria.

Cultivation.—It is known that well cultivated pear trees suffer more severely from "fire blight" than do those not so treated. Constant cultivation results in rapid growth and consequently succulent tissues, which are most favorable for the development of the blight bacteria. My observations seem to show that the same thing is true as regards the canker form of the disease in the apple tree. A number of young orchards were visited that had received little or no cultivation since setting and had consequently made a much slower growth than cultivated ones of the same age. They were, however, remarkably free from cankers, although not entirely so. In one orchard visited, it was noticed that three or four rows of trees at one end were practically free from the disease while the remainder had nearly all died from its effects. Inquiry brought out the fact that these few rows had received but little cultivation while the remainder of the orchard had the best of care in this respect.

Fertilizing.—The abundant application of nitrogenous manures also results in rapid and excessive growth. The tissue does not ripen promptly and so affords conditions favorable to the blight. Certain growers say that they can prevent the ravages of blight by the use of phosphates, either bone meal or some form of phosphoric acid and potash. They do not use stable manure. They point out that the phosphates cause the new growths to ripen quickly.

Rot fungi.—In the first part of this bulletin, I have pointed out that the wounds resulting from the formation of the cankers afford infection courts for the entrance of decay-inducing fungi. The dead bark affords a most suitable food supply on which the fungus can feed in the first stages of its germination and growth. It serves, moreover, as a sponge in the retention of the moisture necessary for the further development of the fungus and its entrance into the wood of the tree. If the canker has been formed about the base of a blighted watersprout, the dead tissue of the shoot affords a direct entrance for the decay fungus to the heartwood of the tree. Once in the heartwood, the mycelium spreads rapidly through the lifeless tissue, causing it to rot. It also frequently attacks the living sapwood and destroys it also, so that the tree is ruined or even killed outright. The crotches of trees where attacked by the canker serve admirably for the entrance of these rot organisms. The cankers formed about pruned stubs also act as infection courts: first, by preventing the prompt and rapid healing of the exposed cut surface; and second, by affording in the dead tissue of the cankered collar, food and moisture for the saprophytic forms. Almost invariably on removing the cankered bark from these stubs, it was found to cover a web of white mycelium which surrounded and penetrated the dead stub. The heartwood of these diseased stubs had frequently reached that stage of decay that it was soft and watery and was easily removed with a knife blade for a long distance down into the limb. In the Hudson River valley, diseased trees were frequently so heart-rotten that limbs apparently healthy were easily snapped in two, showing only a very thin outer shell of healthy sapwood and bark.

This matter of the decay fungi that follow the canker is of very considerable importance and a factor to be reckoned with in any method of treating the cankered trees. Their relatively early appearance in cankered areas makes it imperative that to secure immunity from their attacks the diseased tissue must be removed as soon as discovered and the wound properly treated and painted over.

An examination of a number of old cankers will show a large variety of forms of these saprophytes. Many common species of the imperfect as well as ascomycetous fungi will be found. I have also observed various species of the basidiomycetes fruiting in these dead areas.

14. RESISTANT AND SUSCEPTIBLE VARIETIES

Early in the investigations it was observed that certain varieties are more susceptible to attacks of the canker than others. Fortunately, in the orchards examined there was in each case a number of varieties represented so that considerable data as to relative resistance was secured.

Only one variety so far has been observed that seems to be entirely immune to canker attacks. In an orchard of some 200 trees in the worst infected section of the Hudson River region, all the trees had gone out but seven. These were Wolf River. They showed not a single canker and were strong and thrifty. A single tree of this same variety was also observed in another orchard in the same locality. It, too, was entirely free from the disease. The Wolf River is not regarded as a desirable fruit but could be used to advantage as stock for top-grafting. By setting desirable varieties well out on the main limb the chief source of trouble would be removed. Talman Sweet, although not entirely immune, appears to be fairly resistant and as stock for top grafting seems to be valuable.

A provisional arrangement of varieties so far observed in the order of their resistance may be said to be: Wolf River, Talman Sweet, Pewaukee, Red Astrachan, Tetofsky, Grimes Golden, Wine Sap, Fameuse.

In most of the affected orchards the Baldwin was the first to go out from canker attacks. The Ben Davis seems to be almost as subject to the disease as the Baldwin. The susceptibility of this variety to the so-called "sun scald" has been reported by growers in the Mississippi valley.³ The more susceptible varieties seem to be: Baldwin, Ben Davis, Mann, Hubbardston, Fall Pippin, Stark, Greening.

In general, summer and fall varieties seem to be less liable to attacks of the disease, or at least suffer less, while winter varieties are apparently more susceptible. It may be mentioned here that the writer has observed this same peculiarity in the attacks of the apple rust, the roestelia stage of *Gymnosporangium macropus*.

The study of varietal resistance has not been extensive and the above lists are to be regarded as entirely provisional. Further observation along this line will no doubt very materially change the number and arrangement of varieties. Enough has been observed, however, to indicate that it offers valuable suggestions to growers in regions known to be especially subject to canker epidemics.

15. ACKNOWLEDGMENTS

The writer takes this occasion to acknowledge the many kindnesses and courtesies extended to him by growers whose orchards he has had occasion to examine. He is especially indebted to Mr. L. B. Frear of

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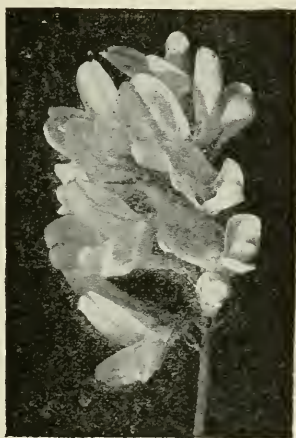


CORNELL UNIVERSITY
AGRICULTURAL EXPERIMENT STATION OF
THE COLLEGE OF AGRICULTURE
Department of Agronomy (Extension Work)

ALFALFA

A REPORT OF PROGRESS

ALSO AN OUTLINE OF COÖPERATIVE DEMONSTRATIONS
FOR 1906



Made under the Direction of THOMAS F. HUNT
By J. L. STONE, JOHN W. GILMORE and SAMUEL FRASER

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ALFALFA

A REPORT OF PROGRESS

In Bulletin 221, "Alfalfa in New York," issued by this Experiment Station in July, 1904, is discussed the effect of the unusually severe winter of 1903-4 on the alfalfa fields of the State. Suggestions as to the methods to pursue in attempting to grow the crop are presented. During the nearly two seasons that have passed since Bulletin 221 was prepared, studies of the crop have been continued, both on the College farm and by means of coöperative experiments and observations throughout the State. While many of the problems on which light is needed have not been solved, it is believed that the work accomplished affords enough suggestions that will be helpful to those interested in alfalfa growing to warrant this further report of progress.

I. CO-OPERATIVE TESTS

Two lines of effort have been undertaken in the study of practical alfalfa problems: Coöperative tests or experiments with farmers in several parts of the State; field tests on the College farms at Ithaca. We will first consider the coöperative tests.

1. *Soils for alfalfa*

The data secured during the past two seasons serves in the main but to emphasize the importance of the suggestions made in the former bulletin as to suitable soils; their thorough preparation; an abundant supply of available plant food (especially in the form of stable manure); freedom from weeds; good, pure seed; dressing with lime in most cases; and inoculation with the proper nitrogen-gathering bacteria.

Our observations and experience are not yet sufficiently extensive to enable us to define with exactness the types and grades of soils on which alfalfa may be successfully grown in the State of New York. It is well understood that the loamy soils with porous subsoils are generally favorable to the crop and it is probable that all soils coming into this class will produce alfalfa successfully if skillfully managed. On the other hand, it is known that soils having an impervious subsoil (especially "hardpan") are unfavorable and it is probable that we will never be able to secure satisfactory results on such soils. There are large areas in the State, intermediate in character between these two, in regard to

some of which it is hoped and believed that further investigation will develop a method of handling that will secure satisfactory results with alfalfa. The tests conducted on the College farm during the past two seasons and to be considered later, point to favorable results with a soil far removed from the ideal alfalfa type.

Observations made about the State in the inspection of alfalfa, and various coöperative experiments, have convinced us that in some sections of the State there are large areas that will grow alfalfa successfully, while in other sections it is only on the creek bottom land that is so situated as not to be subject to serious overflow that success may be expected. Until the soil survey of the State, which is being conducted by the Bureau of Soils of the United States Department of Agriculture, is completed we shall not be able to state with any exactness the location of the areas that will probably prove to be suited to the crop. As this survey is not likely to be completed for many years, we have asked Professor E. O. Fippin, now in charge of the work here, to make a general statement of the prevailing types of soil of the State and the sections in which those favorable to alfalfa growing are most abundant. Professor Fippin's statement follows:

"Not all of the soils of New York State are equally well adapted to the growth of alfalfa. Thorough drainage is chief among the requirements of the plant. Saturation of the soil for even a few days is very injurious to its growth and freezing in this saturated condition is even more disastrous to the life of the roots. Given good drainage the alfalfa plant will make a fair growth under very adverse soil conditions.

"The soils of the State may be grouped into two general classes according to their adaptation to the growth of the crop and these follow closely the natural drainage conditions of those soils. In general, it may be said that the soils in the northern two-thirds of the State are better suited to the production of alfalfa than the soils in the southern third.

"Stretching along lakes Erie and Ontario is a more or less continuous strip of rather dense lake clay known as the Dunkirk clay. The width varies from one to several miles, and east of Buffalo it attains nearly 20 miles. The same soil extends southward in the form of tongues in several of the large river valleys and along the "finger lakes" like Chautauqua, Seneca and Cayuga. It also occurs in small detached areas higher up on the upland. Because of its naturally poor drainage this type is probably the least favorable of the extensive types for the production of alfalfa, but is improved by drainage and the use of lime and in the early stages of growth by the use of organic manures.

"The upland stony and shaly loams which occupy the major portion of this section of the State are generally well adapted to the growing of alfalfa. These soils are classed as the Miami stony loam, Alton stony

loam and the Volusia loam. The first two contain chiefly limestone, sandstone and granitic gravel and stone while the last named contains chiefly shale gravel. These soils are fairly well drained and sufficiently open to favor deep development. The Miami silt loam associated with these types is also a desirable soil for the crop.

“In the northeastern quarter of the State, outside of the roughly mountainous part, gravelly and stony soils predominate and with the exception of small areas will produce alfalfa quite satisfactorily. Through the northern half of the State bed rock not infrequently comes near the surface of the soil but alfalfa has been shown to make a good growth even where the soil covering is only a foot or more in depth, as at points in the vicinity of Syracuse. The roots are able to thread their way along the seams of the stratified rocks and secure sustenance.

“The soils in the river and small stream bottoms of the State, which are for the most part light alluviums, are texturally suited to alfalfa growing, but the drainage must be watched as it not infrequently is defective because of the near approach of the water table to the surface. This is the difficulty with much of the Miami loam which forms the lowest terrace along most of the larger streams. With the exception of very light sand, such as is found chiefly on the eastern end of Long Island, this class of soils is well suited to the crop. The gravels and gravelly loams are mostly good alfalfa soil. The heavier gravelly loam, known as the Miami gravelly loam, is a most excellent soil for alfalfa in this State and the one on which most success has been attained with this crop on the Cornell University farm. It is found as the second terrace along most of the large streams like the Genesee, Mohawk and Susquehanna and their tributaries and the bottoms of nearly all of the smaller streams. Then there is another gravelly soil which is very much more coarse and open and the lower section is frequently used as a source of gravel for commercial purposes. It forms an outward fringe of much of the Dunkirk clay and is classed as the Dunkirk gravelly loam. It is too loose and porous for marked success with alfalfa, but the crop can probably be grown with a moderate degree of success in many places on this soil.

“The soils on the hills in the southern third of the State are generally compact shaly silt and clay loams, mostly the former, with a dense mottled subsoil. Depressed areas have very insufficient drainage and much of the type would be benefited by the use of tile. Special examples of this type may be seen almost anywhere on the southern boundary of the State, in southern Chautauqua, Steuben, southern Tompkins and Delaware counties and in most of the northern counties of Pennsylvania. It is the most extensive uniform body of soil in the State and it reaches furthest north on the highest divides.

"It cannot be said to be well adapted to alfalfa growing but by proper attention to drainage and careful handling of the crop in the early stage of growth it seems probable that a moderate degree of success may be attained. The first proposition must be kept in mind, viz. that good drainage will offset serious physical difficulties, such as hardpan and shallow stony soil."

2. *Inoculation*

During the past season the interest of the coöperative experimenters as regards alfalfa growing seemed to center around the question of inoculation with nitrogen-gathering bacteria. Two hundred farmers asked for and received packages of about four pounds of alfalfa seed, part of which was treated with cultures of the alfalfa bacteria and part without treatment for comparison. Sacks of soil from an old alfalfa field were also sent to a number of persons who expressed a desire to compare soil inoculation with the artificial cultures.

Sixty-four reports containing definite statements have been received at this writing, evidently based on careful examination, regarding the presence and abundance of nodules on the roots of the plants grown under the different treatments.

Results with plain seed.—In the case of plants grown without any attempt at inoculation by soil or cultures, forty of the sixty-four reports state that no nodules were found on the roots; twenty state that a few were found and only four that the nodules were abundant. These figures may probably be taken as fairly representing what may be expected when sowing alfalfa in New York outside the sections where alfalfa growing is well established. In slightly more than six per cent of these cases abundant inoculation took place; in about 31% a partial inoculation occurred that probably by repeated sowings would become abundant; while in about 63% of the cases no nodules were found. Certainly New York farmers must look well after the matter of inoculation if they would secure success with alfalfa.

Results with culture-treated seed.—In the case of plants grown from seed that had been treated with cultures of the alfalfa bacteria, forty-two out of sixty-four reports state that there was no apparent increase of nodules due to the treatment, while twenty-two report that nodules seem to be more abundant than on the plat sown with plain seed. Reduced to percentages, slightly more than 34% of these show increase of nodules supposedly due to treatment of the seed and about 66% show no such increase.

As to the effect upon the vigor and growth of the plants, eleven out of sixty-four, or 17%, report increased vigor apparently due to treating the seed with cultures, while in fifty-three cases, or 83%, no improvement can be detected. Of these eleven cases showing increased growth, two of

them are plats on which no nodules were found. In Bulletin No. 71, Bureau of Plant Industry, "Soil Inoculation for Legumes," p. 36, Dr. Moore states that sometimes inoculation takes place *within* the roots, producing the usual benefit to the plant but no nodules being formed. Possibly the two cases just mentioned are of this character. Both of



FIG. 85.—The eight plants at the left were grown from culture-treated seed, those on the right from untreated seed.

these cases came under the writer's personal observation and there is certainly no question but that the plants grown from the treated seed were more vigorous than the others and many plants were examined without finding a single nodule. No means were at hand for detecting the presence of alfalfa bacteria within the roots.

In the same Bulletin, at p. 34, Dr. Moore calls attention to two forms of alfalfa bacteria, a branched form and a rod form, the former only seeming to be a benefit to the host plant. Whether the thirteen cases in which increased abundance of nodules are reported without any apparent increase of vigor of the plants are due to the presence of the rod form of bacteria or to inaccuracy of observation it is impossible to state.

This data makes a rather disappointing showing for seed inoculation. Only 17 per cent of the experiments indicate any benefit from the treatment and in nearly all these cases the benefit while noticeable was not very marked. The only marked case of benefit apparently due to seed-inoculation coming to our notice during the two seasons' observations occurred in 1904 on the farm of Mr. Hallock in central Long Island. Fig. 85 illustrates eight average plants grown from treated seed on the left and eight average plants from untreated seed on the right. These plats were inspected in October and the difference shown in the field was as manifest as in the illustration. Both plats produced nodules but they were much more abundant where inoculated seed was used. October 30, 1905, Mr. Hallock reports in regard to these plats: "In this the second year from the seedling there is no appreciable difference between plats where seed was inoculated and where it was not. All roots show nodules. The crop has been cut twice this year yielding moderately well each time."

In 1904 the cultures used for seed inoculation were prepared from treated cotton furnished by the United States Department of Agriculture, following the Department's directions. In 1905, treated cotton was secured from the Department of Agriculture and from a commercial concern for alfalfa and several other legumes and were placed in the hands of Professor A. H. Harding, bacteriologist of the Geneva Station, for examination. Professor Harding found these cottons wanting in live alfalfa bacteria. (See Bulletin No. 270, New York State Experiment Station.) However, he supplied a bottle of live cultures which were further propagated in the usual way and the seed used in the 1905 experiments was treated with these.

Results of inoculation with soil.—Seventeen reports giving data relative to the effect of applications of soil from an old alfalfa field have been received. Fifteen of these, or 88 per cent, report an increased abundance of nodules resulting from the treatment, and all but one of those thus reporting, state that there was also an increase in the growth and vigor of the crop. The extent of the increase of growth of the crop was much greater in those cases in which soil was used than where culture inoculation of the seed was practised. This conclusion is based on both an inspection of many of the plats by a representative of the College

and the farmers' statements in the reports. In both the cases where the soil application did not increase the abundance of the nodules, it is stated that nodules were abundant on the plat sown with plain seed and consequently there was no need of inoculation. This makes a record of practically uniform success for soil inoculation and we are of the opinion that this method of inoculation, when needed, will not fail of giving results, unless the soil is in such condition that the bacteria cannot live in it.

The much lower efficiency of the cotton culture method of inoculation as compared with the use of soil (if, indeed, Professor Harding's work does not show the former to be without merit), should leave no question as to which method a farmer should use when he has occasion to attempt inoculation when growing legumes new to his land. It is to be hoped, however, that further investigation and improvement of the method of handling cultures will lead to satisfactory practical results; for the soil method is confessedly somewhat inconvenient and expensive, and involves the risk of introducing insect, weed and fungous pests into localities where they had not before gained a foothold.

3. *Lime for alfalfa*

Seventeen reports state that lime was applied to part of the area sown to alfalfa, and part left without lime for comparison. Of this number ten state that the limed area was distinctly better than the unlimed. Six state that there was no benefit and one reports apparent damage. The marked effect of lime in the experiments conducted on some heavy soil of the College farm, to be described later, taken in conjunction with these results secured throughout the State, indicates that liming takes an important place in connection with alfalfa growing in New York.

The data regarding the present condition of crop growing on the coöperative experiment plats for 1905 is as follows:

Number of favorable reports received	32
Number of unfavorable reports received	30
Number of doubtful reports received	25

From this showing it is evidently wise for those without experience with the crop, or in localities where its culture has not yet become well established to begin with small areas, so that failure will not mean heavy loss, and increase as their experience and successes seem to indicate.

II. ALFALFA EXPERIMENTS ON THE COLLEGE FARM AT ITHACA

On the College farm are found some areas having a gravelly or stony loam soil with a porous subsoil. On these areas alfalfa may be caused to grow successfully with only ordinary effort. On other areas is found

a rather stiff soil underlaid by clay. The Bureau of Soils of the U. S. Department of Agriculture has classified this soil as the Dunkirk clay loam. Judged both by the experience of the College in trying to grow alfalfa here, and from theoretical considerations as to its soil requirements, this land is not favorable to the crop. It is, however, similar to much land in the State on which farmers would like to produce alfalfa. It was decided, therefore, to begin in the spring of 1904 experiments on this land with a view of determining what treatment, if any, will result in success upon lands known to be naturally unsuited to alfalfa. These investigations are being made under the direction of Professor Thomas F. Hunt by John W. Gilmore and Samuel Fraser.

The tract on which these experiments are being conducted has come only recently into the possession of Cornell University. The former management had been such as to reduce somewhat, though not seriously, its crop-producing power. The soil is tenacious and is difficult to work except when moisture conditions are just right. It is usually difficult to get upon this land early in the spring, and early fall rains may prevent fall seeding. It is well adapted to the growth of timothy; and fairly well adapted to the production of wheat, when properly fertilized; and is less valuable for the production of corn and potatoes.

1. *Lessons from the 1904 Seeding*

This land had been in corn in 1902 and in oats in 1903. The oats were removed and the land plowed August 23-25 and fitted on September 13 for wheat. Early fall rains prevented the seeding of the wheat on this tenacious clay soil and it was later decided to devote part of the area to experiments with alfalfa. On May 6, 1904, this land was harrowed and ground unslaked lime was applied to the north half of the plats from the fertilizer distributor of the grain drill at the rate of 1,000 pounds per acre. The drill was driven over the south half of the plats to secure an equal amount of tillage on all plats. The seeding was done May 7 at the rate of 25 pounds per acre.

The plats are 84.88 feet long and 25.67 feet wide and contain one-twentieth acre each. This width is used in much of our plat work because it is the distance covered by four courses of our grain drill.

Ten of these plats are devoted to the alfalfa experiment,—every third plat being used as a check and receiving no special treatment except the lime on its north half. The scheme was as follows:

Plat No. 741. Nothing.

742. Stable manure, 20 tons per acre.

743. Soil, 400 pounds per acre from an old alfalfa field.

744. Nothing.

Plat No. 745. Stable manure and soil as above.

746. Seed inoculated by cultures from U. S. Department of Agriculture.

747. Nothing.

748. Manure and inoculated seed.

749. Commercial fertilizer, 500 pounds per acre 4-12-4 goods.

750. Nothing.

The alfalfa came up promptly and evenly over the several plats and for some time little difference could be observed,— a satisfactory and even stand having been secured. Toward the latter part of June those plats receiving manure or fertilizer began to show to better advantage, and at about the same time it became evident that the north half of all the plats where lime had been applied were making better growth than the south half.

On July 12, areas of one-half square yard, of as nearly average quality as possible, were selected from each end of each plat and all the plants in these areas taken up and critically studied to ascertain just what development was being made on each. The data secured included the number of alfalfa plants on the area, the total fresh weight of these, the length of each plant and the number of leaves it bore, the presence or absence of nodules on the roots, the number of weeds and the kinds and the fresh weight of the weeds. From this data the average weight of the alfalfa plants, their average length and the average number of leaves were computed. Table No. 1 gives a summary of this study:

TABLE NO. 1.—ALFALFA EXPERIMENT, 1904. DATA RECORDED JULY 12

Plat No.	TREATMENT.	Number of alfalfa plants.	Weight alfalfa. (Fresh) (Gms.)	Average weight of alfalfa plants. (Gms.)	Average length alfalfa. (Inches.)	Average number of leaves on alfalfa.	Nodules.	Number weeds.	Weight weeds. (Fresh) (Gms.)
741..	Nothing.....	94	72.30 70.52	.77 .75	5.5 5.2	13.8 12.7	0 0	59 84	76.55 95.00
742..	Stable manure.....	84 134	87.50 61.20	.93 .46	8.8 5.6	13.0 6.6	0 0	110 183	271.55 249.00
743..	Inoculated by soil.....	104 94	59.10 48.55	.58 .52	5.0 4.2	10.3 9.8	Some 0	59 45	76.15 48.50
744..	Nothing.....	120 114	80.30 56.00	.67 .49	5.2 4.0	10.0 9.0	0 0	69 34	78.30 31.20
745..	Manure and soil.....	78 80	86.23 68.79	1.11 .86	9.6 7.9	19.7 13.6	Some Some	36 133	90.86 203.60
746..	Inoculated seed.....	104 91	107.95 69.25	1.04 .76	7.0 5.7	17.6 14.0	0 0	23 48	29.60 46.85
747..	Nothing.....	140 87	76.25 49.32	.54 .57	5.8 4.8	9.7 10.3	0 0	51 131	93.82 77.35
748..	Inoculated seed and manure.....	84 103	93.65 70.77	1.11 .69	9.0 7.3	12.3 8.9	1 0	105 136	252.75 221.50
749..	Commercial fertilizer.....	117 105	133.72 114.40	1.14 1.09	9.7 8.1	13.0 12.0	0 0	70 110	190.20 193.55
750..	Nothing.....	110 83	79.95 42.40	.73 .51	6.3 4.6	12.3 9.8	0 0	50 180	65.50 110.10
	Average.....	103.5 98.5	87.70 65.12	.86 .67	7.19 5.74	13.2 10.7	..... .....	63.2 108.4	122.53 127.86

It is noticeable that up to this time the chief influence of the stable manure had been to stimulate the growth of weeds, as seen by comparing the figures in the column at the right. This increase was largely of alsike and red clover — the seeds of which are supposed to have been in the manure. The crowding of these weeds had hindered the growth of the alfalfa as much as the manure had helped it. The fertilizer had helped the growth both of alfalfa and weeds. It is also noticeable that lime had helped the growth of alfalfa in every instance, and that up to this date very little development of nodules had taken place on any of the plats.

The plats were clipped July 14, and on October 18 other areas were selected and the plants taken up and examined as before. In this case the work could not be promptly completed and weight of the dry plants is taken instead of the fresh. Table No. 2 gives the data obtained by this second study of the plats (in the "inoculation" column, 0 means no inoculation; + abundant inoculation; ++, very abundant; —, very little inoculation; 1, one plant found with inoculation).

TABLE NO. 2.—ALFALFA EXPERIMENT, 1904. DATA RECORDED OCT. 18

Plot No.	TREATMENT.	Lime.....	Number of alfalfa plants.	Alfalfa. (Dry Gms.)	Average weight of alfalfa plants.	Average length alfalfa. (Inches.)	Inoculation.	Number weeds.	Weight weeds. (Dry (Gms.))
741...	Nothing.....	Lime..... No lime..	77 56	22 16.5	.29 .30	2.6 3.0	0 0	96 63	40.5 56.5
742...	Stable manure.....	Lime..... No lime..	47 55	18.0 13.5	.38 .25	4.6 3.1	0 1	103 169	89.0 95.5
743...	Inoculated by soil.....	Lime..... No lime..	62 96	24.0 16.5	.39 .17	5.8 3.0	+ + —	77 25	33.0 11.0
744...	Nothing.....	Lime..... No lime..	67 79	20.0 13.5	.30 .18	4.3 4.5	0 0	41 36	34.0 17.0
745...	Manure and soil.....	Lime..... No lime..	66 73	45.5 28.0	.69 .38	9.0 5.4	+ + + +	62 112	67.0 116.5
746...	Inoculated seed.....	Lime..... No lime..	48 57	25.5 20.5	.53 .36	6.9 5.3	0 0	40 35	25.5 27.0
747...	Nothing.....	Lime..... No lime..	52 80	29.0 20.5	.56 .26	4.7 3.4	0 0	49 66	25.0 38.5
748...	Inoculated seed and manure.....	Lime..... No lime..	77 64	31.5 21.5	.41 .34	4.8 4.1	—	122 122	120.0 175.0
749...	Common fertilizer.....	Lime..... No lime..	83 92	24.0 26.0	.29 .28	3.7 3.9	0 0	67 67	23.5 91.5
750...	Nothing.....	Lime..... No lime..	58 37	21.5 9.0	.37 .24	3.8 3.4	0 0	39 112	59.5 53.5
Average.....		Lime..... No lime..	63 66.7	26.1 18.6	.41 .28	5.1 3.9	.....	62 78.5	51.7 68.0

An inspection of Table No. 2 shows that the weed growth on all plats dressed with stable manure continues to be vigorous, that inoculating the seed with cultures from U. S. Department of Agriculture produced no appreciable improvement either in growth of plant or abundance of nodules while soil alone even surpassed manure alone, that commercial fertilizer which promised so well early in the season failed to maintain its position to the end, that the benefit produced by lime is still very apparent, and finally that the combination of stable manure, lime and soil inoculation alone produced results that promise ultimate success in alfalfa growing on this soil.

In order that the significance of the data given in Tables 1 and 2 may be made more easy of comprehension, Tables 3, 4, 5 and 6 have been compiled from them, each presenting a single feature for consideration. Table No. 3 shows how the vigor of the plants as measured by their average weight and average length was affected by manure, lime and inoculation. Table No. 4 shows the influence of the application of lime on the number and vigor of alfalfa plants and weeds on an area 12x18 inches. Table No. 5 shows the relative abundance of nodules developed by inoculation with soil, inoculation of seed by cultures and no inoculation. Table No. 6 shows the influence of a dressing of stable manure on weed production on these plats.

TABLE NO. 3.—VIGOR OF PLANTS AS EFFECTED BY MANURE, LIME AND INOCULATION. ALFALFA EXPERIMENTS 1904. DATA RECORDED OCT. 18

Plat No.	TREATMENT.	Nodules.	Average weight.	Average length.
741.. } 744.. }	Nothing. Average of two plats..	Lime.....	.30	(Inches.) 3.45
		No lime..	.24	3.45
742....	Stable manure.....	Lime.....	.38	4.5
		No lime..	One.....	.25	3.1
743....	Inoculated by soil.....	Lime.....	.38	5.8
		No lime..	Few.....	.17	3
745....	Manure and soil inoculation....	Lime.....	.69	9
		No lime..	Very abundant..	.38	5.4
746....	Seed inoculated by cultures...	Lime.....	.53	6.9
		No lime..	None.....	.36	5.3
747.. } 750.. }	Nothing. Average of two plats.	Lime.....	.48	4.08
		No lime..	None.....	.25	3.4
748....	Manure and inoculated seed.	Lime.....	.41	4.8
		No lime..	Very few.....	.34	4.1
749....	Commercial fertilizer (50 lbs. per acre, 4-124).....	Lime.....	.29	3.7
		No lime..	None.....	.28	3.9

TABLE NO. 4.—INFLUENCE OF LIME. SOIL, CLAY LOAM; SUBSOIL, CLAY.
ALFALFA EXPERIMENTS, 1904

AVERAGE OF TEN PLATS.	JULY 12.		OCTOBER 18.	
	Lime.	No lime.	Lime.	No lime.
Number alfalfa plants on 12x18 inches.....	103.5	98.5	63	66.7
Weight of alfalfa plants.....	Fresh 87.7	65.12	Dry 26.1	18.6
Average weight of plants.....	Fresh .86	.67	.41	.28
Average length of plants, inches.....	7.19	5.74	5.1	3.9
Average number of leaves.....	13.2	10.7	.....	.....
Average number of weeds on 12x18 inches.	Fresh 63.2	108.4	62	78.5
Average weight of weeds on 12x18 inches.	Fresh 122.53	127.86	Dry 51.7	68

TABLE NO. 5.—INOCULATION EXPERIMENT, SOIL, CLAY LOAM; SUBSOIL, CLAY, 1904

		July 12.	October 18.
Soil inoculation.....	{ With lime.....	Some nodules.....	Very abundant
	{ No lime.....	No nodules found.	Very few nodules
	{ Manure and lime.....	Some nodules.....	Very abundant
	{ Manure and no lime.....	Some nodules.....	Abundant
Seed inoculated by artificial cultures.....	{ With lime.....	None found.....	None found
	{ No lime.....	None found.....	None found
	{ Manure and lime.....	One found.....	Very few nodules
	{ Manure and no lime.....	None found.....	None found
No inoculation attempted	{ 6 plats with lime.....	None found.....	None found
	{ 6 plats no lime.....	None found.....	One found

TABLE NO 6.—THE INFLUENCE OF A DRESSING OF MANURE ON WEED PRODUCTION,
1904

	July 12.	October 18.
Average number of weeds on 3 manured plats Nos. 2, 5, 8	117	115
Average number of weeds on 7 unmanured plats.....	72	58
	Gms.	Gms.
Average weight of weeds on 3 manured plats..... (fresh)	215.2	(dry) 110.1
Average weight of weeds on 7 unmanured plats..... (fresh)	86.3	(dry) 38.3

A series of photographs showing graphically the size and vigor of the alfalfa plants and the abundance of weeds on the various plats was made, but as the same teachings are brought out in illustrations of 1905 seeding to be considered later, it is thought best not to take space for these pictures here.

The winter of 1904-1905 was about normal at Ithaca and there was no unusual damage to alfalfa. On June 9, 1905, the following observations as to the general condition of the various plats of the 1904 seeding were made:

Plat No. 741. Check, no treatment.

Plants light in color, small and not thick, many small weeds, ground covered with small grass.

Plat No. 742. Stable manure.

A solid mat of clover, red and alsike with some fireweed. Alfalfa not prominent but larger than in No. 741, better growth of clover on the limed area than on no-lime.

Plat No. 743. Soil inoculation.

This plat has a good stand of good looking alfalfa. It is noticeably better, and more nodules are found on the lime portion. On no-lime area plants are weaker and lighter colored.

Plat No. 744. Check, no treatment.

On no-lime end the alfalfa and weeds are weak and light colored. On the limed end the alfalfa is stronger, better color and weeds are abundant and larger. Some nodules on limed end.

Plat No. 745. Stable manure and inoculated soil.

A thick stand of red and alsike clover, color of alfalfa good, many nodules on alfalfa and clover.

Plat No. 746. Seed inoculated with U. S. D. A. cultures.

Very weedy, the limed area much the better and somewhat better color than same area of Check 747.

Plat No. 747. Check, no treatment.

Like 746 except as noted above.

Plat No. 748. Stable manure and inoculated seed.

A thick mat of red and alsike clover. Plat appears about the same all over but there are fewer alfalfa plants on the no-lime area.

Plat No. 749. Commercial fertilizer.

Very poor, many fireweeds, alfalfa is of light color.

Plat No. 750. Check, no treatment.

Very poor, weeds not so vigorous as in 749.

On the same date (June 9, 1905), an area of four square feet (2 feet square) was measured off on each end of each of the plats and all of the plants on these areas were taken up and separated into the following categories: alfalfa, clover, grass and weeds. The plants in each class were then counted and weighed green with as much of the root as would come out of the ground, the soil having been washed off. The result of this detailed study of the plants growing on these plats is condensed into tabular form and given below:

TABLE NO. 7.—DATA RECORDED JUNE 9, 1905. THE AREA EXAMINED, FOUR SQUARE FEET. (1904 SEEDING); WEIGHED GREEN

Plat No.	TREATMENT.	ALFALFA.		CLOVER.		GRASS.		WEEDS.	
		Number.	Weight, (Grams.)	Number.	Weight, (Grams.)	Number.	Weight, (Grams.)	Number.	Weight, (Grams.)
741..	Nothing.....	83 70	127 125	3 2	19 10	29 6	13 6	15 15	173 130
742..	Stable manure.....	14 13	47 45	32 35	1,129 1,200	..... 4	..... 19	9 10	79 75
743..	Inoculated by soil.....	109 101	295 240	3 1	4 4	111 4	38 3	23 13	98 74
744..	Nothing.....	71 56	111 72	6	65	20 17	18 30	69 42	385 105
745..	Manure and soil.....	122 61	384 92	34 40	645 660	2 18	4 14	30 42	220 176
746..	Inoculated seed.....	98 20	155 45	2 3	10 17	23 51	22 25	28 42	80 105
747..	Nothing.....	102 23	154 71	44	153	75 16	47 17	30 30	46 140
748..	Inoculated seed and manure.....	30 2	69 3	4 92	1,489 1,106	7	11	28 5	161 44
749..	Commercial fertilizer.....	86 15	62 16	4 1	30 9	67 15	35 10	50 36	127 165
750..	Nothing.....	69 1	106 2	8	37	18 32	17 8	49 30	86 210

Certain lessons seem to be indicated in Table 7 to which it may be well to call attention, though this experiment alone will not warrant accepting them as conclusions. It will be observed that whenever stable manure was applied (plats 742, 745, and 748), the clover was abundant and grew vigorously — contesting possession of the soil with the alfalfa. This suggests the importance of using manure, if possible, free from seeds that may act as weeds in the alfalfa. Comparing these manured plats with those adjacent it seems that this crowding of the clover was more detrimental to the alfalfa than was doing without the plant food the manure supplied, except on plat 745 in which case the alfalfa plants becoming abundantly inoculated through the use of soil from an old field were able to contest the ground stoutly with the clover and make fair growth itself while it held the clover down to about one-half the growth it made on plats 742 and 748. Comparing plats 742 and 743 it seems that so far as the welfare of the alfalfa is concerned the inoculated soil alone is far more effective for good than the manure alone. Comparing 745 and 748 it seems that seed inoculation has been without benefit in this case. Comparing plats 749 and 750 it seems that the application of 500 lbs. per acre of a 4-12-4 fertilizer had no permanent beneficial effect, though it will be remembered that this plat started out with much promise at the beginning. It is believed that had inoculation been early effected on this plat the showing would have been different.

The yield of hay. These plats were mown for hay on June 17, August 24 and October 13, 1905. At the first and second cuttings the herbage contained much that was not alfalfa. Plats 742, 745 and 748, which had received stable manure, produced much clover, the others produced some clover and more weeds. The yields of hay secured at these cuttings do not represent the development of the alfalfa on the several plats at the time. Unfortunately in raking the hay of the second crop the produce of the "limed" and "not limed" areas of each plat were not kept separate for weighing. The respective yields of these areas, however, were computed from the total yields of the plats and the respective yields of the limed and not limed areas at the first cutting, which is approximately correct. The third cutting was almost clear alfalfa and the yields closely represent the relative condition of the alfalfa plants on the various plats. This crop was gathered and weighed green.

Because of the weeds and clover in the hay of the first and second cuttings these yields or the total yield for the season do not furnish a measure of the vigor of the alfalfa on the various plats. The third cutting taken alone is a better measure. Table No. 8 gives the yields of the plats on June 17, August 24 and October 13, 1905, and the total yields for the season:

TABLE NO. 8.—YIELDS OF HAY ON ONE YEAR OLD ALFALFA SEEDING, 1905

Plat No.	TREATMENT.	First cutting lbs. dry.	Second cutting lbs. dry.	Third cutting lbs. green.	Computed total yield of hay at the three cuttings lbs. per acre.
741	Nothing.....	Lime..... 20	32	12	2,186
		No lime.. 13	15	1	1,129
742	Stable manure.....	Lime..... 91	135	52	11,098
		No lime.. 89	68	34	6,579
743	Inoculated by soil.....	Lime..... 42	94	50	5,880
		No lime.. 9	20	40	1,512
744	Nothing.....	Lime..... 23	63	31	3,713
		No lime.. 7	19	17	1,190
745	Manure and soil.....	Lime..... 76	134	115	9,412
		No lime.. 62	110	61	7,417
746	Inoculated seed.....	Lime..... 21	59	26	3,429
		No lime.. 11	31	10	1,768
747	Nothing.....	Lime..... 15	58	20	3,096
		No lime.. 7	29	4	1,476
748	Inoculated seed and manure...	Lime..... 70	127	32	8,162
		No lime.. 59	107	21	6,825
749	Commercial fertilizer.....	Lime..... 13	35	13	2,024
		No lime.. 10	27	5	1,524
750	Nothing.....	Lime..... 7	24	7	1,302
		No lime.. 7	23	1	1,209
Average.....		Lime..... 37.3	76.1	35.8	4,851
		No lime.. 27.4	44.9	19.4	3,063

An inspection of Table No. 8 reveals several points of interest. Most noticeable is the regularity with which the limed areas outyield the not limed areas. In the case of the first two cuttings which include the weeds and clover as well as the alfalfa the increase is 56 per cent. In the third cutting which is nearly clear alfalfa it is 85 per cent. At the first and second cuttings all the plats that had received stable manure (742, 745 and 748) produced markedly heavier yields than the others, but at the third cutting only 745, which also received a dressing of inoculated soil, maintained its superiority in any considerable degree.

It will be remembered that these three plats were quite thoroughly seeded to clover by the manure that was applied to them, so that the hay that was secured from them at the first and second cuttings was chiefly clover with some alfalfa and few weeds. It is of interest to observe that the average yield for the season of the limed ends of these plats was 9,557 pounds of hay per acre while the average yield of the unlimed ends was 6,940 pounds, a difference of 2,617 pounds.



Nothing.	Soil inoculation.	Manure.	Nothing.
No lime. Lime.	No lime. Lime.	No lime. Lime.	No lime. Lime.

FIG. 86.—*Third crop; plats 744, 743, 742, 741.*



Nothing.	Cultures.	Soil and manure.	Nothing.
No lime. Lime.	No lime. Lime.	No lime. Lime.	No lime. Lime.

FIG. 87.—*Third crop; plats 747, 746, 745, 744.*



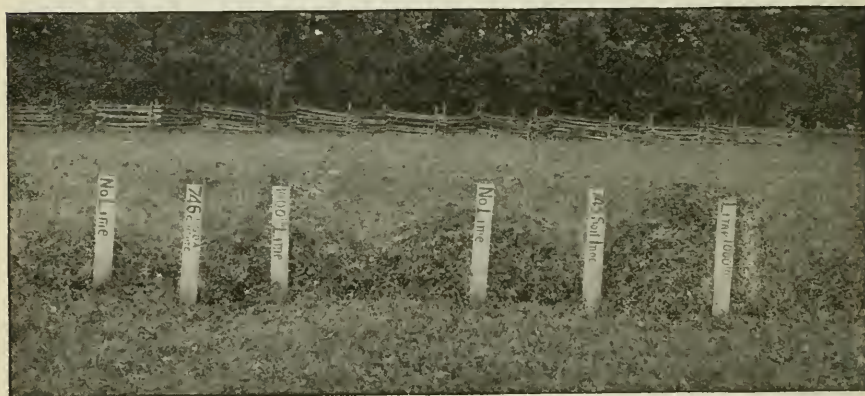
Nothing.	Fertilizers.	Manure and cultures.	Nothing.
No lime. Lime.	No Lime. Lime.	No lime. Lime.	No lime. Lime.

FIG. 88.—*Third crop; plats 750, 749, 748, 747.*

At the time of harvesting the third crop the produce of the several plats was placed in bunches and photographed. In each case the crops from the limed and not limed areas are shown side by side.



Inoculated by cultures. Inoculated by soil.
 No lime. Lime. No lime. Lime.
 FIG. 89.—Third crop; plats 746, 743. No manure applied to these.



Inoculated by cultures. Inoculated by soil.
 No lime. Lime. No lime. Lime.
 FIG. 90.—Third crop; plats 748, 745. Manure applied to these.

2. Lessons from the 1905 Seeding of Alfalfa

While most of the plats of 1904 seeding of alfalfa did not show up well enough in the spring of 1905 to give assurance of their final success, still the combination of lime, stable manure and soil inoculation produced encouraging results. It was decided to continue the effort to grow alfalfa

on this soil and another series of plats was arranged in a different part of the same field. In this series the checks, which occupy each third plat, were treated in the manner that was productive of best results in the 1904 seeding, but it was hoped to escape the introduction of clover seed to the plats receiving manure.

The land selected for this experiment had been in timothy meadow for several years past and was plowed to a depth of eight inches on May 1. The soil was rolled while still fresh, afterward disked, harrowed with the spring-tooth harrow and finally fitted with a Meeker harrow. With this treatment the surface of the ground was rendered fine.

Following the preparation, eighteen one-twentieth acre plats were laid off and divided into four portions transversely. Lime, reduced to powder by the addition of sufficient water to produce dry slaking, was applied to each of these plats as follows:

The north fourth of each plat received at the rate of 3,000 lbs. per acre.

The next fourth south received at the rate of 2,000 lbs. per acre.

The third fourth south received 1,000 lbs. per acre.

The south fourth of each plat received no lime.

The numbering and plan of the plats in this experiment were as follows:

- 1501. Discard. Plain seed, stable manure and soil.
- Check* 1502. Plain seed, stable manure and soil.
- 1503. Inoculated seed and stable manure.
- 1504. Plain seed, stable manure.
- Check* 1505. Plain seed, stable manure and soil.
- 1506. Plain seed, stable manure, commercial fertilizer and soil.
- 1507. Plain seed, stable manure and commercial fertilizer.
- Check* 1508. Plain seed, stable manure and soil.
- 1509. Plain seed, commercial fertilizer and soil.
- 1510. Plain seed and stable manure.
- Check* 1511. Plain seed, stable manure and soil.
- 1512. Plain seed, stable manure and commercial fertilizer.
- 1513. Plain seed, stable manure, commercial fertilizer and soil.
- Check* 1514. Plain seed, stable manure and soil.
- 1515. Plain seed and soil.
- 1516. Inoculated seed.
- Check* 1517. Plain seed, stable manure and soil.
- 1518. Discard. Plain seed, stable manure and soil.

Well rotted manure not being available for this work, somewhat coarse manure was applied to the plats indicated in the plan at the rate of 20 tons per acre, and thoroughly disked in.

Screened soil from an old alfalfa field where tubercular growth was abundant upon the alfalfa roots was sown upon the plats indicated at the rate of 500 lbs. per acre.

A fertilizer mixture containing four per cent nitrogen, 12 per cent phosphoric acid and four per cent potash was applied to the five plats indicated at the rate of 500 lbs. per acre.

Seed that had been treated with alfalfa cultures grown from stock received from Professor H. A. Harding of the State Experiment Station at Geneva, was sown on plats 1503 and 1516. On all other plats untreated seed was sown. The rate of seeding was 25 lbs. per acre and the date of sowing was May 25.

The stand secured on this series of plats was very good and while some weeds appeared, fortunately the manure used did not seed the plats to which it was applied to clover as occurred the previous year. Very heavy rains occurred in June which were unfavorable for the crop, but did not produce disaster.

The Summer Study of the 1905 Seeding

During the summer numerous observations were made upon these plats. Probably those made July 28-29, and October 30, will sufficiently show the progress of the experiment.

On July 28-29, an area of four square feet from the 2-lime section and the no-lime section of average thickness and growth was taken from each plat. The alfalfa plants on each of these areas were counted and divided into three lots according to size. The grass and other weed plants were also counted and put in bunches. The plants from each plat were then placed against a screen marked off into six-inch squares and photographed, those from the limed area on the right, those from the not limed area on the left. Figures 91 to 93 show the relative growth made on some of the various plats at this date. The notes made at the same dates, showing number of plants of each kind, help to a correct understanding of the results.

The notes of October 30 give the appearance of the plats just before the green alfalfa was frozen down.

The plats were last clipped July 29 and the estimate of vigor of the plants is based on the growth they have made since that date and October 30. Nodules are found on all sections of all the plats. It is difficult to estimate their relative abundance as they seem to be losing their vitality and are so easily detached from the roots and the soil is so adhesive that not finding nodules on a plant is not satisfactory evidence that none were there. Nodules do not seem to be very abundant anywhere but can be found on all sections if diligent search is made.

Ten of these eighteen plats received applications of soil from an old alfalfa field and are so distributed among the others that in only one case are there two plats side by side that did not have a dressing of soil.



FIG. 91.—Plat 1511. Plain seed, manure and soil. Alfalfa and weeds from four square feet.



FIG. 92.—Plat 1510. Plain seed and manure. Alfalfa and weeds from four square feet.

The land slopes from the northeast corner of these plats to the southwest, but more from east to west than from north to south. The soil is rather impervious to water and the rainfall during the season has been

abundant. At times it has been superabundant and there has been considerable drainage across these plats, both over the surface in times of downpour and by percolation at other times. On July 28-29, when the earlier notes were taken, numerous plats, or parts of plats, were found



FIG. 93.—Plat 1516. Culture treated seed. No manure. Alfalfa and weeds from four square feet.

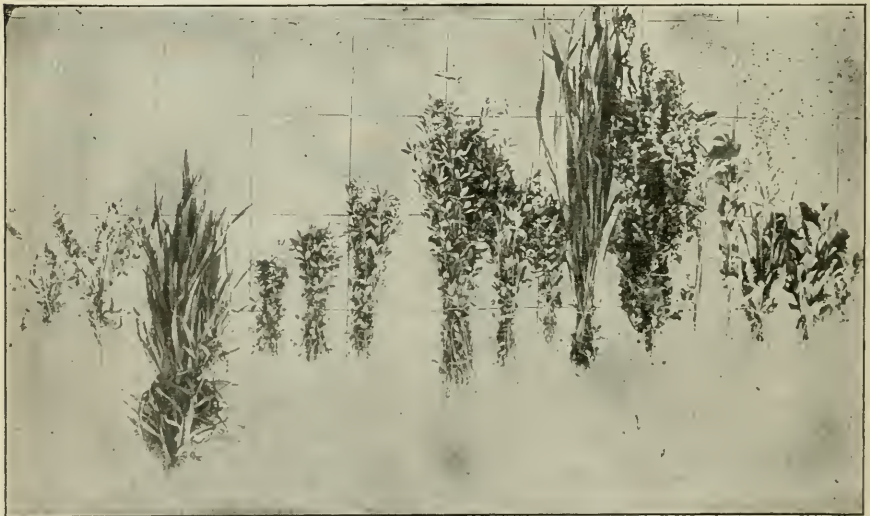


FIG. 94.—Plat 1503. Culture treated seed and manure. Alfalfa and weeds from four square feet. (Note. In comparing Fig. 94 with 91, it should be borne in mind that all the plats soon became inoculated from natural causes, probably owing to proximity to plats to which soil had been applied. See page 162 near bottom.)

that seemed to produce no nodules, but now (October 30) nodules seem to be quite evenly distributed over the whole area. No doubt the lay of the land and the manner of drainage brought about this result.

The soil seems to be dryer and in better physical condition at the east or 1501 end of the series, but darker colored, richer and wetter at the west end. In a general way the growth since clipping has been a trifle larger toward the west end and the stand seems to be a trifle thicker toward the east end. This comment is based on a comparison of the check plats. Plats 1501 and 1518 are discards and are not discussed in the notes.

PLAT 1502. CHECK. PLAIN SEED, MANURE AND INOCULATED SOIL. JULY 28

	No lime.	Lime.
Alfalfa	551	214
Grass	21	17
Other weeds	22	57
Total	594	288

Alfalfa (and weeds) a good stand, alfalfa mostly dark color. Nodules abundant on all sections.

Oct. 30. Plat 1502. Good stand of healthy looking plants on the limed areas and a poor stand of weak, small plants on the no-lime section. Very little difference between the 1-lime, 2-lime and 3-lime sections. The plants mostly stand at five to eight inches high.

PLAT 1503. INOCULATED SEED AND MANURE. JULY 28

	No lime.	Lime.
Alfalfa	134	211
Grass	51	26
Other weeds	14	48
Total	199	285

The weeds on this plat are quite abundant, though the alfalfa is of good growth. On the 3-lime and 2-lime sections a few green spots occur and these are abundantly inoculated, but there are no nodules on the plants of the 1-lime and no-lime sections. Not all of the plants in these green spots, however, bear nodules, and the question is raised whether these plants do not derive some benefit from the inoculated plants. (See Fig. 94.)

Oct. 30. Plat 1503. Patchy and uneven on limed areas. Some of the plants are strong as on 1502. No-lime area like same on 1502.

PLAT 1504. PLAIN SEED, MANURE. JULY 28

	No lime.	Lime.
Alfalfa	131	150
Grass	47	54
Other weeds	23	26
Total	201	230

The alfalfa on this plat is quite large and branched. It is quite spotted, however, showing frequent green patches where nodules may be

found. No nodules were found on the no-lime section. The three limed sections are much alike. This plat as a whole is quite similar to 1503, the alfalfa not being dark green save in the inoculated spots.

Oct. 30. Plat 1504. Like 1503. Not equal to 1502 or 1505.

PLAT 1505. CHECK. PLAIN SEED, MANURE, INOCULATED SOIL. JULY 28

	No lime.	Lime.
Alfalfa	577	294
Grass	48	27
Other weeds	7	19
	<hr/>	<hr/>
Total	632	340

The alfalfa on the no-lime section is very small and yellow. It may be that earlier in the season the plants were more abundant on the other sections and the vigorous ones have killed the weak ones. The color and vigor of the alfalfa on the limed sections are satisfactory, inoculation good.

Oct. 30. Plat 1505. Good stand and fair vigor except on no-lime area which is thin and poor.

PLAT 1506. PLAIN SEED, MANURE, FERTILIZER AND SOIL. JULY 28

	No lime.	Lime.
Alfalfa	346	371
Grass	36	51
Other weeds	15	11
	<hr/>	<hr/>
Total	397	433

The weeds in this plat are not quite so abundant (apparently) as in some of the preceding. The plat shows quite a spotted appearance, the yellow areas having few or no nodules. This plat indicates that dark green color may be due to good condition for growth as well as to inoculation, there being many dark green areas where no nodules occur. The limed sections are much alike. The alfalfa on the no-lime section is much more vigorous than on same section on the adjoining check plat (1505) probably because of the lime supplied in the fertilizer.

Oct. 30. Plat 1506. Good stand throughout. Vigorous growth on 3-lime and 2-lime, fair on 1-lime and weak on no-lime areas.

PLAT 1507. PLAIN SEED, MANURE AND FERTILIZERS. JULY 28

	No lime.	Lime.
Alfalfa	204	231
Grass	23	21
Other weeds	8	9
	<hr/>	<hr/>
Total	235	261

The weeds on this plat are not abundant. Abundant inoculation was found on the limed sections, but few nodules on the no-lime section. The

limed sections are quite uniform. It is noticed that where no nodules occur the roots of the alfalfa are simpler and not so ramifying as they are where nodules occur.

Oct. 30. Plat 1507. A good stand throughout but weaker in growth than 1506 and 1508. It is noticeable that 1506 and 1507, having commercial fertilizer, are both better on the no-lime sections than 1505 and 1508. The fertilizer seems to make up somewhat for the absence of lime but produces little additional effect where lime was applied.

PLAT 1508. CHECK. PLAIN SEED, MANURE AND SOIL. JULY 28

	No lime.	Lime.
Alfalfa	294	241
Grass	48	16
Other weeds	11	35
	<hr/>	<hr/>
Total	353	292

This plat is somewhat spotted, there being few or no nodules in the yellow patches. The green patches are well inoculated. Weeds well developed, and good stand. The 2-lime and 3-lime sections have produced alfalfa a little better than the 1-lime or no-lime sections.

Oct. 30. Plat 1508. Stand fair to good throughout. Vigor fair to good except on no-lime area where plants are small.

PLAT 1509. PLAIN SEED, FERTILIZER AND SOIL. JULY 28

	No lime.	Lime.
Alfalfa	332	223
Grass	71	23
Other weeds	16	26
	<hr/>	<hr/>
Total	419	272

The alfalfa on the no-lime is very small and pale. There are less weeds on this section than the others. Only one plant found bearing nodules on the no-lime section. On the 1-lime section the alfalfa and weeds are a little better than the no-lime and inoculation is a little more abundant, but only where the alfalfa is dark green. On the 2-lime and 3-lime sections both the alfalfa and the weeds are still better and inoculation is abundant.

Oct. 30. Plat 1509. Poorer than 1508 but better than 1510 except on no-lime section which is nearly gone.

PLAT 1510. PLAIN SEED AND MANURE. JULY 28

	No lime.	Lime.
Alfalfa	159	141
Grass	34	24
Other weeds	18	21
	<hr/>	<hr/>
Total	211	186

The alfalfa on the limed sections is vigorous and plants branched, but the color on all sections is not good. Slight inoculation found on

3-line and 1-line sections. The no-lime section is more weedy than the others. The three lined sections are markedly spotted with green patches.

Oct. 30. Plat 1510. Fair stand on 3-line and 2-line sections; poorer on 1-line and very poor on no-lime areas. The general vigor of the plants is less than on 1509 and markedly less than on 1511. (See Fig. 92.)

PLAT 1511. CHECK. PLAIN SEED, MANURE AND SOIL. JULY 28

	No lime.	Lime.
Alfalfa	195	298
Grass	47	8
Other weeds	11	25
	<hr/>	<hr/>
Total	253	331

All sections of this plat have a few yellow patches where no inoculation has taken place. It is abundant in other portions. The stand of alfalfa is good, but the weeds do not seem to be so abundant. 1-line alfalfa larger, dark spots in bloom, nodules abundant, other sections similar, alfalfa dense, good color except in a few spots which have no nodules. (See Fig. 91.)

Oct. 30. Plat 1511. Good stand and good vigor on the 3-line and 2-line sections, a noticeable falling off on the 1-line section and more especially on the no-lime area.

PLAT 1512. PLAIN SEED, MANURE AND FERTILIZER. JULY 28

	No lime.	Lime.
Alfalfa	120	195
Grass	43	11
Other weeds	24	34
	<hr/>	<hr/>
Total	187	240

This plat as a whole is quite weedy and the alfalfa is not uniform. There are a few green spots on all sections where nodules may be found, but they are wanting in the other portions. On the limed sections the weeds are much stimulated, in fact, they are now covering the alfalfa.

Oct. 30. Plat 1512. Patchy. The good areas as good as 1513 and 1514. The effect of the fertilizer is manifest on the no-lime area which is better than the same area in 1511. Nodules are found in the weakest patches.

PLAT 1513. PLAIN SEED, MANURE, FERTILIZER AND SOIL. JULY 28

	No lime.	Lime.
Alfalfa	195	163
Grass	108	68
Other weeds	23	65
	<hr/>	<hr/>
Total	326	296

Similar to 1512 for weeds. The weeds and alfalfa are quite dense and the whole plat is well inoculated and in many places the nodules are

in masses as large as a kernel of corn. On the limed portions the weeds are large and prosperous.

Oct. 30. Plat 1513. Slightly stronger growth throughout than on 1514, especially on the no-lime area.

PLAT 1514. CHECK. PLAIN SEED, MANURE AND SOIL. JULY 28

	No lime.	Lime.
Alfalfa	170	188
Grass	84	32
Other weeds	23	40
Total	277	260

This plat is quite weedy, dock especially abounding on the limed portions. The alfalfa is not uniform, being vigorous in some places and weak in others. On the vigorous and green portions nodules may be found on all sections. The weeds are not so abundant on the no-lime section.

Oct. 30. Plat 1514. Good stand, good vigor except on no-lime section. 3-lime area somewhat better than 2-lime and 1-lime, but the difference between no-lime and 1-lime is much greater than between 1-lime and 2-lime or 3-lime areas. This is probably the strongest check plat and only slightly excelled by 1513.

PLAT 1515. PLAIN SEED AND SOIL. JULY 28

	No lime.	Lime.
Alfalfa	190	174
Grass	81	34
Other weeds	12	15
Total	283	223

The weeds are much smaller and fewer than on the preceding plat. The alfalfa, however, on all sections is not so patchy. There are green and pale plants, but they are interspersed. The green plants bear nodules. The alfalfa on no-lime section is small, but green. This end is wet and low. It is more vigorous and of better color on the limed section.

Oct. 30. Plat 1515. Stand fair. Vigor medium on limed areas and rather poor on no-lime. There is little difference between 1-lime, 2-lime and 3-lime areas.

PLAT 1516. INOCULATED SEED. JULY 28

	No lime.	Lime.
Alfalfa	118	162
Grass	59	55
Other weeds	7	11
Total	184	228

The effect of lime in invigorating the plants does not seem to be so noticeable as on other plats. No nodules could be found on the 3-lime

and 2-lime sections, but they are abundant in spots on the 1-lime and no-lime sections. Weeds on this plat are not so abundant as on preceding plats. The alfalfa on 1-lime section is small and pale, except where nodules occur. On the limed sections, however, it is better, but this may be due, to some extent, to drainage.

Oct. 30. Plat 1516. Scarcely distinguishable in any respect from 1515. Nodules are found on the limed and no-limed areas of both.

PLAT 1517. CHECK. PLAIN SEED, MANURE AND SOIL. JULY 28

	No lime.	Lime.
Alfalfa	95	160
Grass	23	37
Other weeds	8	26
	126	223
Total		

The plants on this plat, neither weeds nor grass, are so vigorous as on those plats toward the other end of the series, but this end is moist. The alfalfa is generally of good color and well inoculated. On the limed sections the weeds and alfalfa are stronger and more vigorous. (See Fig. 93.)

Oct. 30. Plat 1517. Stand good. Vigor good but greatest at 3-lime and inferior on no-lime section. Slightly less growth of top than on 1514.

3. Seeding With and Without a Foster Crop

During 1904 a study was made of the effect of a foster crop on the growth of alfalfa seeding. The seeding was made upon a gravelly loam soil well adapted to alfalfa. A mixture of oats and barley was sown with the alfalfa on part of the area at the rate of one bushel per acre early in May. The stand secured was good and the growth normal. The field was clipped twice during the summer. Critical study of both areas was made on July 12, just before the first clipping, and November 3, at the end of the growing season.

For purposes of study a representative spot was selected in each area and one-half square yard was carefully taken from each and the growths separated into their classes, counted and weighed. The following table shows the result of this examination:

TABLE No. 9.— SEEDING ALFALFA
With and Without a Foster Crop (one-half square yard)

	Alfalfa alone.	Alfalfa with oats and barley.
Data obtained July 12.		
No. of alfalfa plants	215	269
No. of weeds	362	266
No. of oat and barley plants.....		33
Weight of fresh alfalfa plants, gms.....	178.84	100.08
Average weight of alfalfa plants, gms.....	.83	.37
Weight of fresh weeds, gms.....	445.80	156.00
Weight of oats and barley plants, gms.....		614.05
Average height of alfalfa plants, inches.....	7.4	6.2
Data obtained Nov. 3.		
No. of alfalfa plants	288	282
No. of weeds	216	87
No. of dead oat plants.....		27
Weight of dried alfalfa plants, gms.....	151.5	84.0
Average weight of dried alfalfa plants, gms.....	.74	.30
Weight of dried weeds, gms.....	132.0	102
Weight of dead oat stubbles, gms.....		66
Average height of alfalfa plants in inches.....	6.1	4.1

It would appear from this data that the alfalfa grown without a nurse crop certainly possessed double the vigor, at the time of going into the first winter, of that grown with a nurse crop. The following season, however, no difference in the appearance of the different sections was observable, and the plats were therefore not harvested separately.

4. *The Loss of Weight of Alfalfa Hay in the Barn*

Opportunity was embraced in 1904 to secure some data relating to the loss of weight of well cured alfalfa hay after storing in the barn.

On June 20, two bags of alfalfa hay were taken from the loads as brought in. The hay was well cured in the field having been cut 9 days and lying in cocks, without rain for most of this period.

The two bags weighed 2 lbs., 5 ozs. when empty and
 29 lbs., 6 ozs. gross, when filled
 leaving 27 lbs., 1 oz. of alfalfa.

Assuming that the bags weighed practically the same at later weighings the loss of weight of the 27 lbs., 1 oz. of alfalfa on the various dates is shown below.

		Lbs.	Ozs.	Actual loss.
June 20.....	Gross weight	29	6	
July 1.....	Gross weight	26	14	2.8
July 22.....	Gross weight	25	4	4.2
Aug. 2.....	Gross weight	25	2	4.4
Sept. 26.....	Gross weight	25	3	4.3

	Gross weight, ounces.	Weight of alfalfa, ounces.	Total loss in weight, ounces.	Loss, per ct.
June 20.....	470	433		
July 1.....	430	393	40	9.24
July 22.....	404	367	66	15.24
Aug. 2.....	402	365	68	15.70
Sept. 26.....	403	366	67	15.47

The weighing made September 26 was during a wet period when the humidity was high. The hay appears to have reached its lowest weight by August 2, just about seven weeks after it was put in the barn. That a larger quantity placed in one pile in a barn would have lost its water so rapidly is doubtful. The small quantity in a bag permits rapid drying, but then this may check some other losses, which occur when the hay "sweats." The variation in weight thus far is much smaller than occurs with timothy. The loss being probably principally water will depend upon the condition when taken from the field.

SUMMARY

1. *Soil*.—The observations and experience of the past two years confirm the opinion that there are large areas in New York suited to alfalfa and also considerable areas upon which the crop is not likely to succeed. The loamy soils with porous subsoils are best adapted and these are chiefly located in the northern two-thirds of the State. The heavy soils, especially those having impervious clay or hardpan subsoils, are least adapted and these constitute the bulk of the soils in the southern third of the State. Usually creek or river bottom land if not subject to serious overflow will produce alfalfa if skilfully managed.

2. *Inoculation necessary*.—Outside of the districts where alfalfa growing is already well established only six per cent of the coöperative tests indicate no need of efforts to secure inoculation. In 63 per cent of the cases no nodules at all were found. Certainly New York farmers must look well after the matter of inoculation if they would secure success with alfalfa, for without the alfalfa organism the crop does not succeed in New York.

3. *Results with the cotton method of transporting alfalfa bacteria*.—During two seasons only one case of marked increase of vigor of alfalfa plants has attended our efforts to inoculate the seed with bacteria secured on cotton. Our own experience and the results of studies made at the Geneva Station (Geneva Bulletin No. 270) lead to the conclusion that the cotton method is not sufficiently reliable to be of practical value.

4. *Inoculation by soil*.—Extended experiments and observations lead to the conclusion that where inoculation is needed and the conditions are

favorable for the bacteria the use of soil from an old alfalfa field uniformly results in abundance of nodules.

5. *Lime*.—Dressings of lime usually prove beneficial to the crop. On the heavier soil of the College farm, lime is essential to the establishment of the crop. At the end of the first season it appears that 2,000 pounds per acre has produced somewhat better results than 1,000 and practically as good as 3,000 pounds.

6. *Combination treatments*.—On that part of the College farm having the heavy soil, the only method of treatment that produced results that seem to promise ultimate success was a combination of lime, stable manure and inoculation by means of soil from an old alfalfa field. The plats thus treated do at the present time encourage us to believe that practical success may be secured with alfalfa on many soils of the State that are regarded as unsuited to the crop.

7. *Nurse crop*.—On some gravelly loam soil on the College farm, alfalfa grown without a nurse crop went into the first winter manifestly much stronger than that grown with a nurse crop. After a winter of no unusual severity this superiority was not maintained in the season's production.

8. *Loss in barn*.—Thoroughly field-cured alfalfa hay lost between 15 and 16 per cent in weight upon being stored three months in the barn.

COÖPERATIVE EXPERIMENTS 1906

COLLEGE OF AGRICULTURE
CORNELL UNIVERSITY

OUTLINE OF COÖPERATIVE DEMONSTRATIONS TO BE MADE IN 1906

The following schedule gives a list of the demonstrations or experiments that it is proposed to make with New York farmers in the season of 1906. These experiments cover some of the most important of the newer problems that are just now pressing themselves on the attention of our farmers. The list contains enough subjects to offer to every farmer one or two for his particular study. We desire to correspond with any person in the State who may wish to take up any one or more of these subjects on his own place. If there are other important problems pressing for solution in any locality, we should be glad to consider them; but in order to make the work efficient, it is necessary to limit our endeavors.

There are three purposes in this extension experiment work: (1) To illustrate or teach,—to instruct the coöperator in methods, to set him at the working out of his own problems, to bring him into touch with the latest discoveries and points of view. (2) To demonstrate in various parts of the State the value or the inefficiency of various new theories and discoveries,—to determine how far these newer ideas are applicable to local conditions. (3) To discover new truth, which may be worthy of record in bulletins; this is usually the least of the results that follow from such experiments because the experiments are not under perfect control nor continuously under the eye of a trained observer.

These 55 demonstrations and experiments are in eight categories, each category in charge of a specialist: I. Agronomy, J. L. Stone; II. Plant Selection and Breeding, J. W. Gilmore; III. Horticulture, John Craig; IV. Entomology, M. V. Slingerland; V. Animal Husbandry, H. H. Wing; VI. Poultry Husbandry, J. E. Rice; VII. Dairy Industry, R. A. Pearson; VIII. Plant Diseases, H. H. Whetzel. Correspondence should be addressed to the persons who have charge of these branches at Cornell University, Ithaca, N. Y. Specify by number the experiments in which you are interested.

The general plan of work is mutual or coöperative,—the farmer to provide land and labor and to have the crop, the expert to give advice and supervision and, so far as possible, to inspect the work. In some cases,

the College furnishes seeds and other materials. It does not furnish fertilizers. The person on whose farm the experiment is located will receive most of the benefit, but we desire reports from each man so that the results may be given to others.

It will be impossible, of course, to serve every one. We shall take only as many experiments as we think we can handle satisfactorily. Persons who desire to engage in this work must apply quickly. Full instructions, together with blanks for the making of reports, will be sent to applicants.

I. AGRONOMY OR FIELD CROPS

(J. L. STONE)

No. 1. *Alfalfa*. (a) The experimenter to report the conditions existing, the manner of treating the crop and the successes and the failures met in his experience. The direct experiments suggested are

(b) Seeding with and without a nurse crop;

(c) Treating a portion of the area with lime;

(d) When nodules are not found on the alfalfa roots, obtain some infected soil from a field where nodules are abundantly produced and scatter it over a portion of the area;

(e) Apply stable manure to a part of the inoculated area and also to an uninoculated plat.

No. 2. *Oats*. A test of four varieties of oats from selected seed. Seed of each variety sufficient for a plat one rod by two rods will be sent to the experimenter. Weight of total crop and of grain to be determined in each case.

No. 3. *Fertilizers*. A test with nitrogen, phosphoric acid and potash singly and in combinations, eight plats 1-20 to 1-10 acre each. The set comprises 260 lbs. of chemicals that cost the experimenter four dollars.

No. 4. *Potatoes*. (a) Test of varieties. Five pounds of each of three selected varieties will be furnished by the College. To be planted on a definite area and crop weighed.

(b) Cultural experiment. A comparison of the Cornell method with your own as described in Circular No. 18.

No. 5. *Sunflower* in corn for silage. Seed will be furnished for a test.

No. 6. *Soy beans*. A test of several varieties with a view to determine

(a) Their grain producing qualities,

(b) Their forage producing qualities,

(c) Their green manurial qualities,

(d) Adaptation to growing with corn to improve the quality of silage.

(e) Is artificial inoculation necessary?

(Experiments at the Cornell station indicate that this desirable natural stock food may be grown to advantage in New York.)

No. 7. *Field beans*. A test of several leading sorts. About one pint of seed of each variety furnished by the College.

No. 8. *Buckwheat*. (a) Variety test. Seed of each variety sufficient for a plat one rod by two rods will be sent to the experimenter. Also the seed to the two varieties mixed together for one plat. Weight of total crop and of grain to be determined in each case.

(b) Cultural experiment. Plow one plat early and harrow frequently till seeding time. Plow another plat just before seeding.

No. 9. *Winter vetch and rye*. A test of the combination as a cover crop, which may be used as a soil renovator, as early spring pasture, as a forage crop or for the production of seed.

No. 10. The destruction of certain weeds, such as wild mustard, alfalfa, dodder, devils paint brush, wild carrot, rag weed, smartweed, etc., by spraying with chemical solutions.

No. 11. *Testing the effect of lime on soils*.

No. 12. *The inoculation of legumes by means of artificial cultures*.

No. 13. *The renovation of pastures and meadows without plowing*.

No. 14. *Dwarf milo*. Sufficient seed of this new forage and grain plant will be sent for a test. Fuller description and instruction with seed.

No. 15. *Rotation experiment. Legumes vs. non-legumes*. This experiment should extend through several seasons.

No. 16. *Millet. Variety test*. Seed of each of three varieties sufficient for a plat one rod by two rods furnished to each experimenter.

II. PLANT SELECTION AND BREEDING

(J. W. GILMORE)

No. 20. *Potatoes*. An experiment in selection by hills for the purpose of increasing the yield.

No. 21. *Corn*. An experiment in selection and breeding with a view to developing an improved strain. (1) For silage, or (2) for grain.

No. 22. *Oats*. An experiment in selection by individual plants for the purpose of increasing the yield.

No. 23. *Wheat*. An experiment in selection by individual plants for the purpose of increasing the yield.

(NOTE.—Detail of methods suggested in Nos. 20-23 furnished to interested parties.)

III. HORTICULTURE

(JOHN CRAIG)

No. 30. *Orchard cover-crops*. 3 plats. A comparison of the values of hairy vetch, cow peas and mammoth clover, in apple, plum, pear or peach orchard. All plats in cover-crop experiments $\frac{1}{8}$ acre in extent. Keep soil thoroughly stirred from spring until middle of July, when seed should be sown. Seed furnished by the College. Study also the influence on temperature of soil. Record temperature daily at noon in cover-cropped soil and in soil without cover.

No. 31. *Mulching versus cover cropping*. We want a half dozen volunteers to undertake a serious comparison of these two methods of managing orchard soil. We would like to include at least apples and pears in the experiments; other fruits if possible. We should like to include in the range of the experiments different types of soil. Therefore a wide representation is desired. Particulars sent on application.

No. 32. *Spraying experiment*. Compare lime and sulphur with Bordeaux mixture as a fungicide. Prepare according to directions given in Spray Calendar.

No. 33. *Spraying to prevent peach and plum rot*. Ammoniacal copper carbonate against dilute Bordeaux mixture. Spray twice as fruit is ripening. Spraying material furnished by the College.

No. 34. *Spraying to prevent black rot of grape*. Bordeaux mixture with and without sulphur.

No. 35. *Thinning fruit*. Conduct careful tests on early apples, peaches and plums.

No. 36. *Strawberry*. Variety test.

No. 37. *Raspberry*. Variety test.

Experimenters are requested to send the Department of Horticulture descriptions of new varieties of fruits; samples of new seedling or cross-bred fruit will also be gladly received and examined.

IV. ENTOMOLOGY

(M. V. SLINGERLAND)

No. 41. *Poison sprays for plum and quince curculios*. Experiments with arsenate of lead and arsenate of lime sprays. Specific directions and arsenate of lead furnished by the College.

No. 42. *Spraying for grape root-worm*. Experiments with arsenate of lead spray to poison the beetles. Specific directions as given in Bulletin 208 or the Spray Calendar. (Bul. 217.)

No. 43. *Spraying and timely cultivation for the rose-chaffer*. Specific advice in regard to time to cultivate to kill the pupæ, and directions given

for spraying with arsenate of lead to kill the beetles. Poison furnished by the College.

V. ANIMAL HUSBANDRY

(H. H. WING.)

No. 50. *Cattle*. The information sought will include (a) period of gestation of cows, (b) sex of offspring, (c) weight of offspring at birth, (d) in case where calves are raised or vealed weight at four, six and eight weeks of age. To those who undertake this work cards for making reports will be furnished on request.

No. 51. *Swine*. The information asked for will include (a) period of gestation, (b) number of offspring, (c) sex of offspring, (d) weight of litter and if possible of each individual at birth. To those who undertake this work, cards for making reports will be furnished on request.

VI. POULTRY HUSBANDRY

(J. E. RICE)

No. 60. *Importance of supplying grit to fowls* to determine the amount consumed, the best kind, and the effect upon the quantity of eggs, hardness of shell, and in preventing "egg eating."

No. 61. *The importance of meat in a ration for egg-production*, and to observe the effects upon number, size and fertility of eggs and vitality of chickens.

No. 62. *The value of a ration of whole grain* as compared to the same ration part of which is ground and fed dry or fed in a "hot mash."

No. 63. *Comparative value of hot mash* and the same feed fed dry.

No. 64. *Breed test*. A comparison of pens of the same number of individuals of different varieties of similar age.

No. 65. *Study of poultry houses*. To determine temperature inside and out, also dampness, and to observe comparative value of different types and styles of construction. For example,—with and without hooded roosts. With and without curtains in front of windows; with and without double walls or gables stuffed with straw. With and without various kinds of ventilators, cloth windows or glass windows, etc., etc.

No. 66. *Feeding chickens whole grain versus soft food*, or rations with and without some form of meat or skimmed milk.

No. 68. Weigh all the food which a flock of fowls consume during one or more weeks. Keep a record of the eggs laid each day and the age, variety and number of hens in the flock. Send report on blanks which we will furnish on application and, if it is desired, we will figure the nutritive ratio and cost of the ration, and will suggest changes if necessary.

No. 69. Send measurements of poultry houses, giving length, breadth, height to plate and ridge. Figure the square feet of floor space,

cubic feet of air space, square feet of window opening; number and kind of fowls inclosed. Draw end view, front view, ground plan and show construction of walls, kind of roof, straw loft, etc. Blank forms will be furnished.

VII. DAIRY INDUSTRY

(R. A. PEARSON)

No. 80. *Churning.* To churn cream from fresh and stripper cows to determine best methods of handling the cream from cows far advanced in the period of lactation.

No. 81. *Small-top milk pails.* To determine their practical advantages and disadvantages.

No. 82. *Period of ripening.* A comparison of long and short periods of cream ripening.

No. 83. *Washing cream.* The effect of this treatment upon the flavor and grain of butter.

No. 84. *Whey butter.* Best method of handling whey and cream for making whey butter.

No. 85. *Sanitary dairying.* To determine cost in labor and cash outlay necessary to improve the sanitary condition of a dairy, using score card to report conditions existing.

No. 86. *Over-run in Churning.* To determine effect of temperatures of churning and temperatures of wash water.

VIII. PLANT DISEASES

(H. H. WHETZEL)

No. 90. *Loss from corn smut.* To determine the loss from any given field to see if it will pay to eradicate smut from corn-fields.

No. 91. *Loose smut of wheat.* Special hot water treatment of seed wheat to determine to what extent smut in the succeeding crop may be reduced.

No. 92. *Bean anthracnose or pod spot.* Spraying with Bordeaux mixture to determine: (1) number of sprayings that will give maximum returns; (2) stages in the growth of the bean plants at which these sprayings should be made to get the best results; (3) strength of the Bordeaux mixture that will give maximum results; (4) cost of spraying per acre; (5) average increased yield per acre.

No. 93. *Bean blight.* To determine the value of Bordeaux mixture as a preventative of this disease.

No. 94. *Formalin.* Its value for sterilizing soil in green-house beds.

No. 95. Plans for treating fungus diseases in any crop in which you are interested will be prepared if possible and furnished upon application

CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION

THE FOLLOWING BULLETINS ARE AVAILABLE FOR DISTRIBUTION TO THOSE RESIDENTS OF NEW YORK STATE WHO MAY DESIRE THEM.

- | | |
|---|--|
| <p>72 The Cultivation of Orchards, 22 pp.
 119 Texture of the Soil, 8 pp.
 121 Suggestions for planting Shrubbery.
 126 The Currant-Stem Girdler and the Raspberry-Cane Maggot, 22 pp.
 129 How to Conduct Field Experiments with Fertilizers, 11 pp.
 134 Strawberries under Glass, 10 pp.
 135 Forage Crops, 28 pp.
 136 Chrysanthemums, 24 pp.
 127 Agricultural Extension Work, Sketch of its Origin and Progress, 11 pp.
 138 Studies and Illustrations of Mushrooms; I. 32 pp.
 139 Third Report upon Japanese Plums, 16 pp.
 140 Second Report upon Potato Culture, 24 pp.
 141 Powdered Soap as a Cause of Death Among Swill-Fed Hogs.
 142 The Codling-Moth.
 143 Sugar Beet Investigations, 88 pp.
 144 Suggestions on Spraying and on the San José Scale.
 145 Some Important Pear Diseases.
 146 Fourth Report of Progress on Extension Work, 26 pp.
 147 Fourth Report upon Chrysanthemums, 36 pp.
 148 Quince Curculio, 26 pp.
 149 Some Spraying Mixtures.
 150 Tuberculosis in Cattle and its Control.
 151 Gravity or Dilution Separators.
 152 Studies in Milk Secretion.
 153 Impressions of Fruit-Growing Industries.
 154 Table for Computing Rations for Farm Animals.
 155 Second Report on the San José Scale.
 157 Grape-vine Flea-beetle.
 158 Source of Gas and Taint Producing Bacteria in Cheese Curd.
 159 An effort to help the Farmer.
 160 Hints on Rural School Grounds.
 161 Annual Flowers.
 162 The Period of Gestation in Cows.
 163 Three Important Fungous Diseases of the Sugar Beet.
 164 Peach Leaf-Curl.
 165 Ropiness in Milk and Cream.
 166 Sugar Beet Investigations for 1898.
 168 Studies and Illustrations of Mushrooms; II
 169 Studies in Milk Secretion.
 170 Tent Caterpillars.
 171 Concerning Patents on Gravity or Dilution Separators.
 172 The Cherry Fruit-Fly; A New Cherry Pest.
 173 The Relation of Food to Milk Fat.
 176 The Peach-Tree Borer.
 177 Spraying Notes.
 178 The Invasion of the Udder by Bacteria.
 179 Field Experiments with Fertilizers.
 180 The Prevention of Peach-Leaf Curl.
 181 Pollination in Orchards.</p> | <p>182 Sugar Beet Investigations for 1899.
 183 Sugar Beet Pulp as a Food for Cows.
 184 The Grape Root-Worm; New Grape Pest in New York.
 185 The Common European Praying Mantis; A New Beneficial Insect in America.
 186 The Sterile Fungus Rhizoctonia.
 187 The Palmer Worm.
 188 Spraying Calendar.
 189 Oswego Strawberries.
 190 Three Unusual Strawberry Pests and a Green-house Pest.
 191 Tillage Experiments with Potatoes.
 192 Further Experiments against the Peach-Tree Borer.
 193 Shade Trees and Timber Destroying Fungi.
 194 The Hessian Fly. Its Ravages in New York in 1901.
 195 Further Observations upon the Ropiness in Milk and Cream.
 196 Fourth Report on Potato Culture.
 198 Orchard Cover Crops.
 199 Separator Skimmed Milk as Food for Pigs.
 200 Muskmelons.
 201 Buying and Using Commercial Fertilizers.
 205 Shade Trees.
 206 Sixth Report of Extension Work.
 207 Pink Rot an Attendant of Apple Scab.
 208 The Grape Root-Worm.
 209 Distinctive Characteristics of the Species of the Genus Lecanium.
 210 Commercial Bean Growing in New York.
 211 Coöperative Poultry Experiments. The Yearly Record of Three Flocks.
 212 Cost of Producing Eggs. Second Report.
 215 The Grape-Leaf Hopper.
 216 Spraying for Wild Mustard and the Dust Spray.
 217 Spraying Calendar.
 218 Onion Blight.
 219 Diseases of Ginseng.
 220 Skimmed Milk for Pigs.
 221 Alfalfa in New York.
 222 Attempt to Increase the Fat in Milk by Means of Liberal Feeding.
 225 Bovine Tuberculosis.
 227 Cultivation of Mushrooms by Amateurs.
 228 Potato Growing in New York.
 229 An Apple Orchard Survey of Orleans County.
 230 Quality in Potatoes.
 231 Forcing of Strawberries, Tomatoes, Cucumbers and Melons.
 232 Influence of Fertilizers upon the yield of Timothy Hay.
 233 Two New Shade-Tree Pests.
 234 The Bronze Birch Borer.
 235 Coöperative Spraying Experiments.
 236 The Blight Canker of Apple-Trees.
 237 Alfalfa — A Report of Progress.</p> |
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Address,

COLLEGE OF AGRICULTURE,
ITHACA, N. Y.

CORNELL UNIVERSITY
AGRICULTURAL EXPERIMENT STATION OF
THE COLLEGE OF AGRICULTURE
Department of Agronomy (Extension Work)

BUCKWHEAT



By J. L. STONE

ITHACA, N. Y.
PUBLISHED BY THE UNIVERSITY

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Office of the Director, 17 Morrill Hall.

The regular bulletins of the Station are sent free to persons residing in New York State who request them.

COLLEGE OF AGRICULTURE, CORNELL UNIVERSITY,
ITHACA, N. Y.

HON. C. A. WIETING,

Commissioner of Agriculture, Albany:

Sir:—Herewith I submit a popular account of buckwheat, suggesting the best methods for its treatment in New York. There are no bulletins, so far as I know, devoted to this important crop. The subject demands greater study than has yet been devoted to it.

The highest point in buckwheat production in the United States seems to have been reached in 1866, when the crop as reported by the United States Department of Agriculture was 22,791,839 bushels. The average crop for the five years 1866 to 1870 was 18,257,428 bushels. The average crop for the five years 1901–1905 was 14,898,361. While the total production in the United States has not in recent years equaled that of the sixties, the crop in the States of chief production has increased in volume. New York and Pennsylvania now produce more than two-thirds of the total crop of the United States. Maine, Michigan, Wisconsin, West Virginia, North Carolina, New Jersey and Massachusetts, ranking in the order named, produce the major portion of the other third. The following table gives the statistics of buckwheat production in New York and Pennsylvania for the five-year period 1901–1905:

TABLE I.—SHOWING THE AVERAGE ANNUAL ACREAGE, YIELD, PRODUCTION, PRICE AND FARM VALUE OF BUCKWHEAT IN NEW YORK AND PENNSYLVANIA FOR THE PERIOD OF 1901–1905

	Acreage.	Yield per acre.	Production.	Price. Cts. Dec. 1.	Farm value, Dec. 1.
New York.....	336,993	18.5	6,241,414	59	\$3,602,286
Pennsylvania.....	243,775	18.6	4,522,052	60	2,708,068

Respectfully submitted,

L. H. BAILEY,
Director.

BUCKWHEAT.

Buckwheat is the least important in respect to quantity produced of the six principal grain crops of the United States. The cultivation of buckwheat in the United States is practically limited to the northern States that lie east of the Mississippi river. According to the statistics of 1900, the North Atlantic division, together with the States of the North Central division that lie east of the Mississippi, contained 89.4 per cent of the total area under buckwheat and produced 90.9 per cent of the total yield in 1899. By including three States of the South Atlantic division, Maryland, Virginia, and West Virginia, it is found that the sections named contained 95.5 per cent of the total buckwheat area and produced 96.5 per cent of the total yield.

I. GENERAL ACCOUNT OF THE BUCKWHEAT PLANT

Name and relationship.—The name "Buckwheat" seems to be a corruption of the German *buchweizen*, meaning beech-wheat, a name given to the plant on account of the shape of the seeds, being similar to that of the beechnut, while their food constituents are similar to those of wheat grains. Botanically buckwheat is not a cereal, but since its seeds serve the same purposes as the cereal grains it is usually classed in market reports among the cereals. The family to which buckwheat belongs (*Polygonaceæ*) includes several well-known, troublesome weeds, as sorrel and dock (*Rumex*) and smartweed, knotweed and bindweed (*Polygonum*).

The plant.—Buckwheat is an annual of erect habit, under ordinary conditions attaining about three feet in height. The root system consists of one primary root and several branches, the former extending well downward to reach moist earth, but the total development of roots is not large. The stem varies from one-fourth to five-eighths inch in diameter and from green to purplish red in color while fresh, and changes to brown at maturity.

Only one stem is produced from each seed,—the plant, instead of tillering or producing suckers, branching more or less freely, depending on the thickness of seeding. It thus adapts itself to its environment even more completely than the cereals, which tiller freely. The leaves are

alternate, triangular-heart-shaped, slightly longer than broad, varying from two to four inches in length, borne on a pedicel varying from nearly sessile to four inches in length. The flowers are white, tinged with red or pink and are borne on the end of the stem or on a slender pedicel springing from the axils of the leaves. They are without petals, but the sepals of the calyx have the appearance of petals and the bloom is so abundant that fields of buckwheat make a beautiful appearance. There are eight stamens and one three parted pistil. On threshing the ripened grain, the calyx remains attached at the base of the grain. Two forms of flowers are produced,—one with long stamens and short styles, and the other with short stamens and long styles. Though each plant bears but one form of flower the seeds from either form will produce plants bearing both forms. This arrangement is believed to facilitate the crossing between plants by means of insect visitation. The grain of buckwheat consists of a single seed inclosed in a pericarp, of the kind known to botanists as an akene. The paricarp or hull is thick, hard, smooth and shining, and varies in color from silver gray to brown or black. It separates readily from its contents. In form the grain is a triangular pyramid with rounded base. The usual length of the grain is from three-sixteenths to three-eighths and the width from one-eighth to three-sixteenths inch.

In States of chief production, the legal weight of buckwheat is forty-eight pounds per bushel. In some others it varies from forty to fifty-six pounds.

Composition.—The following table, compiled by Professor T. F. Hunt, in "The Cereals in America," shows the composition of the grain, straw, flour, middlings and hulls of buckwheat:

	Grain.	Straw.	Flour.	Middlings.	Hulls.
Number of analyses.....	8	3	4	6	3
Water.....	12.6	9.9	14.6	12.7	10.1
Ash.....	2	5.5	1	5.1	2
Protein (Nx6.25).....	10	5.2	6.9	28.1	4.6
Crude fiber.....	8.7	43	.3	4.2	44.7
Nitrogen-free extract.....	64.5	35.1	75.8	42.4	37.7
Fat.....	2.2	1.3	1.4	7	.9

Owing to its thick, heavy hull, buckwheat contains a larger percentage of crude fiber than the cereal grains. The percentage of protein and nitrogen-free extract is somewhat lower than in the case of wheat. Buckwheat flour contains only about two-thirds as much protein as wheat flour. The straw of buckwheat contains a somewhat higher percentage

of protein and crude fiber and a lower percentage of nitrogen-free extract than wheat straw. Buckwheat middlings, on account of its high percentage of protein and fat, is in great demand as a food for dairy cows. The hulls are so hard and indigestible that they are not often used for animal food, although the analysis would suggest that they have some feeding value.

Species and distribution.—Botanists have assigned the cultivated forms of buckwheat to three distinct species.

1. *Fagopyrum esculentum*, common or true buckwheat.
2. *F. emarginatum*, notch-seeded buckwheat.
3. *F. Tataricum*, Tartary or Siberian buckwheat.

The notch-seeded buckwheat is not known to have been grown in this country but is reported as cultivated in India and China. By some botanists it is regarded as a form of *Fagopyrum esculentum*, the common buckwheat. It is distinguished by having the angles of the hull extended into wide margins or wings.

The Tartary buckwheat is cultivated in the cooler and more mountainous regions of Asia and to some extent in Canada and Maine. It is recommended for its superior hardiness. It has been tried in Pennsylvania but without satisfactory results. The grain is smaller than the common buckwheat, the plants are more slender and the leaves arrow-shaped. It is sometimes called India wheat and duckwheat. The true buckwheat has bright, white or pink-tinged flowers in large trusses or heads; the India wheat has smaller greenish white flowers in small heads; and also small leaves. The grain of buckwheat has regular angles; that of the India wheat has wavy or slightly notched angles.

The common buckwheat (*Fagopyrum esculentum*) is the most valuable and most widely grown form. It is met with wild in China and Siberia and enters into the agriculture of every country where grain crops are cultivated. In China it has been grown and used for food from time immemorial. In Japan it is held in general esteem and in Russia it is also largely consumed. It has been cultivated for centuries in England, France, Spain, Italy and Germany. In all the European countries it is chiefly consumed by the poorer classes, but it has remained for the American housewife to learn how to prepare it so as to please the palate of the epicure. The buckwheat pancake is a peculiarly American institution. Formerly it constituted the major part of the bread diet of the greater portion of the rural population of the New England and Middle States during the winter season. It has now won its way to the break-



FIG. 95.—Representative plants from an early plowed plat on the left, and from a late plowed plat on the right.



FIG. 96.—Results of early plowing and thorough fitting of the soil.

fast table of the city resident as well, and when served hot with maple syrup is considered the peer of the finest productions of the French chef.

II. THE CULTIVATION OF BUCKWHEAT

A moist, cool climate is most favorable for buckwheat, although the seeds will germinate in a very dry soil, and considerable heat in the early stages of growth is an advantage. High temperatures in the period of seed formation, especially hot sunshine following showers, is usually disastrous to crop yield, causing blasting of the flowers. The same effect is attributed to strong east winds. The yield is much reduced by drought during this period. Buckwheat will mature in a shorter period than any other grain crop, eight or ten weeks being sufficient under favorable con-



FIG. 97.—Results of late plowing and hasty fitting on land contiguous and similar to Fig. 96.

ditions. It is thus well adapted to high altitudes and short seasons, but its period of growth must be free from frosts as the plants are very sensitive to cold.

Soil.—Buckwheat will grow on a wide range of soils, but those of a rather light, well-drained character are best suited. It will give fair yields on soils too poor or too badly tilled to produce most other crops and seems to be less affected by soil than by season. It is not desirable, however, to attempt to grow buckwheat on very rich land, as under such conditions the crop frequently lodges badly with results even more serious than occur when other grain crops go down, as the plant has no method of rising again. This ability to produce fair crops on poor soils

and under indifferent cultivation has led to buckwheat being often considered the poor farmer's crop, and to poor and unskilled farmers being dubbed "buckwheaters." The crop lends itself well to the farmer who lacks capital to secure timely labor or wait for returns on investments in tillage and fertilizer. It may be planted after the rush of spring work is over; it may be resorted to as a substitute for spring crops or meadows that have failed and it brings quick return for investment in fertilizers. One farmer is reported as saying: "I like to raise buckwheat because it is the only grain for which I can buy fertilizer on a 90-day note and pay for it out of the crop it makes." Buckwheat, however, responds to more generous and intelligent treatment and deserves to be held in higher esteem than it usually enjoys.

Preparation of the soil.—Since buckwheat is not usually planted till the last of June, owing to pressure of other work, the land too often is not plowed till just before seeding and then receives hasty and indifferent fitting. This allows little time for sods and other organic matter to decay and become incorporated with the soil and capillarity is not re-established between the sub-soil and the seed-bed. Under these conditions, the development of the crop is slow and if drought ensues disaster is the result. Early plowing of the land so as to allow of several harrowings at intervals of two weeks and a thorough settling of the soil nearly insures the maximum crop the land is capable of producing. If early plowing is impracticable, then the greater attention should be given to a thorough fitting of the seed-bed. See Figs. 95, 96 and 97.

Fertilization.—Stable manure is not usually applied to land intended for buckwheat, but is reserved for more exacting crops. Moderate applications of manure, however, on poor soils result in largely increased yields. Buckwheat, when grown on poor land, responds well to moderate dressings of even low grade fertilizers, and many farmers who do not use fertilizers on other crops find it profitable to buy for this.

In experiments conducted at the Cornell Experiment Station in 1901 on rather heavy soil, but in a state of fertility to produce a fair crop without fertilization, applications of acid rock, dried blood and muriate of potash produced uncertain and somewhat contradictory results. These experiments were conducted on a neighboring farm on land leased for the purpose. In the fall of 1900 the land had been plowed and seeded to rye. Owing to the partial failure of the rye it was decided to seed the land to buckwheat and the land was secured for the experiment. The soil is a clay loam and was in a fair state of productivity. On May 10, 1901, two

strips in this field were plowed, one near the east end and afterward constituting plats 21 and 22 of the experiment, another near the middle and becoming plats 9 and 10. The purpose of plowing these strips was to determine whether better results would be secured by turning the rye under in the early season or by allowing it to grow till shortly before drilling in the buckwheat. On June 20th, the entire area, including the two strips just mentioned, was plowed. At this time the rye in some places was as high as the horses' backs and a heavy chain was used to draw it under the furrows. In preparing the seed-bed the harrow and roller were each used twice. The seeding was at the rate of three pecks per acre and the drilling was done on June 24th. The varieties sown, the fertilizers applied to the various plats and the computed yields per acre are best shown in the following table. Each plat was approximately one-tenth acre. Plats 1 to 8 sown with the Japanese variety constitute one fertilizer test and plats 12 to 23, excluding 13, 21 and 22, sown with Silver Hull variety, constitute a duplicate test:



FIG. 98.—Buckwheat responds to dressings of commercial fertilizers.

TABLE NO. 2.—TABULAR EXHIBIT OF THE 1901 BUCKWHEAT EXPERIMENT

Plat No.	When plowed.	Variety.	Fertilizer applied lbs. per acre.	Yield bushels per acre.
1.....	June 20.....	Japanese.....	200 Acid rock.....	38
2.....	June 20.....	Japanese.....	100 Muriate of potash.....	35.7
3.....	June 20.....	Japanese.....	200 Dried blood.....	38.5
4.....	June 20.....	Japanese.....	Check. Nothing.....	31
5.....	June 20.....	Japanese.....	200 Acid rock.....	30.4
			100 Muriate of potash.....	
6.....	June 20.....	Japanese.....	200 Acid rock.....	33.2
			200 Dried blood.....	
7.....	June 20.....	Japanese.....	100 Muriate of potash.....	35.6
			200 Dried blood.....	

TABLE NO. 2.—TABULAR EXHIBIT OF THE 1901 BUCKWHEAT EXPERIMENT—*Con'd*

Plat No.	When plowed.	Variety.	Fertilizer applied lbs. per acre.	Yield bushels per acre.
8.....	June 20.....	Japanese.....	200 Acid rock..... 100 Muriate of potash.....	34.6
9.....	May 10 and June 20.....	Japanese.....	200 Dried blood..... 200 Acid rock..... 100 Muriate of potash..... 200 Dried blood.....	35.9
10.....	May 10 and June 20.....	Japanese.....	Check. Nothing.....	34.4
11.....	June 20.....	Japanese.....	Check. Nothing.....	31.2
12.....	June 20.....	Silver Hull.....	Check. Nothing.....	20.4
13.....	June 20.....	Common Gray.....	Check. Nothing.....	30
14.....	June 20.....	Silver Hull.....	200 Acid rock.....	24.8
15.....	June 20.....	Silver Hull.....	100 Muriate of potash.....	21.8
16.....	June 20.....	Silver Hull.....	200 Dried blood.....	25.8
17.....	June 20.....	Silver Hull.....	200 Acid rock..... 100 Muriate of potash.....	24.3
18.....	June 20.....	Silver Hull.....	200 Acid rock..... 200 Dried blood.....	25.5 24.1
19.....	June 20.....	Silver Hull.....	100 Muriate of potash..... 200 Dried blood.....	22.6
20.....	June 20.....	Silver Hull.....	200 Acid rock..... 100 Muriate of potash..... 200 Dried blood.....	22.8
21.....	May 10 and June 20.....	Silver Hull.....	200 Acid rock..... 100 Muriate of potash..... 200 Dried blood.....	22.8
22.....	May 10 and June 20.....	Silver Hull.....	Nothing.....	22.8
23.....	June 20.....	Silver Hull.....	Nothing.....	18.7
24.....	June 20.....	Common Gray.....	Nothing.....	23.6
25.....	June 20.....	Japanese.....	Nothing.....	23.8

Seeding.—The amount of seed used per acre in seeding buckwheat varies from three to five pecks but is usually four pecks. It may be sown with the ordinary grain drill or broadcasted and harrowed in.

The time of seeding varies in different localities, but in New York and Pennsylvania is the last week in June or the first week in July. To avoid hot weather while the grain is forming, it is desirable to sow as late as possible and have the crop well developed before severe frosts occur. Buckwheat begins to bloom before the plants have nearly reached full growth and continues blooming till stopped by frost or the harvest. Hence there will be at harvest time on the same plants mature and immature grain and flowers. It is sought to cut the crop just before the first hard frost. Much of the immature grain will ripen while lying in the swath or gravel.

Harvesting.—Buckwheat is rarely harvested with the self-binder, but may be cut with the hand-cradle or the dropper-reaper. To avoid the shelling and loss of the more mature grains it is preferably cut early in the morning while damp from dew or during damp, cloudy weather. It is usually allowed to lie a few days in swath or gravel when it is set up in small independent shocks or stooks. It is not bound tightly by bands as are most cereal grains, but the tops of the shocks are held together by a few stems being twisted around in a way peculiar to the crop. This setting up is also usually done when the crop is damp to avoid shelling of the grain.

The unthreshed crop is not often stored in barns or stacked but is threshed direct from the field. Formerly much of the threshing was done with the hand flail, in which case it is necessary that the work be performed on a dry, airy day so that the grain will shell easily. If threshed by machinery, neither crop nor day need be so dry. It is usual to remove from the thresher the spiked concave and put in its place a smooth one, or a suitable piece of hardwood plank. This is to avoid cracking the grain and unnecessarily breaking the straw. The pedicels bearing the seeds are slender, and these as well as the straw, when dry, are brittle so that the grain threshes much easier than the cereals.



FIG. 99.—*Buckwheat in the stook. A plat on the Cornell Station grounds.*

Rotation.—Buckwheat usually has no definite place in the rotation of crops. This is chiefly due to its being used as a substitute for meadow or spring-planted crops that have failed. The poorer lands and the left-over fields are usually sown to buckwheat. While buckwheat seems not to be materially affected by the crop that precedes it, on the other hand it is reported to affect unfavorably certain crops when they follow it. Oats and corn are said by many to be less successful after buckwheat than after other crops. That this is so has not been established by any experiment station. Buckwheat leaves the soil in a peculiarly mellow, ashy condition. In the case of rather heavy soils on which it is desired to grow potatoes,

this is a decided benefit and in some localities the practice of preceding potatoes by buckwheat, for the purpose of securing this effect, has come to be common. The following rotation is sometimes recommended for such soils: clover, buckwheat, potatoes, oats or wheat with clover seeds. The first crop of clover is harvested early and the land immediately plowed and sown to buckwheat as a preparation for potatoes.

Varieties.—There are three principal varieties of buckwheat grown in America,—the Common Gray, Silver Hull, and Japanese. The seed of Silver Hull is slightly smaller than the Common Gray,—the color is lighter and of a glossy, silvery appearance. The Japanese is larger than the Gray, of somewhat darker color and there is a tendency for the angles or edges of the hull to extend into a wing, making the faces of the grain more concave. The plant of the Japanese variety is a somewhat larger grower than the others, the fresh stem has a green color and the flowers seem not to be quite so subject to blasting from hot sunshine as the others. On this account it is recommended in some localities to sow the Silver Hull and Japanese varieties mixed, it being said that the later and hardier Japanese will shade and protect the others from hot sunshine, thus avoiding blasting and securing a larger zone of seed-bearing straw than is furnished by either sort alone, a larger yield resulting. The Silver Hull variety has a red stem and branches more freely than the others. The leaves also are smaller.

Each of these varieties has produced largest yield in certain tests. It seems that there is adaptation of variety to soil or climate or, perhaps, to weather conditions that has not yet been worked out, that produces these contradictory results. However, the yielding quality of the Japanese variety is usually conceded to be superior to that of the others.

By reference to Table No. 2 it will be seen that plats 11, 12, 13, also 23, 24 and 25, give the comparative yields of the three varieties in the 1901 experiment. In each case the Japanese variety gives largest yield and Silver Hull smallest. It was observed in these tests that Silver Hull is much slower-growing and less vigorous in its early stages but comes on later to make a good stand. In the case before us the average yields were:

Japanese.....	27.5 bushels per acre
Common Gray.....	26.8 bushels per acre
Silver Hull.....	19.5 bushels per acre

In this experiment there were eleven plats seeded with Japanese buckwheat and eleven with Silver Hull. The fertilizers and also the culture treatment applied to one are duplicated on the other. The average of the eleven plats sown to Japanese variety was 36.6 bushels and of the eleven sown to Silver Hull was 23.1 bushels per acre. Probably these figures are

unfair to Silver Hull, as apparently the east end of the field was less productive than the west end where the Japanese was grown, though there was nothing to indicate this in the appearance of the soil.

Comparative tests of the Japanese and Silver Hull varieties have been included in the coöperative experiments conducted among the farmers in various parts of the State. Table No. 3 gives the results secured in a number of these tests:

TABLE NO. 3.—YIELDS OF JAPANESE AND SILVER HULL BUCKWHEAT IN CO-OPERATIVE EXPERIMENTS

EXPERIMENTS.	County.	Japanese bu. per acre.	Silver-Hull bu. per acre.
Spencer Hatch.....	Washington.....	41.50	39
G. H. Chace (frostcd).....	Chautauqua.....	14.25	12.50
N. J. Hitchcock.....	Madison.....	10	13.25
C. H. Libby.....	Chautauqua.....	24	22.50
Wm. F. Roe.....	Tioga.....	22.50	18.66
Geo. H. Townsend.....	Albany.....	15.00	8.66
Herbert Green.....	Dutchess.....	16.70	22.90
H. E. Bunnell.....	Tioga.....	29.20	15.80
W. L. McConnell.....	Schuyler.....	20.00	20.00
T. C. Squires.....	Jefferson.....	9.30	8.30
R. V. A. Hughes.....	Chautauqua.....	32.90	28.70
D. B. Boomhower.....	Albany.....	8.80	17.60
W. V. Clemens.....	St. Lawrence.....	20.00	25.00
G. R. Schaubcr.....	Saratoga.....	35.00	27.90
Average.....	.....	21.29	20.05

Formerly the flouring qualities of the Japanese variety were pronounced by many millers to be inferior to the other sorts and not infrequently the price of Japanese buckwheat was five or ten cents per bushel less than the others. In some localities this condition still prevails; in others the reverse is true. In parts of Seneca county, N. Y., in recent seasons the millers have offered a bonus of five cents per bushel for the Japanese variety. Whether this change in the estimate of the variety is due to improvement in the quality of the grain due to acclimatization, or to better adaptation of the milling methods to the variety has not been ascertained.

Consumption.—Formerly a considerable part of the buckwheat was used for animal food, only enough flour being manufactured to meet the requirements of the rural districts during the winter season. Of late the demand for the flour in the cities has been such that most of the grain is ground for flour and less of the flour is consumed in the rural districts.

Buckwheat flour is whiter than that made from wheat and has a peculiar mealy feel to the hand that enables one readily to distinguish it from wheat flour. The first flour on the market after harvest brings a high price, but the price rapidly declines as the supply increases. The grain must be well dried and the grinding performed in cool, dry weather to secure best results in milling. The yield of flour per bushel of buck-

wheat is usually about twenty-five pounds, though twenty-eight or more may be secured if the grain is plump and very dry. The middlings, a by-product of the flouring process, is much sought by dairymen as food for dairy cows on account of its high content of protein. The hulls have little or no value. Sometimes they are ground and used as an adulterant for black pepper.

Buckwheat grain is much relished by poultry and has a reputation of being of special value in egg-production. In recent feeding experiments this reputation is scarcely sustained.

Enemies.—The buckwheat crop is unusually free from interference from weeds or plant diseases. It starts so quickly and grows so rapidly that most weeds get no chance to make headway against it. In fact buckwheat is one of the best crops for cleaning land by smothering out weed growths. Wild birds as well as domestic are fond of the grain and when abundant sometimes cause considerable loss. No insect or fungous troubles have been sufficiently destructive to attract much attention.

Buckwheat as a soiling crop.—A number of farmers have reported favorably upon the use of buckwheat as a soiling crop, but its use for this purpose has not been sufficiently extended to establish its value.

Buckwheat as a green manure crop.—The use of buckwheat as a green manure has been much more extended. It possesses several characteristics that adapt it to this purpose. It thrives on quite poor soil. It grows rapidly. It smothers out weeds, thus helping to clean the land. It leaves hard soils in a remarkably mellow condition. It decays quickly when plowed under.

CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION

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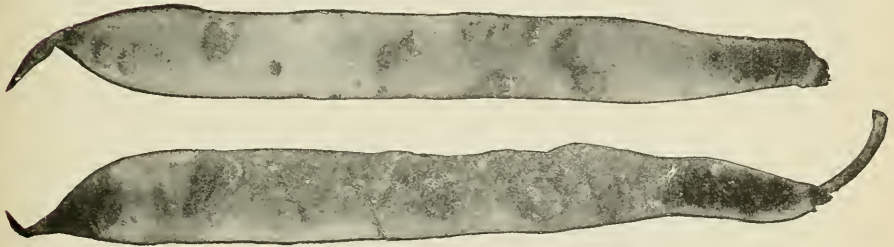
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CORNELL UNIVERSITY
AGRICULTURAL EXPERIMENT STATION OF
THE COLLEGE OF AGRICULTURE
Botanical Department (Extension Work)

SOME DISEASES OF BEANS



By H. H. WHETZEL

ITHACA, N. Y.

PUBLISHED BY THE UNIVERSITY

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Office of the Director, 17 Morrill Hall.

The regular bulletins of the Station are sent free to persons residing in New York State who request them.

HON. CHARLES A. WIETING,

Commissioner of Agriculture, Albany:

Sir:—For several years, serious diseases have threatened the great bean industry of New York. These diseases are not yet thoroughly understood, but enough is known about them to warrant the preparation of a brief popular bulletin of advice. It is hoped that this bulletin will call out the expressions of bean-growers who have had experience that will be useful to others; and this Experiment Station will continue its investigations.

Following is an outline of the subjects treated in this bulletin:

General Discussion

How to determine what disease is attacking the beans

I. BEAN ANTHRACNOSE, page 239

Nature of the disease

The disease on the seedlings

The disease on the leaves and stems

The disease on the pods

The disease in the seed

Treatment:

Seed treatment

Selection of clean seed

Removal of diseased seedlings

Spraying with Bordeaux mixture

Removal and destruction of diseased pods and stalks

Cultivating or working in the beans when wet

Susceptibility of varieties

II. BEAN BLIGHT, page 295

Nature of the disease

The disease in the leaves

The disease in the pods

The disease in the seed

Treatment:

Seed treatment

Selection of clean seed

Destruction of diseased tops, and rotation

Spraying

III. BEAN RUST, page 298

Nature of the disease

Appearance of the disease on the leaves

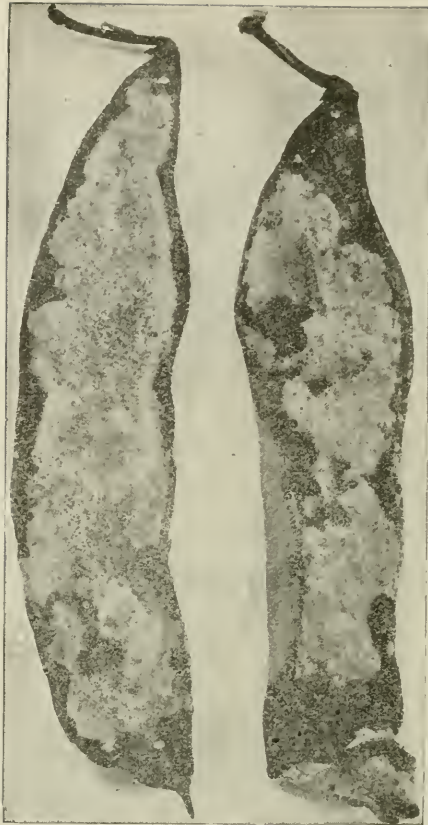
Treatment

IV. SPRAYING MACHINES, page 299

Respectfully submitted,

L. H. BAILEY,

Director.



Mildew on Lima Beans. This disease has not yet been reported in New York but may appear at any time. It is not described in this bulletin, but the picture is placed here in order to call attention to the disease. We desire reports of its presence, in case it is found. The disease attacks only Lima Beans. It produces on the pods a covering of white mildew or mold.

Acknowledgments.— This bulletin is largely compiled from information contained in Experiment Station bulletins. Three have been especially valuable. They are:

New York (Geneva) Experiment Station Bull. No. 48, 1892, by Professor S. A. Beach, on "Some Bean Diseases" (Now out of print); New Jersey State Experiment Station Bulletin No. 151, 1901, by Dr. B. D. Halsted, on "Bean Diseases and Their Remedies;" and Ontario Agricultural College Bulletin No. 136, 1904, by Dr. F. C. Harrison and Professor B. Barlow, on "Some Bacterial Diseases of Plants Prevalent in Ontario."

SOME DISEASES OF BEANS

GENERAL DISCUSSION

Three diseases occur commonly on beans in the State of New York. Named in the order of their abundance and destructiveness, they are: Anthracnose, or "Pod-Spot;" Blight, a bacterial disease; Rust. These diseases are commonly confused by growers. The term "rust" is in many



FIG. 100.—*Anthracnose* or "Pod-Spot" of bean.

localities applied to the anthracnose or "pod-spot," probably from the fact that the diseased spots are often of a rusty brown color. In other sections the word "blight" is used to indicate any disease of beans. This confusion of names is very unfortunate, since it leads to the common conception that these troubles are due to the same cause. The three diseases named above are each caused by distinctly different parasitic plants. The life history of these parasites,—i. e., their method of reproduction, of

entrance into the bean plant and the means by which they are carried over from one season to the next,—differs in many respects. In order to combat them successfully it is necessary that the grower have some idea of these differences or at least that he apply the correct name so that he may intelligently consult bulletins or books dealing with these maladies.



FIG. 101.—Showing anthracnose spots on stem and leaves of bean just before blossoming time. It is from these spots that spores are distributed to the pods.

As the first step, then, determine which disease is causing the trouble in your beans. The following key will, I think, enable you to determine this with considerable certainty:

How to determine which disease is in your beans.—With some of the diseased beans before you, carefully read the following and compare the specimens with the pictures.

1. Rusty brown or black spots on stems, pods or leaves. Frequently on all (See Figs. 100 and 101). These spots occur on the seed leaves of

plants just up (Fig. 103). On the leaves of older plants they blacken and kill the veins on the under side (Fig. 101). Diseased seeds show reddish brown or black spots and are often shrunken or shriveled (Fig. 104). This disease is the *Anthracnose* (See page 286).

2. Leaves at first with large watery brown patches which shortly become dry and brittle (Fig. 109). The diseased leaves curl more or less and look as though they had been scorched. Affected pods show



FIG. 102.—*Anthracnosed bean plants. The disease has eaten off the leaf stalks. From New Jersey Bull. No. 151.*

“watery” spots (Figs. 110 and 111) which do not become black as in the case of anthracnose. Entire pod may become soft and rotten. This disease is the *Blight* (See page 295).

3. Leaves usually remaining green or in severe cases becoming of a sickly yellowish color. Spots on the under side of the leaf very small, rusty brown or black. Sometimes showing on the upper surface of the leaf as black spots with yellow borders (Fig. 113); seldom occurring on the stems or pods. This is the true *Rust* (See page 239).

If, after having carefully studied this key and the photographs, you are not satisfied which disease you have on your beans, send some of the affected plants to the Plant Pathologist, Cornell University Experiment Station, Ithaca, N. Y. He will be glad to make an examination and report to you. Having determined which disease is giving you trouble, turn to the page indicated and carefully read the description and treatment for that disease. You will frequently find both the anthracnose and the blight on the same plant, and sometimes even the rust also.

I. BEAN ANTHRACNOSE



FIG. 103.—*Bean seedling showing the anthracnose spots on stem and seed-leaves (After Halsted).*

The anthracnose is at present the most common and destructive disease of beans in this State. It is very probably the disease that is destroying your crop. Its most apparent injury is on the pods, where it forms large dark rusty brown or black spots (See cover). It is on this account frequently known as "pod-spot." The disease may and usually does occur, however, on all parts of the plant except the roots (Fig. 101). It is caused by a fungus known to botanists as (*Colletotrichum lindemuthianum*) which lives as a parasite in the tissues of the bean. This fungus is a plant, as much a plant as the bean on which it lives. It has a thread-like mycelium that grows into the tissue of the bean to obtain food for its growth and development and it produces *spores* that serve the purpose of seeds by which it spreads to healthy beans and so reproduces itself. In fighting the anthracnose fungus, we are fighting a parasitic weed, in its habits not greatly unlike the dodder which often destroys alfalfa.

The fungus itself is too minute to be seen by the unaided eye. This makes an understanding of its nature and ways of life rather difficult, but the picture of the parasite as shown in Fig. 105 will help to make clear the discussion of the disease. Study the picture carefully before reading the following account.

The disease on seedlings.—The disease makes its first appearance on the bean seedlings, as they come up. It may then be detected, on at least some of the young plants, as brown discolored sunken spots or cankers on the seed-leaves or the stem (Fig. 103). This early appearance of the disease is due to the fact that the fungus is usually carried over winter in the seed and so is already in the bean when it is planted. This is fully explained later (Page 289). In severe cases the spots or cankers may be

so numerous as to cause heavy loss in the seedlings and result in a poor stand. Sometimes the stem is so badly diseased or "eaten" near the base that it falls over and dies. Usually so few of the seedlings are attacked that the presence of the disease in a field is at first overlooked. Nevertheless, as the season advances the fungus spreads to healthy plants near by, by means of its multitude of tiny spores produced in these spots on the seedling, and before the grower knows it his entire field may be badly affected.

The disease on leaves and stems.—From the spots on stem and seed-leaves of the seedlings the spores find their way to the large leaves and branches of the rapidly growing plants (Fig. 101). The large veins of the leaf are frequently eaten through and killed by the fungus, and

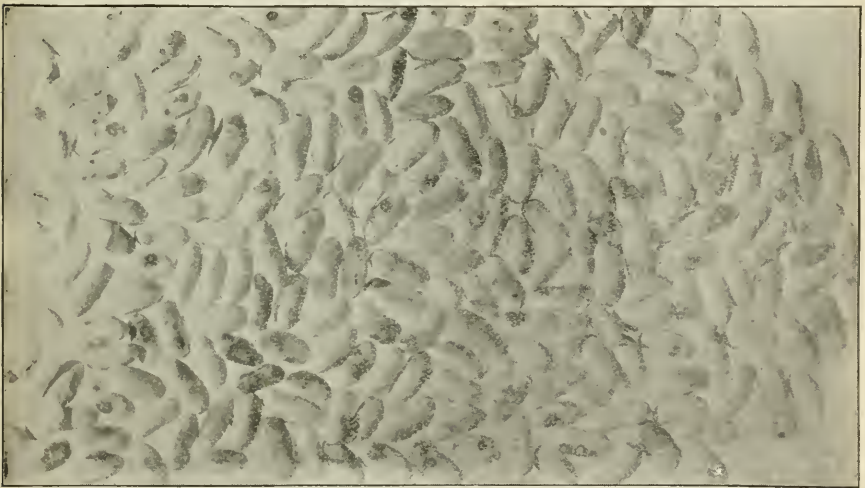


FIG. 104.—Beans badly affected with anthracnose. Such seed should never be planted.

holes or cracks with blackened margins appear in the blade. While this may not entirely kill the leaf, it greatly lessens its efficiency as a starch maker and so indirectly but effectively reduces the yield of seed. Many times, however, the attack is so severe that the leaf stems are cut off and the entire plant is practically ruined (Fig. 102).

The disease on pods.—It is from the attack of the disease on the pods that the most direct and apparent damage to the crop results. During the time of blossoming and previous, the fungus has been spreading and becoming established on the stems and leaves, and it now attacks the young and succulent pods. With their tender growing tissue full of water and food materials, these pods offer the best of conditions for the

growth and development of the parasite. Spores from the spots on the leaves and stems fall on the pods where, in the presence of moisture and the high summer temperature, they germinate, forming a little sprout or germ-tube, which penetrates the tender skin of the pod (Fig. 105) and, branching in the juicy tissues, gives rise to an anthracnose canker. These first appear as little brown or rusty spots which enlarge and darken until nearly or quite black. The dead tissue dries and settles, causing a little pit or sunken place in the pod. In the center of the spot the spores of

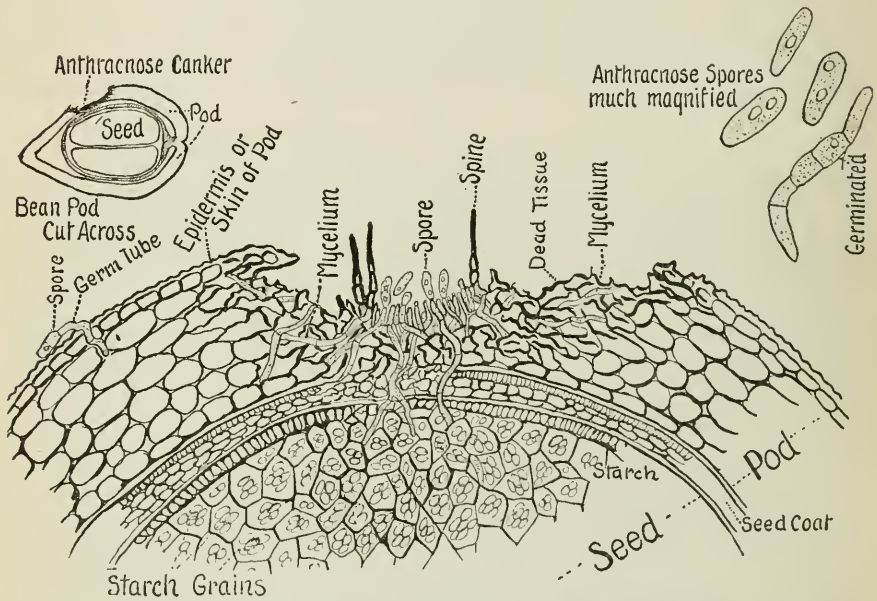


FIG. 105.—Showing the relation of the anthracnose fungus to the tissues of the bean. To the left above is a diagram of a section across a bean pod through an anthracnose canker. The large drawing below is a much enlarged view of a portion of this same section. It is largely diagrammatic. It shows how the mycelial threads of the fungus may penetrate the seed coat and enter the starchy tissue of the seed, there to remain dormant until the following season. On the left of the large drawing is shown a spore germinating and penetrating the epidermis. This germ tube branches, spreads through the tissues of the pod and so gives rise to a new spot or canker. To the right above is shown a magnified view of some of the spores of the anthracnose fungus. One has germinated. (Original.)

the fungus are now produced in great abundance. They ooze out and pile up, forming little pink masses easily seen with the naked eye (See diseased pods on cover). These masses of spores are held together by a kind of glue or mucilage which, when dry, sticks them tightly to the spot. When a drop of rain or dew falls on the spot the mucilage is at once dissolved, and the spores are set free in the water. At this time any disturbance of the bean plants will scatter these spores in the flying

drops of water. In this way they reach healthy plants near by. This explains why beans should not be cultivated or handled in the early morning while the dew is still on them or directly after a shower. The spores of the anthracnose fungus are scattered only when they are wet. This will also explain why a warm rainy season is so favorable to the development of the fungus. The spores require moisture in which to be distributed and in which to germinate. A relatively high temperature is also most favorable to the disease. The spores are produced in unlimited numbers in the spots on the pod. Fig. 106 shows the spores



FIG. 106.—*Spores of the anthracnose fungus taken on the point of a needle and placed in a drop of water. Magnified about 55 times. The large blur is a mass of the spores from which others have become detached and scattered about in the water.*

taken on the point of a pin and placed in a drop of water. Only one of these tiny spores is necessary to start a spot. Under favorable conditions these spores spread from pod to pod until practically every bean in a large field may be affected. Sometimes "string beans" that appear to be perfectly clean and free from the disease will become very badly spotted if left in boxes or bags for a short time. This frequently occurs during shipment to market. In such cases the beans are either infected before or during picking or become contaminated from a few spotted pods that have

been overlooked and put into the bags with the clean beans. *No spots will appear on the leaves, stems or pods unless spores find their way to these parts of the plant.* The spores may be scattered by the cultivator, the pickers, by animals, or by the wind in damp or rainy weather.

The disease in the seed.—As the threads or mycelium of the fungus penetrate deeper into the pod they finally reach the seed within (Fig. 105). In the unripe condition the seed-coat is easily penetrated by the mycelium and the fungus is thus established directly in the seed itself. Unless the seed is entirely destroyed by the fungus, it ripens and the enclosed mycelium becomes dormant. The presence of the fungus in the seed may

usually be detected by the brown or yellowish discoloration of the seed-coat. When the seeds are badly affected, they become more or less shriveled as well as discolored (Fig. 104). It is thus easy to tell with considerable certainty whether seed to be planted is affected with anthracnose. When the seed is planted in the spring the enclosed but dormant fungus is planted with it. The moisture and warmth which stirs the bean to life awakens the fungus also. In the soft and fleshy seed-leaves in which it is imbedded the mycelium finds an abundance of food and grows rapidly, soon forming a spot or canker and producing spores which at once begin again to spread the disease to neighboring healthy plants.



FIG. 107.—Above, unsprayed; below, sprayed once with Bordeaux mixture. The spotted pods are placed at the left in each case.

Treatment of Anthracnose

Seed treatment.—Soaking the seed in formalin, corrosive sublimate and other poisons, and in hot water, have been tried by different experimenters with varying results. So far no one has been able to prevent the

disease entirely by such treatment. As already pointed out, the fungus mycelium is imbedded in the bean itself. Any poison that will penetrate sufficiently to kill the fungus will usually kill the seed. There are also other objections: that soaked seeds cannot be conveniently handled in the planter and if allowed to dry, many will "slip" their coats; the reduction in "stand" and consequent necessity of planting a larger quantity of seed is also another objection. On the whole, seed treatment cannot yet be recommended. It is a point that needs further experimental investigation.

Selection of clean seed is of first importance in growing a clean crop. All beans to be planted should be most carefully "hand picked" and all



FIG. 108.—Niagara Gas Sprayer with nozzles especially arranged for spraying beans. Used on the farm of C. N. Keeney, LeRoy, N. Y., during the season of 1905.

beans showing discolorations, wrinkles or blisters should be discarded. *This cannot be too carefully done.* It has been found that in some cases where 95 per cent of the beans were marketable *only one per cent was fit for seed.*

Removal of diseased seedlings.—As soon as the bean plants are well through the ground, they should be carefully examined and *all diseased seedlings pulled up, carried from the field in a sack, and burned.* This is the second step in the contest with the anthracnose and it is important,

since even the most expert will overlook some of the diseased seeds in sorting.

Spraying with Bordeaux mixture.—As soon as the plants are well up, and the first pair of true leaves begins to unfold, *spray thoroughly with Bordeaux mixture.* Probably the best formula to use is five pounds of



FIG. 109. — "Blight" on bean leaflet. From New Jersey
Bull. No. 151.

copper sulfate, four pounds of stone lime to 50 gallons of water. A stronger solution has been found to dwarf the plants, while the weaker solution is equally as effective in preventing the anthracnose. This should

be so *thoroughly applied that every part of the plant above ground will be completely covered.*

In about ten days or two weeks the plants should have a second spraying, using the same strength of mixture. This application should be as thorough as the first. This is to cover and protect the new growth of leaves and branches.

Unless excessive rains wash the mixture off, it will not be necessary to spray again until the pods are forming, shortly after blossoming time. A third application of the same strength and thoroughness should now be made. The nozzles should be so arranged that the *pods as well as stems and leaves will be thoroughly coated. This is important* (See Fig. 108).

In most cases three sprayings will be sufficient. If the seed was badly diseased and if the plants show an abundance of the anthracnose, more sprayings will probably be necessary to insure a clean crop. Excessive rains will also necessitate more frequent applications. The effect of heavy rains in washing off the mixture may be overcome by adding to the Bordeaux mixture the following: two pounds resin, one pound sal soda, one gallon of water. Boil together until of a clear brown color. Add one-half this amount to each barrel of the Bordeaux. An extra spraying between the second and third, and another after the third when the pods are nearly full grown, will no doubt be sufficient in the worst cases. That this disease is easily controlled by the Bordeaux mixture is shown in Fig. 107. Repeated experiments by the writer have shown that one or two thorough sprayings even after a large percentage of the plants are badly diseased will insure a comparatively clean and profitable crop. A single spraying done under the direction of Professor Craig in a field of Mr. C. N. Kee-ney near LeRoy, N. Y., reduced the anthracnose 20 per cent.

The removal and destruction of diseased pods and stalks is also a matter not to be overlooked. While the disease is most commonly carried over in the seed, it has also been demonstrated that diseased pods and stems thrown on the fields in which beans are to be planted will result in a marked increase of the disease the next season. For this reason all diseased pods and stalks should be burned, or, if they go into the manure pile, the manure should not be put on fields in which beans are to be planted.

Cultivating or working in the beans when wet should be avoided as much as possible. As already pointed out, the spores of the disease are disseminated only when in drops of rain or dew. When dry the mucic-

lage in which they are enclosed fastens them to the spot and they cannot be scattered. For the same reason "string" or "snap" beans should not be picked when wet. The handling of a single spotted pod may



FIG. 110.—"Blight" on pods of Wax beans. From *New Jersey Bulletin No. 151.*

be sufficient to spread the disease throughout an entire row, or spot all the pods gathered. Repeated cropping of the same land with beans is not desirable and, fortunately, not commonly practiced.

Susceptibility of varieties.—It is well known that certain varieties are more susceptible than others to this disease. This is notably true of the common "Wax" varieties. So far as the writer has been able to discover, no very extensive information on this point is to be had. Numerous "Rust Proof" varieties

have been placed on the market, but while some of them are more or less resistant probably all will spot under conditions most favorable to the fungus. Dependence, therefore, should not be placed on the resistance ability of any variety. *All should be thoroughly sprayed if immunity to the disease is to be expected.* No record has been discovered of anthracnose on Lima beans.

II. BEAN BLIGHT

The blight is a bacterial disease. It is caused by a minute parasitic plant (*Bacterium phaseoli*) in form and habits of life quite unlike the anthracnose fungus. These tiny bacteria have no mycelial threads and no spores. Each little cell (Fig. 112) is a plant in itself. The bacteria increase in numbers by each one simply dividing into two which, when full grown, repeat the process. Each one is supplied with a long fine *flagellum* or tail by which it may wiggle about to some extent in the tissues of the bean.

The blight attacks the ordinary field and garden varieties and also the Lima Beans. It was first observed in this State by Professor Beach of the State Experiment Station in 1892. Like the anthracnose, it attacks all parts of the bean above ground but is most conspicuous on the foliage and pods.



FIG. 111.—“Blight” on pods of Lima beans. From *New Jersey Bulletin No. 151*.

The disease on leaves.—The first evidence of the blight is usually to be observed in the leaves. These show large brown dead patches (Fig. 109), often spreading through the entire leaf. When wet, the spot is soft and watery, but when dry, becomes papery and brittle. On a badly blighted patch the leaves become dry and curled, as if scorched. The bacteria probably always enter the bean plant through a wound. Judging from some observations made last season, it seems likely that certain insects are in most cases the agents by which this disease is carried from plant to plant. This is an important point in the life history of the para-

site and one that requires further observation before definite statements can be made. Having gained entrance to the leaf, the disease gradually travels down the stem to other leaves and to the pods. Professor Barlow, of the Ontario Agricultural College, has shown that the progress of the disease is comparatively slow. Leaves of beans inoculated with the bacteria did not show symptoms of the disease until the third week. The bacteria increase in such numbers that finally they may fill up the sap tubes in the stem, cutting off the water supply and so cause the entire plant to wilt and die.

The disease in the pods.—Through wounds or by way of the stem the bacteria find their way into the pods which, if young, may shrivel and die. In the larger pods they produce spreading watery spots (Figs. 110 and 111) which finally become more or less discolored but never sunken and black as in the case of the anthracnose.

The disease in the seed.—From the pod the disease readily gains entrance to the growing seeds. The pods are not destroyed unless attacked when very young, and when ripe they may show considerable discoloration or none at all. The bacteria, however, having gained entrance into the seed, as in the case of the anthracnose, remain there dormant throughout the winter. With the germination of the seed in the spring the bacteria also begin to multiply and find their way to healthy beans and so the infection spreads.



FIG. 112.—Bacteria that cause the bean blight much magnified. (After Smith.)

Treatment of Blight

Seed treatment.—No method of treating the seed to prevent the blight has yet been proposed and properly tested. Professor Barlow has demonstrated that the bacteria are readily killed by exposure for ten minutes to

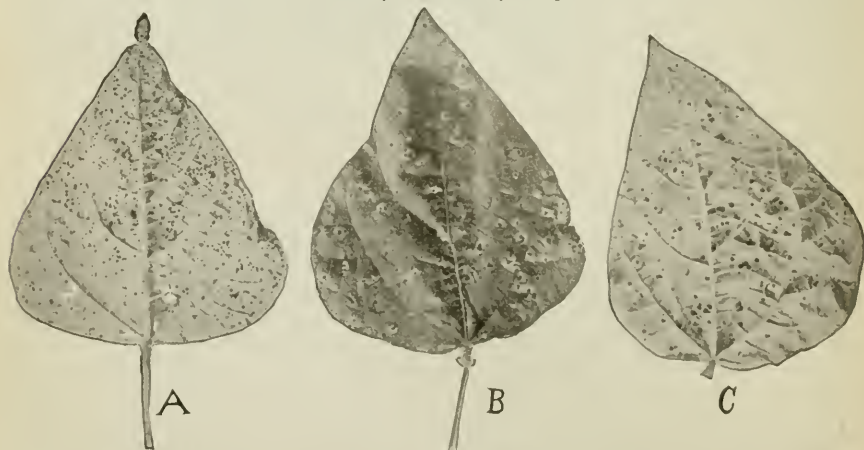


FIG. 113.—Bean rust. A. Summer spores on under side of leaf. B. and C. Winter spore. Note the light border around the spots on the upper side of the leaf B.

water heated to 122° F., while dry beans can endure such a temperature for some time without injury. While this gives some promise of success the treatment is open to many of the objections raised in the case of the anthracnose (See page 291).

Selection of clean seed.—The sorting of seed affected with anthracnose has been shown to be highly desirable. Its value in the case of seed affected with blight is very questionable. Owing to the fact that blight-affected seeds are often not discolored, it is manifestly impossible to sort them from the healthy ones. The safest method is to discard all seed known to have come from fields that showed the disease.

Destruction of diseased tops; rotation.—In regard to these practices Professor Barlow says, "A field where beans have sickened with this disease is unfit for growing beans for at least one season, as the germ lives over at least one winter in the stems and leaves left on the ground. How long such a field may remain infected is unknown, for we do not yet know whether the germ can live and increase in the soil where no beans are growing, although this is probable. Bean straw from infected fields may be burned. If it is fed to animals or used in bedding, the manure should be returned to the field on which the beans grew, and not spread on fields as yet free from the disease."

Spraying.—At the New Jersey Experiment Station, Dr. Halsted has experimented for a number of years with several spray mixtures for the prevention of bean blight. The Bordeaux mixture of the strength recommended for the anthracnose has been found to be very satisfactory. Probably a larger number of applications will be necessary for the blight than for the anthracnose.

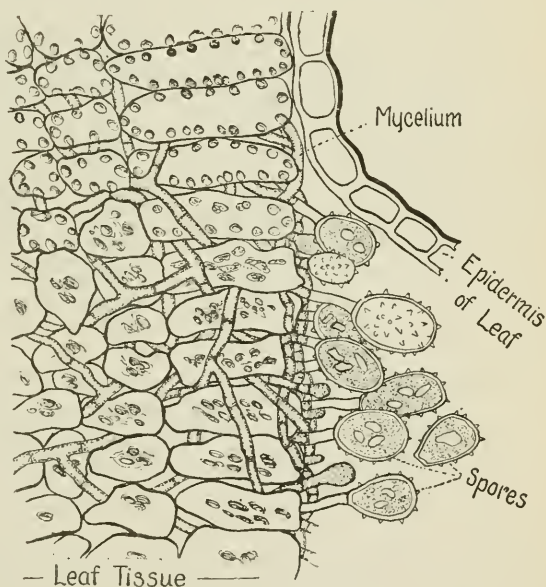


FIG. 114.—Diagrammatic section across a bean leaf affected with "summer stage" of the "Rust." The spores are formed on the ends of the mycelial threads, just beneath the epidermis which is pushed up and broken. The light brown summer spores are thin-walled and warted. The mycelium grows through the leaf tissues between the cells which become shrunken and distorted, and so unable to do their work properly.

III. BEAN RUST

The true rust of beans is, like the anthracnose, a fungous disease. It differs from the anthracnose, however, in many important respects. The most important difference from the grower's point of view is that it is a much less common and destructive disease. It occurs usually only on the leaves of the bean, rarely on the stems and pods. Except in very severe cases, it does not materially injure the leaves.

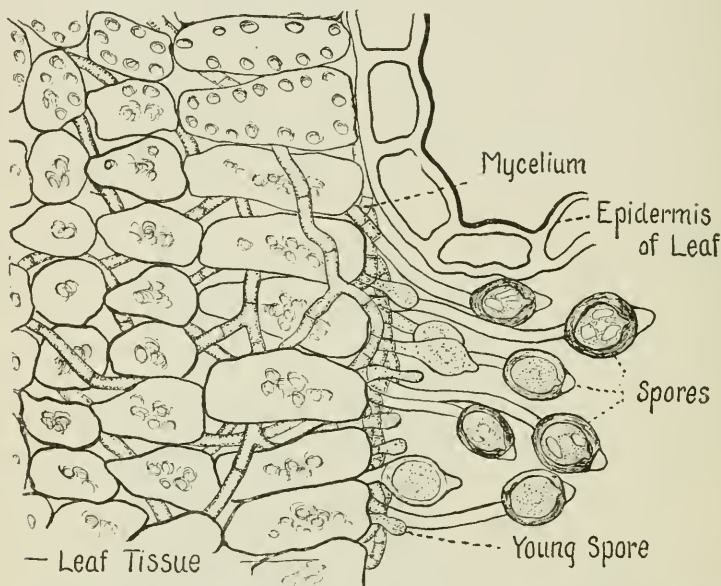


FIG. 115.—Diagrammatic section through a bean leaf affected with "winter stage" of the "Rust." The spores are formed like the summer spores on the ends of mycelial threads just beneath the epidermis. The spores are, however, smooth and very dark brown or nearly black. Their walls are thick and their contents oily, which enables them to withstand much cold and drying.

The rust fungus (*Uromyces appendiculatus*) sends its mycelial threads into the tissues of the bean leaf, there to secure nourishment for its own growth and development. From the ends of the threads that come to the surface at certain spots, spores are formed (Fig. 114). These are of two kinds: the summer spores, brown and forming powdery specks (Fig. 113 A) on the under side of the leaf which readily rub off on the hands as a rusty brown powder; the winter spores, black and produced in small compact warts on the under side of the leaf or sometimes also on the upper side (Fig. 113 B and C). The spots on the upper side are commonly surrounded by a yellow border. The summer spores appear rather early in the season and are produced in abundance.

It is by means of these spores that the disease is spread. The black winter spores (Fig. 115) appear later. They result from the late infections by the summer spores. The mycelium never spreads far from the point of infection and, unless these points are numerous, but little damage is done to the leaf. The disease winters in the old leaves.

Treatment of Rust

While this disease is not common and is rarely destructive, yet it is desirable that it should not become well established on a farm. Under very favorable conditions it might become sufficiently abundant materially to injure the crop. Therefore, it is well to learn to know it and so be able to stamp it out whenever it appears. Since the disease winters only in the diseased tops, it is readily exterminated by burning all diseased plants after the beans are harvested. When beans are sprayed for anthracnose this disease will also be controlled.

IV. APPARATUS FOR SPRAYING BEANS

Any sprayer that will *thoroughly cover every part of the plant* with the Bordeaux mixture may be used. It is not possible to recommend any one machine as the best for spraying beans. The kind of power used is immaterial so far as effectiveness is concerned, provided it gives sufficient pressure. The grower must decide for himself what power will be most desirable in his case. The important thing aside from the pressure is the arrangement of nozzles. Fig. 109 shows an arrangement of nozzles which are said to be very satisfactory. Below is given a list of spraying machine manufacturers who furnish with their machines nozzle arrangements for spraying beans (probably others will also furnish them) :

Niagara Sprayer Company, Middleport, N. Y. Liquefied Carbonic Gas.

The E. C. Brown Company, Rochester, N. Y. Compressed air, compressed by power from the axle.

The Gould's Manufacturing Company, Seneca Falls, N. Y. Hand power or Gasoline engine.

The Standard Harrow Company, Utica, N. Y.

Field Force Pump Co., Elmira, N. Y.

Bateman Manufacturing Co., Grenloch, N. J.

CORNELL UNIVERSITY
AGRICULTURAL EXPERIMENT STATION OF
THE COLLEGE OF AGRICULTURE
Botanical Division

THE INFLUENCE OF MUSHROOMS
ON
The Growth of Some Plants



By GEO. F. ATKINSON

ITHACA, N. Y.

PUBLISHED BY THE UNIVERSITY

THE INFLUENCE OF MUSHROOMS ON THE GROWTH OF SOME PLANTS*

By GEO. F. ATKINSON

The problem.—The large number of mushrooms, or fleshy fungi, including the large basidiomycetes which are developed annually and then disintegrate, represent a large amount of plant substance. Some of the food substances of certain fleshy fungi are probably in a form which is available for the green plants as food, but the large number of the basidiomycetes make use of organic matter for food which is not in a condition to be used by the green plants. The problem set for this investigation is to determine if the substance of these fungi whether derived from food substances already available for the green plants or from organic matter not available to them can be used as food to any extent by the green plants in an undecomposed condition, or when partially decomposed by bacteria or fungi, or both, or when the substance is completely decomposed. It would also include a study of the influence of decoctions of mushrooms, or of decaying mushrooms in different stages of putrefaction on the growth of green plants. Finally it should include the determination of the products of decomposition of these fungi to learn the final end products of decay, and their relation to the nutrition of green plants, or to the questions of increase or decrease of available substances for the nutrition of green plants. All these fungi are of importance in the matter of the disintegration of plant remains, reducing the bulky and firm parts of dead plants to a finer condition of forest or vegetable mold which in itself is beneficial since this detritus improves the physical condition of soils, and represents steps also in returning at least some of the organic matter not absorbed as food by these plants to a condition in which it can again enter the circulation of food substances for autotrophic green plants. In addition to this is the actual substance of the fleshy fungi lost, or is all or a part of it finally returned to the circulation again?

Some preliminary experiments were conducted during the spring of 1905 with *Agaricus campestris* as the source of plant food for corn, peas, beans and buckwheat. Sterile sand was employed as a substratum, some pots being of pure sand for checks, while in others fresh mushrooms were crushed and plentifully mixed with the lower layer of the sand. Where there was an abundance of the mushroom substance and near the surface the decomposition products formed in the decay of the mushroom either caused the seed to rot, or prevented the growth of the roots. In other cases where the mushroom substance was less in quantity and in the

*Contribution from the Department of Botany of Cornell University No. 112.



FIG. 116.—Corn seedlings showing conditions of roots after growing in mushroom material. The two plants at the left show the black root tips which are injured by growing in the fermenting mushroom material. The two at the right show healthy root tips which were growing in previously fermenting mushroom material.

bottom of the pot the tap roots growing into this fermenting substance were killed and blackened at the tips. The leaves died back from the tips, and the plants showed symptoms of severe injury. But as the fermentation was completed the plants gradually recovered, became healthy, grew to some size, and the buckwheat, peas and beans flowered. Since the experiment was a preliminary one to obtain suggestions for more accurate work, the plants were watered with ordinary tap water which contained certain mineral and possibly other substances available as plant food. Notwithstanding this the plants which were supplied with mushrooms for food made more growth than the checks.

In the winter and spring of 1906 these experiments were repeated



FIG. 117.—Corn seedlings growing in mushroom material. Photographed April 13th. From left to right the material is as follows: First, distilled water; second, not previously fermented mushroom material; third, stronger concentration of previously fermented mushroom material; fourth, weaker concentration of previously fermented mushroom material.

under conditions of greater precision and better control, while at the same time so arranged as to answer several of the phases of the problem as outlined above.

I. CULTURES WITH QUARTZ SAND AS SUBSTRATUM

A rather coarse quartz sand was obtained by special order through a local construction company. This was analyzed by Mr. Bizzel in the Chemical Division of the Experiment Station and was found to contain

less than one-tenth of one per cent organic matter and less than one-tenth of one per cent mineral matter, the latter being mostly an iron substance. Wire culture baskets nineteen and one-half cm. deep by twelve cm. in diameter were employed, and after being filled with sand were paraffined according to the method employed by the Bureau of Soils of the U. S. Dept. Agr.*

The mushrooms were grown in the basement and in the greenhouse. They were first dried and then powdered. Some of this material was used fresh, i. e., it was placed in the crates of sand in an unfermented condition, while other material was allowed to ferment in distilled water



FIG. 118.—Corn seedlings growing in mushroom material. Photographed May 7th. From left to right the material is as follows: First, distilled water; second, not previously fermented mushroom material; third, stronger concentration of previously fermented mushroom material; fourth, weaker concentration of previously fermented mushroom material.

before using at the rate of two grams dried mushrooms to two hundred cc. distilled water and a weaker concentration at the rate of two-thirds gram powdered dry mushroom in two hundred cc. distilled water. There were thirty-six baskets with ingredients of the foregoing as follows:

Numbers 1-14 contained two grams powdered dry unfermented mushroom in the bottom third of each basket.

Numbers 15-23, pure sand as check.

* Circular No. 18, Bureau of Soils, U. S. Dept. Agr., 1-6, 1905.

Numbers 24-30, 200 cc liquid containing two grams powdered dry mushroom which had fermented, placed in bottom third of each basket.

Number 31, 200 cc. liquid containing one and one-third grams powdered dry mushroom which had fermented, placed in bottom third of basket.

Number 32-36, 200 cc liquid containing two-thirds gram powdered dry mushroom which had fermented, placed in bottom third of each basket. The mushroom material was placed in the bottom third of the baskets in order to allow the seedlings a good start before coming in contact with the substance.

These were planted March 22, 1906, with seeds previously germinated as follows:

	Two grams powdered mushroom.	Check.	Two grams fermented mushroom.	Two-thirds gram fermented mushroom.
Wheat.....	Numbers 1, 2, 3.....	15, 16	24, 25	32
Buckwheat.....	Numbers 4, 5, 6.....	17, 18	26, 27	33
Corn.....	Numbers 9, 10, 11...	20, 21	28, 29	34
Sunflower.....	Numbers 12, 13, 14..	22, 23	30	35, 36
Radish.....	Numbers 7, 8.....	19	.....	One and one-third grams solid fermented mushroom. 31

The material in baskets was all watered with carefully distilled water at time of planting, and thereafter as necessary.

April 4th, there was a noticeable difference in the growth; in the corn, wheat, sunflower, buckwheat, the stronger fermented substance producing the richest color and the plants were taller. The weaker strength of fermented substance stood next, the unfermented mushroom next, and the check plants were the smallest and had the poorest color. In the fermented mushroom material the roots of the plants having reached the material were normal. In the unfermented mushroom the root tips having reached the mushroom substance which was now fermenting by the action of bacteria were black and dead, but there were numerous lateral roots above, which probably obtained some of the fermented substance which had risen in the sand by diffusion and which was not strong enough to cause injury but furnished plant food. The tips of some of the blades of corn in the check were dead. The roots of the buckwheat had not yet reached the lower third where the mushroom was located. The sunflower and buckwheat showed less difference, except in case of the fer-

mented material where the growth and color were strikingly better, the first leaves after the cotyledons appearing sooner and growing more rapidly than in the checks and in the unfermented mushroom. In case of buckwheat the plants in unfermented mushroom were slightly better than in checks, while the sunflower plants showed little advantage. In the checks and unfermented mushroom the sunflower plants did not do well. Large areas on the stem were collapsed and dead; also dead spots appeared on the leaves. Some of these plants later died and some of the

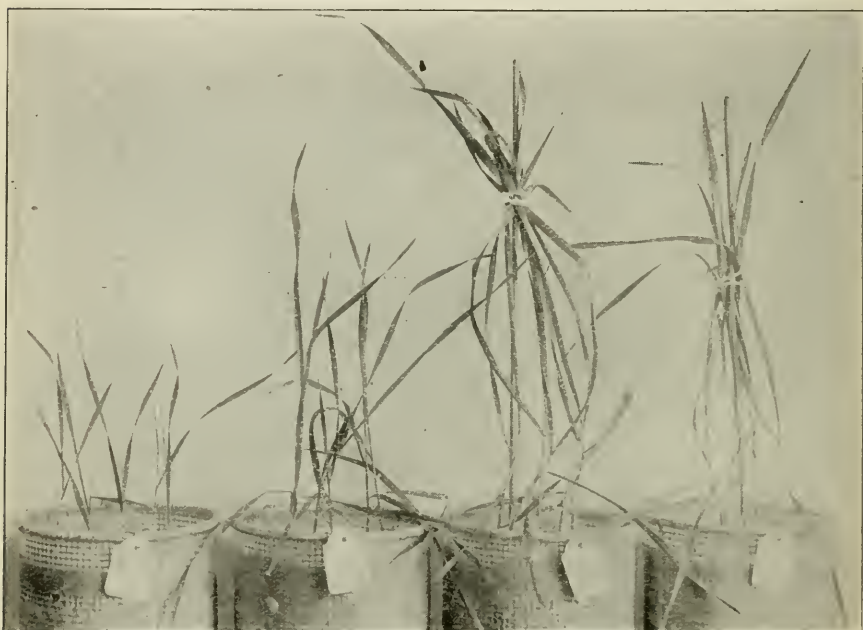


FIG. 119.—Wheat seedlings growing in mushroom material. Photographed April 13th. From left to right the material is as follows: First, distilled water; second, not previously fermented mushroom material; third, stronger concentration of previously fermented mushroom material; fourth, weaker concentration of previously fermented mushroom material.

leaves later showed Botrytis. The sunflower plants seemed to be weakened by the action of the freshly formed products of fermentation so that they were susceptible to the attack of the Botrytis.

In case of the radish, the plants in the baskets with unfermented mushroom outgrew all the others and showed better color, those in the fermented were next, all showing rich color. The checks were small, puny, and yellowish on margins of leaves.

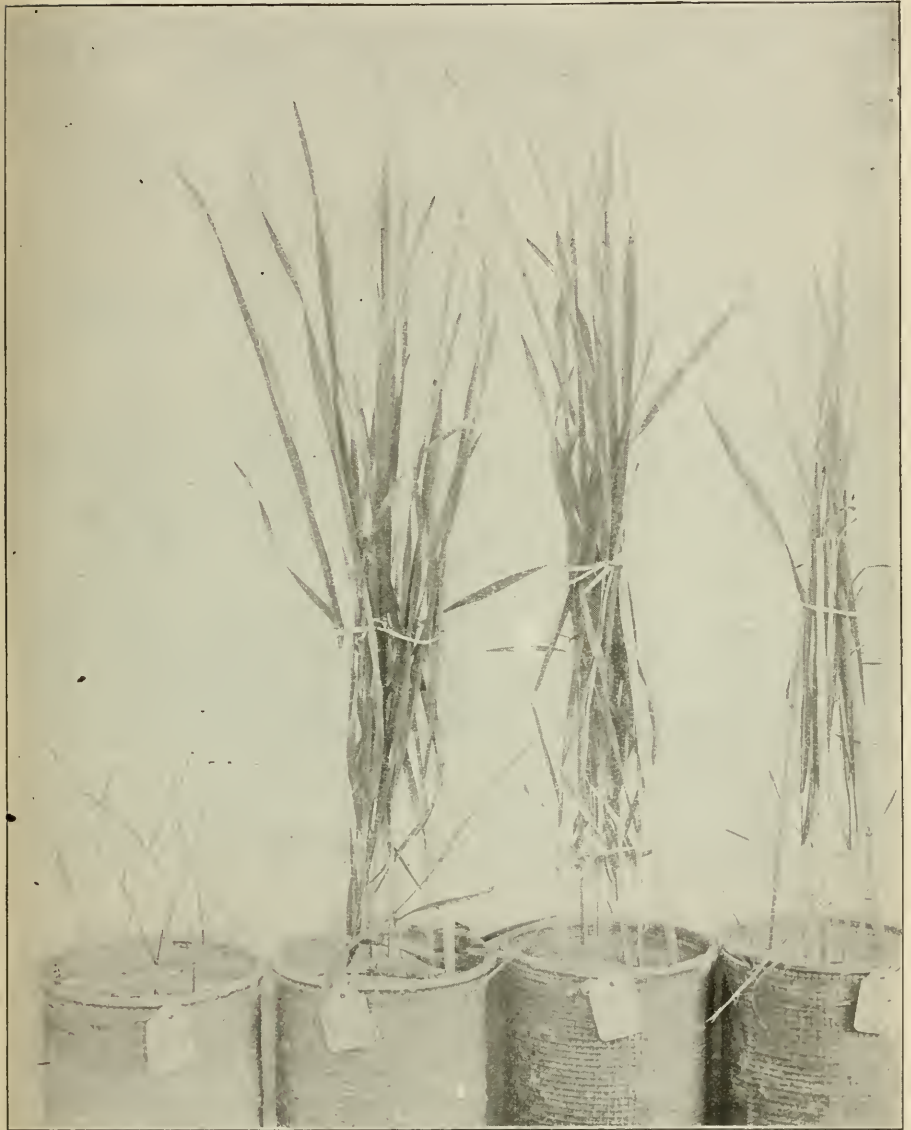


FIG. 120.—Wheat seedlings growing in mushroom material. Photographed May 7th. From left to right the material is as follows: First, distilled water; second, not previously fermented mushroom material; third, stronger concentration of previously fermented mushroom material; fourth, weaker concentration of previously fermented mushroom material.

These differences in all became more pronounced during the following week, except in case of sunflower in which the plants in the unfermented mushroom were no better than in the checks. April 5th a set of the corn plants was photographed after being taken from the soil to show injury to roots by the fermenting mushroom (See Fig. 116).

On April 13th the sets were photographed to show the relative size of the individuals growing under the different conditions, one basket of each different kind or concentration of material used, and were arranged in all cases from left to right as follows: pure sand, two grams dried mushroom not previously fermented, two grams dried mushroom previously fermented, and two-thirds gram dried mushroom previously fermented. Since an accident happened soon after to one of the radish plants, these



FIG. 121.—*Buckwheat seedlings growing in mushroom material. Photographed April 13th. From left to right the material is as follows: First, distilled water; second, not previously fermented mushroom material; third, stronger concentration of previously fermented mushroom material; fourth, weaker concentration of previously fermented mushroom material.*

were not photographed again, but the corn, wheat sunflower and buckwheat were photographed again on May 7, 1906. Since the test had continued long enough to get comparative results, and since the baskets were not large enough to grow the corn to maturity this experiment was discontinued on May 18th, and the following notes were taken at that time, although the plants had been allowed to suffer slightly for the last two days for want of water.

Buckwheat.—Check plants five to seven cm. high, with flowers on one plant. Plants in fermenting material eight to thirteen cm. high, flowers on several. Plants in stronger concentration of previously

fermented material twenty to twenty-five cm. high, flowers numerous on each. Plants in weaker concentration of previously fermented material ten to sixteen cm. high, several flowers on each.

Sunflower.—Check plants which were still alive four to six cm. high, with three crowded pairs of leaves. Plants in fermenting material all dead. Plant in stronger concentration of previously fermented material forty-three cm. high. Plant in weaker concentration of previously fermented material thirty-eight cm. high.



FIG. 122.—*Buckwheat seedlings growing in mushroom material. Photographed May 7th. From left to right the material is as follows: First, distilled water; second, not previously fermented mushroom material; third, stronger concentration of previously fermented mushroom material; fourth, weaker concentration of previously fermented mushroom material.*

Wheat.—Check plants thirteen to fifteen cm. high, several of the lower leaves dead. Plants in fermenting material forty to forty-two cm. high, best condition of all, green. Plants in stronger concentration of previously fermented material thirty-eight to forty cm. high; green. Plants in weaker concentration of previously fermented material thirty-seven cm. high.

Corn.—Check plants twelve to fifteen cm. high, somewhat yellowish and several of the lower leaves dead. Plants in fermenting material forty-five to fifty-three cm. high, with better green color than any other of the corn plants but some yellowish patches. Plants in stronger concentration of previously fermented material forty-five to sixty cm. high, yellowish tinged and somewhat yellowish striped. Plants in weaker concentration of previously fermented material twenty-five to thirty cm. high, yellowish.

An examination of the photographs shows the constancy of the curve of growth in all the different kinds of plants. In the earlier period the plants in stronger concentration of previously fermented material outgrew the others and presented a healthier growth. There being more food sub-



FIG. 123.—Sunflower seedlings growing in mushroom material. Photographed April 13th. From left to right the material is as follows: First, distilled water; second, not previously fermented mushroom material; third, stronger concentration of previously fermented mushroom material; fourth, weaker concentration of previously fermented mushroom material.

stance in the stronger concentration, it is reasonable to conclude, accounts for the greater growth of the plants than in the weaker concentration. The plants supplied with the previously fermented material, while outgrowing those in pure sand are checked somewhat perhaps because of the slight injury to the tips of the deeper roots from the fermentation now going on, but it is likely due more to the small amount of food made available at first by the process of fermentation. But after the material has reached an advanced stage of fermentation the corn and wheat plants in the baskets where fermentation was going on during their growth soon surpassed the others in healthy color and equalled or surpassed them in height.

II. PURE CULTURES WITH AGAR-AGAR AS A SUBSTRATUM

These cultures were made for the purpose of getting at the relative value of fermented and unfermented mushroom for plant food under conditions of precision which would permit the control of the material from fermentation or change by the action of other organisms during the period of growth of the plant employed in the cultures. Radishes and cabbages were planted in the medium. Bottles and flasks* with a capacity of three-fourths of one liter were used and each contained 250 cc. of the medium employed. The consistency of the agar-agar was six-tenths per cent except that containing Schimper's nutrient solution which was nine-tenths per cent. The mushroom material was dried and powdered *Agaricus campestris*, and was used in three different conditions: first, a cold infusion with the solid matter retained; second, a cold infusion of five hours with the solid parts then filtered out; third, material which had fermented for two to three months in distilled water.

After some preliminary experiments to obtain some idea as to the strength of material to use and to determine a method of sterilizing the seed to shut out bacteria and mold fungi, the following media and methods were employed.

The media with infusion minus the solid matter was employed in two strengths so that in some flasks there was the infusion from five-twelfths gram of mushroom, and in others from five twenty-fourths gram of mushroom. The media with the solid matter retained was also in two strengths, in some there was five twenty-fourths gram of mushroom, and in others there was five forty-eighths gram of mushroom. In the case of the fermented mushroom some contained the liquid from five twenty-fourths gram and others from five forty-eighths gram. Several flasks were prepared with agar-agar alone for checks and others with Schimper's normal nutrient solution† to which a trace of iron was added.

*See also Molliard, M., Sur la production expérimentale de Radis á réserves amylacées, Comp. rend. Acad. sci., Paris 139, 885-887, 1904.

†6. g calcium nitrate
 1.5 g potassium nitrate
 1.5 g magnesium sulphate
 1.5 g neutral potassium phosphate
 1.5 g sodium chloride
 600 cc distilled water

The flasks and bottles were wide mouthed, each received 250 cc. medium, were plugged with cotton and sterilized in the autoclav.

The seedlings were prepared as follows: radish seed were rinsed in sixty-five per cent alcohol for one minute, then in a one-tenth per cent corrosive sublimate for five minutes, followed by rinsing in four per cent formalin for eight minutes. The rinsing was done in a Petri dish, the formalin was decanted and the seeds were lifted with the aid of a looped, flamed platinum needle and were transplanted on to wet cotton in a test tube previously sterilized in the autoclav. The cotton was slanted in the tube and sufficient water was added to cover the base of the slant (See Fig. 125). The seeds were placed in the test tubes April 6, 1906, and on April 9th young seedlings were transplanted to the culture flasks.

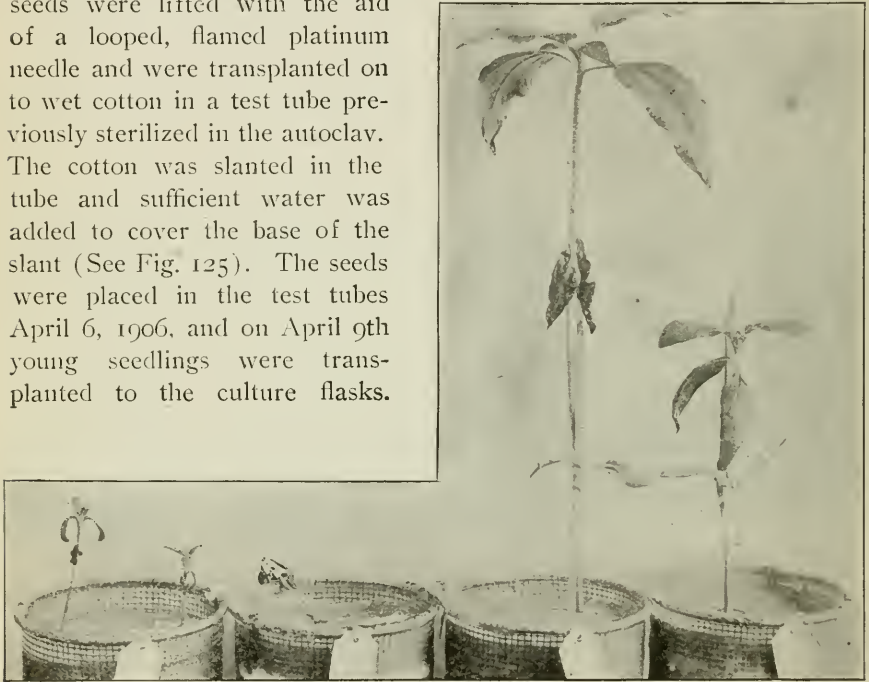


FIG. 124.—Sunflower seedlings growing in mushroom material. Photographed May 7th. From left to right the material is as follows: First, distilled water; second, not previously fermented mushroom material; third, stronger concentration of previously fermented mushroom material; fourth, weaker concentration of previously fermented mushroom material.

The seedlings were lifted with a flamed platinum needle and, as an assistant opened the culture flask by holding it in a nearly horizontal position to avoid as much as possible the gravitation of germs into the medium were transplanted one each in a flask. Where the root was long enough it was pushed into the agar-agar. After a few days the few seedlings which had not gained a roothold were pushed with a platinum needle into the agar-agar. The transplanting of the seedlings was done

in a moist room of the green house since there would be less danger of contamination than in a dry room of the laboratory.

Nearly all of the cultures remained pure, that is, there were very few in which moulds or bacteria entered at the time of transplanting the seed. The growth was fair in all the media. It was the best in the nutrient solution, the poorest in distilled water, in the fermented mushroom slightly better than in the unfermented mushroom, whether in the infusion alone or in infusion with fine solid matter. In the two latter the growth was about equal. There was a tendency to a chlorotic condition in the leaves of the plants grown in the unfermented mushroom, giving the leaves a somewhat mottled appearance. This was more striking in some than in others. In some cases all of the leaf was whitish except along the principal veins where it remained green. In forty days those in nutrient solution were eleven cm. high, those in the stronger fermented medium nine cm. high, those in the stronger powdered unfermented medium four to nine cm. high, those in the weaker powdered, unfermented medium four to five cm. high, those in the weaker fermented medium five cm. high. In the weaker fermented medium there was a tendency to the chlorotic condition, and a few plants in the stronger fermented medium also showed a slight chlorosis. Those grown in distilled water were three to four cm. high.

The plants were photographed on May 17, 1906, as follows: one in distilled water, one in the stronger powdered unfermented medium, one in the stronger unfermented infusion, one in the stronger fermented medium, one in the nutrient solution.

These plants had developed the following number of leaves besides the cotyledons: in distilled water, four leaves with one young one; in the stronger powdered unfermented medium, five leaves and one medium young; in the stronger fermented mushroom, four leaves, one very young; in nutrient solution, six leaves, one medium young.

In general there was a good development of the root system, extending well into the medium, but in the great majority of cases with mushroom as nutrient food there was quite a profuse development of

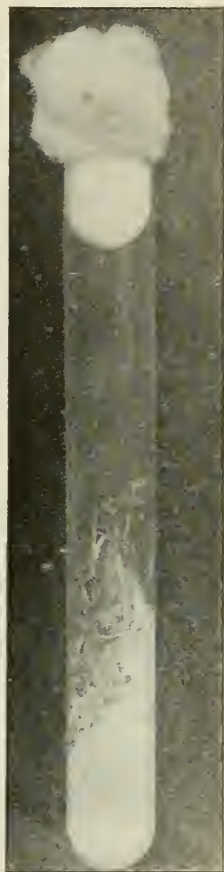


FIG. 125.—Test tubes showing pure culture of seedlings ready to transplant.

roots on the surface of the agar. In the nutrient solution and distilled water the root system was developed altogether underneath the surface.

Pure cultures in sterilized mushroom agar were also made with cabbage, the seeds being sterilized and the strengths and kinds of the medium being the same as with the pure cultures of the radish. The growth of the cabbage was somewhat slower than the radish. The fact that cabbages do well in swampy and partially fermented ground when brought into cultivation suggested that this plant might perhaps be an especially favorable one to experiment with in using these peculiar substances as nutrients. So far as the present experiments go the cabbage has not grown quite so luxuriantly as the radish, but the healthfulness of the

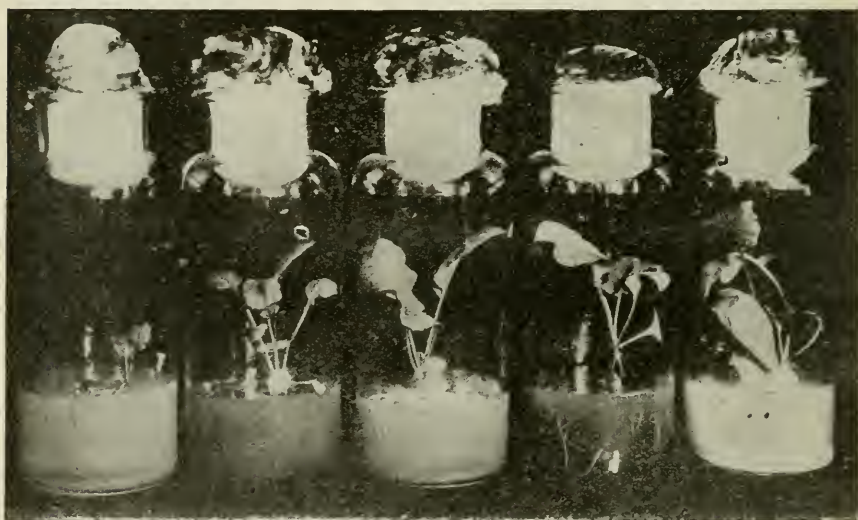


FIG. 126.—Radish seedlings growing in sterilized material in bottles. From left to right the material is as follows: First, distilled water; second, in unfermented material with fine solid particles included; third, in unfermented infusion; fourth, in fermented material; fifth, in Schimper's normal nutrient solution.

plant is about the same. While in the case of the radish plants the nutrient value of the substances as indicated by growth showed that the previously fermented mushroom stood next to Schimper's normal nutrient solution, with the other substances in order as follows: infusion of dried mushroom unfermented, infusion of dried mushroom with fine solid particles included and unfermented, distilled water; in the cabbage so far as size of the plants is concerned the plants in previously fermented substance stood next those grown in distilled water, while those in the unfermented mushroom whether infusion alone or with the fine solid particles included stood next those grown in Schimper's solution. If

there was any difference between the nutrient value of the unfermented material it was in favor of the infusion with the fine solid particles included. The cultures were started April 25th. On June 15th all of the plants whether in unfermented or previously fermented material had the same number of leaves, viz., seven including the cotyledons, while some of those in the unfermented material were larger and the plants were taller. (The plants in the normal solution had seven leaves while those in distilled water had four.) The plants in the fermented material were, however, healthier, the leaves of those grown in the unfermented material showing a slight chlorotic condition between the veins due probably to a slight toxic influence of certain of the salts like sulphuric acid which are abundant in the common mushroom and thus out of proportion to other constituents as compared with a normal solution.

These pure cultures show that for the radish and cabbage there is plant food for autotrophs in an unfermented infusion of the common mushroom, for they grow to a larger size here than in distilled water. The unfermented mushroom, however, does not offer so good a nutrient as the products of fermentation do, and this is not surprising although it is a little surprising that the unfermented mushroom can serve as a nutrient for autotrophic green plants. Mendel* (p. 227) has shown, however, that a considerable part of the nitrogen in mushrooms probably exists as non-proteid nitrogen, some in the form of cellulose nitrogen and some in a form which can be extracted with alcohol ("extractive nitrogen"). The former probably becomes available in the fermented mushroom while the latter probably is directly available in the infusions of the unfermented mushroom. Another interesting fact is that while in the unfermented mushroom as well as in the products of fermentation there are nutrient substances for autotrophs, it either does not form a perfect plant food, or there are certain slightly poisonous substances both in the unfermented and fermented mushrooms. This seems to be manifested in a more or less chlorotic condition of most of the plants fed on these substances. That it is not due to the lack of iron is shown first by the fact that the check plants grown in distilled water had not so long as the experiment continued shown any signs of chlorosis, and second by the fact that a chemical analysis of the common mushroom (*Agaricus campestris*) shows the presence of iron. Analysis also shows that all of the substances required in a normal solution for autotrophs are present in the common mushroom,† as nitrogen, potassium, sodium, calcium, magnesium, iron, chlorine, phosphoric and sulphuric acids.

*The chemical composition and nutritive value of some edible American fungi, *Am. Jour. Phys.*, I, 225-238, 1898.

†Zopf. *Die Pilze*, 117, 1890.

Dr. Lafayette B. Mendel of Yale University, who has given some attention to the analysis of different mushrooms from the standpoint of their nutritive value as food for man, kindly offered to analyze some of the liquids containing fermented mushroom prepared in the same way and at the same time as that used as "fermented" mushroom in these experiments. I here quote from his report,—

"My attention was first directed to the character and relative amounts of the nitrogenous constituents *in solution*. The filtered fermented infusions were examined quantitatively for total nitrogen content (Kjeldahl's method); nitrogen in the form of ammonium compounds (Folin's method); nitrogen in the form of compounds of albuminoid nature, precipitable by tannic acid (by the method of Hedin: Jour. Physiol. xxx). The solutions were practically neutral to litmus and therefore contained no free ammonia at the time they were examined. The analytical data are summarized in the following table:

SUMMARY OF ANALYSES OF THE SOLUBLE "FERMENTATION PRODUCTS"

Nitrogenous Compounds

	ONE HUNDRED CC. CONTAIN IN MGRMS.			
	No. 1 mgrms. nitrogen.	Per cent. total nitrogen.	No. 3 mgrms. nitrogen.	Per cent. total nitrogen.
Total nitrogen.....	80	100	79	100
Tannic-acid nitrogen ("albuminoids").....	14	17½	27	35
Non-proteid nitrogen in filtrate.....	66	82½	52	65
Nitrogen in ammonium compounds.....	12	15	7	9
Non-proteid N. not as NH ₄ —compounds....	.....	67½	.....	56

It will be noted that the bulk of the nitrogen is represented by compounds not precipitated by tannic acid, such as amino-acids, amides, diamines, etc., in addition to the ammonia nitrogen (easily available) which I estimated separately and which is not so abundant relatively. I made no search for the possible occurrence of nitrates.

The fluids contain no tryptophan and only traces, if any, of indol and skatol. I have searched for the types of sulphur compounds present, by the methods pursued in my laboratory by Rettger: American Journ. Physiol., viii, 284. Mercaptan was not found; but traces of hydrogen sulphide were present in each case. I was quite surprised to find a considerable quantity of sulphates in the fluids.

The solutions contain volatile fatty acids which furnish a part of the available carbon in the culture medium.

The ash of the preparation contains iron, phosphoric acid and sulphuric acid salts in abundance.

Judging from the results of Czapek's interesting studies in Holmeister's *Beiträge zur chemischen Physiologie*, i and ii, the high food value of nutrient solutions such as the ones analyzed, would be attributable to the relative richness in nitrogenous compounds of the non-proteid type indicated in the analyses. Of course, his studies apply only to such plants as can utilize organic nitrogenous compounds directly. In the absence of information as to the character of the plants studied by you, i. e., whether fungi or higher plants, etc., I cannot say whether such a suggestion would apply. If you are working with the higher forms, it may be that the final decomposition of the mushroom constituents is of a type *speedily* resulting in the more available nitrogen compounds like ammonia. At any rate your extracts soon pass into a stage where there is relatively little nitrogen left in forms precipitable by tannic acid."

The heating in sterilization of the unfermented mushroom probably results in making some of the material available while the decomposition products resulting from the fermentative decay of the mushroom furnish a greater quantity of available ammonium compounds, sulphates, etc. It would be interesting to know how extensive is the formation of ammonium compounds, since these are directly available to corn and wheat (and other Gramineæ), and in the forests where mushrooms are more abundant, the nitrates are small in quantity, and forest trees and other forest plants obtain most of their nitrogen in the form of ammonia compounds.*

The large quantity of sulphuric acid salts in the ash of the fermented mushroom as well as in the ash (24.29 per cent) of the unfermented mushroom, may account for the slightly poisonous effect on the radish and cabbage plants in the pure cultures, and the still less poisonous effect of the fermented mushroom on the corn and wheat in the sand cultures. In the forest or field these injurious salts would quickly filter away in the soil during rains and their injurious effect would probably not be felt except in case of very large masses of decaying mushrooms.

One reason why certain ammonium compounds are harmful to green plants is due to the fact that they are strongly alkaline. The ammonia nitrogen at the time of its formation during the ferment action of the bacteria is probably alkaline. This may have caused the injury to the tips of the roots of the corn, wheat, sunflower and buckwheat in the early stage of growth of the seedlings when the fermentation was more active. Later when the fermentation is less active, the corn and wheat in the

*Jost, *Vorlesungen über Pflanzenphysiologie*, 163, 1904.

fermenting mushroom surpass in growth and in healthy color that grown in the previously fermented material. This may be due to the fact that during the process of decomposition of the mushroom material in the sand by bacteria simple nitrogen compounds (non-proteid) in the form of ammonia compounds are formed which are immediately available for plant food by the green plants, while in the mushroom material which was previously fermented some of these simple compounds may be held in a more complex and less available form. If this is so it might explain why the corn and wheat made proportionately more growth than the buckwheat in the material which was fermenting during the period of growth, and also why the sunflower plants were so weakened. That certain of the ammonia compounds may be used by growing corn without nitrification is very probable in view of the work of Mazé* who obtained as great an increase in feeding corn with a one-half per cent solution of ammonium sulfate as with nitrate feeding. The other Gramineae also can make use of ammonium compounds without nitrification.

If the toxic effect of the fermenting mushroom, the material ferments rapidly, is due to the alkalinity of certain of the simple ammonia compounds formed during the more active fermentation by the bacteria, this is not manifest in the case of the plants grown in the previously fermented material. The simple ammonia nitrogen which is formed during the rapid and early stage of decomposition of the mushroom does not appear to be lost, however, even in the case of the mushroom material previously fermented. As Dr. Mendel's analysis shows one characteristic of the fermented extracts of the mushroom is that fatty acids are present and these probably hold the ammonia compounds formed in the putrefaction of the mushroom which in the case of the putrefaction of animals volatilizes and is lost, since there are no carbohydrate groups present to form the fatty acids and the medium becomes alkaline. The ammonia compounds and the fatty acids probably furnish some of the available food both nitrogen and carbon for Lövinson† has shown that certain fatty acids can replace to a certain extent the mineral acids in a normal culture solution for autotrophs.

In conclusion then we can say as a result of these experiments that a portion of the substance of the common mushroom, and probably of

* Mazé, P., Recherches sur l'influence de l'azote nitrique et de l'azote ammoniacal sur le développement du Mais, Ann. Inst. Pasteur 14, 26-48, 1900.

See also Soave, M., L'azotoammoniacale e l'azoto nitrico nello sviluppo del mais Annali di Bot., 4, 99-114, 1906.

† Lövinson, O., Ueber Keimungs- und Wachstumsversuche an Erbsen in Lösungen von fettsauren Salzen unter Ausschluss von Mineral-säuren, Bot. Centralb., 83, 1-12, 33-43, 65-75, 97-106, 129-138, 185-195, 209-2118, 1900.

all the Basidiomycetes becomes available as food for autotrophic green plants. This was anticipated since it is well known that in many processes of decay decomposition products are formed by the nutrient and physiological action of micro-organisms, some of which are at once available as food for the autotrophs, while other decomposition products become the prey of successive micro-organisms with different nutritive and physiological demands so that the final products themselves become available. But it is rather surprising that the decomposition products from a heterotrophic plant should form so nearly a perfect food for an autotroph. The decomposition of the larger fungi thus is seen to proceed along the same general physiological lines as that of other organisms which have been studied, the final products entering again into circulation in the organic world. There is also probably a greater conservation of the ammonia nitrogen in the decomposition of the mushrooms in nature than in the case of the putrefaction of animal bodies because of the alkalinity of the products of the latter compared with the acidity of the products of the former.

The chief ecological function of the mushroom is to disintegrate leafy and woody structures without which action the world would in time be choked with a deep layer of debris. These disintegrated remnants after serving as food for many successive kinds of organisms with different nutritive and physiological demands become available as food for autotrophs again, much of it in the meantime playing an important rôle in improving the physical condition of the soil. But while this is their chief ecological function they themselves are subject to similar decomposition stages and again enter into the general nutritive circulation in the organic world.

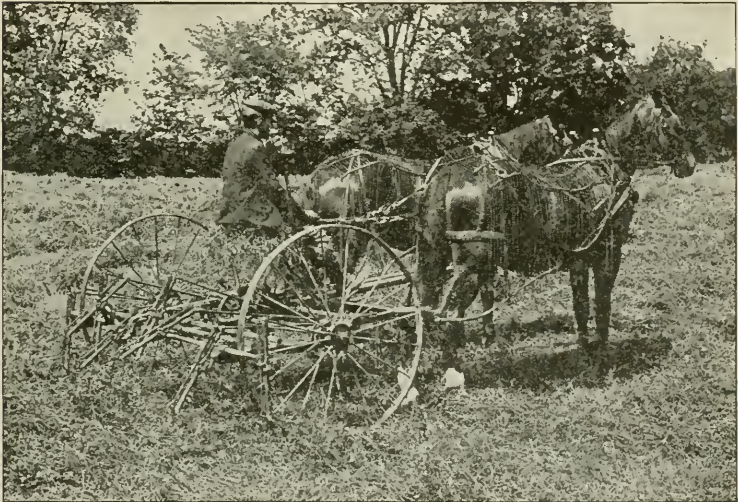
It would be interesting to know if the symbiosis observed in the case of certain fairy ring fungi growing in grass, where the grass in the ring of mushrooms is greener than that on either side of the ring, has any relation to available simple ammonia compounds formed by the mycelium of the fungi. These might be obtained either from old portions of the mycelium which have died and fermented, or through absorption by the roots of the grass from living mycelium in contact. The results of this study may also help to explain the method of nutrition of mycorrhiza, where the fungus symbiont from the humus and other organic matter produces simple ammonia compounds as well as certain carbon compounds, mineral substances, etc., which are passed on to the higher plant whether a green plant or a chlorophyllless one. In the latter case nearly all the food may be supplied by the fungus symbiont. In the case of the so-called saprophytic seed plants a similar relation may exist between fungus mycelia not in contact, but within the area of root action pro-

ducing these food substances which are later absorbed by the "saprophyte" as in typical cases of metabiosis.

I wish in closing to acknowledge my indebtedness to Dr. L. B. Mendel of Yale University for the analysis of the fermented mushroom extracts, and for suggestions on certain of the chemical problems, and to C. W. Edgerton, Assistant in Botany in Cornell University, who under my direction has prepared all the media, the distilled water, and has assisted in other ways.

CORNELL UNIVERSITY
AGRICULTURAL EXPERIMENT STATION OF
THE COLLEGE OF AGRICULTURE
Department of Agronomy

SECOND REPORT ON THE INFLUENCE OF
FERTILIZERS ON THE YIELD OF
TIMOTHY HAY



Made under the Direction of **THOMAS F. HUNT**
By **JOHN W. GILMORE** and **CHARLES F. CLARK**

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EXPERIMENTS ON THE INFLUENCE OF FERTILIZERS UPON THE YIELD OF TIMOTHY HAY WHEN GROWN ON DUNKIRK CLAY LOAM IN TOMPKINS COUNTY, NEW YORK

On Dunkirk clay loam a single application of stable manure at the rate of 20 tons per acre, applied in the fall of 1903, has produced an increased yield of oats in 1904 and an increased yield of hay in 1905 and 1906 valued at \$51.69. The value of the increase yield of hay alone was \$47.88. The increase yield of oats and hay where 10 tons of manure were applied, was at about the same rate per ton of manure when 20 tons were applied, the value of the increase being at the rate of \$2.58 per



714	713	712	711
No treatment	80 lbs. muriate potash	320 lbs. acid phosphate	No treatment
4040 lbs. hay per acre	5370 lbs. hay per acre	4670 lbs. hay per acre	4360 lbs. hay per acre

ton of manure applied. Notwithstanding the cost of the application of commercial fertilizers to the oat crop was in every case greater than the value of the increase in the oats, yet during three years the annual applications of commercial fertilizers have cost less than the value of the increase in the oats and timothy hay produced.

The most important ingredient in increasing the yield of timothy hay has been nitrate of soda. Muriate of potash has caused a marked increase in the growth of "volunteer" Alsike clover, and thereby increased the yield somewhat. Acid phosphate had but little effect and when applied in

too large proportions seemed clearly to decrease the yield of hay, fig. —. Within certain limits the "net gain" from larger applications has been greater than from smaller applications of fertilizers. The best results from the use of commercial fertilizers as a top dressing for timothy meadows were with 320 pounds of nitrate of soda, 320 pounds of acid phosphate and 80 pounds of muriate of potash, per acre. With this application made annually during three years the value of the increase has been about \$16 greater than the cost of the fertilizer applied. The increase yield of six plats receiving complete fertilizer was 3848.5 pounds. The experiments suggest that better results might have been obtained if a larger proportion of nitrogen to phosphorus had been used. Very important factors in the results obtained have been the soil, a stiff clay loam, and the seasons, which have been especially favorable to the yield of timothy hay and probably to the action of the fertilizers applied.

In connection with a study of grasses and other forage crops for New York State, the Cornell Station published in 1905 the results of experiments begun in 1903, on the influence of fertilizers upon the yield of timothy hay when grown on Dunkirk clay loam in central New York. The results for 1906 tend to confirm in the main those obtained in the previous years and bring out some additional points of importance. Since Bulletin 232 gives the details of this experiment, they will not be repeated in this bulletin except so far as is necessary to a general understanding of the results obtained.

The tract of land on which this experiment is being conducted is a rather tenacious clay loam, difficult to work except when moisture conditions are just right. The former management had been such as to reduce somewhat, although not seriously, the crop-producing power of the soil. It is well adapted to the production of timothy; fairly well adapted to the production of wheat, when properly fertilized, and is less valuable for the production of corn and potatoes. The area was in corn in 1902; in oats in 1903, and would properly have been sown to wheat in fall of 1903. Early fall rains, however, prevented upon this type of soil the seeding of wheat. Oats were therefore sown again in the spring of 1904 and the land seeded to timothy. The first application of fertilizers was made, however, in the fall of 1903 instead of in the spring of 1904.

In 1906 the same kinds and amounts of fertilizers were applied as in 1904 and 1905 with the exception of plats 727 and 728 which were treated as follows: (See Bulletin 232, .—.)

PLAT 727.

320 lbs. Nitrate of Soda.....	} ½ applied April 17
80 lbs. Muriate of Potash.....	
320 lbs. Acid Phosphate.....		} ½ applied May 8



717
No treatment
3520 lbs. hay per acre

716
160 lbs. nitrate soda
320 lbs acid phosphate
5920 lbs. hay per acre

715
160 lbs. nitrate soda
5590 lbs. hay per acre



720
No treatment
3700 lbs. hay per acre

719
80 lbs. muriate potash
6110 lbs. hay per acre

718
160 lbs. nitrate soda
320 lbs. acid phosphate
80 lbs. muriate of potash
5360 lbs. hay per acre

PLAT 728.

640 lbs. Nitrate of Soda.....	} $\frac{1}{2}$ applied April 17
80 lbs. Muriate of Potash.....	
320 lbs. Acid Phosphate.....		$\frac{1}{2}$ applied May 8

The fertilizers were applied April 17 with the exception of the second application on plats 727 and 728 as noted above.

The hay on all the plats was cut July 11, and was weighed July 12, 13.

In this experiment there are 22 tenth acre plats, eight of which are left without the application of fertilizer of any kind in order to determine the increase due to the fertilizer applied to the other 14 plats. Twelve plats received commercial fertilizers of various kinds, combinations and amounts, while two received an application of stable manure. There is this important difference between the application of the commercial fertilizers and the stable manure: thus far only one application of stable manure has been made to the plats thus treated, while in the case of the commercial fertilizers, three annual applications have thus far been made. One of these applications was made in the fall of 1903 preceding the sowing of the oats in the spring of 1904, while both in the spring of 1905 and 1906 the timothy has received a top dressing of commercial fertilizers as indicated in the table on page —. The only application of stable manure was made in the fall of 1903, on one plat at the rate of 10 tons per acre and on the other at the rate of 20 tons per acre. In the table on page — are given the actual yields calculated in pounds per acre and also the apparent increase in yield due to the application of the different fertilizers as indicated.

Plat No.	TREATMENT.	1905.		1906.		Average apparent increase in yield of hay, lbs.
		Yield of hay per acre, lbs.	Apparent increase in yield of hay, lbs.	Yield of hay per acre, lbs.	Apparent increase in yield of hay, lbs.	
711	No treatment.....	1,910	.....	4,360	.....	.....
712	320 lbs. acid phosphate.....	2,680	607	4,670	417	512
713	80 lbs. muriate potash.....	3,190	954	5,370	1,224	1,089
714	No treatment.....	2,400	.....	4,040	.....	.....
715	160 lbs. nitrate of soda.....	3,550	1,216	5,590	1,723	1,470
716	320 lbs. acid phosphate.....	3,840	1,573	5,820	2,126	1,850
	160 lbs. nitrate soda.....					
717	No treatment.....	2,200	.....	3,520	.....	.....
718	320 lbs. acid phosphate.....	2,800	510	5,360	1,780	1,145
	80 lbs. muriate potash.....					
719	160 lbs. nitrate soda.....	4,280	1,900	6,110	2,470	2,185
	80 lbs. muriate potash.....					
720	No treatment.....	2,470	.....	3,700	.....	.....
721	160 lbs. nitrate soda.....	4,590	1,877	6,550	2,987	2,432
	80 lbs. muriate potash.....					
	320 lbs. acid phosphate.....					

Plat No.	TREATMENT.	1905.		1806.		Average apparent increase in yield of hay, lbs.
		Yield of hay per acre, lbs.	Apparent increase in yield of hay, lbs.	Yield of hay per acre, lbs.	Apparent increase in yield of hay, lbs.	
722	160 lbs. nitrate soda..... 80 lbs. muriate potash..... 640 lbs. acid phosphate.....	4,350	1,394	5,730	2,304	1,849
723	No treatment.....	3,200	.....	3,290	.....	.....
724	320 lbs. nitrate soda..... 80 lbs. muriate potash..... 640 lbs. acid phosphate.....	5,880	3,044	7,940	4,683	3,864
725	320 lbs. nitrate soda..... 80 lbs. muriate potash..... 320 lbs. acid phosphate.....	6,610	4,137	7,420	4,197	4,167
726	No treatment.....	2,110	.....	3,190	.....	.....
727	320 lbs. nitrate soda..... 80 lbs. muriate potash..... 320 lbs. acid phosphate.....	4,310	2,380	7,110	4,120	3,250
728	640 lbs. nitrate soda..... 80 lbs. muriate potash..... 320 lbs. acid phosphate.....	2,470	720	7,590	4,800	*
729	No treatment.....	1,570	.....	2,590	.....	.....
730	No treatment.....	1,420	.....	2,230	.....	.....
731	10 tons of manure.....	4,090	2,595	4,350	1,940	2,268
732	20 tons of manure.....	5,520	4,025	7,420	5,010	4,518

A striking difference is noted in the greater average yield of the plats receiving no fertilizer in 1906 than in 1905. In 1905 the eight plats receiving no fertilizer gave an average yield of 2160 pounds, while in 1906 these same plats without any additional treatment of any kind gave an average yield of 3365 pounds, or a yield fully 55 per cent greater. This increased yield may be fairly attributed to more favorable weather conditions.

The months of April, May and June in 1906 averaged higher in temperature and rainfall than in 1905. The total rainfall during the three months mentioned was 11.37 inches in 1905, and 12.54 inches in 1906 against a normal of 9.65 inches. This indicates unusually favorable weather conditions for the growth of timothy. It is also probable that these seasons have been especially favorable for the use of commercial fertilizers and it may be that when seasons of normal or less than normal rainfall occur during these months, that less benefit will be derived from the application of fertilizers.

* Received no application of fertilizer in 1905.

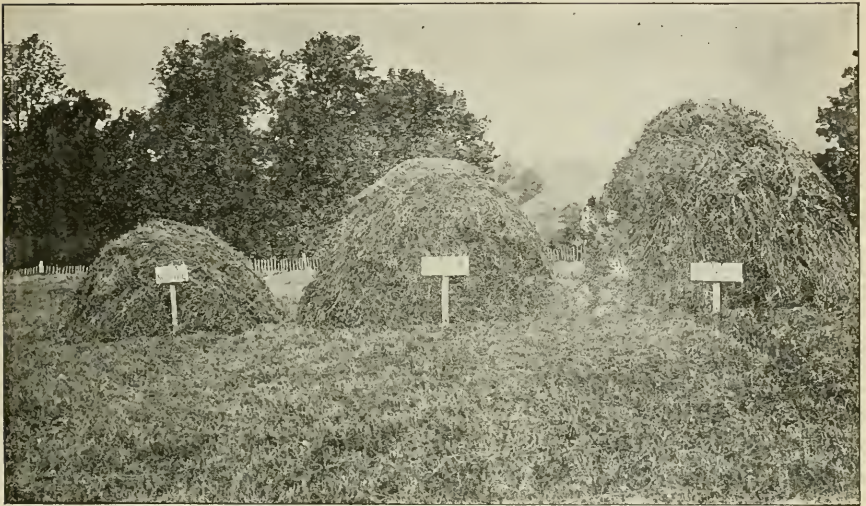
MONTHLY AND ANNUAL TEMPERATURES AT ITHACA, NEW YORK

	Normal.	1903.	1904.	1905.	1906.
January.....	23.8	25.0	16.8	20.0	31.8
February.....	24.2	27.8	17.0	18.4	23.4
March.....	31.5	42.1	30.4	32.8	27.0
April.....	44.4	44.6	40.2	42.9	44.7
May.....	57.3	57.6	59.6	55.8	56.1
June.....	66.3	60.8	65.6	65.4	67.0
July.....	70.2	67.4	68.4	70.4	69.4
August.....	67.8	63.6	65.8	67.1	71.0
September.....	61.5	61.6	59.6	61.4	.....
October.....	50.0	50.6	47.2	50.6	.....
November.....	38.4	34.7	36.0	36.4	.....
December.....	28.9	23.2	23.6	31.2	.....
Annual.....	47.0	46.6	44.2	46.0	.....

MONTHLY AND ANNUAL PRECIPITATION AT ITHACA, NEW YORK

	Normal.	1903.	1904.	1905.	1906.
January.....	2.17	2.19	3.46	2.82	1.07
February.....	1.93	1.97	1.40	0.71	1.21
March.....	2.52	4.62	2.29	3.06	3.28
April.....	2.22	1.04	2.93	2.64	1.77
May.....	3.72	0.30	4.64	1.92	3.71
June.....	3.71	5.65	1.77	6.81	7.06
July.....	3.81	2.64	3.79	4.97	1.94
August.....	3.37	7.15	2.20	2.83	2.53
September.....	2.78	1.21	1.93	3.66	.....
October.....	3.16	5.69	2.71	4.36	.....
November.....	2.52	1.83	0.84	1.34	.....
December.....	2.49	1.15	2.08	2.92	.....
Annual.....	34.40	35.46	30.04	38.04	.....

It is interesting to note that the apparent increase in yield due to fertilizer was also greater in 1906 than in 1905. Thus, while eight plats in 1905 receiving no fertilizers yielded 2160 pounds, the average apparent increase in yield of ten plats receiving commercial fertilizers was 1721.2 pounds, but in 1906 when the average yield of the eight plats receiving no fertilizer was at the rate of 3365, the apparent increase in yield, on the



723
No treatment
3290 lbs. hay per acre

722
160 lbs. nitrate soda
640 lbs. acid phosphate
80 lbs. muriate potash
5730 lbs. hay per acre

721
160 lbs. nitrate soda
320 lbs. acid phosphate
80 lbs. muriate potash
6550 lbs. hay per acre



726
No treatment
3190 lbs. hay per acre

725
320 lbs. nitrate soda
80 lbs. muriate potash
320 lbs. acid phosphate
7420 lbs. hay per acre

724
320 lbs. nitrate soda
80 lbs. muriate potash
640 lbs. acid phosphate
7940 lbs. hay per acre

ten plats receiving precisely the same application of commercial fertilizer as in the year 1905, was at the rate of 2391.1 pounds per acre or 39 per cent greater. While the actual increase was thus greater in 1906, the percentage increase, when compared with the yield of the plats receiving no treatment considered as 100, was generally less (See table p.).

There are two possible explanations for this result. The greater increase in yield may have been due to the more favorable season for the growth of timothy, making it possible for the plants to make greater use of the fertilizers applied, or the application of the previous year may have had a residual effect, either in the way of plant food actually carried over, or by producing more vigorous plants. It is fair to assume that a vigorous plant will stool more abundantly, and that the new plants thus produced will be more vigorous than those from less vigorous plants, if the better environment is maintained. Thus, the number and vigor of plants may be increased upon the plats receiving fertilizers as compared with those which did not have such treatment. Whether in this case the greater increase in yield, when fertilizers were applied in 1906, as compared with 1905, was due to the previous application of the fertilizer or to better seasonal conditions in 1906, must be left for further study, but it seems not unlikely that both may have been factors in the results obtained.

RESULTS WITH FERTILIZERS STATED IN TERMS OF MONEY

In 1906, in every case the increase in hay was worth more than the cost of the fertilizer applied. The value of the increase over the cost of the fertilizer applied, varied from 61 cents per acre, when acid phosphate only was applied in the spring of 1906, to \$26.54 per acre, when 20 tons of manure had been applied in the fall of 1903. The cost of the fertilizers applied to the oat crop raised in 1904 was in every instance greater than the value of the increase. Starting with this handicap, the cost of the fertilizers applied during the three years, has been less than the value of the increase in the three crops with the exception of the plats where acid phosphate alone was applied, or an excessive proportion of acid phosphate was applied. Aside from the stable manure, the largest net gain from the application of fertilizers was where 320 pounds of nitrate of soda, 320 pounds of acid phosphate and 80 pounds of muriate of potash were applied. The reader should be careful to observe that the net gain is not necessarily the new profit obtained from the application of the fertilizers. The net gain or net loss is merely the difference between the value of the crop produced, based upon the December farm price of the product for an average of ten years and the cost of the fertilizer at the valuation placed upon them in Bulletin 232, p. 3. It is entirely prob-



729
No treatment
2590 lbs. hay per acre

728
640 lbs. nitrate soda
320 lbs. acid phosphate
80 lbs. muriate potash
7590 lbs. hay per acre

727
320 lbs. nitrate soda
320 lbs. acid phosphate
80 lbs. muriate potash
7110 lbs. hay per acre



732
No treatment
20 tons manure
7420 lbs. hay per acre

731
10 tons manure
4350 lbs. hay per acre

730
No treatment
2230 lbs. hay per acre

able that the farmer may pay more for the fertilizers when purchased at retail, or may sell his oats and hay or may value them for feeding purposes at more or less than the average December farm price. In any case there are other factors which enter into the actual profit or loss and must be considered by each farmer for himself. The table on page is simply a comparative statement of increased yields as related to fertilizers applied, stated in terms of money.

NET GAIN OR LOSS FROM FERTILIZERS WITH OATS AND TIMOTHY HAY

Plat No.	TREATMENT.	NET GAIN OR LOSS (—) FROM FERTILIZER WITH			
		Oats 1904.	Timothy 1905.	Timothy 1906.	Three crops.
711....	No treatment.....				
712....	320 lbs. acid phosphate.....	—\$2.82	\$1.61	\$0.61	\$0.60
713....	80 lbs. muriate potash.....	— 4.05	3.45	4.89	4.29
714....	No treatment.....				
715....	160 lbs. nitrate soda.....	— 2.07	2.84	5.53	6.30
716....	320 lbs. acid phosphate.....				
	160 lbs. nitrate soda.....	— 3.09	3.14	6.07	6.12
717....	No treatment.....				
718....	320 lbs. acid phosphate.....				
	80 lbs. muriate potash.....	— .99	— .50	6.23	4.74
719....	160 lbs. nitrate soda.....				
	80 lbs. muriate potash.....	— 1.73	4.87	7.89	11.03
720....	No treatment.....				
721....	160 lbs. nitrate soda.....				
	80 lbs. muriate potash.....	— 3.60	3.15	9.03	8.58
	360 lbs. acid phosphate.....				
722....	160 lbs. nitrate soda.....				
	80 lbs. muriate potash.....	— 5.99	— 1.01	3.81	— 3.19
	640 lbs. acid phosphate.....				
723....	No treatment.....				
724....	320 lbs. nitrate soda.....				
	80 lbs. muriate potash.....	— 7.92	4.13	12.82	9.03
	640 lbs. acid phosphate.....				
725....	320 lbs. nitrate soda.....				
	80 lbs. muriate potash.....	— 6.90	11.53	11.83	16.46
	320 lbs. acid phosphate.....				
726....	No treatment.....				
727....	320 lbs. nitrate soda.....				
	80 lbs. muriate potash.....	— 5.24	5.81	11.44	12.01
	320 lbs. acid phosphate.....				
728....	640 lbs. nitrate soda.....	*	*	*	
	80 lbs. muriate potash.....				
	320 lbs. acid phosphate.....				
729....	No treatment.....				
730....	No treatment.....				
731....	10 tons of manure.....	— 3.20	13.75	10.27	20.82
732....	20 tons of manure.....	— 6.19	21.33	26.54	41.68

* "Niterlime" applied in 1903; valuation not known.

DISCUSSION OF RESULTS

While the primary purpose of this experiment is to study the influence of fertilizers upon meadows, the problem cannot be studied apart from a systematic rotation of crops. The final value of fertilizers will not be known until a full rotation has been accomplished, which in this case will be timothy, three years; oats and wheat, each one year. It will thus be four years before the financial aspects of this experiment may be discussed safely. Such striking results have been obtained, however, as to suggest the possibility of a rather extended use of commercial fertilizers in the production of hay, and emphasizing anew the importance of systems of farm management which will bring to soils of this type in New York State the largest supply of readily available nitrogen. To this end, the use of leguminous crops and the proper preservation of stable manure, and particularly the liquid excrement, is of first importance. Below are given some of the more important facts brought out by the experiment thus far:

1. In 1904, the average yield of oats on eight plats not fertilized was at the rate of 53.8 bushels per acre; upon 14 fertilized plats, 59.6 bushels. The apparent increase in yield was most marked where a complete fertilizer high in nitrogen and phosphoric acid was used and where 20 tons of stable manure were applied per acre. The inference is that both nitrogen and phosphoric acid had an influence in increasing the yield of oats.
2. Upon timothy the influence of nitrogen was most marked as shown both in the growing crop and in the yield and quality of the hay. In 1905, the average yield of hay on eight plats receiving no fertilizer was at the rate of 2160 pounds per acre; on three plats receiving only mineral fertilizers, 2890 pounds; on seven plats receiving nitrogen as nitrate of soda with or without mineral fertilizer, 4728 pounds; and on two plats receiving nitrogen in stable manure, 4805 pounds. In 1906, the average amount of hay on eight plats receiving no fertilizer was at the rate of 3365 pounds per acre; on three plats receiving only mineral fertilizers, 5133 pounds; on seven plats receiving nitrogen as nitrate of soda with or without mineral fertilizers, 6451 pounds; and on two plats receiving nitrogen in stable manure, 5885 pounds. In this comparison plats 727 and 728 have been omitted because they were not treated precisely alike both years. From this it will be seen that while the yield on the unfertilized plats was low, the plats receiving fertilizer gave satisfactory yields. The plat which received, in the fall of 1903, 20 tons of stable manure per acre and has since received no application of any kind in 1906 yielded at the rate of 7420 pounds of hay per acre, while two unfertilized plats

nearest adjacent yielded at the rate of 2410 pounds of hay per acre. Six plats, which received a complete commercial fertilizer in varying amounts and proportions, yielded in 1906 at the rate of 7057 pounds per acre, while four unfertilized plats nearest adjacent, yielded at the rate of 3192 pounds or approximately three and one-half and one and one-half tons respectively. The average cost of the fertilizer, which on some plats was put on in excessive and not economical amounts, was at the price given in Bulletin 232, \$10.93 per acre.

3. The relative influence of the different fertilizers can best be seen by studying in detail the apparent increases in yield due to fertilizers as shown on pages — —. The following table gives the results in condensed form:

No. of Plats.		APPARENT INCREASE IN YIELD OF HAY, LBS. PER ACRE.		Average of two years.
		1905.	1906.	
1.	Nitrogen	1,216	1,723	1,470
1.	Phosphorus	607	417	512
1.	Potassium	954	1,224	1,089
1.	Nitrogen and Phosphorus	1,573	2,126	1,850
1.	Nitrogen and Potassium	1,900	2,470	2,185
1.	Phosphorus and Potassium	510	1,780	1,145
4.	Nitrogen, Phosphorus and Potassium	2,613	3,543	3,078
2.	Manure, 10 and 20 tons	3,310	3,472	3,393

This table shows clearly that fertilizers containing nitrogen produced the greatest increase in yield of hay, that fertilizers containing potassium stood next, while fertilizers containing phosphorus in the form of acid phosphate produced the least increase in yield. At least a part of the increase in yield on the plats receiving potassium was due to the increase in alsike clover. While only timothy was supposed to be sown, on the plats receiving potassium alone or potassium and phosphorus alone, alsike clover assumed an important part of the total crop, while elsewhere the hay would pass for pure timothy. A critical examination of the plats, however, showed a few plants of alsike clover. On plats receiving potassium alone, or potassium and phosphorus only, these plants grew to large size, but on the other plats they were so small as to escape the notice of the casual observer. The stand of alsike clover seemed greater also, but this may have been due to the larger size of the individual plants.

Two striking features of the above table are, the lesser increase in yield due to the application of phosphorus alone in 1906 than in 1905, and the much greater increase in yield due to application of potassium and phosphorus in the latter season as compared with the former.

4. From the above table it will be seen that the yield of hay was greater where a fertilizer containing nitrogen, phosphorus and potassium was applied, than where only one or two of these elements entered into the fertilizer. This table would be misleading, however, unless it is pointed out that some of the plats receiving a complete fertilizer, received larger amounts of the single elements than where only one or two elements were applied. The following table shows the average increase in yield for two years, where the quantities of the elements on the several plats remain the same:

	Apparent increased yield due to fertilizer. Pounds hay per acre.
Nitrogen	1,470
Phosphorus	512
Potassium	1,089
Nitrogen and Phosphorus.....	1,850
Nitrogen and Potassium.....	2,185
Phosphorus and Potassium.....	1,145
Nitrogen, Phosphorus and Potassium.....	2,432

For further details see table on page —.

5. The evidence seems to be accumulating that the relation of nitrogen to phosphorus is a matter of importance on Dunkirk clay loam in the production of timothy hay. The following table shows the increase in yield of hay where the three elements were applied in different proportions and amounts:

Plat No.	TREATMENT.	APPARENT INCREASE IN YIELD OF HAY, LBS. PER ACRE.		Pounds per acre, average.
		1905.	1906.	
721 . . .	160 lbs. nitrate of soda 80 lbs. muriate of potash 320 lbs. acid phosphate	1,877	2,987	2,432
722 . . .	160 lbs. nitrate of soda 80 lbs. muriate of potash 640 lbs. acid phosphate	1,394	2,304	1,849
724 . . .	320 lbs. nitrate of soda 80 lbs. muriate of potash 640 lbs. acid phosphate	3,044	4,683	3,864
725 . . .	320 lbs. nitrate of soda 80 lbs. muriate of potash 320 lbs. acid phosphate	4,137	4,196	4,167

In both years plat 722, which received twice the amount of acid phosphate, gave a lesser increase in yield than plat 721. In 1905, plat 724, which received twice the acid phosphate that plat 725 received, yielded one-fourth less hay, but in 1906 yielded a somewhat greater increase. This apparent depression in yield, where too large a proportion of acid phosphate to nitrogen was used, was further brought out by the Bureau of Soils by means of the basket method. Brown, while detailed to the Cornell Experiment Station, procured soil from the untreated plat 729 of this experiment, and treated the soil of different baskets with fertilizers in the same quantities and proportions as were applied in the field test. In the soil of each of these baskets he grew thirty wheat plants from December 2, 1905, to January 2, 1906, when the variation in green weight was determined.

Below is given the variation in green weight representing the yield on the untreated soil as 100. For comparison, the variation in yield of field cured hay for the preceding and succeeding seasons is given, by representing the average of the eight untreated plats as 100 and adding the percentage increases to 100:

TREATMENT.	Variation in weight of green wheat by basket method soil from Plat 729.	VARIATION IN WEIGHT OF FIELD CURED HAY IN PLAT EXPERIMENTS.	
		Preceding season. 1905.	Following season. 1906.
No treatment.....	100	100	100
320 lbs. acid phosphate.....	82	128	112
80 lbs. muriate potash.....	104	144	136
160 lbs. nitrate soda.....	155	156	151
320 lbs. acid phosphate.....			
160 lbs. nitrate soda.....	127	173	163
320 lbs. acid phosphate.....			
80 lbs. muriate potash.....	95	124	153
160 lbs. nitrate soda.....			
80 lbs. muriate potash.....	147	188	173
160 lbs. nitrate soda.....			
80 lbs. muriate potash.....			
320 lbs. acid phosphate.....	147	187	189
160 lbs. nitrate soda.....			
80 lbs. muriate potash.....			
640 lbs. acid phosphate.....	142	165	168
320 lbs. nitrate soda.....			
80 lbs. muriate potash.....			
640 lbs. acid phosphate.....	189	241	239
320 lbs. nitrate soda.....			
80 lbs. muriate potash.....			
320 lbs. acid phosphate.....	209	291	225
10 tons of manure.....	133	220	158
20 tons of manure.....	151	286	249

It will be noted that in the baskets there was a depression in the yield whenever acid phosphate was applied, except in one instance, where the yields were the same.

6. Not only did nitrate of soda cause a marked increase in the yield of timothy hay, but 320 pounds gave much larger yields than 160 pounds; thus 160 pounds of nitrate of soda with 320 pounds acid phosphate and 80 pounds of muriate of potash gave an average total yield during two years of 5570 pounds, while an application of 320 pounds of nitrate of soda with the same quantity of mineral fertilizer as before, gave an average yield of 7015 pounds and an apparent increase yield of 4167 pounds per acre. In 1906, 640 pounds of nitrate of soda was applied to plat 728 with the same amount of mineral fertilizers as heretofore. Since the plat received no fertilizer the previous year, no conclusion may be drawn from the slightly increased yield obtained, but it was evident from observing the growth during the season, that 640 pounds of nitrate of soda was too large an application for the soil and the climate. Aside from the stable manure, the most satisfactory yield was obtained by applying 320 pounds of nitrate of soda, 320 pounds of acid phosphate and 80 pounds of muriate of potash. This is equal to an application of 720 pounds of an 8-7-6 mixed fertilizer. The ordinary mixed fertilizers usually contain a much larger proportion of phosphoric acid and potash.

It seems probable from these results that more economical results could have been obtained by the application of a different quantity and a different proportion of the several ingredients. If called upon to suggest an application, which would probably bring under a proper rotation the most favorable results on Dunkirk clay loam in this climate, we should tentatively propose 200 pounds of nitrate of soda, 100 pounds of acid phosphate and 50 pounds of muriate potash. We do not mean by this that these carriers should necessarily be used, although probably as good as any, but that equivalent amounts of available elements carried by these should be used. It would be equivalent to the application of 250 pounds of a 15-6-10 mixed fertilizer.

7. Thus far the largest average yield has been obtained by the use of stable manure. A single application at the rate of 20 tons per acre produced an apparent increase of 11.2 bushels of oats in 1904; 4025 pounds of hay in 1905; 5010 pounds of hay per acre in 1906. At the average December farm prices for oats and hay in New York State this increase would be worth \$51.69, or \$2.58 per ton of manure applied.

When the application was at the rate of ten tons, the apparent increase in yield of oats was 5.3 bushels; of hay in 1905, 2595

pounds and in 1906, 1937 pounds per acre. Estimating the values as before, the increase would be worth \$25.82, or \$2.58 per ton of manure applied.

It is perfectly obvious from these experiments, that on the Dunkirk clay loam on which this experiment was conducted and in this climate and under the conditions of this experiment, that stable manure at fifty cents a load, brought much better financial results, than any application of commercial fertilizer at current prices for the same. It also demonstrates, that on this soil which has been under cultivation for two or three generations, when stable manure is available, magnificent crops of timothy hay may be produced. Where stable manure can be procured in sufficient quantity, the use of commercial fertilizers is not necessary. On the other hand, these experiments give reason to believe, that when stable manure is lacking or not sufficiently abundant, commercial fertilizers may be used, if used judiciously, with good results.

For the New York farmer, especially those who wish to raise the maximum amount of hay, a judicial blending of stable manure, leguminous crops and commercial fertilizers will probably bring both the maximum yield and the most economic returns. For the farmer who wishes to raise a larger proportion of hay on Dunkirk clay loam, an eight-year rotation may be suggested of hay, five years; an intertilled crop, such as corn, potatoes, beans, mangels, rutabagas or cabbages, one year; oats, one year; winter wheat or rye, one year. Timothy would be seeded in the fall with the wheat or rye and a mixture of red and alsike clover the following spring. In this rotation, stable manure should be applied to the grass land before plowing for the cultivated crop. No fertilizer of any sort need be applied for oats. To the wheat apply commercial fertilizer relatively high in phosphoric acid and potash and low in nitrogen. Apply in the spring to each grass crop, just as soon as the grass starts, commercial fertilizers relatively high in nitrogen and low in phosphoric acid and potash. Mixed fertilizers usually contain too high a proportion of phosphoric acid and too low a proportion of nitrogen for the production of timothy hay upon the soil and in the climate under consideration. It would probably be best for the farmer to buy the separate ingredients and mix them himself. The following mixture or its equivalent is recommended: nitrate of soda, 200 pounds; 16 per cent acid phosphate, 100 pounds, and muriate of potash, 80 per cent purity, 50 pounds. Whether this quantity should be applied per acre or a greater or less quantity can best be determined from the history of the land and the appearance of the meadow from year to year. In the experiments under consideration, only acid phosphate has been used as a source of phosphoric acid, although experiments at the Pennsylvania and Illinois Stations indicate that finely ground phosphate rock may, in the course of a rotation, be equally useful.

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ALICE G. McCLOSKEY, Editor

New Series. Vol. 2

ITHACA, N. Y., OCTOBER, 1905.

No. 1

No clouds are in the morning sky,
The vapors hug the stream,—
Who says that life and love can die
In all this northern gleam?
At every turn the maples burn,
The quail is whistling free,
The partridge whirs, and the frosted burrs
Are dropping for you and me.
Ho! Hilly ho! Heigh O!
Hilly ho!
In the clear October morning.

EDMUND CLARENCE STEDMAN.

HOW CHICKENS CHANGE THEIR CLOTHES

JAMES E. RICE

Of course, chickens have clothes! Two or three suits of them. Have you never heard of the hen's *cape*, her *laced* feathers, or about *booted* bantams?

Yes, chickens have clothes and they change them too. When their clothes get old and faded, they fall off and a brand-new suit is put on. If you have never seen chickens change their clothes, it will interest you to watch them. Instead of saying "change their clothes," I suppose I should be more exact and say "shed their feathers, or moult." These are more correct terms. Do you think chickens or birds change all their



FIG. 1.—Are these chickens moulting? Can you see the feathers falling?

feathers at the same time? If they did, would they not get sun-burned,

or catch cold, or have their bare skin bitten by mosquitoes? And how could they fly away from their enemies? Did you ever notice crows fly with big holes in both wings? I have, and I used to wonder whether some one had shot the feathers out. Do you think I was right?

Watch the birds and chickens and see whether they shed their feathers all at once or only a few at a time. Which way do you think would be better? Examine the wings and learn whether similar feathers are shed from each wing at the same time. Could the birds fly if all the feathers were shed first from one wing and then from the other? Did you ever see a hen try to fly with one wing clipped?

It is interesting to know where the feathers come from and how they grow. Look for yourselves and see the pin feathers under the skin. Notice how they push through and spread out like plumes; then form the quill and the web with all its beautiful colors.

Yes, I did say birds and chickens have several suits of clothes. These suits are adapted to various conditions of season and age. Do you know that the little bird called the ptarmigan has a white suit of clothes when the ground is covered with snow and a dark suit of clothes during the summer? By this change of feathers he is less likely to be seen by his enemies. At first little chickens have their downy "baby clothes;" then their short pointed feathers, or "short clothes," and later when they are grown up they have their full sized feathers or "long clothes." When chickens are all dressed up in their best clothes and ready for company, we say they are in full plumage or full plumed, ready for exhibition. You see now that chickens have clothes after all.

Some Questions for Naturalists

1. At what time of the year do fowls moult?
2. Which feathers do the chickens shed first? Which last? Which in pairs?
3. Do hens lay while they are moulting?
4. Do fowls seek seclusion during the moulting season? Why?

LESSON II. WHEN IS A PLANT A WEED?

HERBERT WHETZEL

When is a plant a weed? Here is a conundrum for you and the answer is: "When the plant is where it is not wanted." Let us see whether this is a good answer. I think the teasel is quite familiar to most of the children in New York State, especially to the boys and girls living in the country. Those of you who live in the central part of the State have seen great cultivated fields of it. Perhaps you have helped to hoe it when it was small and planted in the rows with corn. Some of you may even have carried the basket before you and clipped off the large king heads when they were ready for the fuller.

It seemed very strange to me the first time I saw a large field of teasels so carefully cultivated in straight rows. I learned to know the teasel when I was a little boy in Indiana, but there it is always a weed. It grows along the roadside and the thrifty farmer hastens to cut it down before it goes to seed. I have often seen it growing as a weed along the roadside in this State.

There is some slight difference between the teasel that the farmer cultivates and the one that usually occurs as a weed. Get one from the roadside and one from the field and see whether you can find the difference. Probably the cultivated teasel was at first wild,—a weed. But man has cultivated it so long that it has become in some ways quite different from its wild relations.

Now I think you can see how a plant where it is not wanted may be regarded as a weed while in other places it is often cultivated as a very useful plant. Many of our weeds, like the teasel, are foreigners which have come to us in various ways. In their own home they may be valuable cultivated plants or at least harmless, growing in places where they are not in the way.

weeds almost and they seem to If, however, you good qualities of surprised to find valuable to some

Many of these plants, aside from to man. Our teasel about the stem at formed by the leaves which are a long time after rains these keeps animals, as ants, snails and reaching and destroying the little lake which they cannot interesting things perhaps you will find themselves.

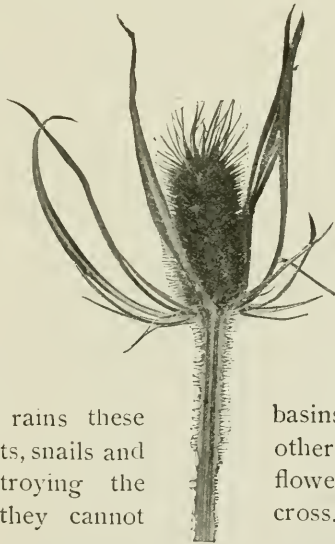


FIG. 2.—Wild teasel. How does it differ from the cultivated teasel?

A few plants are everywhere they grow be entirely worthless. began to look for the weeds, you would be how many are really one, somewhere.

weeds are interesting any use they may have has peculiar little cups each joint. They are bases of the two grown together. For

basins are full of water. This other crawling creatures from flowers. You see it forms a cross. There are many other about the teasel. Per-

them out for your-

A Few Suggestions

1. Carry a teasel plant into the schoolroom. Are there blossoms on the plant or has it gone to seed?

2. Count the number of seeds that you find on one teasel head. Why do you think this plant is a nuisance to the farmer when it is a weed?

3. Notice the teasel in the field in late autumn. How do you think it distributes its seeds? In what way do you think the wind might be helpful to the plant in distributing its seeds?

4. Why is the teasel cultivated?

5. Notice the blossoms of the teasel. Where are they? What color are the blossoms?

6. How long does a teasel plant live?

LESSON III. HOMES FOR OUTDOOR FOLK

It happens very often that boys and girls find little wild creatures on their way to school; a butterfly, perhaps, a cricket, some pollywogs, a toad, or a turtle. These outdoor folk would be interesting in the school-room if you had some place to keep them. Why not have an aquarium jar (Fig. 3) for the water folk, and for little land animals, you might have a terrarium (Fig. 4), an enclosed bit of earth in which things will live and grow? If there is a manual training department connected with your school, the teacher will probably let you make a terrarium similar to that illustrated in Fig. 4, or some friendly carpenter may be willing to help the boys make one outside of school hours. The front is made of glass and the sides and top of wire screening. The top is fastened on

one side by means of hinges, and can be raised easily when the little guests are placed in their indoor home.

Boys and girls who are interested in farms and gardens should know the wild life about them, for many of the outdoor creatures are either friends or enemies to the farmer and gardener. If you become acquainted with them you may be able to induce some that are friendly to act as farm hands.



FIG. 3.—An aquarian jar. Watching some of the water folk.

The terrarium illustrated in Fig. 4 has sheltered many an interesting little wanderer. Let me see how many I can remember:—Toads, salamanders, crickets, long-horned grasshoppers, short-horned grasshoppers,

caterpillars, and many butterflies, among which were the monarch, mourning cloak, painted lady, painted beauty, and viceroy. Then there was the little bat that hung himself upside down on the wire screening, and a Caroline box turtle that had to be banished from the terrarium because he insisted on eating up so many of his small associates.

The floor of this terrarium was covered with stones, gravel, and rich soil, over the greater part of which a carpet of moss was laid. A tiny maple tree lived in it for a season, and many pretty wood plants have made it attractive at different times.

One year the pet of the school was *Bufo*, a very solemn old toad. Often he was so unsocial as to back down into the earth and refuse to come out, but the children would take him gently in their hands and he did not seem to mind. Once when we were watching a cabbage butterfly that was in the terrarium, *Bufo* came out of his hiding place to watch it, too. He remained as still as a stone and looked like one. The cabbage butterfly flitted down and rested on old *Bufo*'s nose. Of course you know what happened. *Bufo*'s tongue was out and the cabbage butterfly was in his mouth before you could wink an eye. This is one of the ways in which *Bufo* showed that he is a good gardener. The cabbage butterfly, you know, lays the eggs from which the caterpillars hatch that



FIG. 4.—*The terrarium.*

eat the cabbages. If you watch a toad in the garden, you will find that he eats many destructive insects.

Now I hope that there will be well-stocked terrariums in many of your schools. You will enjoy watching the little wild neighbors and you will learn a great deal from your observations. Here are a few things you ought to remember in trying to make your visitors comfortable:—

1. The terrarium world will need an occasional shower. A small watering can is convenient for this purpose.

2. A partition should be built between turtles and frogs for they do not always live in friendly relations.

3. Try to find the food that your terrarium folk will eat. Caterpillars should have fresh leaves from the plant on which you find them

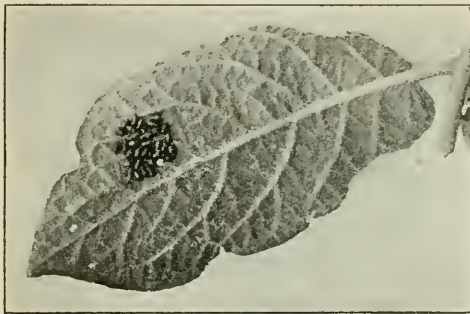


FIG. 5.—*Larvæ of potato beetle just hatched. They have eaten their own egg-shells.*

feeding. Your butterflies may sip the sweets from flowers. Put some thistle blossoms, milk weed plants, and other flowering plants where they can reach them. In fresh mosses and rich soil the toads and salamanders will probably find food to their liking.

* * * * *

When boys are fishing in ponds and streams, they often find interesting water forms.

These should be taken to school and placed in a glass jar filled with water, Fig. 3. Unless the aquarium jar is large only a few things should be kept in it at one time. Place a few stones in the bottom, but do not put mud into the jar. I find that the water salamanders, water insects, and little fishes will eat fish food. They will also eat each other, if you are not careful. The large dark-colored beetles (predacious diving beetles) are not at all considerate for their associates and will eat whatever they can reach. You would better keep them by themselves in a Mason fruit can. The water scorpion that looks like a twig will dispose of your small fishes. I think that he, too, should live by himself.

Uncle John will hope to hear of some interesting experiences that Junior Naturalists have had in their study of animal life found in the water.

LESSON IV. AN UNINVITED GUEST

Nearly all of our Junior Naturalists are gardeners, and good gardeners need to know insect pests and how to keep them away from the growing plants.

The potato beetles, or potato bugs, as they are commonly called, are among the most frequent and troublesome visitors that enter our gardens. They arrive early, remain late, and, judging from their appetites, the air usually agrees with them.

Let us study potato beetles this fall and perhaps we shall be able to keep them away from our gardens next year. Even if you have no garden you will find the beetles interesting to study, and you may be helpful to people near your home who are trying to grow a good crop of potatoes.



FIG. 6.—Colorado potato beetle larvæ or "soft shells" or "slugs," as the farmers call them. Natural size.

How to Study the Potato Beetle

1. Go into a potato field and notice whether there are any beetles on the plants. Have the leaves been eaten to any great extent?

2. Carry a plant with some of the beetles on it into the schoolroom. Watch the beetles from day to day. Keep the plant as fresh as possible. Give the beetles new leaves when needed. If you have no terrarium keep your specimens in a box covered with mosquito netting, or place them under a lamp chimney and cover the top with a piece of netting.

3. I suppose many Junior Naturalists know that some insects appear in four different forms



FIG. 7.—Pupa in its earthen cell in soil, enlarged.

during their lives. This is true of the potato beetle. The eggs, dark orange in color, are usually found in clusters of from 10 to 40, on the under side of the leaves. The young or larvæ, Figs. 5, 6, are called "soft-shells" by the farmers. The period of rest, called the pupa, Fig. 7, when the "soft-shells" change to beetles. This change takes place in little round cells in the earth. The fourth period is the adult or beetle, Fig. 8, with its striped wing covers. How many stages in the life of the potato beetle can you find?

4. Late in the fall the beetles go down into the earth to sleep until spring. See whether you can find any in the field. It is said that usually they do not go down deeper than ten inches.

5. Find out whether the beetles eat as well as the young.

6. There are little friends in our gardens as well as enemies. One of these good friends is a lady bird beetle, or lady bug. You have often sung:

"Lady bug, lady bug, fly away home,
Your house is on fire and your children will burn!"

When you come to know the lady bug you will hope that when she does fly away she will find her home in your garden.

One thing that most of the lady birds do is to eat the eggs of the potato beetle, and some feed on the young; so, you see, they help us to control the potato bugs.

The lady bug's eggs look much like the eggs of the potato beetle. They are smaller and there are not so many in each cluster, but it is difficult to distinguish the two kinds of eggs.

LESSON V. THE APPLE HARVEST

The apple harvest time is here,
The tender apple harvest time;
A sheltering calm, unknown at prime,
Settles upon the brooding year.

— BLISS CARMAN.

How many varieties of apples are raised near your home? Appoint a committee of four or five members of your class to secure an apple of each variety. Let these apples be labeled, if possible, that the children

may become familiar with the names of the different kinds. The names, however, are not so important as to note the differences in the apples: Shape, size, color, flavor, etc. Try to become familiar with the trees on which the apples grew.

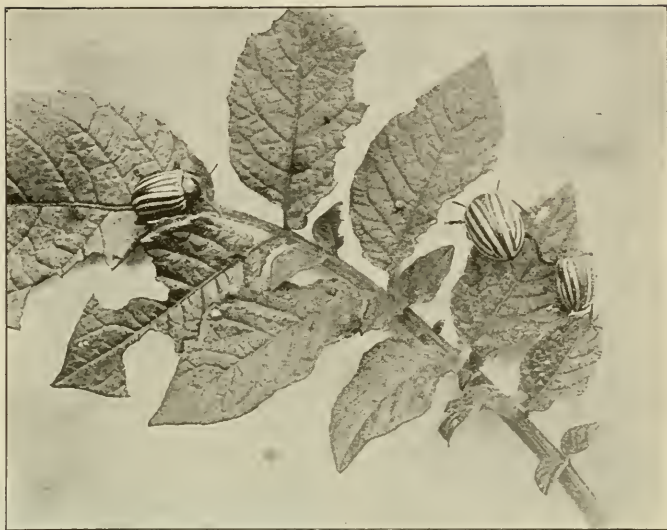


FIG. 8.—*Colorado potato beetle*, natural size, from life.

Try to learn why the farmer grows different kinds of apples.

Some day, ask your teacher to give you an opportunity to study an apple in the schoolroom. Then write to Uncle John and answer the following questions about it:

1. How much of the apple is occupied by the core?
2. How many parts or compartments are there in the core?
3. How many seeds are there in each part?
4. Which way do the seeds point?
5. Are the seeds attached or joined to any part of the core? Explain.
6. What do you see in the blossom end of the apple?
7. What do you see in the opposite end?
8. Is there any connection between the blossom end and the core?
9. Find a wormy apple and see whether you can make out where the worm left the apple. Perhaps you can make a drawing. To do this, cut the apple in two. Press the cut surface on a piece of paper. When the apple is removed, you can trace out the marks.
10. When you hold an apple in your hand, see which way it looks to be bigger,—lengthwise or crosswise, then cut in two lengthwise, measure it each way, and see which diameter is the greater.



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No. 2

November woods are bare and still;
November days are clear and bright;
Each noon burns up the morning's chill;
The morning's snow is gone by night.
Each day my steps grow slow, grow light,
As through the woods I reverent creep,
Watching all things lie "down to sleep."

—HELEN HUNT JACKSON.

FOR HOME AND SCHOOL



FIG. 1.—*Indian pipes.* The dish in which the Indian pipes are placed was modeled by school children.

Home is the best place in the world, and the more attractive and cheery it is the better we enjoy being in it. Boys and girls can do a great deal to make attractive homes. This year we are planning to publish each month in the JUNIOR NATURALIST MONTHLY simple suggestions for giving a clean, bright touch to the home and school. We are sure that many girls and boys will be able also to give suggestions along these lines that will be worth the while. If so, we shall publish them from time to time. Occasionally you may be able to send us a photograph to illustrate your idea.

Not long ago I was associated with some young persons in a summer school. They were active naturalists and knew how to enjoy the out-of-doors. These young folk had been taught to protect the things of beauty in the woods and along the wayside, and did not gather them in large quantities; but on one occasion a little girl, in passing through a deep wood, found a small colony of Indian pipes. She did not know what they were and brought them into

the schoolroom to learn their name. The Indian pipes were very much admired, and since they had been gathered we decided to make the most of them. In a clay dish which had been modeled in the school, some moss and rich mould from the woods were placed in which the Indian pipes were planted. We expected that the strange, white plants accustomed to forest shade would turn black when exposed to the light, but for the several days they were very pretty. The illustration, Fig. 1, will show how they looked. Do you not think the dish made by the children was just the thing for the Indian pipes? I have seen this same clay dish used for ferns and other plants found in the woods. If you have clay modeling in your school, perhaps the teacher will let you make a similar dish and have it fired so that it will not fall apart. Try the effect of



FIG. 2.—Seed-heads of ten common weeds. How many do you know?

placing it on a table in your schoolroom with a piece of clean, nicely-ironed linen underneath. Then keep something fresh and pretty from the out-of-doors in it. You will not be able to get Indian pipes in November, but I have found very attractive ferns at this season and little sprays of partridge berry will give a touch of color which I know you will enjoy. Try this and let me know what success you have.

WEEDS AND THEIR SEEDS

HERBERT WIETZEL

Most girls and boys like to work out puzzles, so I think you will enjoy this puzzle in weeds. In Fig. 2 are illustrated the seed-heads of ten of our common weeds. I gathered them all in one back-yard and

garden as I walked through the other morning. How many of them grow about your home and what do you call each of them? Run to the garden and see how many you can find. Here are a few hints to help you in naming them. Numbers 1 and 2 are named from their resemblance to parts of certain animals. The canary is very fond of the seeds of No. 3. No. 4 is the "Hobo" of the crowd. No. 5 must have been used by Good Queen Isabel in making her royal robes. No. 6 is a near cousin to the plant which gives material for your winter morning pancakes. It is the only climber among these weeds. No. 7 is a cousin of the radish. It is so common that I fear you have never stopped to look at it. No. 8 has a large red root and very tiny black seeds. I used to make little baskets of 9. No. 10 is the queerest of all. Some people call it the "bird's nest weed." Can you guess why?

Fig. 3 illustrates the seeds from nine of these weeds. Find out which of the seeds belong to the weeds shown in Fig. 2. Numbers 5 and 6 are



FIG. 3.—Seeds from nine of the weeds.

black and shiny, almost alike, but you will notice that those at 5 are the smaller.

After you have found out the names of these common weeds and have learned to know their seeds you will like to find out some other things about them, especially if you have to help keep them out of the garden and yard. Some of them live only through the summer, producing their seed and then dying, root and all. Others die down to the ground when the frost comes but their roots live all winter and send up new sprouts in the spring. You see you will have to fight each one in a slightly different way, for each has peculiar habits of its own. You will want to find out which ones produce their seeds the first year and which must grow for two seasons before they have seeds. Then, too, there is the question of how the seeds get into the garden. Some have hooks and have come with you from the woods or fields. How do others travel?

I wish that each of you would send me an answer to this puzzle. You can write it out like this: Seed-head No. 7 is hedge mustard; its seeds No. 4. Then tell anything you may know about this weed; how you would try to banish it from your garden and why you would fight it in the way you suggest. I will then send you a correct answer to the puzzle and some interesting things that I know about the weeds. If you keep a copy of the letter that you send me you can tell how many you had correct.

LESSONS ON SOILS

Do you remember, boys and girls, how you used to enjoy playing in the sand long ago? And how you knew the kind of sand that would make good mud pies and the kind of sand that would make a fort or a castle? Perhaps you also recall the many hours you spent breaking wayside pebbles to see the pretty colors and sparkling bits inside, not knowing that you were helping to make soil. In those days you used the soil as a plaything; now you are ready to learn some of the things about it that a naturalist should know.

LESSON NO. 1. WHAT THE SOIL IS

E. O. FIPPIN

The soil is the covering of the land portion of the globe in which plants grow. It covers a large part of the earth. High in the mountains and on dry deserts there are always a few plants growing, and hence there is soil in those places though it may not be very productive. The plants of all kinds reach their roots into it for food, water and warmth, and for a solid foundation to hold their tops upright in the air. Whether there are many or few roots depends on whether the soil offers them a good place in which to grow.

It will be seen that the soil is very important. It is interesting to look at and think about since it furnishes all the crops that are food for man, the fibers that are made into his clothing, such as cotton and flax, and the forest trees that yield wood for building houses and many other useful purposes.

Many plants are small and have short roots and many others have most of their roots near the surface of the ground. These open numerous passageways in the soil. Many of these die and, with leaves and twigs, are mixed with the surface of the ground, forming a material that is usually darker in color and more easy to dig than the material beneath.

This darker and more loose material is the true soil. It is one of the two parts of the great earth covering that produces plants.

Just beneath the soil the material is of a different color — usually lighter — and not so loose and open, for it does not contain so many plant roots and rotten wood and is not stirred. This is the subsoil. It reaches down several feet or as far as plant roots grow, and is just as important as the true soil, since it helps to furnish what the plant must have — food, water, and heat.



FIG. 4.—A spray of barberry.

Questions on Lesson 1

1. Do you know of any place in the field or among the hills where plants do not grow?
2. How deep in the ground did you ever find roots of plants? Look at the creek bank where the water has washed away the earth or where the earth has been carried away in making the road more level, and see the many roots — some fine and threadlike and others large and knotty.
3. Can you tell the difference between the soil and the subsoil in the school yard?
4. Do the soil and the subsoil look the same in different places, as in the creek bottom and on the hillside?
5. What is the greatest depth of soil you know anywhere in your neighborhood?

SOME AUTUMN AND WINTER BERRIES

How many boys and girls know barberry? It is often used as an ornamental shrub in the garden. One can make use of the berries for table decoration at Thanksgiving and Christmas time. Then, too, it furnishes food for winter birds. It may be that you will find barberry growing near your home, and, if so, I wish you would help mother make the table attractive with it for the Thanksgiving dinner. You need not gather a great deal because you want to leave some of it out-of-doors to look pretty and some for the birds. A small spray of the berries by the side of each plate and a few larger sprays in the center of the table will be sufficient. Perhaps you might write some pretty bit of poetry or prose of three or four lines on a white card, and lay the piece of barberry on the card beside the plate. If you do this, I wish you would let me know whether you are successful in making your table attractive and also what poetry you use. I think that your parents and the Thanksgiving guests would probably enjoy lines relating to the out-of-doors.

If you cannot find barberry, you may be able to secure some of the false or climbing bittersweet. The false bittersweet has the crimson and orange fruit. Many persons speak of this as the bittersweet, a name that is more often given to the nightshade. The common bittersweet or nightshade is very attractive out-of-doors but it does not make such a pretty table decoration as the false bittersweet.

FEATHERS

JAMES E. RICE

"Why do hens have feathers?" That is a good question. Who can answer it? "To keep them comfortable?" Yes, during the winter, but how about the summer? Do the feathers then keep the birds warm or cool? Watch hens on a hot day and notice how they raise their wings and loosen up their feathers. Look in an encyclopedia and find out whether feathers are good non-conductors of heat. How warm we sleep in a feather bed! But who has another reason why hens have feathers? "To protect their bodies from the sun, the heat and the rain?" Good! but there are other reasons. How about protection against injury and wet? Does it hurt your hands with gloves on as it does with bare hands to catch a hard ball? Feathers form a splendid armor plate. Each feather is a little shield. They are lapped over one another like shingles on a roof, so that they are several feathers deep on all parts of the body.

Who can tell by the appearance of a feather what part of the bird's body it came from? Here is a good opportunity for bright eyes to observe common sense styles in hens' clothing. I wanted to help you a little on this question, therefore photographed some feathers. Notice how each kind of feather has a particular utility for which it is perfectly adapted. No. 5 is a wing feather. Do you see how strong and broad it is to enable the bird to fly? No. 4 is the beautiful curved sickle feather that adds so much grace and beauty to the fowl. Which has sickle feathers, hens or roosters? No. 3 is one of the tail coverts that cover up the wide



FIG. 5.—There are many different kinds of feathers on fowls. How many can you find on a hen or rooster?

strong main tail feathers that serve as a rudder with which to steer when birds fly. No. 11 is a "fluff" feather. How different it looks? All soft and downy. It came from the under side of the body, back of the thighs where there is great need of protection against excessive heat and cold, but where there is less danger from injury, because less exposed, than any other part of the body. Heavy, hard feathers would be in the way. No. 2 is—Oh! I guess you would better catch a chicken and find out for yourself what part of the body the rest of the feathers shown came from. Do not make the mistake, however, of trying to find all the kinds of feathers on a hen. Try a rooster. No. 12 is from the back of a pullet. No. 13 is from the same place on a cockerel. Do you see the difference? There is at least one more good reason why hens have feathers. The photograph shows it. Who knows what it is? I will let you think about this until you get your next Junior Naturalist Monthly.

VEGETABLES AT THANKSGIVING TIME.

How many of you in passing markets enjoy looking at the vegetables spread out to attract purchasers? I sometimes find them as interesting and often as handsome as flowers. Now, at this season of the year, when the harvest time is past, you will see many varieties and I think you can have some good Nature-Study lessons in connection with them.

Suppose you plan to have different members of the class bring certain kinds of vegetables to school. John, perhaps, will get a fine, large pumpkin; Mary might bring two or three carrots; Helen a squash;

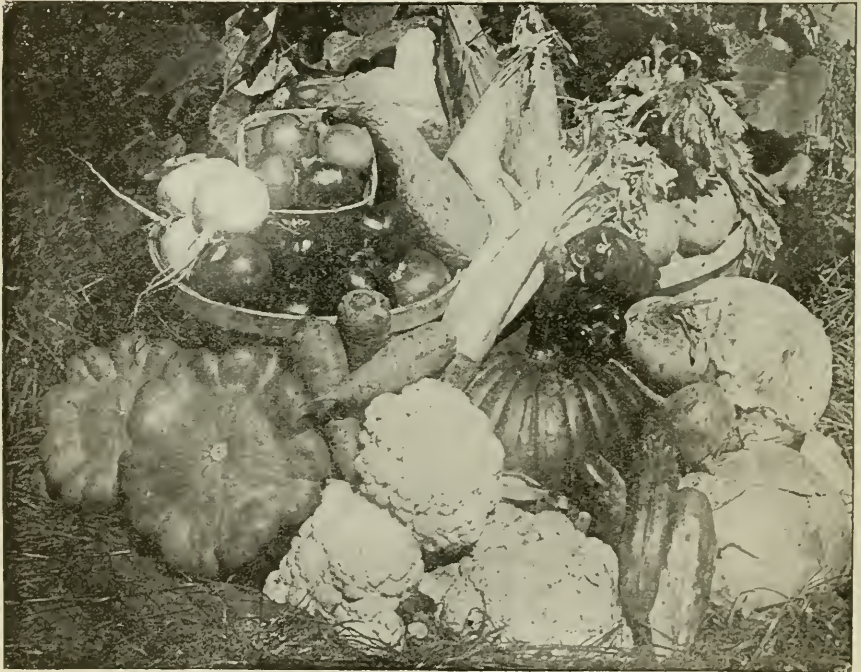


FIG. 6.—A collection of vegetables. How many kinds are there?

Richard some beets; other members of the class might get a few onions, some corn, beans, celery, or anything else that is grown in the country round. Arrange the vegetables on a table in a corner of the room where you can look at them. Then, when you have finished your other work, answer the following questions and ask your teacher to send your written observations to Uncle John:

1. Write a list of the vegetables that are on the table and after each one state what part of the vegetable has been harvested. Is it the whole root, part of the root, the stem, or the fruit?

2. Notice the colors in the group of vegetables. How many colors can you see and name? Which vegetable lying on the table has the greatest number of colors? Which do you think is the handsomest of all? Which one do you think makes the best food?



FIG. 7.—*Nightfall. All-hallow-e'en.*

basket. The basket might be given to some one who could make good use of the contents.

* * *

The grain is gatheréd in;
 The season's work is done;
 No more the hurrying din
 Of the stress of noon-time sun.
 But beautiful and calm,
 And full of healing balm,
 The autumn rest is won.

—EUDORA S. BUMSTEAD.

3. How many in the class know how the seeds of different vegetables look? Could you make a drawing of the seeds of the pumpkin? What can you tell about the seeds of the onion; of celery; of carrots?

4. If you have an ear of pop corn and one of the common corn, compare them and tell what differences you can see.

5. After you have finished your study of the vegetables, some of them might be used for a Thanksgiving

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No. 3

WINTER BIRDS

Ah, may I be as cheerful
As yonder winter birds,
Through ills and petty crosses,
With no repining words;
So, teaching me this lesson,
Away, away they go,
And leave their tiny footprints
In stars upon the snow.

— GEORGE COOPER.

If I should go into your school and should ask you why so many birds go South in the winter, what would you answer? Do you think you would say, "Because it is so cold?" Probably, and yet the real reason is because a great many birds that stay with us in summer cannot get food enough when snows lie deep and winds blow cold. Now, in order to understand why birds cannot get the food they need in winter, we must consider what they eat. I shall mention a number of things and perhaps some of our girls and boys will be able to add to the list.

Let me see. Birds eat *seeds*, such as ragweed, smartweed, rib grass, tick trefoil, and pigeon grass. *Berries*, such as wintergreen, partridge berry, sumac berries, ber-

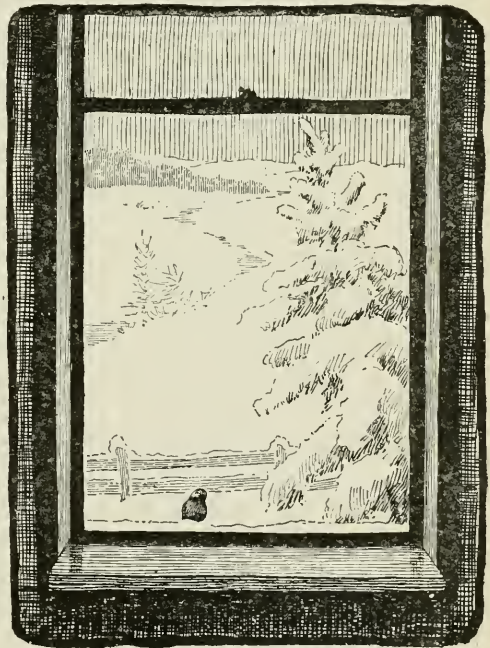


FIG. 1.—A hungry little bird.

ries of poison ivy, cranberries, black alder, dogwood, and wild grapes. *Nuts*, as acorns. *Buds of trees*, particularly those of the apple, ironwood, birch, and poplar. They also eat mushrooms, grains, insects, spiders, mice, eggs and young of many insects, and some of the larger birds eat rabbits, squirrels and poultry. Then you remember that old Jim Crow, as well as other birds, eats corn, and some birds will attack ripening fruit and garden vegetables.

As you look over this list, you will see that if all the birds stayed with us in the winter time, they would have great difficulty in finding food; particularly those birds that feed largely on insects. What would the flicker do in winter for the ant-hill that you find him haunting in the summer time? How long do you think a flycatcher would sit on a telegraph pole before an insect in passing would give him an opportunity to get something for his dinner? And what would the birds do that feed on worms, caterpillars, and butterflies?

No, large numbers of birds leave us in winter; yet there are a few that brave the cold weather, and by their industry and by adapting themselves to the kind of food that can be found in winter fields and woods, they are able to stay with us. How fortunate we are to have them! Who would be without the downy woodpecker, the busy nuthatch, or the cheery chickadee? Who would permit one of these little birds to go hungry outside his window if he could help it to get food? These are questions for young naturalists to consider these cold days, and to decide what they can do to help the little out-door brothers.

For many years we have asked Junior Naturalists to have a Christmas tree for the birds. We hope that as each year comes round, boys and girls will enjoy furnishing one for the winter neighbors and give them a feast day occasionally.

Winter birds often become tame and will come very near to your window for something to eat. The woodpecker, nuthatch, and chickadee are able to stay in our climate during the winter because they eat the eggs, larvæ, and pupæ of insects that are found beneath the bark of trees. They seem to like quite as well as this their natural food, a piece of suet fastened to a tree by some thoughtful naturalist. This gives the little bird a chance to get something good to eat on a cold day, and gives the Junior Naturalist a chance to study the bird near at hand. For the seed-eaters, it will be well to furnish some grain or seeds of weeds which can still be found above the snow. Occasionally you might hang out a bone that has a little meat on it and put some seeds in a basket so that they will not blow away. These will be thoughtful attentions which I am sure the birds will appreciate. Keep a record of every bird that visits you and see each time whether you can learn something new of its appearance or ways.



FIG. 2.—A winter night. What can you see from your window when the moon and stars are out?

A NIGHT BEFORE CHRISTMAS

'Twas night
 And all life
 Dreaming in repose was still;
 The fields, the wood, the mountain rill.
 The beasts,
 And many tinted birds,
 The fishes in the lakes,
 The herds.
 The golden stars sailed on,
 And sorrow, care,
 And sin had gone.

— JAC LOWELL.*

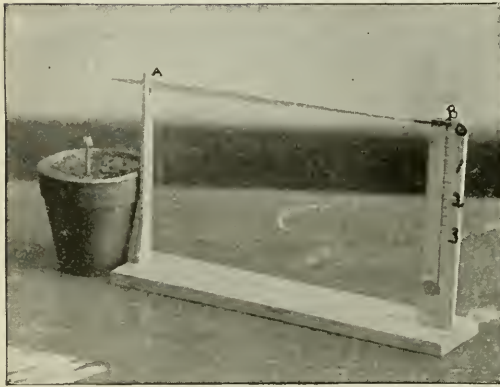


FIG. 3.—An arrangement for measuring the growth of plants. Who can make one like it?

Some evening this December, a little while before mother says it is bedtime, raise the curtain and look out at the stars. I want you also to see the moonlight at least once during the month. Perhaps you will wrap up warmly and stand out-of-doors a few minutes under the starry sky. Ask father to go with you and to tell you some of the things that he knows about the stars and the

moon and the great, still night.

How beautiful the fields look in the moonlight, so white and so shadowy and so quiet! How far can you see from your window on a moonlight night? How far can you see by starlight? Notice the trees in the night. Look at the stars through the branches. Watch the shadows of the trees on the snow.

What sounds can you hear at night?

What little animals of the field are out? Look in the morning and see whether you find tracks that any of them have made in the snow.

HOW FAST DO PLANTS GROW?

HERBERT WHETZEL

Of course you know that plants grow. That is how trees become taller and strawberry runners longer. That is how the morning glory climbs the string that you tie up at the window for it. But do you know

* From *Birds and Nature*, by courtesy of The Mumford Publishing Company.

how fast these plants grow? What is needed to make them grow most rapidly? When do they grow most, at night or in the day time, or just as fast one time as another? I think you will find it good fun to try to find out the answers to some of these questions.

The best way to find out these things is to let the plants answer the questions. First, then, we must have the plants. Get three small pots, cans, or boxes. Fill each with earth, sawdust, or even fine chaff from the barn will do. Plant three grains of corn in one can, five grains of oats in another, and five grains of buckwheat in a third. If you do not have these seeds, any other kind will do. Wet the soil of each with lukewarm water and place near the stove.

Now, while we wait for our plants to come up, we will make some machines with which to measure how fast they grow. The girls may make a machine like this, such as we have illustrated in Fig 4; if, however, they know how to use a jackknife or have a brother to make one for them, they may prefer the one shown in Fig. 3. The machine in Fig. 4 is a smooth, flat stick with inches, half inches, and quarter inches marked on it. When the little plant first peeps above the ground, put the stick into the soil beside the plant, pushing it down until the zero mark comes just to the tip. Put the plant back by the stove and see whether the tip stays at zero all night. You can make a machine for each plant and see which grows the fastest.

Many of you I am sure will like to make a machine like the one shown in Fig. 3. You will need some thin pine boards, pins, thread, paper, a jackknife, and gimlet to work with. The long arm of the pointer is four times as long as the short arm including the pin. The tip of the pointer is dipped in ink so that it will show more plainly. A common pin is used as a pivot at *A* on which the pointer must swing freely. The long piece of paper with the pin holes in it is used so that you can regulate the length of the thread to suit the distance from the tip of the plant to the short arm of the pointer. The short bit of paper is to attach the plant to the machine. Stick this bit of paper to



FIG. 4.—A more simple arrangement for measuring the growth of plants. Try it.

the tip with some paste or the white of an egg. The pin at the top of the scale is a place on which the pointer can rest until the paste has dried and fastened the tip of the plant to the machine. This pin should be a little above the zero mark so that when the paste is dry you can remove the pin carefully and the pointer will stand exactly at zero. The machine with the plant attached should be set in a warm place where it will not be moved or interfered with. It is best to do this before the plant is attached and certainly before the pin is removed that releases the pointer.

This machine is better than the other for at least one reason. Can you tell what the reason is? Does the pointer show exactly how much the plant grows? If not, how will you find the true growth in length?

The machine should be kept attached to one plant at least twenty-four hours. It should not be moved during this time. Try it on the different plants. Be sure to keep the machine for we shall want to use it next month. See how many of the questions you ask about plant growth can be answered by the machine.

A SUGGESTION FOR CHRISTMAS TIME

Every young person should have a library all his own and he should learn to take care of his books. I should like our boys and girls to begin now to make a collection of good reading material and to have it in your own room or in some attractive corner of the living room. If you do not own a bookcase, perhaps it will be well to consult St. Nicholas in regard to the matter. In the stores, one can purchase small bookcases such as you see illustrated in Fig. 5, for one dollar and twenty-five cents each, and I doubt not that there are many to be found in the workshop where Christmas gifts are made.

Then, when you have your bookcase, I hope you will get some good Nature-Study books for it. The real naturalist must study out-of-door things, not books, but it will always interest him to learn what other naturalists have found out, and the experience of older naturalists will be helpful always to young students. From time to time, therefore, we shall suggest some good Nature-Study books for the library of Junior Naturalists. Following are three that I have in mind for this issue of the Leaflet:

Bird Life, by Chapman.

Insect life, by J. H. Comstock.

Familiar Trees and Their Leaves, by S. Mathews.

NOTE.—*We shall occasionally suggest books that will be useful on the teacher's desk. Nature-Study and Life, by C. F. Hodge, of Clark University, contains many useful suggestions for Nature-Study in the public schools.*

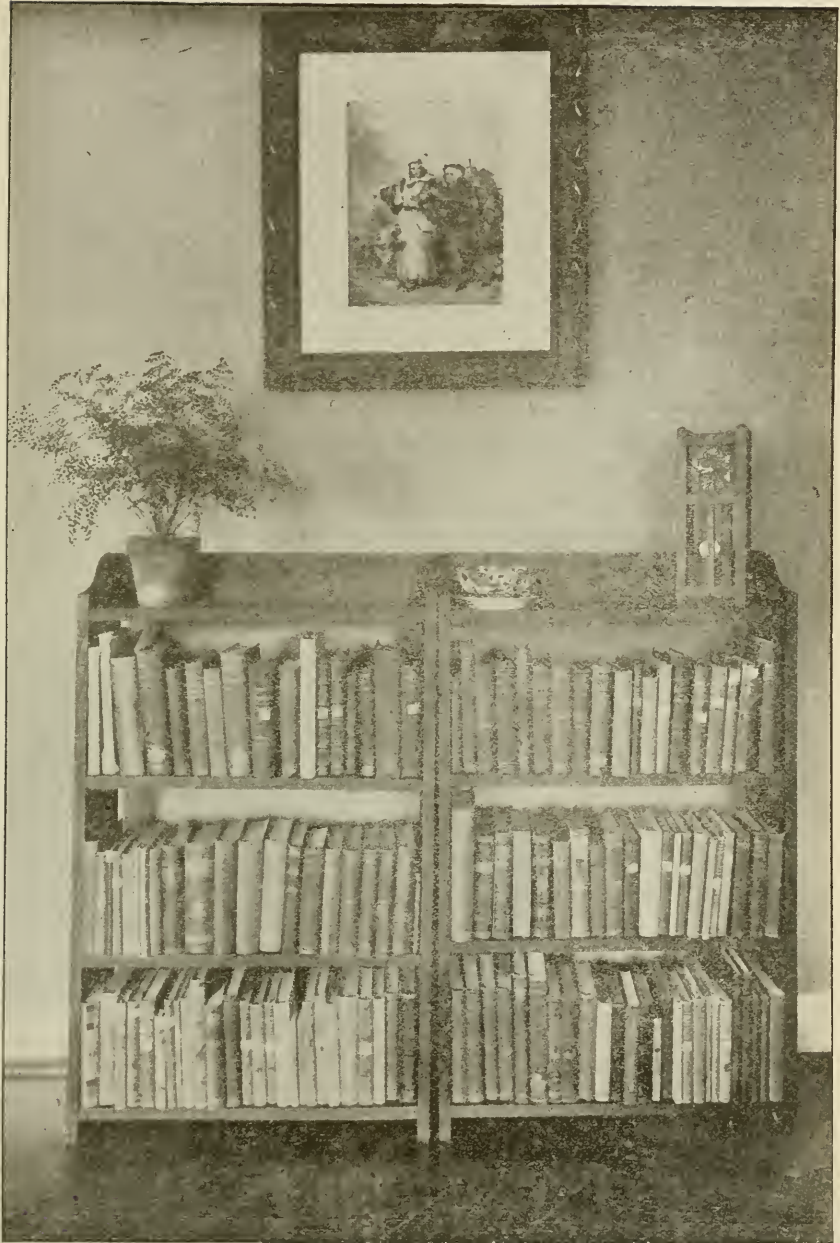


FIG. 5.—Two bookcases that cost one dollar and twenty-five cents each. Start a nature library.

A VISIT TO A RURAL SCHOOL

Not long ago I spent an afternoon in a country schoolhouse in which there were fifteen boys and girls. I had such a happy time there and saw so many things to interest me, that I want Junior Naturalists to know something about it.

The schoolhouse stood alone in a very attractive place. There were rolling hills in front and all about were brown fields rich in late autumn colors. Many splendid trees could be seen from the windows and above them was a wonderful gray sky. It was a very pretty place for a school building and I wondered how many of the young persons had learned to love the rolling hills, the fine trees, and the gray sky.

But it was not the outside of this school that interested me most that October afternoon. It was what had been done inside to make a cheerful and homelike place — a place in which young hearts and minds could grow.

In the first place, the room was clean. The children, with the help and direction of a wise teacher, took care of it. The floor was nicely swept, the desks dusted. In one corner of the room was a box neatly covered, on which was a sofa cushion. This made a little cosy corner in which some boy or girl might sit and read.

Then at each window was a white curtain. The curtains were made by the pupils and gave a clean and cheerful touch to the room. On the window sills were plants, some of which had bright scarlet blossoms.

But best of all was the library! This consisted of a bookcase in which were several books, many, if not all, owned by the teacher. The children had the privilege of using these books.

The walls had been made attractive by some pictures and charts. I noticed one chart on which were pictures of birds. The teacher informed me that she had in her possession several of these pictures, and when the children saw a bird, they were allowed to place the picture of it on the wall. I was pleased to see that the young folks had been successful in seeing a number of birds although it was late in the year.

On the desk at which I sat was a small white card on which was written: "Aim high and believe yourself capable of great things." I liked to read this. Do you know why?

I was sorry when my afternoon came to an end, there was so much to interest me in the little school; and as I went away along the country road, I had much to think about. In how many rural schools, I wondered, have teachers and pupils worked together to make the schoolroom cheerful and homelike, and full of happy thoughts and bright spirits? If there are such, I should like to hear about them. Tell Uncle John about your schoolroom.

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No. 4

OF WHAT THE SOIL IS COMPOSED, AND THE KINDS OF SOIL

O. H. FIPPIN

The soil is made of small particles of rock and of decayed plants. In most soils nearly all these particles are bits of rock of all sizes. Stones and pebbles may be found, but most of the particles are so small that they cannot be seen with naked eye. A hundred of the finest particles in a row would only equal the thickness of this paper. These finest particles are called clay. Those particles a little larger are called silt, and a handful of them would feel soft and velvety. The fine particles that can be seen with the eye alone are sand. Some of these sand particles are very fine

and can just be seen, while others are as large as the head of a pin. Sand feels gritty and makes a dull harsh noise when rubbed together.

A lump of soil may contain all these different sized particles. It may look as if it is composed of a lot of little grains, but these are the fine particles that stick together. Stones and gravel are



FIG. 1.—*Experimenting with soils.*

a real part of the soil when they occur in it.

When these different sized particles are mixed in different amounts, they form different kinds of soil. If most of them are very fine, the soil is a clay and when wet has a slippery, greasy feeling. If the soil contains mostly sand particles, it is a sand or sandy loam. It may consist of the coarse or the fine grade of sand, or all of these, as is usually the case.

The important points to remember are, that the soil is made up of a very great number of particles of different sizes, with small spaces between the particles as there are in a pile of brick or stone, and that there is every imaginable mixture of these particles. The soil down by the creek may be very different from that on the hill.

Questions on Soils

1. How many kinds of particles can you find in a handful of soil?
2. Put a little soil on a hot stove. Does any of it burn? Does the color change any? How?
3. You like to play in clean white sand and you remember it is made up of an innumerable lot of little particles—grains, you might call them. Can you find any of these sand particles in the soil from the garden?
4. Did you ever notice the fine sparkle of some soils? What colors are there?
5. How many different sizes of particles can you see?
6. What is the shape of some of these little particles? Are they shaped anything like the boulders you have seen at the gravel pit or on the stone pile?
7. How many different kinds of soil do you know, such as sand, clay, etc.?
8. When you washed the different sized particles from the soil, did you find it as good as making mud pies?

Note.—Many Junior Naturalists collected samples of soil in October. This lesson will give them an opportunity to do some experimental work with the soils.

SOMETHING ABOUT MICE

In my office there is a little house mouse as friendly and as much at home there as if it were his own abiding place, and such he has made it. He comes in and plays about my chair, runs across my desk, and in general keeps in touch with what is going on about him.

Now I do not think that we can permit mice to live in our homes and I am sure that the good housekeeper is right when she refuses to share her house with them. I do think, however, that the young naturalist can learn much from the study of house mice and field mice, and this is a good time to begin. The true naturalist will always find out for himself the animal life that is useful and that which is harmful. This can be done only by patient and careful study. Here are a few questions that will help you:

Are there mice in your home? Where do they live? What do they eat? When do they come out to find food? What harm do they do? Have you found them of use in any way? Of what do they make their nests?

There are two wild mice that you ought to know : the meadow mouse that looks like a tiny bear, and the little deer mouse or white-footed mouse, as it is sometimes called. Do you ever see these mice in winter? What kind of tracks do they make in the snow? Do you know any way in which they are useful? In which they do harm?

THE THISTLEDOWN HOUSE

VAUGHAN McCAUGHEY

One cloudy afternoon in October when most persons were indoors, a friend and I were sitting on a mossy old rail fence, near the edge of a little patch of woodland, watching the birds. The birds were as busy



FIG. 2.—*What kind of mouse is this?*

and cheerful as if it were June. Robins were feeding among the dead leaves, field sparrows were twittering in the weeds, and a little woodpecker was pounding vigorously at the loose bark of a nearby stump. His "rat-a-tat-tat" attracted our attention, and after he had flown away, we went over to examine the stump. The bark was so loose that a great, flaky fragment fell off into my hand, disclosing to our astonished gaze a thistledown house.

Near the top of the stump was a small opening, so rough and jagged that no one would imagine it to be the front door of a silver palace. This front door opened into a little round runway, between the stump and the loose bark. This hallway in turn opened into a snug little room, thickly

lined with soft, warm, glistening white thistledown. We scarcely had time to notice this cozy nest when out jumped a deer mouse, exposing to our delight three dainty pink and white baby mice, nestled together. Upon careful search we found the shy little mother, a deer mouse, trembling under a fence-rail near. Gently we placed her in the thistledown nest, and when her young ones again cuddled against her warm breast, she took courage and laid still. Softly we laid back the strip of bark, propped it securely in place and stole away, leaving in peace the thistledown house.

TRACKS IN THE SNOW

ADA E. GEORGIA

What a wonderful teacher and playfellow is the snow! When it first comes, how the children shout in anticipation of the good times they will have with it, snowballing, coasting, and building forts!

But did you ever go to it quietly and ask it to tell you some of the strange and wonderful things it knows? Sometimes it can tell most interesting stories and tell them very plainly. We like to read stories of the Indian hunters who follow "trails" so skilfully, but how came they to have such keen eyes? Yours and mine are probably just as good if only we knew how to look.

Let us see whether we can read a few tracks in the snow, taking the very easiest and nearest at hand. Can you tell your Malta cat's track from that of your neighbor's terrier whose feet are no larger? Look sharp!

Oh, yes; Puss draws back every claw in its sheath and leaves only the mark of a velvet pad with four toe dots in front. Nipper's nails do not retract and each leaves its mark in front of the toe. Also Malta's hind feet drop neatly upon the front paw's tracks, so that she seems to walk two-footed. Nipper cannot match his tracks like that.

Study the tracks of your chickens and pigeons and the birds of the street; even the tracks of different people are very interesting.

On my way home from school one winter evening, I saw the tracks of two persons which pleased me greatly; one of them a tall man—I knew he was tall by the long steps—and beside these tracks were the mark of some wee rubber boots, trotting three steps to one. They were new rubber boots and I smiled as I pictured a little man wearing his first pair and going proudly out to meet father. Presently I turned a corner and came into view of the track-makers and the little man turned out to

be a little girl. Do you not think she enjoyed wearing the new rubber boots as well as any boy would?

But it is the country lad that can play at trailing. About the poultry yard comes the marauding skunk, fox, and weasel and every wood path tells a story—if the snow is just right.

I remember one March morning when a "sap snow" covered the ground and I was on my way through a little wood to a country school, I came across a most remarkable track. It looked just like a tiny baby's foot. The well-defined heel, the slender sole, each dainty separate toe—it was perfect! It led down to the recently thawed brook. Much puzzled I went on to school and asked my pupils about it, and there was a shout, "'Twas a coon! Oh, teacher, coons have waked up!"

Through the pastures and brush lots Bunny Cottontail goes; but look out that you do not trail him backward, for Bunny overreaches and at every jump plants his larger and longer hind feet well in front of the tracks made by his tiny forepaws.

Squirrels, with the exception of the ground squirrel, are ready to come out every warm spell and search for the nuts they have hidden. And mice! They are everywhere: especially along the edge of a millet field. They do not seem to take winter naps. They make miles of little runways through the grass under the snow, which are uncovered when it melts, and seem to have a social time above it as well, from their numberless tracks. Sometimes you catch sight of a mouse track that is perfect from each tiny claw mark to the knitting-needle scratch of mousie's little tail.

Do not fail to take walks in winter weather and question the snow. Keep a record of all the different tracks that you find. If you do not know what animal made the tracks, send us drawings of them. Perhaps we can tell you what they are.

THINGS THAT MAKE PLANTS GROW

HERBERT WHETZEL

Well, what did the measuring machine tell you? Did you learn while watching it that water made the plant grow faster and that heat did the same thing? You know how necessary it is that the rain should come in the spring and summer. When there is plenty of it, how fast the corn grows and how tall! You walk between the rows and look up to see the tassels just peeping out and sometimes even the ears are lifted above your head. But when a dry summer comes, and day after day the sky is clear and the sun is hot, what a difference it makes in the cornfield!

You cannot hide in the corn for you are often taller than the stalks, and the farmer's back aches as he bends over all day to cut the short fodder. The shocks are small and far apart. "Dry weather," says the farmer

as he looks at his field.

Thirsty plants cannot grow.



FIG. 3.—*Keeping a record of the growth of a plant.*

Have you ever noticed the cornfield when the spring days are cold? There is plenty of water; it rains often, but still the little plants get no taller as you watch them day after day. "Warm nights," says the farmer, "we must have warm nights."

Then by and by when

every one is sure the crops will all fail and every one looks glum and growls about the weather, suddenly the sky clears and the nights grow warm. Sometimes it is so hot you cannot sleep, but it is fine for the corn. See how it grows in a night. It seems as though you can almost see it grow. If the cold weather has not lingered too long, the little plants may forget the chilly days and grow tall and strong, seeming to make up for lost time when the warm weather does come. But if the cold nights continue too long, the stalks will never be tall and the ears will be small, even though there has been plenty of rain. *Warm weather and plenty of rain; that is what makes plants grow.*

What did the machine tell you about the growth during day time and during night time? When the plants were small, you will perhaps have noticed but little difference in the rapidity of growth during night and day. If you will measure the growth of the youngest leaf on your wheat plant when the plant is a month old, you will very likely find that it grows quite a bit faster at night. When the little plant is very young, it lives almost entirely on the starch that the mother plant made and packed away in the seed for it. This food is ready to be used at once and can be made over into root, stem, and leaf during the day as well as at night. As it gets older, this starch food is used up and the little plant must make starch for itself.

Now starch is only made in green parts of plants, the leaves and green stems. The leaves of plants are the only starch factories in the world. But the green leaves can only make the starch when the sun shines upon them. The sunlight is the power that makes the factory go. It is, then, in the daylight that the food is made. During the night this starch is changed to root, stem, and leaf — the little plant grows. To be sure it grows some during the day but most of its energy is then given to making food.

A shower in the morning, a warm, sunny afternoon and a warm night; what could suit a growing plant better?

Have you made a machine for measuring the growth of plants? If not, try it this month. The boy in the picture is keeping a daily record of his plant. If you keep such a record, Uncle John will be glad to see it.

HOME MAKING

There are many ways in which even small boys and girls can make the home brighter and happier. How many things have you done during the past month to be helpful to mother or a comfort to father? What can you do this month?

Oftentimes boys and girls would do more for the home folks if they knew how to begin. It is best to start with small efforts. The little things done every day count most. I was much interested one summer in a young friend who, by a simple daily act, made life mean more to one for whom she cared. Early in the morning she went into the field, gathered a bunch of pink clover wet with dew, and left it in the room of her friend. All through the summer, in sunshine and rain, this small bouquet was gathered, and it was so fresh and sweet that the whole household as well as the one to whom it was given enjoyed it. I am sure you will believe that this little girl was missed when she went away and the bunch of pink clover no longer appeared. Let each one of us think of a daily kind act that we can do for some one in the home.

Why not plan this month to make father feel that he is in our minds and hearts while he is away at work? You can do some little thing that he will appreciate even though he may not say anything about it. Perhaps you might make the place where he reads his evening paper more attractive. Ask mother if you may make the table neat for him this one month and see how much you will enjoy it.

Now let us think of some simple way in which this can be done. First, take everything off from the table and dust it well. Then see that the



FIG. 4.—The table ready for father. The clean table looks better than if it were covered with a dusty, soiled cloth.

lamp is well cleaned and the wick trimmed. Next, place on the table a piece of clean, nicely-ironed linen, fringed or pin-stitched by some little maid who enjoys seeing things neat in the home. On this piece of linen put a plate of apples which you have wiped off carefully with a clean, damp cloth. There will still be room on the table for the plant that the young naturalist has been taking care of. I hope it is a geranium with a bright scarlet blossom, for this kind of a plant always looks so cheery. Then do not forget the evening paper. Be sure it is on the table so that father will not have to look for it.

For Little Home Makers to Remember

1. A feather duster should never be used. A cloth that can be washed frequently is best for dusting.

2. It is better to have one thrifty plant in a clean place than a great many surrounded by untidy conditions. Give your plant water and light and keep the foliage clean; then when you put it on the table, you will enjoy it.

3. Do not have many things on the table at which father reads. Neatness and convenience are important to comfort.

4. At first you may get tired of doing the same thing every day, but if you persevere you will soon enjoy doing something that makes home more comfortable for the home folks.

NOTES

1. Although Uncle John has not this year insisted that Junior Naturalists should write a letter each month, he is hoping that you may choose to tell him at least as often as this, what you are doing in your study of nature. He would feel very sorry indeed not to have the usual number of letters from his boys and girls.

2. Do not forget to keep a record of the winter birds. See how many new things you can learn about them. Have you put out any food for them? Have you seen a red headed woodpecker, a nuthatch, a bluejay, a chickadee or any of the other winter neighbors?

3. Make a list of things you find out-of-doors this month that birds could eat. How many seeds of weeds do you find? Have you seen any insects?

4. Can you name all the evergreens that grow about your home and school? Do you know the hemlock tree, the spruce, the white pine, the

cedar, and fir trees? What have you learned new this year about the evergreens?

5. Observe the forms of snow flakes. Count the rays and angles of the star-shaped ones when they fall on your woolen wraps as you play out in the snow. If you find one that is not rayed in multiples of three, tell us about it.

6. *The mailing list for the Junior Naturalist Monthly is being revised. All persons desiring the publication who have not registered as Junior Naturalists this year, should send their names to the editor as soon as possible.*

Junior Naturalist Monthly

Published by the College of Agriculture of Cornell University, from October to May, and entered at Ithaca as second-class matter. L. H. Bailey, Director

ALICE G. McCLOSKEY, Editor

New Series. Vol. 2. ITHACA, N. Y., February, 1906.

No. 5

Chill airs and wintry winds! My ear
Has grown familiar with your song;
I hear it in the opening year,
I listen, and it cheers me long.

— HENRY WADSWORTH LONGFELLOW.

SOMETHING ABOUT PIGEONS



FIG. 1.—*Pigeons are interesting play-mates.*

A long time ago in a far away country I became acquainted with some pigeons. I was a stranger in a strange land and these friendly little birds were in a garden where I was being served with refreshments. I had ordered cake and coffee. The pigeons seemed to understand that something of interest to them was about to happen, and they approached my table with as much self-possession as if they were invited guests. Two of them perched on the back of my chair, and one, more courageous than the rest, took a place on the table. When the cake was brought, this bold little pigeon flew away for a minute, but he soon returned, and, without waiting to find out whether I would share my luncheon with him, he immediately began to eat the cake. The two that

were on my chair joined him. Being a polite hostess on this occasion, I thought I would wait until my guests were well served before I took my share of refreshment. The pigeons, however, seemed to forget that I was there, and pretty soon my cake disappeared. I forgave the small visitors because their pleasant company more than made up for the loss of the cake.

As I watched the pigeons, it occurred to me that when I reached home I would encourage our Junior Naturalists to have a few of these tame birds for pets. I wish you would think about this and perhaps you

will be able to have them in the school yard where they will remain from year to year. This will give the children who come to the building from time to time an opportunity to study their ways and become familiar with their lives. I shall tell you how we are planning to do this in one school in New York State.

In the city of Ithaca there is a school building situated on a hillside. In this school there are about two hundred young persons whom I have often noticed in the yard at recess time and before the opening of school. It occurred to me that they might like to have some pigeons for playmates and when I consulted them, they were pleased with the prospect.



FIG. 2.—*Cecropia molh.*

In preparation for these little neighbors, we are going to ask the girls and boys to make a pigeon house, because it is a good thing for children to learn to use tools and provide comfortable houses for their pets. The pupils in this school have made bird houses, so I do not think they will find it difficult to make a pigeon house. We shall have the floor space eighteen inches square, the height fifteen inches, and the doorway six inches high. For pigeons there must be a platform in front of the door. The pigeon house may be painted, for these birds do not mind the paint which wild birds frequently object to. The house should be placed on a building, if possible.

Boys and girls may find it somewhat difficult to keep the surroundings of the pigeon house clean, but I am sure they will willingly do it for the privilege of having these pets. During this month I wish you would try to get the house made and put in the school yard. Next month we shall tell you how to feed your pigeons and how to take care of them, giving some suggestions for observation which will interest boys and girls,

A MOTH IN THE SCHOOL ROOM

Last year I received a letter from a Junior Naturalist stating that a butterfly had come out of a cocoon in the schoolroom. He made a drawing of the cocoon and I knew that he had not seen a butterfly come out of it but a large, handsome silk-worm moth. In order that young naturalists may not make the mistake of calling a moth a butterfly, I have shown you a picture of the cocoon in Fig. 3 and of the moth which comes out of it in Fig. 2. These large cocoons are frequently found by girls and boys and taken to the schoolroom. They are the winter quarters of the



FIG. 3.—*Cocoon of cecropia.*

Cecropia moth. This is a long name but the moth has no common name. I think our boys and girls will be able to remember the word *Ce-cro-pi-a* (pronounced *Ce-cró-pe-a*). The caterpillar from which this moth develops is frequently found on apple trees and shade trees in summer time. It is a large, stout green caterpillar with conspicuous tubercles on its back. The caterpillar spins its cocoon and then has a period of rest until spring. If you take one of the cocoons into the schoolroom, keeping it cool and moist, you may be able to see the large and handsome moth that comes

from it. If you are likely to confuse moths and butterflies, remember that moths usually come out of cocoons, that they have straight or feathered antennae or feelers without any knobs on the ends, and that when they are resting they spread their wings. The butterflies have knobs on the ends of the antennae and rest with the wings folded together. Notice whether the antennae or feelers of the *Ce-cro-pi-a* are straight or feathered.

FOOD OF BIRDS IN LATE WINTER

"What do little birds eat at this time of the year?" The children often ask. If, as you go home from school, you will notice the old plant stalks bearing seeds that are sticking up above the snow, you will see food

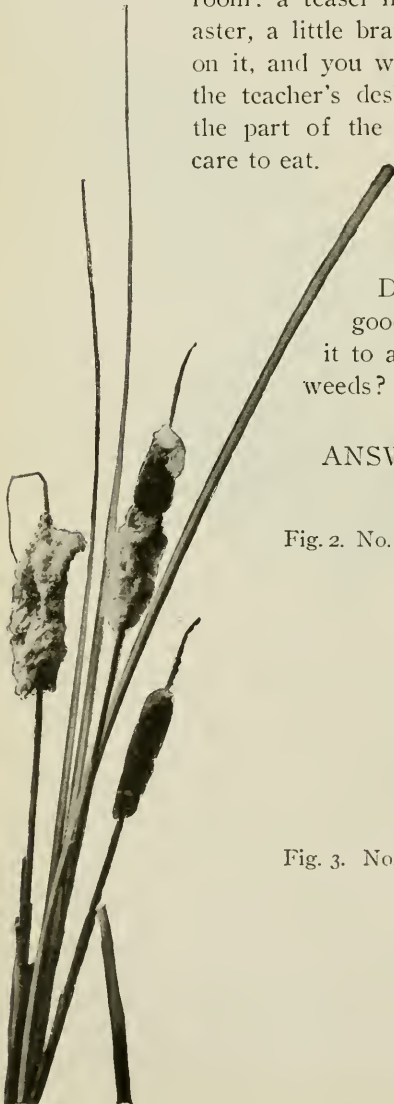
that some birds eat. Not long ago I saw a number of old cattails on which some birds had been feeding. You know that earlier in the year the seeds of the cattail are in a compact head or pressed closely together. When a little bird comes along and wants something to eat, he pecks at this part of the old cattail stalk. In this way he loosens the seeds which gives them an opportunity to blow away; so the little bird is doing two things: he is getting something to eat, and at the same time is helping the seeds to get away from the parent plant. I wish you would notice how many stalks of plants with seeds you can find. Take some of them into the school-room: a teasel head, some of the golden-rod stalk, an aster, a little branch of bittersweet with the red berries on it, and you will have something attractive to put on the teacher's desk, a winter bouquet. Look closely at the part of the plant that you think the birds might care to eat.

When you find one out-of-doors observe closely the seeds of the cattail head which the birds have loosened. Do they look as if they might be in good condition to grow? Of what value is it to a farmer to have birds eat the seeds of weeds?

ANSWER TO WEED PUZZLE IN OCTOBER LEAFLET

- Fig. 2. No. 1. Fox tail grass.
 2. Lambs quarter.
 3. Plantain (broad leaved).
 4. Ragweed.
 5. Spanish Needle.
 6. Wild Buckwheat.
 7. Hedge Mustard.
 8. Pig Weed.
 9. Burdock.
 10. Wild Carrot or Birds Nest Weed.

- Fig. 3. No. 1. Burdock.
 2. Wild Carrot.
 3. Fox tail.
 4. Hedge Mustard.
 5. Pig Weed.
 6. Lambs Quarter.
 7. Plantain.
 8. Ragweed.
 9. Spanish Needle.



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No. 6

"Oh, every year hath its winter,
And every year hath its rain—
But a day is always coming
When the birds go North again."

AN EAR OF CORN

JOHN W. GILMORE



A good ear of corn — but what do you mean by a good ear of corn? Do you mean that some ears of corn are bitter and not good to eat? No, but I mean an ear of corn that is good-looking.

Show you a good looking ear of corn? Well, here is one. See it has good shape; that is, it is moderately long and moderately large and it is almost as large at the tip as it is at the base. If you look at the base of the ear where it was broken from the stalk you will see that the cob is not very large. The grain at this end is rounded over (in most good ears) and forms a little cup with the base of the cob. Now look at the other end. Here the grains practically cover the cob. Some ears, though good looking

otherwise, have the tip of the cob exposed. Those are not the best.

Now let us examine some of the grains. In the first place they are crowded on the cob so tight that they can scarcely be moved unless they be broken from the cob. Sometimes, though, when the corn is cut green the grains will be looser on the cob than if the corn had been allowed to ripen. The grains themselves are of good size and thickness and the germ is much more than half as long as the grain. Each grain, like the ear, is nearly as large at one end as it is at the other.

The corn must not only be good looking, but it must have power to grow when it is planted. Not every ear or grain that is good looking has this power; it may have lost the power because it is old, or because it has not been kept well. Every boy or girl who reads this should not only help his father select the seed corn this spring but should test it to see whether it has the power to grow. How shall you do this? Get some shallow boxes, about two inches deep; or if your mother will let you take

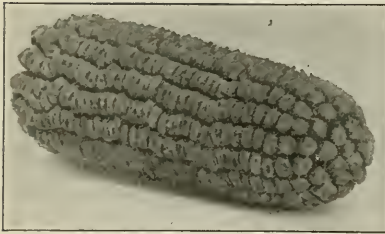


FIG. 2.—*This is a good looking ear of corn. The tip is well filled out.*

not take long and the children can do it, and it may save several days of replanting and this is work that only grown up people can do well. If less than four grains out of five, or eight out of ten sprout, the ear should be thrown out.

Study of an Ear of Corn

1. Is the color of the grain always the same as the color of the cob?
2. Count the rows of grains on a cob. Are there always the same number on different cobs? Is the number of rows always even, or sometimes odd?
3. What is the proportion of circumference to the length of the good ears which you have selected?
4. What is the relation of space occupied by shelled corn to the space occupied by the whole ear from which it came? (To find this, wrap the ear in a piece of writing paper so that the butt comes even with the paper. Twist the paper around the tip. Pin or glue the paper so that it will keep its shape. Shell the corn and pour it in the paper wrapper.)
5. What is the percentage of grain on a good ear?
6. Toward which end of the ear is the germ of the grain placed?
7. Can you devise any other way for sprouting the grains?
8. Here is a suggestion for a special lesson on corn. Ask ten pupils in your class to bring an ear of corn. Have the ears numbered and placed in a row on a table. It might be well to ask the pupil who brought the corn to put his name on the label with the number.

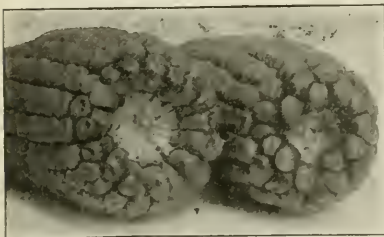


FIG. 3.—*A medium sized cob is better than a large cob.*

some plates, these are good. Fill the boxes or plates with sand. Now take five or ten grains from each ear and place them in rows in the sand. Each row should bear a number corresponding to a number on the ear from which the grain was taken. The boxes or plates should be moistened, covered, and then placed near the kitchen stove, especially at night. This work is worth while, for it will

Uncle John who brought the best ear of corn.

WINTER APPLES

ADA E. GEORGIA

“What cheer is there that is half so good,
 In the snowy waste of a winter night,
 As a dancing fire of hickory wood,
 And an easy chair in its mellow light,
 And a Pearmain apple, ruddy and sleek,
 Or a Janetting with a freckled cheek?”

After you have read the little verse above, close your eyes and try to *see* the pleasant picture it describes. Apples do, indeed, taste good when eaten in good company about a glowing home fire in the evening; but I think the place where I have seen them eaten with the greatest gusto, is by hungry boys and girls at noon lunch at school. The fresh fruit seems to give the whole lunch a more wholesome taste.

How many can tell the name of the apple which you have in your lunch basket? How many varieties can you name with certainty? There are so few kinds that keep as late as March that it will not be difficult for you to learn their names, and observe so closely the characteristics of each that you may be sure of them always.

Not all the grown-ups are careful to make the acquaintance of apples by name. “Have you any Northern Spies?” I asked a groceryman. “Yes, I have some fine ones,” and he pulled forth a crate. They were, indeed, such fine apples that I immediately bought some — but they were Spitzenburgs. I suppose that to him, apples were just apples, yet it would have paid him to have placarded his crate, “Choice Spitzenburgs.”

Let us see how many apples we can name. If you live in the country, ask your father to tell you the names of all the kinds in his bins or on the shelves. Perhaps you have some Roxbury Russets laid away in the coolest, driest place to grow more mellow and spicy until far in May or June. I remember once eating “Roxbury Rusticoats” on the Fourth of July. They are the best of long keepers. Nobody could mistake a Rhode Island Greening. Its golden flesh seems to show through its green coat, and when thoroughly ripe, how delicious! And the King’s oily red coat covers meat fit for kings’ tables. Sometimes the Gilliflower’s mealy sweetness appeals to the taste; this apple you may also know as the Sheep-nose. Seek-no-furtherers are as good as their name, and keep well. And the dark red coat — sometimes almost black — of the Ben Davis, is very attractive and makes for it a ready sale.

If you live in town or village, see how many varieties of the fruit you can find in market now. Most grocers are careful to buy and sell by name. Different kinds are favorites in different parts of the State, but

almost everywhere you will find Baldwins. Very choice varieties, like the Newtown Pippins, are sold at high prices in the large cities for dessert fruit, and are also sent abroad. I think that you may be able to make sure of a round dozen distinct varieties.

With people, we never call ourselves friends until we know the name and quality of each acquaintance. It should be the same with the apple.

“A Russet apple is fair to view,
 With a tawny tint like an autumn leaf,
 The warmth of a ripen'd corn-field's hue,
 Or golden hint of a harvest sheaf;
 And the wholesome breath of the finished year
 Is held in the wine-sap's blooming sphere.”

— HATTIE WHITNEY.— *St. Nicholas.*

A STUDY OF APPLES

Secure as many different kinds of apples as you can and have them on the teacher's desk. How many of the different varieties can you name? Make a list. It will be of interest to Uncle John to know how many you have been able to find in your locality.

If you do not know the names of the apples that you have, write out some of their characteristics as follows:

Size.

Color.

Markings.

Shape.

Color of flesh.

State whether the apple is juicy; whether it is tender; whether it is crisp.

Is it flat or does it taper at the blossom end?

Is the skin tough, tender, waxy, oily?

Is the apple you are describing plentiful at this season of the year?

How many different apples do you know that keep a long time?

MORE ABOUT THE PIGEONS

The pigeon house of which we spoke in the last Leaflet has been finished and the children have chosen the site. The home is now ready for the playmates that are to come. We are planning to place young pigeons in the house because they will be less likely to return to their original home, and they will also be more easily trained. Pigeons are capable of caring for themselves when they are five weeks old.

Perhaps you would like to know what we shall feed the pigeons. We shall give them grains: millet, oats, rye, Kaffir corn, peas and barley. For one pair of birds a handful a day is enough. When birds are kept in confinement, they should be supplied with charcoal, cracked oyster shells,

salt and water. If free they find these things for themselves. I would suggest that the pigeons have grain and plenty of water always.

In the pigeon house illustrated in Fig. 4, the floor space is eighteen inches square and the house is fifteen inches high. The door is six inches high and has a small platform in front. Can you suggest a better kind of pigeon house, or a better place for it than is shown in the illustration? If you have raised pigeons, you may be able to give some good suggestions to other Junior Naturalists.

HOME BIRDS

This year we shall offer a prize to the naturalist who will send us the

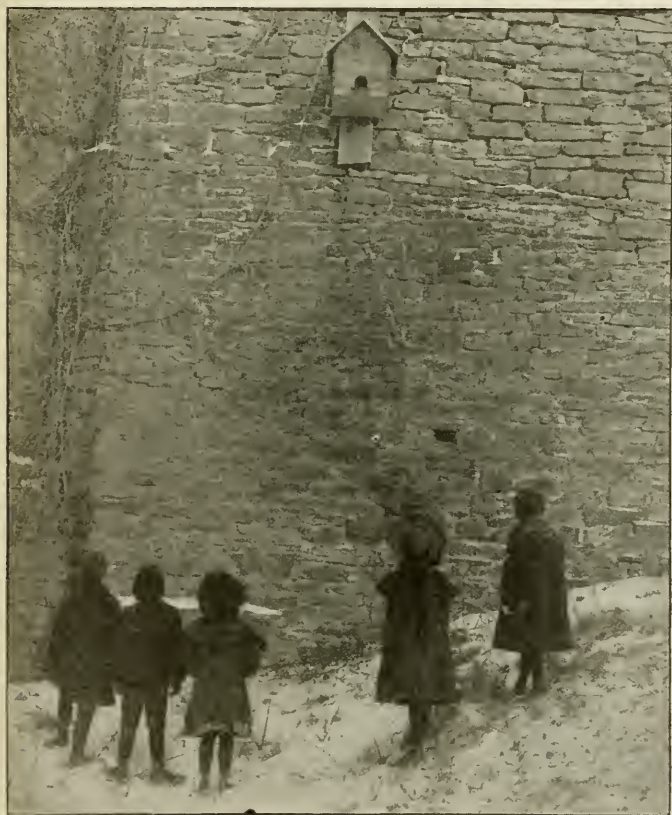


FIG. 4.—*The pigeon house is ready. Have you any criticism to make as to the size, where it is placed, etc.?*

best account of efforts made to protect the birds. The composition will be judged not by the pupil's knowledge of birds nor his power to write an interesting essay, but by the personal effort he has made to take care of birds near his home. The boy or girl competing for this prize should build a bird house and encourage others to do the same. Here are

some suggestions that must always be followed in making a bird house:

1. The floor space should be about six inches by eight inches.

2. For wrens and chickadees, the doorway should be an inch augur hole. For bluebirds, tree-swallows, or martins, the doorway should measure about one-and-a-half inches. A perch should be placed beneath each doorway.

3. See that your bird house is out of the reach of cats and other enemies.

4. Keep the cat from roaming about at night during the nesting season. Tie a bell on her neck when she is out in the daytime. A tin shelf placed around a tree about eight feet from the ground will prevent cats from climbing the tree. The shelf may be used as a dining table for the birds. Place food and water on it occasionally.

The little bird sits at his door in the sun,
 Atilt like a blossom among the leaves,
 And lets his illumined being o'errun
 With the deluge of summer it receives;
 His mate feels the eggs beneath her wings;
 And the heart in her dumb breast flutters and sings;
 He sings to the wide world, and she to her nest,—
 In the nice ear of Nature which song is the best?

—JAMES RUSSELL LOWELL.

AN OUTDOOR SCENE IN MARCH

Some day when you have to write a composition in school, I wish you would ask your teacher to let you go to the window, or stand in your school yard for a few minutes, so that you may be able to describe a snow scene. Nearly always we have snow in March; if, however, you have to write your composition some day when there is no snow, describe the landscape as you find it. Make a copy of your composition and send it to Uncle John.

If you will notice Fig. 5, you will find a very interesting scene. As you look at it, I am sure you would like to go to the bit of wood that you see in the distance; that you would like to walk over the snow-covered hillside, or perhaps to stop a minute to talk with some one whom you might find living in the home at the foot of the hill. What are the two trees that stand so boldly in the foreground? What trees do you know that hold the leaves through the winter? Notice the snow that clings to the tree trunks, and notice also the little weedy things growing on the ground near the base of the trees. These weedy things in winter are interesting to me. What kind of trees do you suppose those are standing between the rail fence and the farm house,—the trees that look so far away? Do you think you have such a pretty scene near your home?



FIG. 5.—What can you see in this picture? What can you see from the windows of your home or school?

LEAFLESS TREES

Sometimes as you look across the fields you see leafless trees that you cannot name. Perhaps you would know them if the leaves were out. It would be interesting to take a few twigs about a foot long from these trees and place them in water in the schoolroom. As you watch the buds swell, you will observe many things about the twigs that you never saw before and another year you will be more interested in the tree when the leaves are gone. A student whom I know can tell a great many trees by looking at the twigs in winter. I hope our naturalists will become familiar with a few leafless trees this month.

THE WINNER OF THE PRIZE FOR THE BROOK BOOK

Last year there was published in the JUNIOR NATURALIST MONTHLY a lesson on the brook. We asked the Junior Naturalists to study a brook and to write Uncle John all that they had learned about it. A prize was offered for the one who would send the best letter showing the naturalist had really studied the brook. We received hundreds of letters and it was difficult to decide which one was the best. After much consideration we decided that the prize should go to Grover Goodman, Seneca Falls, N. Y. I am sorry that there is not space to publish Grover's letter. From it we learned that he really visited a brook and was interested in all the plant and animal life about it.

'Tis the sweetest thing to remember
If courage be on the wane,
When the cold dark days are over —
Why the birds go North again?

— ELLA HIGGINSON.

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No. 7

CARE OF NESTLINGS

No longer now the wing'd habitants,
That in the woods their sweet lives sing away,
Flee from the form of man; but gather round,
And prune their sunny feathers on the hands
Which little children stretch in friendly sport
Toward these dreadless partners of their play.

—SHELLEY.

In the last JUNIOR NATURALIST MONTHLY we spoke of the care of young birds. Do not forget this. The old birds have to fight so many enemies that boys and girls will, I know, be glad to help them. Probably the one most to be feared is the household cat. Keep her indoors at night during the nesting season. Tie a bell on her neck when she is out in the daytime and watch her; this will be helpful to the old birds. If any boy or girl is ambitious to raise five or six kittens, he must remember that if he would have song birds in his neighborhood, there must not be too many cats. Think of the harm that one cat in every household would make in the bird world!



Photographed by Verne Morton.

Have you tried placing the tin shelf around the trees to keep the cats from climbing up to the nests?

THE BLUE JAY

How many of our boys and girls have ever heard the Blue Jay called a rascal, a thief, and other harsh names? I am sure that I have and I have often wondered how much truth there is in these remarks about our handsome Blue Jay. Sometimes, you know, a bird may be caught in one unworthy act and the story of his misdeeds will be increased and passed on for many years. Sometimes a bird may merely resemble another bird that does harm, and in this way lose his reputation, as is the case with the Downy Woodpecker. Because he is a woodpecker, many farmers and their boys have abused him; while, in fact, he is most industrious and helpful in the farm work. One woodpecker has been harmful to trees, the sapsucker, and many of the useful woodpeckers have been abused because of one member of the family that has not a good reputation.

And so it is that I am going to ask our Junior Naturalists to investigate the true character of the Blue Jay. Make up your mind that during one year you will study the ways of the merry fellow and find out for yourself how much that has been said of him is true.

In studying the ways of the Blue Jay, perhaps you would like suggestions that will help you in your observation. Doubtless the following will be useful:

1. During what months of the year have you seen the Blue Jay?
2. How many different notes have you heard him give? What other birds have you heard him imitate?
3. What evidence have you that Blue Jays lay up a supply of food for hard times?
4. What insects have you seen him eating? What fruits? What grains?
5. Have you ever known them to take the eggs or young of other birds? Do not tell me what you have heard other people say about this. Let me know whether you have ever seen them commit this theft yourself.
6. Do Blue Jays stay in the forest or do they visit orchards and meadows, farmyards and gardens?
7. This bird has been accused of eating fruits; but does he take fruits that are found in the wild, or the fruits of orchard and vineyard?
8. What harmful insects have you ever seen the Blue Jay eat?

A BUSY LITTLE FARM HAND

Every Junior Naturalist will, of course, have a garden this year. It will be very disappointing, indeed, to Uncle John to learn that any one



Courtesy of Houghton, Mifflin & Co. From "True Bird Stories" by Olive Thorne Miller.

The Blue Jay.—One of the bright and lively spring visitors.

who has a piece of ground has failed to grow vegetables or flowers. I am sure when you get your garden started, you will find there is quite a bit of work to do keeping out the weeds and preventing bugs from eating your plants. It seems to me that you ought to have some one to help you in one way or another.

But, you say, I cannot afford to hire any help. Perhaps this is true. Boys do not have a great deal of money and it is rather a difficult thing to get help unless you can pay them well. Now I can tell you about a little farm hand that will save you a great deal of work. He is quiet, makes no trouble, is industrious, and never asks for a dollar when Saturday night comes.

Perhaps you will laugh when I tell you that this industrious and accommodating farm hand is a hop toad,—a quiet, plain little creature that some of you have treated carelessly and some of you, I fear, have abused. But you would never have abused him, nor would you have passed him by without notice, if you had but realized how much good this one little fellow does in helping the farmer and the gardener. In fact, I would not be surprised if you boys would feel like taking off your hat to him.

Did you say the hop toad is ugly? I do not know about that. It seems to me he looks just the way he ought to for his purpose in life. If he did not look like a clod of earth, many enemies would be able to see him readily and take his life. Then, too, he cares only for live food. Insects frequently alight on this bit of earth, as he seems to be, and in that way he can get his dinner without much effort. It is indeed a good thing for the toad that he looks so much like the soil on which he lives.

You should have seen a nice old hop toad that was in a school that I visited during the past year. This toad was a great pet. At first, some of the girls would not handle him because they had been told that he would give them warts, but they soon learned that this was an untrue statement. The children were warned that if handled carelessly a poisonous substance might come from the toad, but they did not pay much attention to it, and no one was poisoned by it. The young folks all paid the toad a great deal of attention. They would take turns holding him up to the windows where he would catch flies as fast as they appeared.

But our little farm helper will eat other things besides flies. He will eat ants, cut-worms, thousand-legged worms, tent caterpillars, ground beetles, May beetles, wire-worm beetles, weevils, many kinds of caterpillars, grasshoppers, sow bugs, potato beetles, snails, and many other things; and he has a very good appetite. Now you can see why he could be very helpful to you among your garden plants.

In order that you may have some toads in your garden, I am going to make a suggestion. It is not an easy thing to go into your neighbor's yard and take a toad over into yours, because these little creatures seem to have a homing instinct, and when once accustomed to a place, they are likely to return. I would suggest, therefore, that every young person

who has a garden should raise his own toads. You should have some sort of an artificial pond in which you can keep watered plants and into which you may put a few eggs of the toad or a few tadpoles. A water-tight tub would be a good thing for this purpose. I have found that tadpoles will feed on fish food and fresh meat. I always fasten the meat to a bit of cork so that I can easily remove what the tadpoles do not eat. In this way the water does not become foul. You will be interested to watch the tadpoles hatch from the string of toad eggs with which Junior Naturalists are now familiar, the long strings of gelatine-like substance with the little, black, bead-like eggs in them. You can find toad's eggs in almost any pool in the spring time.

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No. 8

SUGGESTIONS FOR SUMMER WORK

Prizes for Junior Naturalists

This will be the last issue of the JUNIOR NATURALIST MONTHLY during the present school year. We have been very much pleased with the work done by the members of the club and hope that Junior Naturalists have enjoyed writing their letters as much as Uncle John has enjoyed



A country road is interesting for study.

receiving them. We are sorry that we cannot send lessons to our boys and girls during the summer months, for there are so many different things to study in summer.

Since we cannot send monthly lessons we are planning to give some all Junior Naturalists special work to do during the coming season and we shall offer a number of prizes for patient outdoor study. Even though

we do not send lessons, there will be many opportunities for you to continue your observational work. We shall suggest several subjects for study and each young naturalist may select one from among them. He must send the results of his observation to us by October 15th. We do not care for any information in these compositions that you have found in books or that some older person has told you. The prizes will be books on outdoor subjects and will be given to those whose compositions show actual outdoor study by the naturalist who writes the paper. Some children enjoy one line of outdoor study and some another. Make your selection from the following:

1. The study of plant and animal life along a country roadside.
2. The study of a brook and the brookside. All life in and along a brook.
3. What you have learned about bird life. We shall be particularly interested in information obtained on the value of birds to the farmer.
4. What you can learn from personal observation of the animals of field and forest. In this line of observation, it would be well for you to consider the field mice, muskrats, squirrels, moles, woodchucks, and any other life that you find. Observe snakes, toads, and salamanders. These creatures are often useful. Can you find out in what ways? Try to get over your fear of small snakes. Study their habits.
5. The history of one tree from May 20th to October 1st. The kind of tree; where it stands; when it blossoms; the kind of fruit it bears; the insect and bird life in connection with the tree; whether or no it makes a good shade tree; how long it has stood in the place where you found it; whether the tree has been abused in any way and if so, how; whether the tree has marked characteristics by which you can tell it when it has no leaves.
6. The story of your garden. Where it is located; when you planted it; how you planted; what you planted. Write about the care of the garden; the pests that annoyed you most; the weeds that annoyed you most; the birds, butterflies, and other forms of life that came to your garden.
7. The history of some plant colony either in woods, along the way-side, or in a corner of your garden. Give the size of the region you studied; what plants you found growing there; which plant seemed most thrifty; why you think this combination of plants associated with each other.
8. The study of some insect pest such as potato beetle, peach borer, tent caterpillar, mosquito. In this line of work we would like to have the young naturalist secure specimens of the insect and find out as much as possible of its life history.

9. As much of the life history of a moth or butterfly as you can study during the summer. I would suggest the Monarch butterfly as being available. You will find the larva or caterpillar on milkweed. If you take the caterpillar home and feed it fresh leaves of the milkweed, it will become a chrysalis and a butterfly will emerge from this chrysalis so that you will be able to give us a very interesting account of it. The caterpillar which afterward becomes a Monarch butterfly has a white body with narrow black and yellow cross stripes.

10. What you have done to improve your school grounds.

11. What farm crop has been most interesting to you? What can you learn about this crop? How was the ground prepared for it? How was it handled? How harvested?

We shall give one prize for the best results in each of the subjects mentioned above. Write your description to Uncle John, who will be very much interested in them all. For the purpose of separating these letters from the large numbers that will come on other subjects, address them to Alice G. McCloskey, Ithaca, N. Y. We shall file every letter written on these subjects. All compositions must reach us by October 15th.

A LITTLE CHICK'S HAMMOCK

JAMES E. RICE

Whoever heard of such a thing? A little chick swinging in a hammock! Not many persons have heard about it, that is true, but it is because the little chick's hammock is out of sight most of the time and in such an unexpected place. Where do you think? Out in the chicken coop? Under mother hen's wing? Beneath a berry bush? No, indeed! You could never guess it; not in a hundred years, because the little chickens that we usually see running about are too big to swing in this hammock. They have outgrown it. So I must tell you the secret, must I? Well, the little chick and his hammock are inside of an egg. You never saw one? You are not the only one who never saw a hammock inside of an egg. I shall try to tell you right away how you can see the hammock, and some day I will show you how to see the little chick actually swinging in the hammock.

Of course you would not expect to find a rope hammock that looks like a fish net, nor a canvas hammock with bright colors swinging inside of an egg, would you? We could not eat eggs if they had such things inside them. The chick's hammock is so clear and transparent that you can scarcely see it, except the ropes on the ends. The ropes are white in color, twisted and very strong. Get a saucer and carefully break into

it an egg. If you break the yolk, you may be unable to see the hammock strings. The transparent part of the hammock surrounds the yolk, and if it is broken, the yellow fluid will run out. With a splinter of wood you can stretch out the hammock cords and swing the yolk around. Now boil an egg without breaking the shell, and see whether you can find the little white ropes. You may have to search a long time, but they are there imbedded in the white of the egg, near the yolk, toward the large and the small end of the egg. You can find them if you try real hard. To do this, break open the egg carefully by chipping away the shell and then see whether you can peel off the white in layers. There should be three layers. Some of the layers are thick and some of them are thin. The thin layer next to the yolk is the chick hammock. Why do we call it a *chick* hammock when there is no chick in it? Look again at the egg



Looking for the chick hammock.

which you left in the saucer, and see whether you can find a little white spot on the yolk of the egg. This white spot is where the little chick will grow.

I know you are wondering why an egg should contain a hammock. If you will hold a fresh egg up to a bright light in a dark room, you may be able to see for yourself the yolk floating inside. Hold the egg in the position in which it would naturally lie. Closely envelop it with your hands. You will notice that whichever way you turn the egg, the yolk will always float toward the upper side, and will not float readily toward either end of the egg. This is because the hammock ropes keep it in position. They do so in order that the little white spot on the yolk where the baby chick grows, will always be up close to the top surface of the egg. In this position, the egg comes in contact with the warm body of

the mother hen when the eggs lie snugly in the nest while they are being hatched. The hammock ropes also prevent the little white spot from becoming injured by coming in contact with the shell when the eggs are roughly handled.

I wonder how many of you know why eggs which are kept for hatching should be turned every few days. It is to prevent the yolk from floating up so close to the shell that it becomes attached to it.

How do I know that a little chick will grow on the white spot? I think I shall have to ask you to take my word for it for a while. It is too long a story. I shall try to show you how to find out for yourself some other time.



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ALICE G. McCLOSKEY, Editor

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No. 2

CHILDREN'S PLANTS, AND HOW THEY GROW

BY JOHN W. SPENCER

"Do you know where the first crocus blows?
Under the snows;
Wide-eyed and winsome and daintily fair
As waxen exotic, close tended and rare;
Every child knows
Where the first crocus blows."

— SHERWOOD.

TEDDY AND HIS BULB BED

This is Teddy. He is not so tall as he looks in the picture.

In two years he hopes to go to the High School.

He likes best to learn by doing. He would much rather study the things themselves than study about them in books.

He will learn all he can about flowers by raising them. Some people say that they will not plant flowers until they know all about raising them.

One can learn to swim only by going into the water.

Neither can one know how to make plants grow without first growing them.

Teddy is much bewildered when he turns the pages of a bulb catalogue and sees the hundreds of long names that he cannot pronounce.

He is as much lost as though he were put in the midst of a thousand people whom he had never seen before and tried to learn the name of each one and become acquainted with all of them.





But he decides to ask some one who knows about bulbs to help him in choosing.

Teddy is now cleaning up the ground where he will plant his bulbs.

He will begin with crocuses and tulips. Those will give him an abundance of flowers next spring with the least work.

With this introduction into the bulb family his acquaintance will extend to other members and he will soon know how to make his friends comfortable.

Have you ever thought how one acquaintance among boys and girls leads to other acquaintances? The same is true in making acquaintances with plants.

Teddy is driving the center stake of his circular bed for tulips.

Teddy is raking off the small stones and some weeds before beginning to make his tulip bed.

Some people say that this kind of soil and that kind of soil is proper in which to grow this kind or that kind of plants.

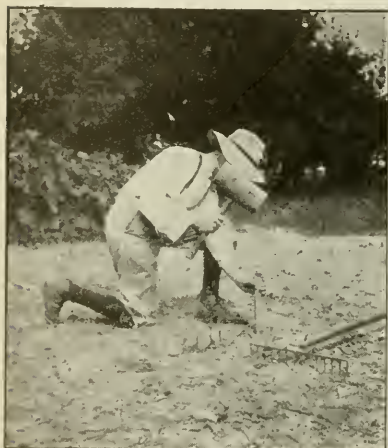
Teddy takes the only soil he can get and will prepare it the best he knows how. Many boys and girls are in the same circumstances.

Learn this with your flower growing: If you cannot have what you want most, learn to want what you can get.

Once upon a time a farmer corrected his son for planting corn in crooked rows.

The son replied that he did not care. The corn would grow straight if the rows were crooked.

When that boy became a man, he did business in a higgledy-piggledy



way and took ten steps where others take one to do the same thing.

Teddy has tied a rope to the center stake. With a sharp stick fastened to the other end of the rope, he is marking out the circular size of the bed. Teddy takes pride in the accuracy of his work.

Teddy now proceeds to dig a pit about two feet deep. He sets the spading fork erect and with his foot drives it into the soil to the hilt. Then he bends the handle toward him and breaks out a lump.

He will put the top fertile soil on one side of the bed, and the bottom infertile soil will be placed on the other side. The latter he will not put back into the bed because it has no fertility.

Spading big forkfuls of earth is bringing beads of sweat on Teddy's forehead and a drop stands on the end of his freckled nose.

But he does not mind it any more than though he were playing ball.

Why doesn't he?

Because he is thinking that some Sunday afternoon next May he will take a walk out on the Avenue where the banker and other rich people live.

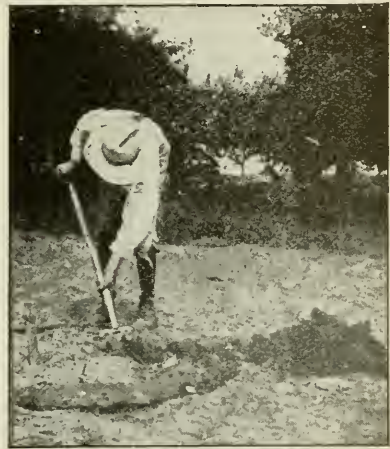
Perhaps he will find that his tulips have as gorgeous colors as those of the most wealthy man in town.

Then so far as tulips go, Teddy may feel as rich as any of them.

Teddy is now resting by changing work and wheeling stone, which is harder work than digging.

But a boy does not like to do the same thing all the time.

The soil is clay and during the spring and fall storms the water does not





drain away but stands in puddles for days.

That gives bulbs wet feet and they do not grow well.

When Teddy has finished digging the pit, he will put several loads of stone in the bottom so that water may drain away.

If the soil were sand or gravel or loam, there would be no need for putting stone in the bottom of the pit.

The pit has been dug and the stones put in the bottom and some rotted leaves spaded into the fertile clay soil, to make it more porous.

The bed has been mounded up so that the surface water will drain off.

Teddy is now raking the soil fine before planting his tulips.

After the bulbs are properly put in the ground, the planting need not be done over again for three or four years. Even then no new bulbs need be bought.

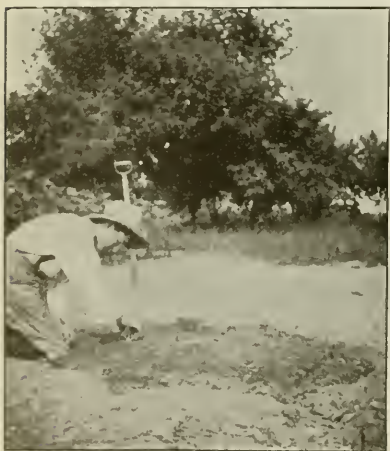
In the end, most flowering bulbs are the cheapest flowers that we can have.

Now Teddy is planting tulips and thinking what gorgeous flowers he will have the next spring and how little work he will have to do.

But few weeds will grow after he plants in October and none next spring when the tulips bloom in May.

He is planting them about four inches deep and five inches apart. About Thanksgiving time or a little later, when the frosts make a frozen crust of earth, he will cover the bed, with a thick blanket of stable fertilizer.

If instead he uses dead leaves, he will put sticks or boards over them so they will not blow away.



The time to take off the blanket in the spring is when he has heard the bluebird and robin two weeks. Some people wait until they have heard the frogs peep.

Teddy wants to plant some crocuses that blossom so early in the spring that sometimes a late snow covers them.

But the crocus belongs to the cold-blooded class of plants and the white mantle does them no harm.

You now see him driving some pegs showing the circle where he will plant the crocus bulbs.

Teddy takes the spade and cuts the circle in the sod.

Then he will take the spading fork and loosen the soil and make it fine with the garden rake.

Next he will push the crocus bulbs into the mellow soil about three inches deep.

About the time that small ponds of water have ice thick enough to bear the weight of a dog, he will cover the circular bed with a blanket of stable fertilizer or dead leaves.

He will take the blanket from the crocuses a little earlier in the spring than from his tulip bed, for they are so eager to blossom that they will not wait for the warm May days as the tulips do.



TEDDY AND HIS FLOWER GARDEN

Teddy has a bed of Sweet Alyssum. It has given him a lot of blossoms since July. Other flowers in the mean time have become tired and ceased blooming.

He is so fond of it that he will try potting a plant for indoor flowers this winter.

Teddy says that some day he will be a doctor. He takes care of a doctor's horse and uses a doctor's language. When he takes a plant from the



That is what the dentist once said to Teddy when he had a tooth pulled.

Here you see Doctor Teddy with his patient on the operating table.

The pot in which he will put the plant is six inches in diameter. There is a hole in the bottom for drainage.

The doctor says that his experience as a plant physician has led him to know the absolute necessity of drain-



open ground and prepares it for life indoors he calls it plant surgery.

His first step is to give the plant a thorough drenching with water. He says that he has found in his practice that drenching lessens the shock. (Perhaps your teacher will be able to tell you what surgical shock is.)

When cutting about the plant with his spade he cuts hundreds of roots which he fancies to be as hard for the plant to bear as cutting that many nerves. The plant surgeon says to the Sweet Alyssum: "Grin and bear it like a Major. It won't last long."



age for the comfort of all dry land plants.

A tin tomato can with good drainage is better than a hand-painted terra cotta vase with none.

Drainage is making it possible for water that does not stick to the grains of soil may leak away.

The plant of Sweet Alyssum is carefully lifted from the table into the pot. The reason for so much care is to save the very small roots from injury. They are sometimes called the working roots.

Whatever new earth the doctor uses is mellow potting earth. It contains an unusually large percentage of de-

caying vegetable matter, and does not harden by frequent watering. Sand mixed with garden soil helps to prevent "caking,"

The soil is pressed firmly about the small roots. Remember the difference between gently pressing the earth and "jamming" the earth about the roots.

Now comes the part of the operation that tries the nerves of the beginner.

The growth of more roots in the soil makes more branches in the air and more branches make more roots.

Before the plant of Sweet Alyssum was taken from the garden—the roots found plant-food and moisture from half a bushel of soil.

Now there will be less than two quarts of soil from which food and moisture may be taken.

The last thing before removing the patient from the operating table is to give another watering.

Teddy says it is like dressing a wound.

Our surgeon Teddy speaks in three languages—English, medical and base ball.

He says that cold water prevents the patient getting fever. I do not think he is right in saying that plants have fever.

However, plants are often sick. When just enough water is given, it is a good medicine.

Plants sometimes stand for days in soil from which the sun has drawn all the moisture and their drooping leaves show what they "suffer."

Do any of my boys and girls know of plants that they can rescue by giving them water?

The operation is now over and Doctor Teddy is putting the patient into a hospital.



A cool and shady shed or the bottom of a cellar is one of the best places for a plant to recover.

In what Teddy calls the hospital the conditions are such that the parts of the plant that are in the air will not grow and will make but little demand on the roots for water.

This will give the wounded roots a chance to recover and to get a fresh hold on the soil.

After about ten days the plant may be given light, a big part of which may be shade and a little part sunshine, so that the growth of the working roots may keep ahead of the growth of the leaves.

It should not be given the warmth of a living room for some time after this.

If you have a patient, telephone Doctor Teddy to send his ambulance to your home.



PEPPERPOD AND PEPPERGRASS

This is Little Miss Pepperpod. She is called that because she has a bit of a temper, enough so that she does not give up easily when she has hard things to do.

Last term at school she raised some peppergrass in an egg-shell farm. A bite of peppergrass sandwich has made her wish for a bigger farm.

Little Miss Pepperpod has found a quart berry-box.

She will fill it with good soil and have a big peppergrass farm.

But see the big holes in the berry-box. Pepperpod can put her fingers through them.

She must in some way stop the holes. If she does not, the soil will leak away when she waters her farm.

Little Miss Pepperpod borrows her mamma's shears. She learned to cut paper at the Kindergarten.

When she is through, the paper will be neatly cut and will make a tidy fit for the berry-box.

She is now at the age when she is fond of doing useful things.



Her experience with peppergrass farms is making her acquainted with plants.

Here is Pepperpod putting the paper inside the berry-box.

Her lips are pressed together as though the work is a very serious thing.

One good way of managing a peppergrass farm is to sow the seed about half an inch apart in all directions.

Then cover the seed with sand about a quarter of an inch thick.

Little Miss Pepperpod has found some garden soil that grew large potatoes last year. Why will it not grow good peppergrass in her quart garden?

"With my little garden trowel I will scrape up the finest soil with no stones larger than a grain of corn," she is saying.

"And I will jounce each trowel of earth so that the

little grains of sand will all snuggle close to each other."

Here is Little Miss Pepperpod sowing her farm to peppergrass seed.

She thinks: "How strange that anything having life can come from these dead little things called seeds."

The first sprouts that come out of the seed are two. One reaches up toward the light. The other goes down into the moist and dark soil.

Little Pepperpod is preparing what she calls a harvest feast. Among her guests is one who thinks himself nearly a young man. He has felt so ever since he has had pockets in his clothes. The accomplishment that he now wants most is to be able to whistle and wear an Eton cap on the back of his head.

Each day he tries very hard to learn, much harder than some girls who play piano exercises. He can ask "thirty questions" every minute.

He expects to be a guest at the harvest feast of peppergrass and sit at the first table.

See how the guests at the feast of peppergrass enjoy their food.





Everything is just right and tastes good.

A child born in the lap of luxury might be able to see some faults.

If there are any, the children in the picture do not know it.

Many a man with great wealth would give a big red automobile if he could find the same pleasure in his food as do the guests of Little Miss Pepperpod.

Now that spring has come, Little Pepperpod wants to try having a bed of peppergrass in the open garden.

She gets a garden fork. She steps upon it and finds that her little body does not sink it very deep into the earth.



She wriggles the spading fork back and forth and jumps on it a little, but she cannot jump very hard for it hurts her bare feet.

At last she drives it down as far as you see it in the picture. Then she pulls back on the handle of the spading fork as one would pull at the end of a lever.

Up comes a lump of soil and then another and another and another and another.

Seeds and plants are not comfortable when growing among clods and sticks and stones. They like a soft bed as much as boys and girls do.

Little Pepperpod whacks and spansks the lumps of earth with the back of her spade. That breaks them into fine pieces.

Often when spading in the garden, one will find earth worms. Do not mangle their bodies if you can help it.

They do more for the benefit of mankind than all the loafers in the world.



They can tell an interesting story about themselves. Some day I will help them to tell you the story of their work and lives.

This is the boy who can ask "thirty questions" a minute, who has pockets in his knee pants and who is trying to learn to whistle.

After the clods have been made fine he gets the garden rake.

He works it through the soil as he would a comb through his hair.

That makes the seed bed finer than did the thumping with the back of the spade.

He has been told that if he would have plants comfortable, he must scratch the soil with a rake and tickle it with a hoe.

Little Pepperpod has pride in her work.

She likes to do her work with exactness and have it look as though she was fond of her task.

Some people are proud of their white hands. Little Pepperpod is proud of her "velvet hands" that are capable of doing things well and without a clatter.

So now she gets a board and lays it down on the soft fine earth that has been so carefully prepared and scratched. She makes a straight groove with the end of the garden rake by drawing it along the edge of the board.

Now Little Miss Pepperpod sows the peppergrass seed in the bottom of the groove in the soil.

She scatters the seed about as far apart as her finger nail is wide.

If the seeds should all grow and the plants stand too thick, she can pull





out and eat those that she does not want to grow.

Plants may be crowded so close that they become weeds to each other.

The next thing Little Pepperpod does is to push back the plank and scatter a thin covering of earth over the peppergrass seed.

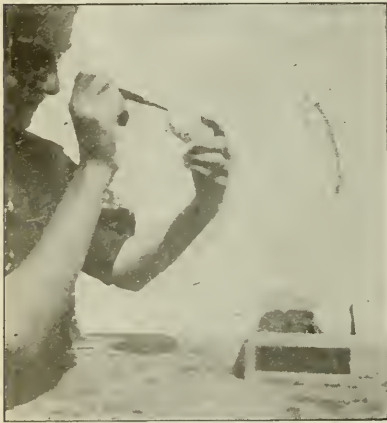
Seeds need a covering as much as boys and girls do when they go to bed.

This covering should be thicker for large seeds than for small ones.

It would better be at least four times thicker than the seed is big.

Next she walks over the row, heel and toe.

This is very important, for it snug-gles the grains of soil together and makes the seed more sure to grow.



GERTIE GUMPTION AND HER EGG-SHELL FARM

This is Gertie Gumption. She is making a small hole in the big end of a hard boiled egg. When she has finished making the hole, it will be as large as the lead part of a pencil.

When she has put some fine and rich soil in the egg-shell in place of the meat of the egg, she will sow some seed in it and call it her egg-shell farm.

She will then write her name on the shell and put it in the window with the farms of other pupils.

The small hole that Gertie Gumption is making is for drainage—that is, to let all the water that the soil does not need run out of the shell.

This is the same Gertie Gumption and the same hard boiled egg. This time she has broken the shell at the other or small end of the egg.

She has made the opening large enough to put in the handle of a tea-



spoon. With the handle she is taking out the meat of the egg. She is doing it neatly and cleanly so it will be good for a lunch.

Gertie Gumption does all her work with a velvet hand. By that I mean that she works with the opposite of a slap-dash, helter-skelter, hit-or-miss style.

Children who work without a velvet hand would ruin four eggs before getting one shell fit for the soil and seed. Gertie Gumption did the task with one egg the first time.

Now we see her filling one of the egg-shell farms with soil. She has three such farms.

One she will fill with clean sand, one with soil from the garden, and one with soil that came from the florist. All will be sowed to pepper-grass and each will be given the same opportunity. The crops in each may be about the same at the beginning. Note the difference at the end of four or six weeks.

Here Gertie Gumption has the three egg-shell farms, each set up on the drainage end in a small box partly filled with earth or sand.

Each shell has a dent in the earth that holds it upright.

Gertie is gently pouring on water until it runs out of the drainage hole in the bottom. If the surplus water could not run away the plants would be in a little "mud-hole" and would be very uncomfortable.

The soil can provide comfort for the plants when it is moist and not wet.

Can you children tell when a soil is moist and when it is wet?

UNCLE JOHN.



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No. 3

HOW TO HELP PLANTS TO GROW

BY JOHN W. SPENCER

Last month I showed you how Little Miss Pepperpod sowed some lifeless looking seeds and from them came some living peppergrass plants. That was bringing a plant into life. This month I must tell you how to help them to grow and become adult plants.

Some people say that plants never grow for them, and would lead you to suppose that plants sometimes become sulky and cross and would not grow if they could.

That is a mistake. Here is something I hope you will remember as long as you live. You may call it one of the "garden commandments:" *Every plant has an impulse or tendency to grow and become the very best of its kind.*

The help that plants ask of you that they may do their best, is that you make them comfortable. You ask me what you must do to make plants comfortable? Ah, there's the rub!

I shall help you to learn all that by keeping and watching some growing plants that are your very own.

Another "garden commandment" that you must remember is this: *We have what we might call cold-loving plants and warm-loving plants.*

The peppergrass belongs to the cold-loving class of plants. We will talk about the warm-loving class when the days are growing longer and warmer, rather than now when they are growing shorter and colder.

Peppergrass is more comfortable during the moist and cool weather of spring and fall when school is in session than during the hot and dry months of the midsummer vacations.

If you have some peppergrass farms in the schoolroom and there should be no fires Saturday and Sunday, the farms should be left in the

room at some place that is farthest from the windows, covered with a newspaper for a bedquilt. It must be very cold weather that will kill them under such conditions.

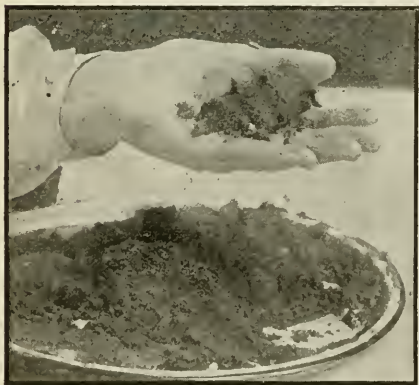
Much of your comfort depends on your food and drink. The same is true of plants. Another "garden commandment" is: *More plants suffer from thirst than from hunger.*

The reason that plants so often suffer for want of water is because they use so much of it. For example, one pound of sun-dried buckwheat — straw and grain — during its growth has sweat out through its leaves three hundred and sixty-five pounds of water,—as many pounds of water as there are days in the year.

Let us suppose that a pound of sun-dried buckwheat may be raised on a square yard of good soil. Then imagine the labor that would be necessary to carry the three hundred and sixty-five pounds of water to give all that would be needed to make the buckwheat comfortable.

We will drop all fractions and say that a gallon of water weighs about eight pounds. Tell me, please, how many gallons there are in three hundred sixty-five pounds of water. Compare the result secured with the capacity of an oil barrel which holds about fifty gallons.

When I water pot plants, I first make the soil wet, even to putting the pot into a pail of water. Then I let the pot stand where all the extra water may drain away. Then I have a moist soil.



A moist soil.

It is all right to have the pots stand in saucers to catch the water, but when there is no drainage from the soil the saucer should be emptied. To leave the plant standing in the saucer gives the plant wet feet; and most of our garden plants are not comfortable with wet feet. It is different with plants growing in swamps.

I am sometimes asked how often plants should be watered. My answer is: "Often enough to keep the soil moist but not wet." Who

of you can tell me the difference between a moist soil and a wet soil?

A wet soil is one in which there is more water than can stick to the grains of earth, having a surplus that settles down and drains away.

A moist soil is one that holds all the water that will stick to all the little grains — no more and no less.



A dry soil.

That is dry soil and is unable to afford much drink to the plant. When soil is in that condition about the roots, they suffer from thirst and therefore are very uncomfortable.

Most of you never thought that water has the power to stick to anything. It has, however. It does not stick like tar or molasses, but it can hold to things to some degree.



Removing the water.

Do you see that the hand in this picture has been squeezing some soil but no water has been pressed out, yet it is damp enough to hold together and shows the impression of the fingers. That is a moist soil, and plants are most comfortable when the soil is in that condition.

Notice that in this picture the soil has been squeezed, but when released it crumbles into a shapeless pile.

You can see what a boy is doing in this picture. He is just out of bed in the morning and has washed his face and hands. I hope he did it thoroughly and when he goes to the breakfast table will not be sent back to do it all over again. With a towel he is wiping off the water that has held to his skin.

In the next picture some one has a pebble in one hand and a fountain pen filler in the other. Instead of ink in the filler there is water.

After putting on the first drop, watch it spread over the pebble. That drop, spread out, is called a water-film. After

waiting a moment, watch the second drop make a larger film than the first.



The water on the pebble.

Add drop after drop and with each drop note the change in the film.

Soon the film on the pebble will be much thicker at the bottom than at the top. As drops of water continue to fall, the film becomes so thick and heavy at the bottom that it can no longer cling to the pebble and it falls in the form of a drop.

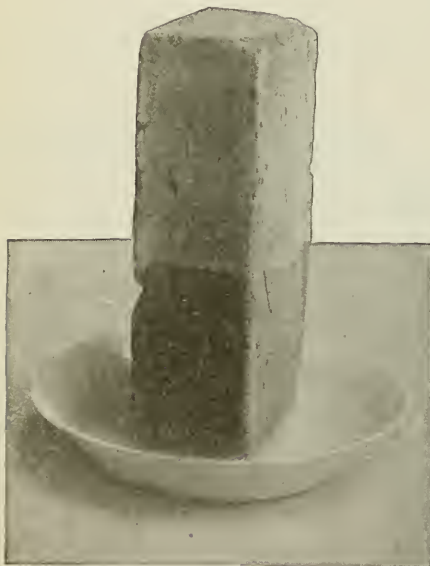
It is somewhat after this manner that rain works downward from pebble to pebble and from soil grain to soil grain until some hard clay or rock stops its downward course. This point is called the water-table.

I have another "garden commandment" to give you. It relates to water. The knowledge of it will sooner or later help you to know how to make plants comfortable: *When water is left to itself, it never stands still.*

It is always in motion unless it is chained up so that it has to remain out of motion,—when it is corked inside a bottle, for example.

As soon as the drops of water have stopped draining downward and reach the water-table, they turn about and begin climbing upward to the surface of the earth. You may see for yourself how water travels uphill and downhill.

Secure a brick — a soft one — and put it on end in a plate con-



How water climbs a brick.



How water climbs through sand.

cultivated soil like the sand — than in a hard, uncultivated one — like the brick.

taining water. Call the plate the water-table. In about half an hour see if the water has started toward the top of the brick. Look again after an hour and at two hours. At last observe how much time passes before the water reaches the top.

The same thing may be shown in another way. Tie some cheesecloth over the bottom of a lamp chimney and fill the chimney with common sand. Set it into a plate of water, which will correspond to the water-table. The water runs uphill much faster through the sand than through the brick.

A plant could get a drink quicker and more of it by means of the sand than by means of the brick. You may now see one of the reasons why plants are more comfortable in a loose, well

cultivated soil like the sand — than in a hard, uncultivated one — like the brick.

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No. 4

UNCLE JOHN'S TALK WITH THE GARDENERS

My dear Nieces and Nephews:

Do you know anybody who makes his own living? I do not mean "earns" or "gets" his living,—that is common enough,—but one who really *makes* his living.

Did Robinson Crusoe make his own living during his lonely life on the island of Juan Fernandez? He found fruits, and skins of goats. He cooked one so that it gave him sustaining food, and he shaped the other in a way that gave him protective clothing. As a matter of fact, he

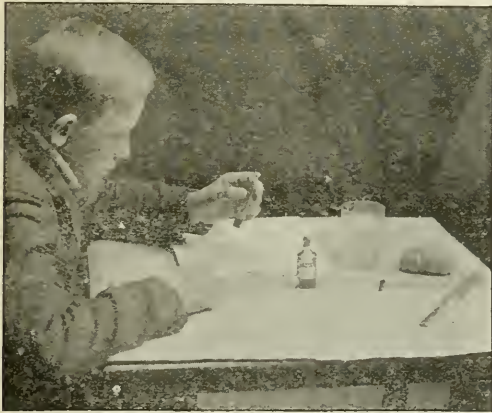


FIG. 1.—A boy's laboratory. Testing for starch with iodine.

neither made breadfruit nor goatskins. What he did was to change their form in a way that suited his convenience. Both were made before he gathered them.

There have been men who have accomplished great things and have been held in honor for hundreds of years, because of their wisdom and power, but not one of them was able to do more toward making his own food than was Robinson Crusoe.

What I have just said has been to awaken your minds and set you to thinking. Little bodies can do great things. Plant life — even the weeds and grass at our feet — can do one thing that even the wisest men who ever lived cannot do.

Plants derive their living from inorganic matter

This line sounds as though I had copied it from a book on chemistry. Many of my boys and girls will not understand what is meant. That is the very reason that I have brought up the subject at this time, so that we can have a talk about the meaning of organic and inorganic matter.

All the many things in this world of ours may be placed in two great groups. Things that are living or remains of things that have once had life and things that have never had life. There is a great difference between the two.

Those things that have had life must also have known death, and are now in a process of decay—wasting or fading away, probably to appear again in some new form of life. That which has never had life is practically the same in structure now as it was a thousand years ago. A stone that a century ago may have been as big as a meeting-house may now be broken into pieces some of them as small as pin heads and the pieces may be widely scattered, but each tiny piece keeps the same character as had the big rock. It cannot die, for it never had a life to give up.

Your teacher can make an interesting contest by asking each of you to see who can write out the longest list of organic and inorganic substances. I once knew a man who learned to make such classification many years after he had left school. When he read or heard the word

“organic” the thought would run through his mind, “Had organs, therefore had life.” When he read or heard the word “inorganic” the thought would come, “Never had organs, never had life.” He remembered that the prefix “in” meant “not.” At this time he has heard the words so often and is now using them in his own speech and writing that the two meanings come to him with the words without the



FIG. 2.—*The boy professor. Now add fourteen parts of water.*

peculiar translation of which I have spoken.

Since writing the above I have been leaning back in my chair, wondering whether you now have the meaning of the two words, organic (once had life) and inorganic (never had life) so clearly and well placed in your minds that I may now use the terms and you will not in any way lose the sense of what I am trying to say.

The plan of grouping things into families saves much time and thought and aids to a clearer understanding. It is something like going cross-lots. It is called classification. We will talk more about it by-and-by.

Let us go back where I left off about plants that are able to make their own living from inorganic (never had life) matter. No other form of life can do that. Some of you boys who are fond of fishing and use earth worms for bait may think that they live on fine particles of sand and grit. That the worms swallow much of such inorganic (never had life) matter is very true, but it gives no nutriment. The worms find food in the organic (has had life) matter which is mixed with the inorganic (never had life).

Plants are the only living things that can draw any food from inorganic matter. Were it not for this power of plants we should all perish from starvation. The food of all animal life from nidget flies to elephants depends directly or indirectly on the food made by vegetable growths having green leaves.

We come now to another point which I hope will greatly interest you, which is this: How is the food upon which all life depends made by the plants?

I think no scientist will deny me the privilege of saying that it is all made in factories. Very busy factories they are, but silent ones. They are mainly in the leaves of plants. The leaves must be green and of very healthy growth or the factories will get out of repair. Some of the raw material that is used comes from the soil, but more of it comes from the air.

The power to run the factories comes from the sunbeams

You are all familiar with the sight of house plants all bent toward the



FIG. 3.—*The test. Watch the starch grains change in color.*

window. That is because they are reaching out to get the power in the sunbeams to run the factories in their leaves. The power in the sunbeams is greatest in the summer when the freckles come on faces and tan on bare feet. In winter, even though the moisture and temperature of the greenhouse are made just right, the starch factories are not so active as in the summer. The shorter and cloudier day is part of the

reason and the glancing of the sun's rays is another and greater one. Ask your teacher or some one who has studied physical geography why the

rays of light become more vertical — more up and down — as the days become longer.

The product of the factories is starch. All the starch the world has ever known has been made by plants. The greatest chemist who ever lived could not make enough starch to stiffen his own shirt collar, yet every summer tons and tons of it are made by the plants all about us.

All the life in the world depends on starch. It is the foundation food. When in the plant it is capable of going through a number of changes, much as water can change to vapor, steam, snow or ice, but to a chemist, whatever the change of form may be, it is always water. The starch grains which are made in the green parts of the plant can take on changes and travel to all parts of its body and change back to starch grains again and rest there until they are needed to enter the growth of some of the many parts, such as new twigs, new roots, flowers or fruit and particularly seeds.

All thrifty trees — fruit trees we will say — will have more starch than is needed for the time being and it is held for future use much as a prudent man will put money into the savings bank for a time of need.

If you wish to see with your own eyes the grains of starch which a plant has stored away for future use, you can do so by using what is called the iodine test. It is simple to make and your teacher may be kind enough to help you in doing it.

Into a small bottle put a few drops of tincture of iodine and add fifteen times as much water as the quantity of the tincture. Keep the bottle corked when not in use. On a thin slice of potato put a small drop of diluted iodine, no more than will stick to the tip of a tooth pick or broom splint.

Instantly you will see a purple stain. Under a lens, even of very low power, the stain shows as a collection of purple specks. Those are starch grains which the iodine has colored. The starch grains in a potato are important factors that make it so valuable as food.

Not many weeks will pass by before you will be watching the willows which are among the first shrubs to awaken in the spring. Cut some twigs and put them in a bottle of water. After a short time the buds will enlarge and then the leaves will put out and a shoot will show a little growth.

All that growth requires sustenance, which comes from the starch that was stored in the twig the season before. The water in the bottle enables the starch to take a form so as to be available for making growth, but water alone cannot give that growth.

If hard times should come to plantdom, all the trees and plants having abundant stores of starch will live, while the half-starved trees

and plants will die or be put into a lingering decline that would end in death.

It will not be long before we shall be talking about planting seeds and then you will realize that a plant is a most excellent mother in that she puts up a lunch for the support of each embryo plant until its own starch factories are big enough to be in working order and able to supply itself.

When next summer comes and you have a garden planted and everything seems to be growing prosperously, there will be plants here and there that seem to be ailing, and you will write to your old uncle telling him the symptoms and you will say that you think your plants are sick with some kind of blight. When you say "blight" I'll know what you mean. Unfortunately the industrious plants of which I have been speaking sometimes have guests that do not make any starch for themselves, but sponge their living, and come down on their host plant in such numbers that in supporting them the poor host dies — a very shabby thing for a guest to do.

There are a number of plants of such a mean nature. When you hear of grain being stricken with "rust" you are to understand that some seeds, or more properly speaking, spores, too small to be seen when floating in the air, have taken root on the working plants and are sponging a living.

The dodder on clover makes no starch but is a leech upon its host, draining off enough of its carefully stored sustenance to support itself without such useful activity.

UNCLE JOHN.

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No. 5

A CONTEST BETWEEN BEANS AND POTATOES

To My dear Nieces and Nephews:

This is what I heard one day: "You heedless boy! If you do not take more care in what you do, you will never amount to a hill of beans." A vexed mother was speaking to a careless son.

"I don't want to be a hill of beans; I'd rather be a hill of potatoes," replied the boy.

Beans or potatoes

Which would you prefer to have, a hill of beans or a hill of potatoes? Both beans and potatoes are valuable as food, and also for profit. If you ever go camping or tramping you had better take baked beans. Lumbermen whose work in the woods is very hard, eat great quantities of beans.

There are a number of plants in cultivation that are relatives of the potato. The family name is *Solanum*. I fancy but few of my nieces and nephews know many members of the family, but a potato-bug knows them with his eyes shut. It is surprising how much some bugs know about a few things. When I see him chewing away at a tomato plant or an egg-plant, I know that the plant is a *Solanum* or very closely related to it.

The best way to determine which is the more profitable is to plant the same area of each, or a certain number of hills, and when the crop is harvested, find which is worth the more per hill.

Conditions of the contest

The reports may be made next September, at the beginning of the new school year. Perhaps you can have an exhibition or show at the schoolhouse.

It is necessary that every boy and girl who enters the contest should know the number of hills of beans or potatoes that he or she plants, and also the yield of each that is harvested.

When you return to school next September, you will have some good problems in arithmetic, in finding the rate of production per hill, the value at market prices, and other bits of information that will be worth your while to know.

The contest is to be decided on which crop will bring the most money from a square rod of soil — beans or potatoes.

How to make conditions favorable for both sides in the contest

That each side may get the most out of its choice of crop, it is necessary to give the chosen plant the most favorable conditions for growth. The potato and the bean each has its own peculiar requirements as to what makes it comfortable. They differ as much in this respect as do boys and girls in what they think good to eat. For example, the bean is a warm weather plant, and must not be put in the ground until all danger of frost is past, or, if I may say, until settled barefoot and swimming time has come. But potatoes may be planted from the twentieth of April up to the time when the first strawberries ripen, which in most parts of the State is about June fifteenth.

THE BEANS

There are pole beans and there are bush beans. In some places poles are difficult to obtain. In this contest only bush beans would better be planted.

Among the bush beans there is the field bean, sold after the seed is ripe. It is from this class that our baked beans come. Another type of bush bean is what are sometimes called "string beans," or "snap beans," or "wax podded beans." They are to be picked when the pod is tender and meaty, and when cooked like green peas, some people prefer them as a substitute. They make excellent pickles and match well with the sandwiches at a picnic.

Enemies and disease of the bean

While the beans are growing, look sharp for robbers — I mean weeds. Boys and girls who will let a lot of weeds get the better of them cannot be good for much, but it often happens, nevertheless. I have seen grown men give up to a parcel of weeds. The best time to kill weeds is when they are babies — I mean when they are just peeping through the ground, before they are big enough to steal much of the fertility and moisture from the soil.

The most serious bean trouble is a visit from other plants that come and live on the bean plants, causing what we know as a "plant disease." These plants that sponge their living are fungi (or fungus when we speak of only one). They are "parasites" because they live and grow on other plants. There is a fungus that causes "rust" on beans, and another kind that causes a disease called "an-thrac-nose." The fungi that cause these troubles are so small that they can scarcely be seen by the naked eye.

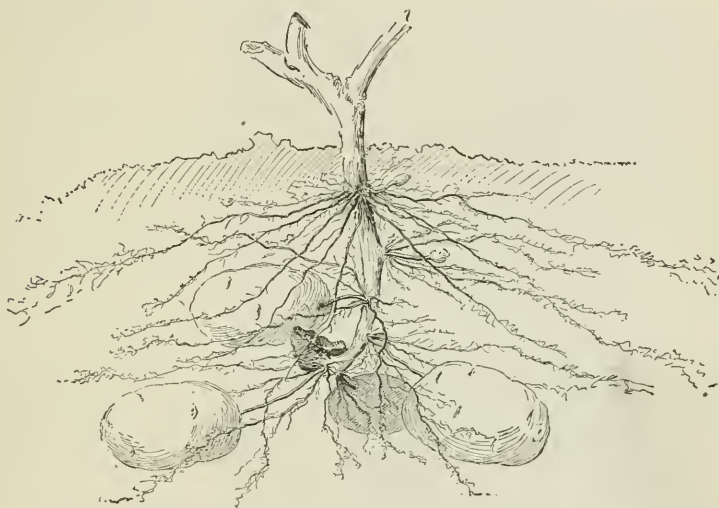
When any fungous disease is well established — started I should say

— it cannot be cured any more than whooping-cough can. Protection lies in covering the foliage by Bordeaux mixture, applied before the dead-beat plants can get a start. The most effective Bordeaux mixture is in a liquid form and is sprayed on the plants.

THE POTATOES

In planting potatoes, we use pieces of potato for seed with one or more "eyes" or buds on them. When a shoot springs from the eye it is sustained by the starch stored in the fleshy part of the potato until it develops feeding roots and leaves, and is able to support itself by its own roots and starch factories.

Some people think that the potatoes grow on the same roots that take



Underground part of potato plant in mellow soil.

water to the leaves, but that is a mistake; they grow on underground branches. I wish you would see what goes on in the soil in a hill of potatoes. Look at the stem where it comes through the surface and follow it down into the soil until you come to its end. There you find the seed pieces that were planted. They were once fresh and plump. The pieces are now practically dead, but before giving up their lives they started a prosperous family. Observe, if you will, the fine thread-like roots spreading out in all directions. They seem to grow in sets, and each set starts from about the same point in the stem, and from the center of these clusters or sets of roots there grows an underground branch. At the end of the underground branch you will find the potato. The fine roots are what supply the leaves or starch factories with moisture and such raw material as is needed from the soil. These roots show great energy in reaching out after moisture and food, and sometimes get into the pasture belonging to the potatoes in the next hill.

Potatoes call the plant doctor more often than the bean

Diseases and pests of the potato are more common than those of the bean. Of insect enemies it has two, the flea-beetle and the potato-bug. The flea-beetles eat tiny holes about the size of a pinhead on the leaves,—not clear through, but on the surface. These holes destroy many starch factories and the wounds are places for the spores of fungi to enter and grow, which causes leaves and stems to die as if they had ripened, and before the potatoes are half grown. This produces the trouble commonly called the "early blight," because it comes in early summer and mid-summer. There is another blight that causes the potato to rot. It is also due to a fungus that first attacks the leaves and later works down to the potatoes themselves. Bordeaux mixture is the best remedy for blight or rot troubles.



Digging the potato crop.

The potato bug is the commonest foe. The blight is not certain to come every year, but the potato-bug never fails to spend a part of the summer with you. I recommend that the bugs be brushed off into a pan having kerosene oil in it. This soon brings death, and I fancy a painless one; but for field culture, the farmer sprays poison on the vines by means of machinery.

The results

When school begins NEXT SEPTEMBER I am wondering how the contest will come out. I want to hear from every one of you who has planted either on the bean side or the potato side. You must tell me all about the yield and its value. If any of you are

able to send photographs showing anything of interest in your work, I shall be glad indeed to get them.

I hope that you will have the show at your schoolhouse, when school opens. You can make the beans and the potatoes the main part of the show, but you can also bring other vegetables and flowers and fruits. I will write you again about the contest.

UNCLE JOHN.

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No. 6

BILLY BOY AND HIS GARDEN

JOHN W. SPENCER

Tell me, Billy Boy, what you intend doing with that box? Oh! yes, now I understand. You say that you mean to have a garden this summer and you will first sow the seed in shallow boxes and keep the boxes in the house away from cold spring storms. You can attend to them there while they are little, very much as a baby is cared for when in the cradle. But it seems to me that the box is much larger than you will need for a crib for infant plants.



FIG. 1.—Just the thing to saw into flats.

I am pleased to see you set about it so early. They say that it is the early bird that catches the worm, and I think that it is the early gardener who catches the good prices for his produce.

To be tardy and unwatchful of opportunities causes damage and loss to men of all trades, but to none quite so much as to the farmer. He must be "on hand" every time.

Mother Nature when left to herself never waits nor hastens in her round-the-year work, but men have learned that with a little skill she can be so managed as to perform wonders for their profit and pleasure; like fresh lettuce in April and fine thrifty tomato plants ready for transplanting in late May.



FIG. 2.—*Measuring carefully.*

Billy says that he intends to make several boxes of that big one. He is now measuring the sides and plans to divide the box into three shallow "flats" of about the same height.

I am glad to see that he is trying to do the work very accurately and well. He means to be a very skillful workman when he is a man. But I am sorry to say that he is not as careful as he should be of his father's tools. He

is nailing on the bottoms of his flats with a clumsy blacksmith's hammer because he has mislaid the good carpenter's hammer which would do the work so much better.

His father says that whenever he misses a tool he does not hunt for it, but immediately looks up Billy instead and sees that he returns it to its place.

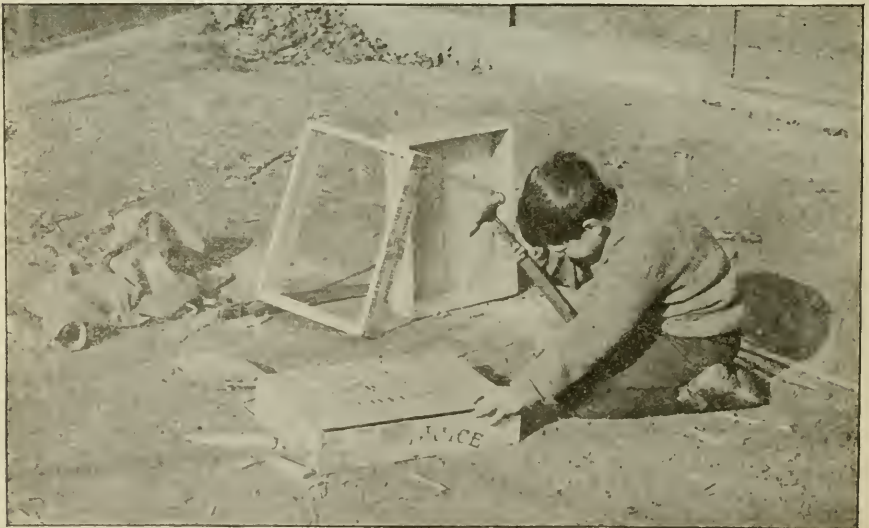


FIG. 3.—*Good work with a poor tool.*



FIG. 4.—*Making holes for drainage.*

Oh, hold the bit vertical, Billy! I mean straight up and down. It will bite its way through the board much more smoothly. Put in plenty of holes so that all the surplus water may drain away. It is even worse

for seedlings to have wet feet, than for plants of older growth. Then put a carpet of moss on the bottom of the flat to keep the fine soil from sifting through, and it will also retain moisture and keep the shallow earth from drying out too rapidly. It means a good deal to a plant as well as to a boy, to be started out in life with a sturdy constitution. And for that, plants must not be kept either too wet or too dry, nor in too warm a place for then



FIG. 5.—*Putting moss in bottom to keep soil from sifting through.*



FIG. 6.—Freeing the soil from lumps and stones.

cannot get wood earth, perhaps Father will let you buy a few cents worth of florists' soil which is prepared with food for hungry plants.

Right again! Firm the earth well, so that the working roots may not find their way into little open spaces where they will dry up. They need some air, but enough will creep through the firmed soil. Roots seem to like to push their way.

I am glad you are making such straight

they are apt to grow tall and "spindling."

That is right. Sift the soil carefully, and if it is clay soil, add a little sand to make it more loose and crumbly. If you are able to get some woods earth to mix with the clay, the plant will like it very much. That kind of soil is mostly made of decaying leaves and wood, and the little fuzzy working roots can find plant food in it to send up to the starch factories in the green leaves. If you



FIG. 7.—Making the soil firm.

rows. It is much better than scattering the seed. For one thing, it is so much easier to distinguish the weeds. If your plants are standing like soldiers on parade, in a perfectly straight line, you will know that the unwelcome intruders that come up between must be weeds, and pick them out before they become big enough to rob the rightful owners of food and moisture.

Be careful not to sow the seeds too thickly. If they are very, very fine, it is a



FIG. 8.—*Making rows for the seeds.*



FIG. 9.—*Sowing the seeds.*

good plan to mix them with about the same amount of sand, and take small pinches, for they slip away through the fingers faster than you think. Seeds of good size, as tomatoes, would better be sown one at a time, about a half inch apart. Crowding is a very bad thing for plants and children. They both need room to grow and do their best. Plants cannot grow well when shading each other, and



FIG. 10.—*Covering the seeds.*

and about four times as thick as the seeds it covers.

Then firm the soil down again. This does not make the surface hard, but only snugs the soil about the seeds so that they feel the warmth and moisture and immediately begin to swell, and shoot from their protecting shells.

It is well to have only one kind of seed in a row, for some sprout much quicker than others. Peppercress is above ground

children do not thrive in crowded city tenements.

That is a good way to cover the seeds. It does not disturb them in the rows. Sand is the best covering, for it never packs, and the tiniest and weakest seedling can push its way easily through.

If you cannot get sand, then sift a little pile of soil several times to make it very fine and light, and keep that for the final soft blanket to help warm the seeds into growth.

But make the blanket of an even thickness,



FIG. 11.—*Firming the soil about the seeds.*

in a week, but parsley takes a month before showing itself.

Label the row with the name of the seed.

I think that you must have been taking lessons in gardening, Billy, for you are doing it all so well. That gunny sacking on the surface will keep the seed from being washed out of place, and also, the darkness keeps the seed-leaf from pushing through before the tiny root-lets are big enough to

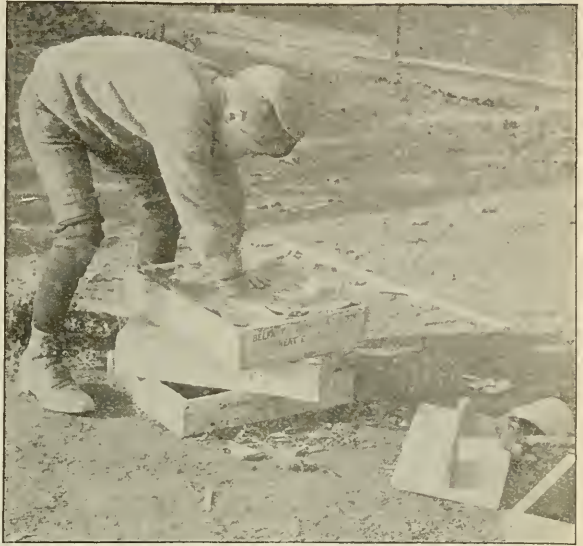


FIG. 12.—Covering with sacking to prevent washing.



FIG. 13.—Drenching well.

through the ground, and I think success will be yours.

gather plant food for the starch factories.

When you water, do it thoroughly. Some people just sprinkle a little on the top, and the working roots in the bottom of the flat get so thirsty they are likely to die. They feel that they are living in a desert. Keep raining till the water runs out through the drainage holes and then let all the surplus flow away.

Now you are ready for the long wait. Be careful that neither drouth nor frost shall touch your seedlings when once they are

UNCLE JOHN.

GARDEN SONG

ADA E. GEORGIA

TUNE: *Marching Through Georgia.*

Now for all the boys and girls to gather with a will,
 And show the learned grown-ups they haven't all the skill.
 For we propose to waken you to admiration's thrill,
 While we are working in our gardens.

CHORUS.

Hurrah! Hurrah! for spade and rake and hoe!
 Hurrah! Hurrah! for helping things to grow!
 So we'll sing in chorus as the seasons come and go,
 While we are working in our gardens.

Break the stubborn clods of earth and crumble them to bits,
 Tiny seeds must have a soil that for their purpose fits.
 Here's a school where every one has need of all his wits,
 While we are working in our gardens.

CHORUS.

Thin the rows and pull the weeds that choke the tender shoots.
 Stir the soil that moisture holds for thirsty working roots,
 We must try for everything to give the care that suits,
 While we are working in our gardens.

CHORUS.

By-and-bye the harvest comes and brings to us return,
 Unto each and every one the just rewards we earn.
 We are glad from growing things of Nature's ways to learn,
 While we are working in our gardens.

CHORUS.

Hurrah! Hurrah! for spade and rake and hoe!
 Hurrah! Hurrah! for helping things to grow!
 So we'll sing in chorus as the seasons come and go,
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No. 7

PEPPERPOD'S BERRY-BOX GARDEN

This is Little Miss Pepperpod. Some of you have met her before. She is called so because her hot temper flashes out so often. However, it helps her to carry through whatever she undertakes.

Last term at school she raised some peppergrass in an egg-shell farm.

The taste of the one small sandwich that she made from her crop then, has made her wish for more. So she has found a quart berry-box and means to have a larger peppergrass farm.

The other name of peppergrass is Curled-Cress. It is of the same family as water-cress, and tastes just like it, but grows willingly in garden soil while its relative insists on having its roots in running water.

But the berry-box is full of holes. If she does not in some way stop them up, the soil will leak away when she waters her farm. At the kindergarten she learned to cut and fold paper very neatly.

So now she borrows her mamma's big shears and cuts and fits a lining of thick paper for her berry-box.

In the garden she has found some fine crumbly soil which she thinks will be good for her box-garden. Her teacher says that soil in boxes and pots must be of a

kind that will not "cake" or harden when it is dry. To make sure that it will not, she will add a little sand or woods earth. She is filling the berry-box much too

full, as you see in the picture. Pots and boxes should not be quite full of earth when ready for seeds or plants. It washes off at watering and makes an untidy mess.

She sows the seed about a half inch apart, on the top of the earth and then covers it carefully with a thin layer of sand, about four times as thick as the seed itself.





She sows these seeds a little deeper than she did the peppergrass, and farther apart, for they are bigger seeds of bigger plants, and need more room. For the nasturtium, she first jarred the berry-box to settle the soil grains well together, and then poked her forefinger into it up to the first joint, and dropped a nasturtium seed into the hole thus made. She put them an inch apart, which made four rows of four holes each. Then she covered the seed and pressed the soil closely upon it.



In a week the tiny shoots will push up through the sand, and in two weeks more she may thin the plants to about an inch apart.

While she was about it, Little-Pepperpod made three berry-box gardens. In the first she sowed peppergrass. But spring is close at hand and she means to have an outdoor garden.

Beneath the kitchen window she wants some nasturtiums and "scarlet runner" beans. Also she wants some tomato plants, started early, for transplanting to the outdoor bed as soon as the weather becomes warm enough for the needs of the warmth loving tomato.



When she transplants her nasturtiums, she will not pull up the plants, but break or cut the berry-box carefully away from the block of soil within it, and gently separate the roots, allowing each plant to keep its tiny clod of earth. By doing so, the fuzzy working roots receive the least injury, and continue their work of gathering food for the starch factories in the green leaves with scarcely any interruption.



She is having pretty hard work in spading up the soil for her outdoor garden. But she works away, jumping upon the spade to drive it into the soil until she has broken up quite a space of the hard ground which she whacks and spansks with the back of the spade to make it fine and mellow. She finishes it by raking it over many times, picking out all sticks and stones as they keep working to the top. Her little neighbor thinks that he can do this work as well as she, and begs, "Please let me comb some, too."

Pepperpod takes pride in doing her work very neatly. Plants will grow

well standing in crooked rows, but they will not look so well, nor can they be cared for so easily. With the handle of the rake she makes a shallow groove in the soil, and sows the seed carefully, not too thickly, and then pushing the board aside gently tumbles a thin covering upon it from the soil at the sides of the groove. Then she walks upon the row, "heel and toe." This is very important, for it is necessary that the



soil should be well firmed down upon the seeds, for if it were left full of tiny "air holes" the delicate rootlet might wither and the plant would never come above the ground.

The young plants will be large enough to show the straight green rows in about a week. In a week after that Pepperpod may stir the soil with a hoe or rake. This will not only kill the weeds, but will prevent the moisture in the soil from passing off into the air,

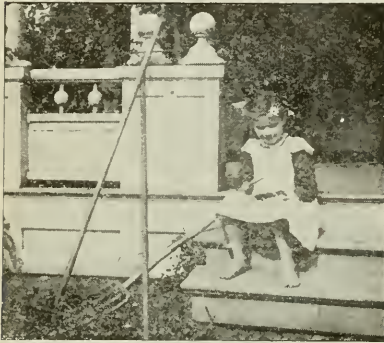
The film of water upon the soil grains is never still, it is always either trickling down, or climbing back to the clouds. It has no difficulty in its upward climb through well firmed soil, but when it reaches the loose "earth mulch" which the careful farmer keeps on the surface of the soil in dry weather, it is obliged to stop. The spaces are too wide for it to cross.

Pepperpod has been out in her garden, thinning the rows of peppergrass, killing the robber weeds, and loosening up the earth between the rows, which the last shower had beaten hard. Now she is tired and wants a rest and a lunch before she puts away her tools. Most of the thinnings she takes to her mamma for a salad at dinner time, but a few she puts

between thin slices of bread and butter, and sits down on the porch to eat and rest.

Her peppergrass bed has given the family so many nice relishes, and she has so greatly enjoyed their pleasure in it, that now she is planning for more things to grow.

She has spaded up a place for her tomatoes, which are getting too big for the berry-box; and she will sow more radishes and lettuce beside.



If she has good success with her radishes and lettuce her mamma has promised to buy them by the bunch, paying the market price, and Pepperpod must learn to put them up neatly for sale. Corn and string beans may be put in after the lettuce and radishes have been pulled. That is, if Pepperpod continues as enthusiastic as she is now. I think she will, especially when she buys Fourth-of-July fireworks with her radish and lettuce money.

She means to have a few flowers too, besides the nasturtiums, which are now big enough to transplant. She planted sweet peas some time ago, for they do not mind cold weather, and asters, bachelor's buttons, pinks, phlox and marigolds grow so easily that even a little girl may succeed with them. I wish you might see her garden when it is in bloom. She will gladly pluck you a bouquet, for her greatest pleasure in her garden is in the pleasure it gives to her friends,



My dear Nephews and Nieces:

Your Uncle John has asked the printer to put all the illustrations on the first four pages of this leaflet. He knows how boys and girls read the pictures first. In fact he often does it himself. If you will read carefully, you will find that two ways are shown for raising peppergrass. With the smaller pictures you are told about raising it when the soil is in boxes up in the air. The rest of the pictures show how to raise it when the soil is lying where nature has placed it. There are many people living in crowded cities who have no other way of growing plants, except when the soil is in boxes, pots or tubs. Even people who have ample lawns, have window-boxes and veranda-boxes, which, when filled with plants, adapted for such places, look very attractive. You can all succeed with plants in such locations, but they need close attention in watering in hot weather. I shall tell you about that later.

When a boy or girl has attained success in raising peppergrass in a berry-box, he has taken an important step toward knowing how to raise beautiful flowers and trailing plants in window-boxes.

I have among my nieces and nephews, beginners, some of whom cannot tell a dandelion from a bit of chickweed, up to boys who aspire to become captains of baseball teams, and girls who give parties with refreshments. In what I may say, I shall try not to reach too high for the one class, nor stoop too low for the other.

It is no fancy or fairy talk when I say that there is such a thing as becoming acquainted and making friends with plants. It is as real as to make friends with a dog or cat. To get such a feeling, in the best way one must begin to care for plants in one's childhood. Like playing the piano, one should begin the work when young. It is much better to begin with simple things — things easy to raise, and go on step by step, learning how to succeed with more difficult plants. I speak of this for the reason that I know the inclination of children to try to walk before being able to creep.

The first and greatest thing of all is to know how to make plants *comfortable*. Remember, plant comfort lies at the bottom of your success in gardening and farming. I may speak of plant comfort as often as did my teacher about some of the important rules when I began the study of arithmetic.

The class of elementary farming better begin with peppergrass. All things considered, it is about the easiest plant to raise that can be found. If sown under favorable conditions, the seed comes through the ground in a week, and sometimes less — and that is a faster pace than that of most weeds. It has no insect enemies worth considering. It is good to eat, and big enough to harvest in a month from the time of sowing. That

is quicker than any grown-up farmer can get a crop from his fields of many acres.

Water-cress and peppergrass belong to the same family, and in the catalogue are found under the head of cress. The two have different ideas about what is plant comfort. Their ideas differ as much as those of ducks and hens. Water-cress likes to have its feet in water, and is found in running streams. Peppergrass is more comfortable when its feet — I mean its roots — are in moist soil. Please note that I have said *moist* soil. Can you conceive a condition of soil that is not wet and yet not dry? If so you will understand what I mean by being moist. Peppergrass belongs to the cool loving class of plants, and in its way is as uncomfortable in the hot, dusty summer as is a St. Bernard dog with all his shaggy hair on his back. It may be sown in the open ground as early as sweet peas. If sown in mid-summer, it quickly goes to seed and does not amount to much. The second sowing may be made in September at about the time school begins, at which time the nights are growing longer and the days shorter.

(In the first pages of this lesson you will see among the illustrations, how Little Pepperpod grew her peppergrass.)

WINDOW-BOX GARDENING

Some of my nieces and nephews have no out-of-door,— no soil even large enough to have a farm or garden as large as a handkerchief. In such instances the berry-box farm is the best they can have, and much fun and profit may be had from them. The process of nature goes on just the same as though the peppergrass was growing in a field of a thousand acres.

Even though you may try hard to make your peppergrass in the berry-boxes comfortable, I feel quite sure that for all of your good intentions it will have many hours of discomfort.

If peppergrass could think and talk and remember stories, there would be many times when it might think about the sufferings of travellers across a desert where no water is to be found for miles and miles; or of shipwrecked sailors who when leaving the sinking ship, took only a small keg of water, which was soon gone, and there followed days and days of parched lips and swollen tongues for the want of a drink. Something like this is quite certain to happen while you are making the acquaintance of your plants and learning how to make them comfortable.

Yes, I know the thought which is coming up in your minds: "Why, Uncle John, can't you tell us how often to water our farms?" No. I cannot. I can no more give you such a rule than I can say how often each of you should be given drink. It is not a question of time but of *when* you

need it. You need much more during the hot dry summer than during cold, winter days. If I had the power to make you drink by rule, summer and winter, there would be many hot days when you would suffer for the want of water, and it would be a punishment to be obliged to drink the same amount on zero days in winter. You must learn to tell of your own knowledge when the plants *need* water. Mothers know when to feed babies and you must know when to water plants.

This knowledge is much more important when plants are growing in pots, berry-boxes, and window-boxes, anywhere up in the air, than when planted in the soil of the garden. There the roots can reach out for moisture, and the moisture can creep up to the roots from away down deep.

The best test that I can give you that you may know how to tell when a plant is feeling like a man lost in a desert, is to take a pinch of the surface soil of the box and squeeze it hard between the thumb and finger. If the grains crumble when you let go, the plant is probably thirsty. If the grains of soil hold together, no water is needed. When you water, make it a bath—a souse of water going entirely through the soil. All the water over and above what does not *stick* to the grains of soil will drain away. It is for such drainage that Billy Boy bored the holes in the bottom of the boxes which you saw in the primer sent you before this one.

Plants may be given too much water even when there is ample drainage. I have seen plants in shady places kept so constantly moist that the surface of the soil was waxy, putty-like, and when in that condition for a long time, tiny mosses would begin to grow. Ferns and swamp plants may be comfortable in such locations, but sun-loving plants are not.

Yes, I know that some plants are very fussy about their comfort, and some boys and girls are the same. They expect to find some one who loves them and loves to gratify them in their fussiness and you must be the same good friend to plants.

From raising peppergrass in a berry-box, it is but a step to having a window-box with attractive flowers. Plants are not proud or haughty and do not seem to mind the difference when growing in a soap-box or tomato can or when growing in an elaborately ornamented window-box with carved ginger bread work. Either makes a happy home if the plant is given comfort. The window-box should be at least ten inches high and ten inches wide, inside measurements, and as long or as short as you wish. Do not forget the oft repeated instruction to put holes in the bottom for drainage.

The soil should be as fertile as good garden soil, but some good garden soil is out of place in a window-box. If the soil is not of a

mealy kind, it will soon bake or become hard because of the frequent watering. Florists use an earth prepared from rotted sods. That is the best for window-boxes as well as pots. The rotted grass roots help to prevent the packing of the soil which I have mentioned. If such soils cannot be obtained, and garden soil is the next best that may be had, add about one-third of woods earth. If not woods earth, add about the same amount of sand. Mix well together and fill the box to within an inch of the top after the soil grains are well jarred. Do not forget the jarring to snuggle the grains of soil close together.

In the choice of flowering plants for a beginner in window-box gardening, select such as are capable of enduring the most neglect. With all the good intentions that you may have to make plants comfortable there will be times when the plants will suffer like the cast-away sailor at sea. Tradescantia, more commonly known as the Wandering Jew, is a plant that will stand a great deal of neglect. It does not mind discomfort in its way any more than a clam does in his. It is not practical to raise it from seed but it grows readily from cuttings.

As yet we have said nothing about propagation of plants by cuttings and I will mention only those coming from seed. To children just getting their first experience in window-gardening, I shall recommend but few plants, as one team of horses is more easily driven than four, six or eight. Nasturtiums and Sweet Alyssum are easily managed. Petunias are good when once started. The seed is as fine as dust and the young plants require much care. When petunias are once well established they are excellent for window-boxes, vases and hanging baskets. Pansies are sometimes used, but as they belong to the class of plants that never need an overcoat on cold spring days, they suffer during the hot months of July and August. It is during springs and falls when the days are shortening and the nights lengthening that pansies are most comfortable.

SOME VEGETABLES IN THE OPEN GROUND

In the State of New York you should plant during the month of April and early May, only cold-loving plants — plants that do not require an overcoat every time a cold wind blows. In vegetables I will mention for planting in the open ground:

Peppergrass, lettuce, radish and spinach.

When the hot days of July come, all of these will be harvested and the same ground may be used for plants that enjoy weather when straw hats are worn. It is always best to raise two crops from the same piece of ground during the same season, when the kinds of plants permit.

After the harvest of peppergrass and radish, plant tomatoes. Later in the place where lettuce and spinach were sown plant string beans. Where the farm is large enough plant corn. Corn is very comfortable during all the warm season and is a good crop to raise. I know of some youngsters who pick it about the time school begins in September and play Indian by having a green corn roast. If they have potatoes of their own raising they roast them in the hot ashes.

Raising plants make lots of trouble just the same as raising boys and girls, but if you are fond of them you find pleasure in caring for them.

UNCLE JOHN.

CORNELL

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BUILDINGS AND YARDS.

NOVEMBER, 1905.

TASTEFUL BUILDINGS.

TASTEFUL FARM BUILDINGS

BY L. H. BAILEY

We are strongly influenced by every constant condition of our lives. All of us live in buildings, and from the first to the last we associate with them. These buildings are silent teachers, always impressing us more deeply than we are aware. Sense of convenience and efficiency, of pleasing proportions, of tasteful shapes and harmonious colors ought to be the lessons that our buildings impress on us; yet how many farm

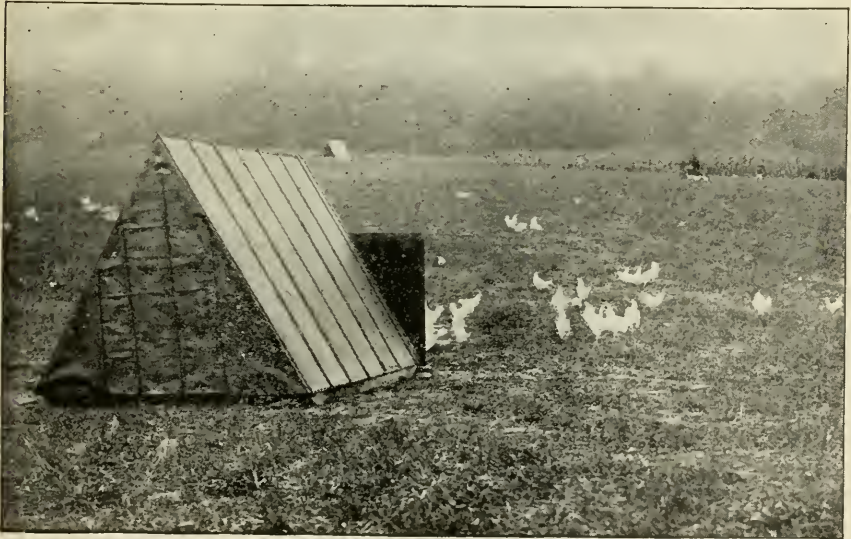


FIG. 270.—A piece of good architecture—simple, direct, of good proportions, and adapted to its purpose.

buildings are really convenient and efficient, or of good proportion, or express harmony of form and color?

It may be difficult to determine what is cause and what is effect—whether poor taste is the result of poor buildings or poor buildings the result of poor taste; but the influence undoubtedly works both ways. The

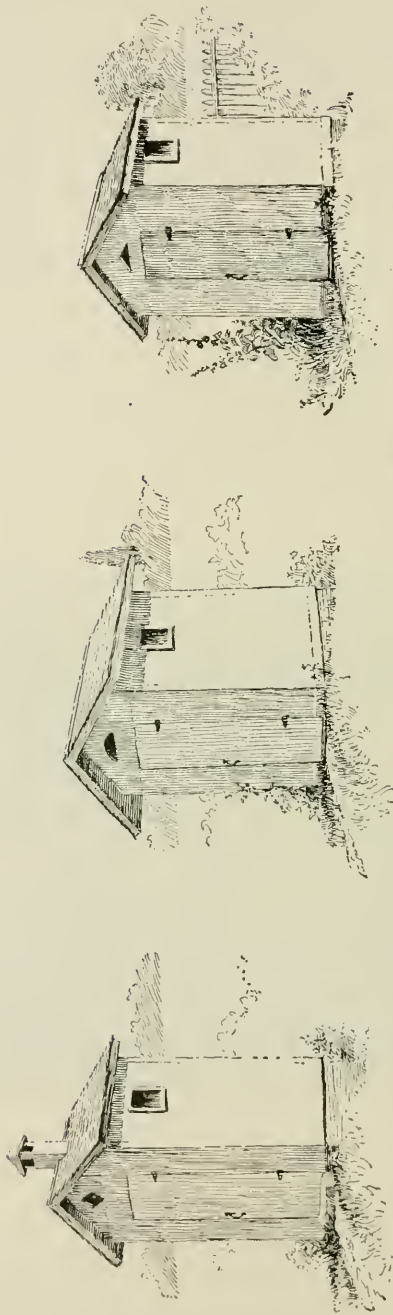


FIG. 271.—A study in proportions. Notice that the door is the same size in all the buildings.

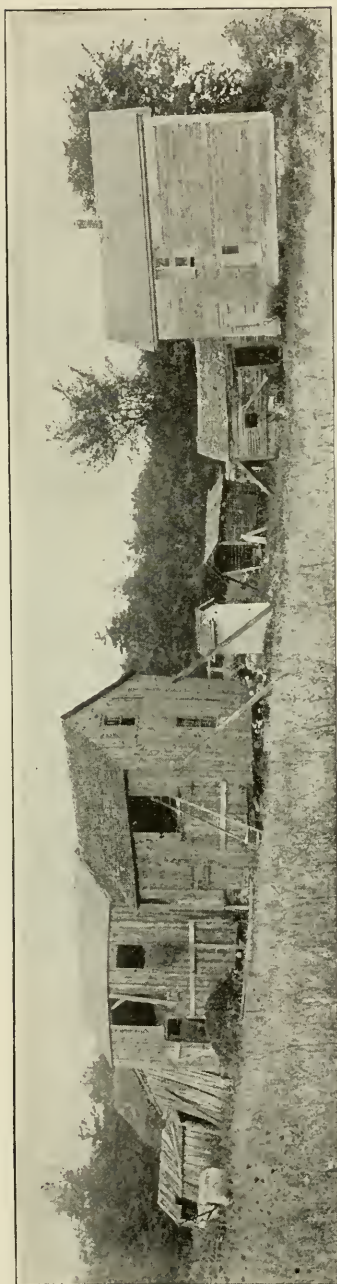


FIG. 272.—A New York farmstead. Study the buildings and the arrangement.

buildings surely express the man,— you know something of his type of mind when you see his house and barns and sheds. Awkward, straggling, unrelated buildings indicate loose and purposeless ways of thinking. Good farming follows only good mental processes; these processes work themselves out in the crop-schemes, the market-business, the buildings. Rarely do you see efficient and convenient buildings without seeing also a good



FIG. 273.—*A city type of farm house.*

farmer; and efficient and convenient buildings are almost necessarily tasteful buildings.

I mean to say that there is no abstract canon of good taste in farm buildings except that they shall be perfectly adapted to the uses for which they are designed and shall bear no meaningless or irrelevant parts or ornament. Theoretically, the cylindrical stave silo is inharmonious in connection with farm barns; but because it serves a direct purpose, we accept it without question. If such a construction were added merely "for looks," it would be ridiculous. The surroundings—the trees, bushes, yards—may correct many of the faults of untasteful buildings by hiding the faults, or by distracting the attention; but every building ought to be attractive in itself.

I. *The building itself*

It should be as easy to make a building attractive as to make it unattractive: it costs no more. What many persons think of as "architecture" is merely the "style" or "looks" of a building. Unfortunately, we seem to have it indelibly written into our minds that attractiveness is only a matter of ornament; but ornament is ludicrous on an ugly building. We must come to realize first of all that every building is good architecture or poor architecture, whether it is a chicken coop or a palace. Good architecture, so far as externals are concerned, consists primarily in proportions, not in trimmings, excrescences, ornaments and oddities. What constitutes good proportion may not be declared offhand, for what is good proportion for one kind of building may be poor proportion for



FIG. 274.—*One of the old-fashioned farm houses.*

another kind of building. Every man can test the question for himself, and he will soon become expert at it: challenge every building that you see and ask whether it is pleasing in general shape. Is it compact and solid-looking, or awkward and gawky?

I sometimes think that the commonest faults with farm houses are that they are high, staring, ill-shaped. I say farm houses advisedly, for farm barns are usually much better in architectural form, and for the simple reason that no effort was expended to make them "handsome" or unusual—they are built for what they are and with no pretensions. I once drove an artistic-minded friend along a country road that he might

see a tall ornamented farm house of which the owner was very proud and which was maintained in spotless condition. Near the house stood the barn, a plain simple structure without ornament or paint. I stopped the horse in front of the house. My friend took in the situation, and remarked, "That barn is a fine piece of architecture."

Most of the old-fashioned farm buildings are pleasing in form. They are relatively broad on the ground, with ample cornices and eaves, stout chimneys, and big simple porch posts. They seem to be adapted to the place. They look like real farm structures. But now we have copied the millinery architecture of the city. We have run our buildings up



FIG. 275.—An abandoned New York farm house. Discuss its proportions.

where they may be seen, and as if land were worth so much the square foot; and often we have loaded them with tating. The porch posts have been run through the turning lathe until they are as slender as possible and yet hold the load, thus contradicting the very purposes for which posts are used—the purpose to provide stability and solidity. The turner shows his skill by cutting them almost in two in several places, and by shaping out various inharmonious forms on the same post. I cannot see how a cylindrical or square pillar of good proportions is made more beautiful or useful by having quirks and undulations run into it, although it may sometimes serve very well as one element in a scheme

of ornament. The spindle-legged porch usually goes with a light-construction and weak-looking house.

The reaction of the town on the country in the matter of architecture is stronger than most of us are aware. One rarely sees a new farm house adopting the old farm house models. Part of the reaction expresses itself in the desire of every person to have a house unlike every other person's. This is really commendable, only that this individuality should



FIG. 276.—A New York farm house.

be got by a different fundamental plan rather than by the introducing of mere oddities or accessories. We now are likely to feel that our buildings must have what we call "style," and this results in a showy building with much effort expended on incidental parts,—scroll work, crests on the ridge, turrets, dormers, fantastic windows, spindle work, and the like.

If any house should look to be strong and substantial, it should be the farm house. The farm house stands by itself. It is not built to sell, nor to serve a single generation. Land is substantial: the buildings go with the land.

I must not be understood as saying that the country is worse than the city in respect of its buildings. In fact, I think that the country is

better off because its buildings are less ambitious and showy. New York State abounds in good ancestral farm houses. It is difficult to conceive of a prospect more ugly than many village or city streets, with

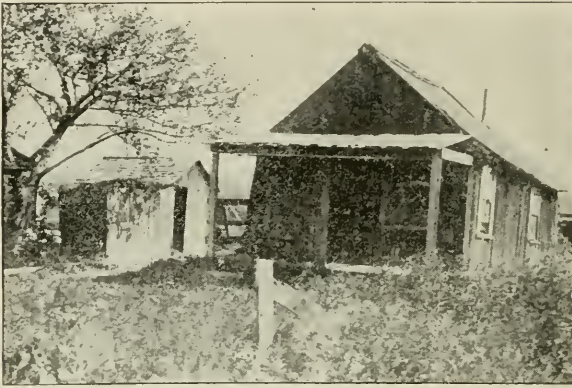


FIG. 277.—*Shiftlessness expressed in a building.*

their heterogeneous and formless houses. I want to set farm people thinking about the "looks" of their buildings and to say that there is

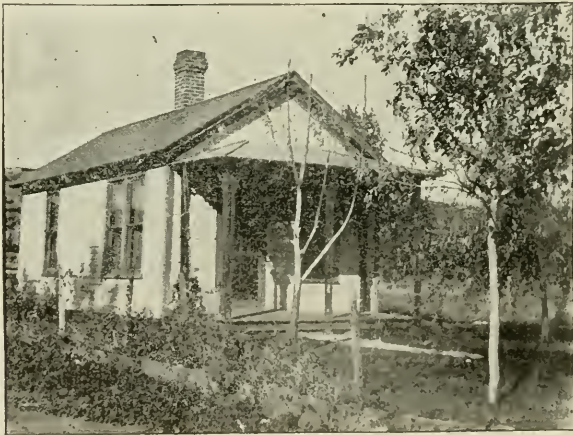


FIG. 278.—*Thriftiness and good management expressed in a building of similar size, although faulty in some characteristics.*

just as much opportunity for the exercise of good taste and for the display of good "architecture" in simple farm buildings as in city buildings.

Nor do I mean to advise the discarding of all ornament on buildings; but there is ornament of proper kind and degree and of improper kind

and degree: just what is proper or improper in any case must be determined for that case alone. A building devoid of all conspicuous ornament may be very attractive, if the general form is good and the openings properly proportioned to each other. The cheap ornament that we so commonly see is added to relieve the "plainness" of the building; but plain buildings—that is, simple and direct ones—are themselves the

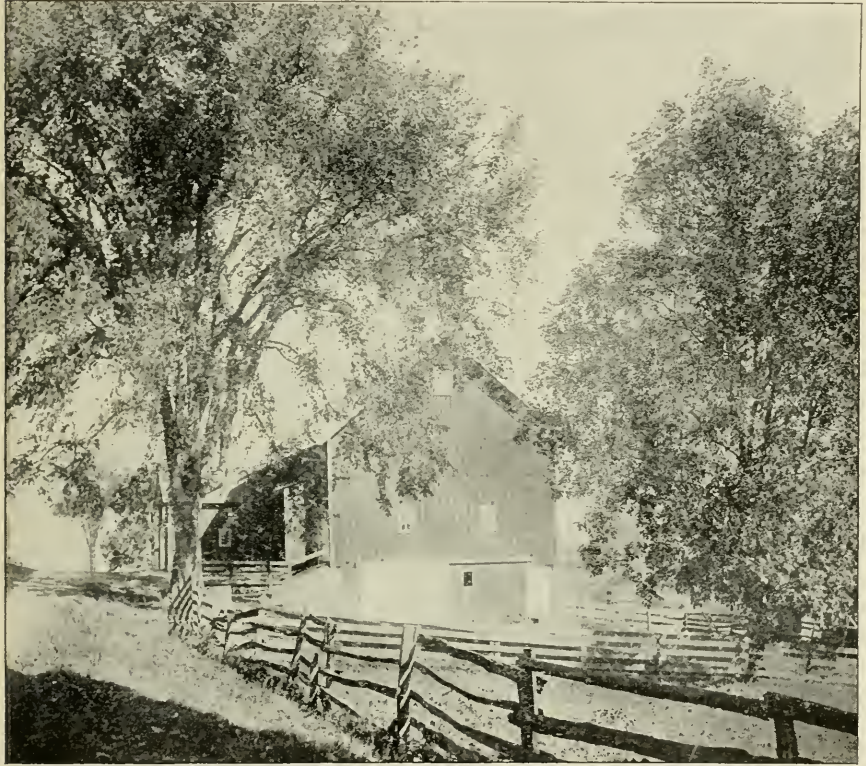


FIG. 279.—An attractive farm barn.

most satisfying buildings if the mass-effect and construction are good. Let a person erect such a plain building in the midst of showy ones and his friends will very likely compare it to a barn. The comparison may really be a compliment; in time the critics will come to like the simple structure and to tire of the others. The simple structure "wears."

In the days of hand-work, the trimmings and ornamental features were worked out by the men who built the house, and there was likely to be harmony in the style of workmanship. Now, the ornamental features are largely machine work, and they may have little relation to the

remainder of the building. For these reasons, we need to exercise great care in the treatment of the "finishings" of a building.

Because a building is in keeping in the city, it does not follow that it would be in keeping in the country. The building should fit the place and the purpose. It should seem to belong just where it stands. It should not seem to be transplanted to the country. The traveller often wonders why the simple and unpretentious peasant cottages in Europe are so interesting. The reason is just because they are simple and unpretentious, and therefore individual. They seem to have grown up



FIG. 280.—*Of no architectural pretension, but attractive because of its picturesqueness and the fact that it is adapted to its purpose.*

out of the land and to be a product of it, expressing merely the necessities of the builder. They were built slowly right where they stand, not carted in bodily from the mill and then set up. It is too bad that in New York State, a land of stones and rocks, there are not more stone buildings. Unfortunately, stone buildings are expensive because of the great cost of masons' wages and the difficulty of securing masons in the country who can lay a good rough untrimmed wall; yet we ought to be developing a class of young farmers who themselves can utilize the native materials of their region.

One finds certain types of houses and barns peculiar to great geographical regions or to people of a certain descent. In parts of New



FIG. 281.

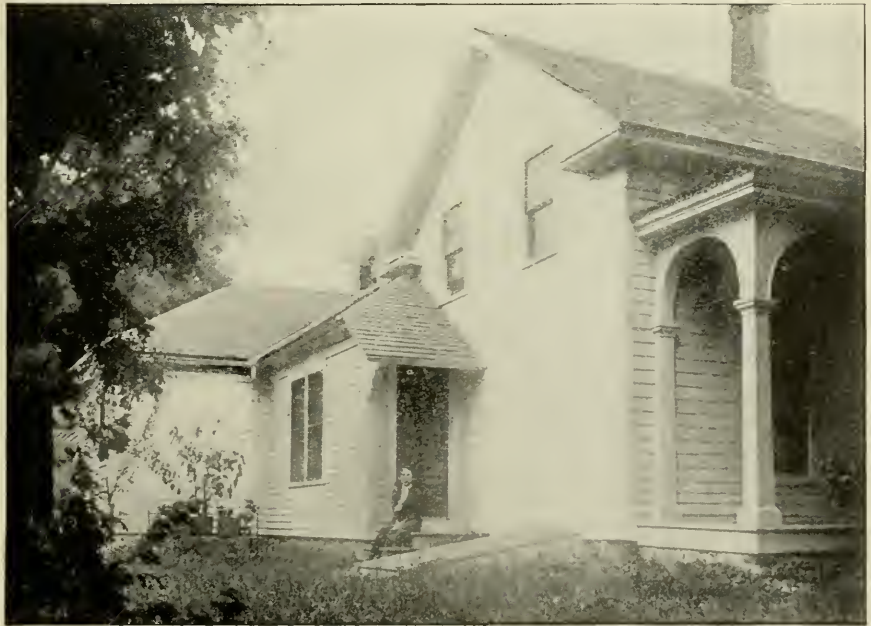


FIG. 282.—A remodelled farm house, the long ell being replaced by a compact wing.
The old form of the house is shown in Fig. 281.

England one sees the house, woodshed and barn comprising one continuous building. In New York, a prevailing type of farm house is the "upright and wing" form. In compact villages and cities this form of house has been given up. It is a question whether it always affords the most useful and convenient house for a farm or allows the most economical use of the materials. It lacks compactness; but it lends itself well to the parlor and the spare-room idea, for these apartments can all be placed in the upright and be out of the way. The family usually lives in the wing. One could write an essay on the type of mind in our ancestors that developed this particular form of house, relegating the family to one sphere and the company to another sphere. Another in-

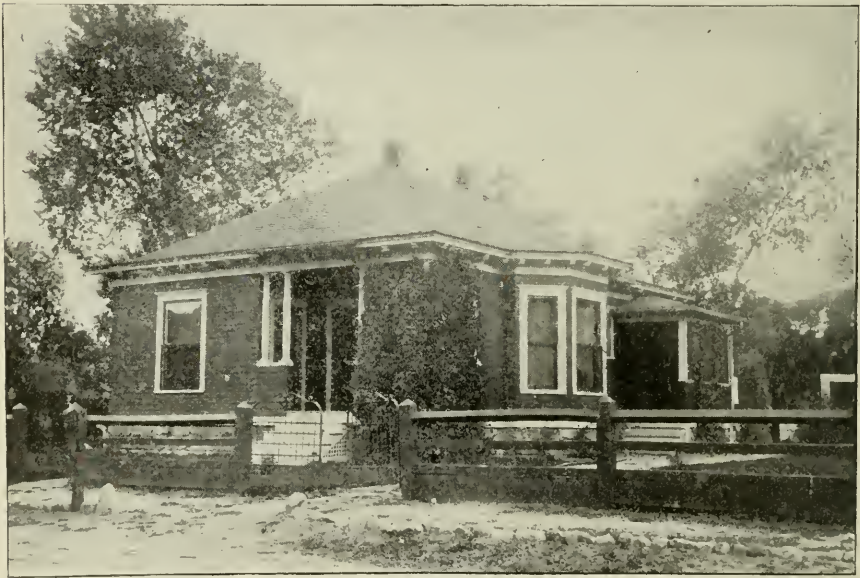


FIG. 283.—A compact house in the western style. Colorado Springs.

teresting discursive type is the "ell," which ambles off to one side. In marked contrast to all this, one finds beyond the Mississippi and especially in California the compact low-topped square house, in which practically all the activities are under one roof. These houses may grow large by extensions rather than by additions or wings, all the parts being under roofs of equal height. These buildings are often models of concreteness and concentration, and usually they are comely. I often wonder why someone has not adapted them to the East.

The old-fashioned box-corniced farm houses were faulty in the small extent of veranda—commonly they had only a "stoop"—and also in

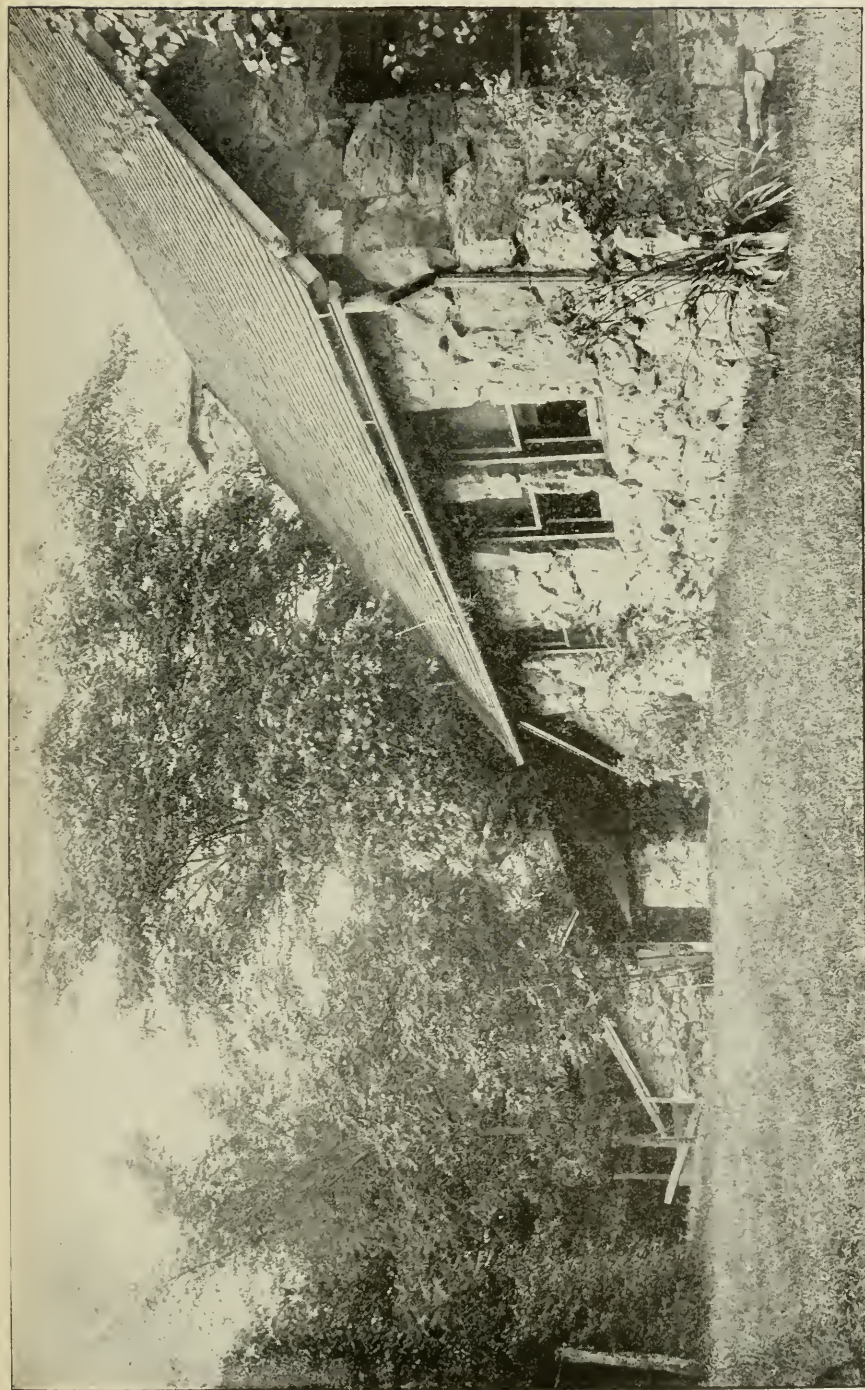


FIG. 284.—A farm cottage built of native stone. The absence of a water-table causes it to appear as if it "grew up out of the ground."

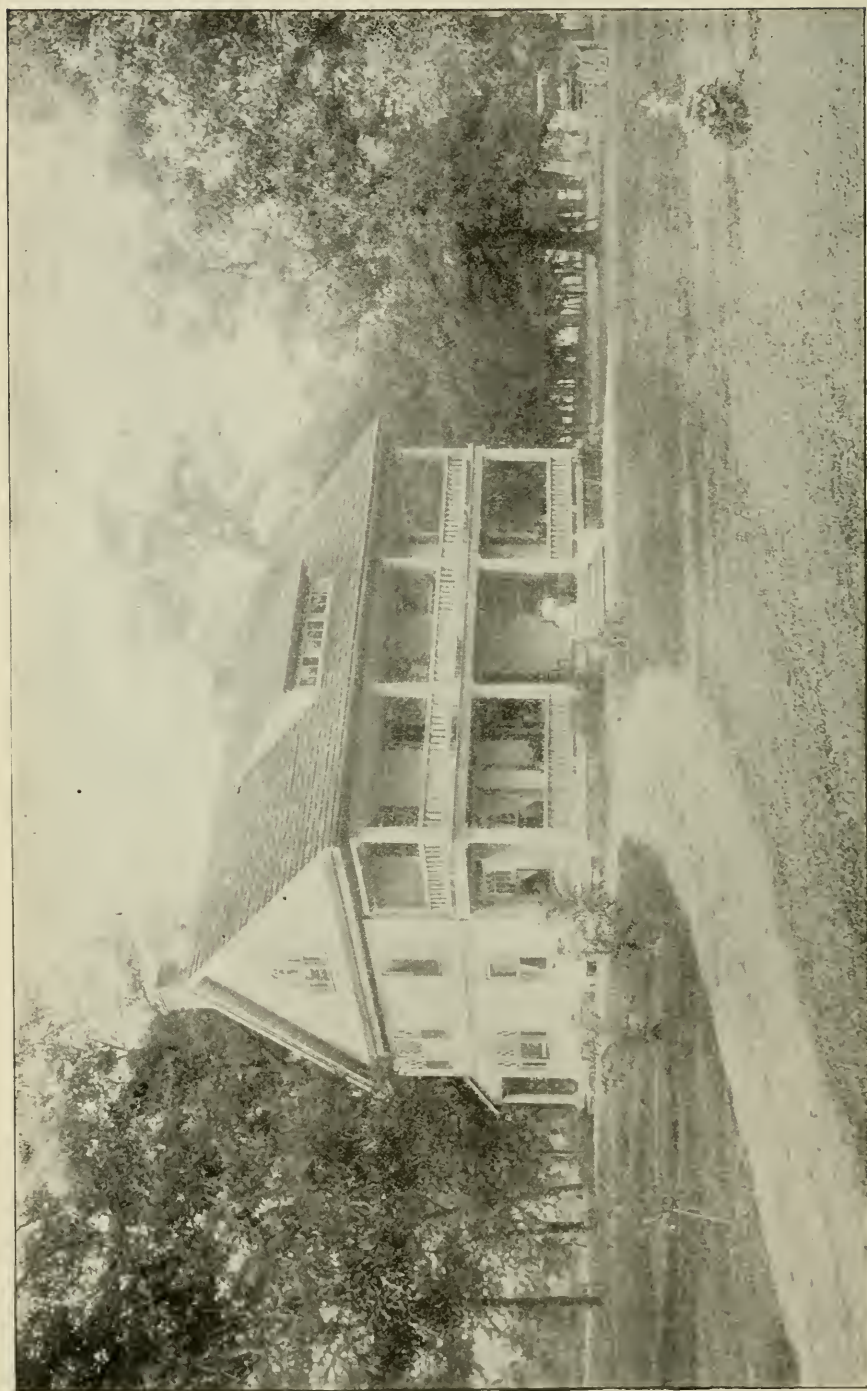


FIG. 285.—An attractive farm home—substantial, dignified, in keeping with its surroundings.

the lowness of the upper story. Many of the newer houses have gained in high roomy chambers, but are likely to have lost in width and in too high and narrow gables. These old buildings were painted white. I shall not commit myself on the proper color for a farm house; but the range of colors in mixed paints affords boundless opportunity for the display of "tastes." I raise the question whether the pleasing effect of the white on the old buildings is not in part its simplicity and plainness and the fact that one cannot make disharmonies with it:

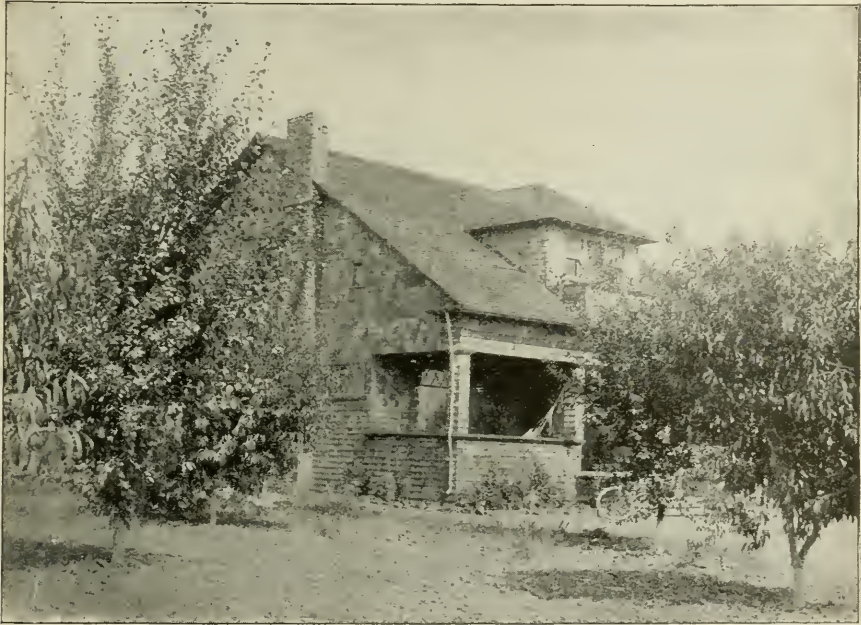


FIG. 286.—A California fruit-rancher's residence, built on the eastern, gable-roof plan.

It is conceivable that the reader may agree with nearly all that I have said; yet he will ask what good it serves, since the farm buildings in New York are now all built. Some new farmsteads are being erected, however, either on wholly new sites or to replace old buildings. Yet the case is not hopeless even with existing buildings. Additions are made to old buildings, and too often these additions contradict the spirit of the older part. I frequently drive past a house that has two porches — one porch with fine big square pillars, the other, of later date, with degenerate turning-lathe posts. Another house is a box-corniced construction with return cornices on the gable ends, built, of course, long ago; a new part, of equal size, has open rafter-work cornices and a different kind of roof. I am always interested, in driving through any country, to see how many buildings show glaring evidence of having been "added

to." Sometimes one can correct minor faults by judicious repairing or inexpensive modification. Often a too slender chimney can be broadened above the roof line. Jig-saw skirting can be sawed off or neatly boarded over. Spindly porch posts can be boxed in and made square. Weak or unsightly foundations can be covered or screened by grading or by planting. Always, the building can be left in a neat and completed condition. It is not uncommon to see scaffolding remaining for years, particularly on silos, and lumber and other material lying loose and exposed. Even if one cannot afford to complete a structure at once, there is a knack of making things look ship-shape. The farmer as well as the mechanic should have a pride of workmanship. But I am less interested



FIG. 287.—Artistic stables. *Agricultural College of Tennessee.*

in the buildings as buildings than I am in the development of good taste. If our buildings express ourselves, it is essential that we give careful attention to ourselves as well as to the buildings; and if buildings are teachers, it is important what kind of appeal they make to children and to strangers.

2. *The arrangement of the buildings.*

Not only the buildings themselves, but the disposition and arrangement of them have relation to their efficiency and tastefulness. It is unquestionably true that there has been a tendency to scatter the buildings, particularly the barns, far beyond the point of efficiency and con-



FIGS. 288 AND 289.—What a porch will do for a poor farm house.

venience. It would be interesting to make a computation as to how much time and labor are wasted each year in doing chores in separated buildings. It would seem that good executive management would try to concentrate one's activities. Often the hay is in one barn, the horses in another, the cows in another, the wagons in another, and the corn in an isolated crib. It would, no doubt, be cheaper to build many of these departments together as compartments in a single structure; or, if these departments arise after the main barn is built, it is often possible to join some of them to the main structure rather than to make wholly separate units. The cost of maintenance of buildings is increased with several small separate structures; and the lack of organization of time and effort entails a still greater loss. The mere protection from the weather in doing chores is no inconsiderable advantage of a centralized



FIG. 290.—A schoolhouse, on the square western plan. Colorado Springs.

lay-out in this climate. An argument against the consolidation of the departments is the greater likelihood that a fire would destroy the entire plant; but, as a matter of fact, it is difficult to save the separate buildings as they are usually placed. Moreover, the buildings are generally protected by insurance, and one can carry a relatively larger protection on one good building than on several poor ones; and the chance of fire is probably less in the one building than in several.

It is surprising what little attention is given to the making of walks about farm buildings. Perhaps no single accessory counts so much for convenience, and for the saving of time and strength; yet it is common to see farmers making their way through muddy yards year after year, and spending more time in picking circuitous trails in order that they may go dry shod than would be required to make good cement or

stone walks. Every farmer should know how to make a cement walk or a concrete foundation. The difficulty of securing good walks is aggravated by the common custom of placing the barn across the road from the house. There are reasons, of course, for preferring the barn and residence on opposite sides of the highway—the highway serves as a lane and the roadside as a yard; yet it is strange, after all, that a person is willing to have a public thoroughfare cut through the most private and



FIG. 291.—*Useful and dignified porch post.*

personal part of his establishment. It would seem that a man would want to have absolute control of the land lying between a farm house and the barns. Yet whatever the position of the buildings, walks should connect them and make them accessible in all kinds of weather; and these walks should be broad, direct and permanent. I know a farmstead in which the women for years have gone to the pump down and up the

sides of a steep hollow; yet one day's work with team and scraper would have filled the place.

3. *The surroundings*

The charm of any farmstead lies to a great degree in the neatness of the premises. The farmer is so isolated that he has little occasion to consider the wishes of his neighbor or the passer-by as to the looks of his place. He also has abundance of room and can let things lie where they fall. There is no local board of health to inspect his place. Therefore the importance of keeping things picked up does not appeal to him as it does to the city man. Yet one wonders why the man should not take as much pride in the keeping of his premises as the woman does in the keeping of her house. I once made a note of the things that I saw scattered about a New York farmstead, and which might have been piled up, put in barns or cellars, or burned. The barn stood near the house, on the same side of the highway. Alongside the barn, in full view from the road, were two old buggy bodies, one of them minus a wheel, bleached by countless rains and snows, with weeds growing through them; about the barn was the frame of a grindstone, a heap of hoops and plow points, several barrels in various positions, the remains of a cutter, and scattered staves, blocks and stones. Near the house were boards lying topsy-turvy, stove-wood scattered over the yard, a wagon-box bottom side up, and a deserted and dilapidated chicken coop. The house and barn were fairly good in general form, but they showed the effects of wear. It was evident that the place had seen better days. It showed lack of organization and of definiteness of purpose. Fortunately, such places are not abundant and they are probably becoming less in number; yet they are common enough to raise the question whether they do not measure the status of farming in some communities. It is usually impossible to reach such farmers by appealing to their sense of tidiness, for the difficulty lies deeper.

The above picture may appeal to the average good farmer as so unusual as not to influence him or even to hold his attention; yet there is a general lack of tidiness in farm premises as compared with city premises. It is urged that it takes time to keep things picked up. Yes; but the farmer is likely to lose his odd minutes or hours by not organizing his time. The busy driving business man must organize every minute into an effective system; his odd minutes are directed into odd jobs or to definite recreation. Perhaps it is not important that the farmstead be kept as scrupulously tidy as the city yard; but it is doubtful whether there is any place on a modern farm for mere carelessness and neglect. Certain it is that the most tasteful buildings lose their effectiveness if repairs are neglected and the premises are slattern.

4. *The lesson*

Perhaps I have said enough to set the reader thinking or to challenge his attention. The best discussion that can come from this lesson will now be suggested by the farm buildings that you see as you come and go. As examples, I have inserted many pictures; if you do not wish to make remarks about the buildings in the neighborhood, you may be willing to make them about these pictures. In succeeding bulletins in this series, some of the practical constructional details of farm buildings will be considered; but it is always well first to approach the discussion of a building from its mass-effect rather than from its incidents. All these discussions will be made in a generous spirit for the betterment of the improving country life in which we all are interested.



FIG. 292.—*An attractive little building. Fruit-house of the late Charles Downing.*

Such discussions are the more important because the professional architects do not give attention to common farm buildings, since there is little chance for remuneration. It is surprising that farm buildings are not worse than they are, seeing that there has been no instruction. Even the agricultural colleges have not given much attention to the subject until very recently; soon the leading institutions will have well-manned departments of rural architecture. It seems to me that farmers must look to these and other public institutions for much of their advice on farm buildings. Farmers here and there are beginning to give attention to these subjects in a new way, and are doing much good as speakers and writers. I wish that New York farmers might feel that the whole subject of rural architecture is worth discussing in the new spirit of the time.

Supplement to

CORNELL

Reading-Course for Farmers

PUBLISHED BY THE COLLEGE OF AGRICULTURE OF CORNELL UNIVERSITY,
FROM NOVEMBER TO MARCH, AND ENTERED AT ITHACA AS SECOND-CLASS
MATTER UNDER ACT OF CONGRESS OF JULY 16, 1891. L. H. BAILEY, DIRECTOR.

SERIES VI.
BUILDINGS AND YARDS.

ITHACA, N. Y.,
NOVEMBER, 1905.

No. 26.
TASTEFUL BUILDINGS.

DISCUSSION-PAPER ON FARMERS' READING-COURSE BULLETIN NO. 26

This Discussion-paper is sent out with all Farmers' Reading-Course Bulletins, for two reasons: (1) We should like to have your own ideas on these subjects. On some of these points you have probably had experience which will be interesting and valuable to us. No matter what the Bulletin says, if you have different opinions on any of these subjects, do not hesitate to state them on this paper and give your reasons. (2) We should like you to use this paper on which to ask us questions. If there are any points which the Bulletin has not made clear, or if there are any problems in your farming, whether on these subjects or others on which you think we may be able to help you, write to us on this paper.

THE NEXT READING-COURSE BULLETINS WILL BE SENT TO THOSE WHO RETURN TO US THIS DISCUSSION-PAPER, WHICH WILL BE AN ACKNOWLEDGMENT OF THE RECEIPT OF THE BULLETIN (2c. postage). *This paper will not be returned to you, but we shall look it over as carefully as we would a personal letter and write to you if there are any points about which correspondence is desirable. You may consider this Discussion-paper, then, as a personal letter to us. It will be treated as such, and under no circumstances will your remarks be made public.*

If you are not interested in this Reading-Course Bulletin, we have others on other subjects, and we shall be glad to send any of these to you on request. The titles of the six Series of the Reading-Course Bulletins now available are: 1. THE SOIL AND THE PLANT. 2. STOCK FEEDING. 3. ORCHARDING. 4. POULTRY. 5. DAIRYING. 6. FARM BUILDINGS AND YARDS. The Farmers' Wives' Reading-Course, on domestic subjects, is also sent to those who desire it.

THESE BULLETINS CANNOT BE SENT TO PERSONS WHO RESIDE OUTSIDE OF THE STATE OF NEW YORK, AS BOTH COURSES ARE SUPPORTED BY A STATE APPROPRIATION.

For our own benefit we shall be glad to have you answer (on these sheets) any or all of the following questions, if you are interested in these subjects; but we do not wish you to feel under any obligation to do this.

1. What is the character of the farm residences in your community, — old buildings of a generation or more ago, or "modern" buildings?
2. What is the general "style" or "looks" of the buildings of recent date? How do they compare in attractiveness and convenience with those made by the past generations?
3. What general form of farm residence would you prefer, if you were building anew?
4. Give any suggestions that occur to you as to the improvement of farm buildings, or as to the needs of the farmer in this direction. Are farm buildings as they exist satisfactory?

Name.....

Date.....

County, Postoffice

Note.—Your name appears on our mailing list as this Bulletin is addressed. If incorrect, please write us.

Address all correspondence to Farmers' Reading-Course, Ithaca, N. Y.

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Reading=Course for Farmers

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SERIES VI.
BUILDINGS AND YARDS.

ITHACA, N. Y.,
DECEMBER, 1905.

No. 27.
FARM YARDS.

TASTEFUL FARM YARDS

By L. H. BAILEY

The buildings and the yards make up the farmstead. In Bulletin No. 26 we discussed the appeal that tasteful and untasteful buildings make to the resident and also to the visitor. The yard makes a similar appeal. The building and the yard together really stand as an index to the char-



FIG. 293.—An open-centered lawn and naturally planted border.

acteristics of the men and women that live on the place. The farm represents the kind of farmer the man is; the farmstead also represents in an even more personal way what the man himself is.

I sometimes think that the yard is more expressive of the man than the buildings are, because it is more immediately within his control. It

also makes a more general appeal. Persons who have never thought of "architecture" as having any particular significance, may be impressed at once by the yards. Few persons can build a house or a barn, but every farmer can make and care for a yard.

I. *The meaning of the place*

In the study of the last Bulletin we came to agree, I hope, that the primary consideration in the construction of a building is to make it serve its purpose as directly as possible; and that the second step is to consider the general mass-effect rather than the details. The same order should be observed in the lay-out of the grounds. Many persons, to judge

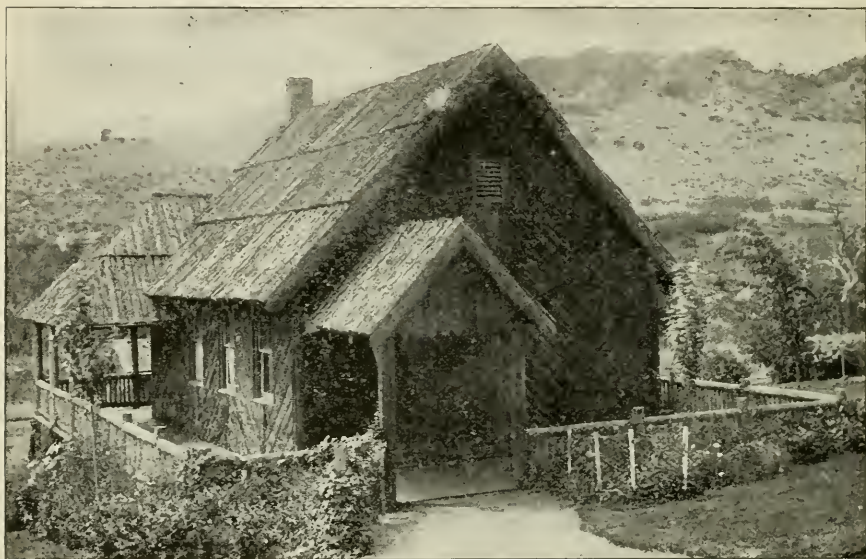


FIG. 204.—A schoolhouse in the west (built by Gen. W. J. Palmer, Colorado Springs). When this picture was shown to a school girl, she exclaimed, "I'd like to go to school there." When asked why, she replied, "Because I don't see how any one could help it."

by the results, conceive of a yard only as a place to set out plants,—they must have roses or hydrangeas, particularly if the nursery agent displays the glories of these subjects. This is like thinking of a house as a construction for the display of fancy chimneys and glowing paint. What kind of trees and bushes to plant represents the final stage in the making of a good yard.

What is the yard for?—this is the first and most important question. It affords a setting for the buildings; it connects the buildings; it provides access to the highway, the well, the barn. Everything about the yard should be convenient: the grades should be "easy," particularly in

the direction in which there is much travel; the surface should be smooth enough to allow of easy mowing; the walks should connect the different parts in the most direct and pleasant way; the drive, if any, should be such that it is easy to drive over and keep clean; there should be no objects or plantings that require the expenditure of much time in tending. Everything about the yard should be "in keeping" or in good taste: if a farm yard, it should be simple and unpretentious; it should be large and generous; it should have a good turf; in some part of it there should be shade and an attractive place in which to sit or lie in warm weather; it should look "natural,"—that is, naturelike, free, country-like, devoid of primp and oddity, harmonious. It should express a home-like feeling.

The last remark brings up the saddest part of farm life,—the fact that so many places are not home-like. Here lies the very root of most of the discontent with the farm in the minds of the young. One cannot blame a youth for desiring not to remain in an unattractive place; we should rather blame him or think him lacking in gumption and imagination, if he desired to remain in such a place. I can drive over almost any farm road and find places in which nobody would care to live. It would be unnecessary to enquire at the house why the boys and girls are leaving the farm. Most of these places are either bare or untidy, usually both. I often wonder how it is possible for some persons to keep their places so bare of attractive vegetation. It would seem as if they must spend more effort in preventing trees and bushes from growing, than would be required to plant and tend a grove or a shrubbery. Did you ever notice how soon many of the abandoned houses come to be attractive because of the trees and bushes that grow about them unmolested and unscared?

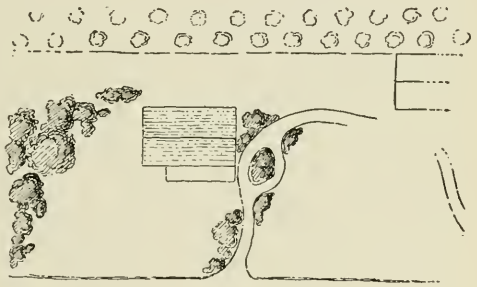


FIG. 295.—Plan showing a house with orchard at rear, mass-planting at the left, open lawn and curved drive leading toward the barn.

2. The picture in the landscape

There are some farm premises of which you feel that you would like a picture to hang on your walls. There are others of which you would not possess a picture even though it were offered you in a gilt frame. Recall the places that you know, and see in which category they fall.

After you have classified the places in this way, try to determine why you have done so. Almost before you know it, you will hit upon the essentials of a good place. It will be excellent practice to analyze your impressions and to jot down the results.

Probably the first result of the analysis will be a feeling that you like the place as a whole, for the general impression that the entire scene makes on you, rather than because some particular trees or other objects please you. In other words, the scene is a picture, not merely a collection of objects. If the home scene is a picture, then it almost necessarily has the following points:

The place is well clothed, or furnished, with trees and shrubbery;

The residence is prominent and has a good setting;

There is an open space or sward;

The trees and smaller plants are mostly massed or grouped at the sides or in the rear, rather than scattered all over the place;

There are no unnecessary fences, walks or drives;

There are no mere curiosities conspicuously placed in the yard, as piles of stones, odd rocks, shells, pieces of statuary;

The place is neat and picked up, looking as if it has good care and as if the residents love it.

3. *Some specific suggestions*

The commonest fault with farm yards is that they seem to have no

thought or care bestowed on them. If care is given them, however, the effort is likely to be expended in scattering plants here and there or in making "beds" in the sward; and this is usually worse than nothing at all, because it emphasizes the value that is placed on individual objects rather than on the place as a whole.



FIG. 206.—*Nature often plants effectively about abandoned buildings.*

Many persons buy furniture in the same spirit—a certain chair merely because it is handsome as a chair, without considering whether it is in keeping with the house or with the other furniture. Many houses might well pass for furniture stores; many yards might well pass as nurseries.

It is a good rule to set out no plant until you are sure that it is needed as a part of the total effect that you are trying to produce. Merely because a plant is "pretty" is no reason for planting it. There should be some general scheme, and all the planting should fall in with the scheme. What shall this scheme be? This question cannot be answered off-hand, for every place is a problem by itself; yet a few general rules or suggestions can be given:

1. Lay out or plan the place. Plan the walks and drives and fences (if any must be had) so that they will best serve the purpose for which

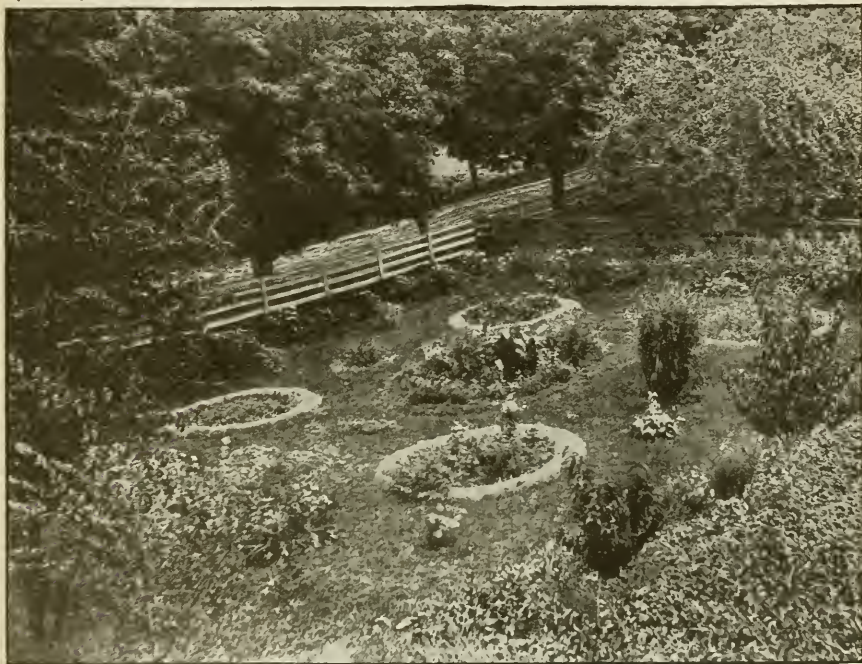


FIG. 207.—A semi-formal flower garden, in its 27th year. It is interesting, if one has time to devote to it. It formerly contained more beds with narrow earth walks between, but, as years advanced, the woman who made it found the task of keeping weeds in check to be too great, and therefore she turned the walks into lawn. Most persons will prefer simpler flower gardens, with more flowers.

they are needed. It is always a help to make a map of the area, drawn to a scale, locating on it all existing permanent objects, as trees and buildings.

2. Plan for an open center, in front of the house. This should be sward or lawn. If the area is small, it can be mown with a lawn mower; if large, the greater part of it, at some distance away from the house, can be mown three or four times a summer with a field mower.

3. Plant part of the sides of the place. The rear, in particular, should be planted. Note how homelike and cosy a farm house looks if there is an orchard behind it; and how bare and bleak if it stands out alone against the sky. These plantings may be trees or bushes, or both.

4. Set at least a part of the plants in groups. Note how attractive an old fence-row is. You may not want a fence-row, but you can get some hints from it. Do not plant the things in severe rows. Plant them irregularly, do not shear them year after year, and then let them grow into each other freely and naturally. If you want a few special and showy plants, as hydrangeas, plant them near a group of other plants, not drop them promiscuously over the front yard where they bear no relation to anything else and have no particular meaning. I always feel sorry for the isolated bushes and dejected little trees that are set down here and there without any use or reason, and which are forced to make a constant struggle with the grass.

5. Be careful not to overcrowd the residence with trees, especially with evergreens. It is always advisable to provide shade, but it is easy to make the place gloomy and depressing. It is seldom that a residence looks



FIG. 298.—*Trees in winter. Trace out the method of branching. The first tree is slippery elm; note the horizontal position of the lower branches.*

well in a grove,—the grove is likely to swallow up and domineer the buildings, and the place lacks in openness and free sweep.

6. Plant as freely of bushes as of trees, perhaps even more freely. It is a common mistake to give too little attention to the shrubs. They comprise the minor furniture of the place, filling it in about the margins, relieving it of bareness and bleakness.

7. The main plantings of the trees and shrubs and herbs should be made of the kinds that you know and that you are sure will grow. Many of

the native trees and shrubs are very desirable and are reliable. The

horticultural novelties may then be used to touch up the place; if they are used to excess, the area looks exotic. On both buildings and yards it is easy to place too much mere ornament.

8. Flower-gardens and vegetable-gardens should be at one side or in the rear. Flower-gardens are for the growing of crops of flowers, and they should be in good soil and in a place where they can receive good care; they cannot have good care in little isolated beds in the lawn, and moreover, they have no relation to anything else in that position. Bulbs appear to better advantage when seen as an edging to a group of shrubbery or as a border, than when standing in a mound in the middle of the yard. Many flowering plants can be grown in the borders, about the foundations of the house, sometimes along or near a walk, but these are for the purpose of heightening the effect of the place as a whole and they are subordinate; flowers grown for flowers need tillage, manure, training, the same as a good vegetable-garden does. One would not think of growing beets and cabbages in pinched holes in the sod; yet we try to grow geraniums and pansies in such places.

You want a flower-garden that will produce you the best crop of flowers, just as you want a vegetable-garden to produce the best crop of vegetables. A selection can be made of the common flowers that will give abundance of bloom throughout the season. If you have strength and time for it, it may be well to have a formally laid out flower-garden, with regular walks and edgings. This will consume much labor for the amount of crop that is produced, but it may yield another kind of satisfaction that is well worth the while; for it is not all of garden-craft merely to grow good flowers.

If there are children in the family, an area should be set aside for their use in the making of gardens. It is astonishing how little the farm boy in general knows about the propagating and growing of plants; yet this should come as a kind of natural knowledge, developed as the child grows. It is astonishing, also, how little affectionate regard he may have for the plants; yet this should be acquired on a farm, for it is naturally a part of farm life.

9. It is advisable in most cases to make low plantings against the foundations of the house, in order to relieve the hard lines and to tie the building to the greensward. This can easily be so managed as to prevent



FIG. 299.—A swamp white oak in winter. The branch-form is characteristic.

darkening of the cellar windows and to obviate any danger of rotting out the woodwork. A free-growing bush may be a good reinforcement at the corner of the house, if it is allowed to take pretty much its natural course, in not being kept sheared. If the eaves drip, it will be impossible to grow anything very satisfactorily near the house; both for the good of the planting and of the foundations, eave-troughs should be provided. A few vines may add much to the looks of snugness and coziness of a house, particularly on porches; and brick or stone houses may well be covered or draped with Boston ivy or Virginia creeper.

10. The yard should have good care. The first necessity in the maintenance of any place is common neatness,—the same kind of pride in tidiness that the good housekeeper has in her work. The slackness in the keeping of yards can rarely be charged to the lack of time, as is so commonly said; it is rather a lack of utilizing the spare minutes, as a thrifty business man or professional man organizes his time. It is often said that the busiest man has the most time. He organizes his efforts, does things quickly, then takes up something else.

The yards show on their face what kind of effort the man puts forth to keep his place in order; and good housekeeping and good care-taking are as important as good architecture or good landscape gardening. It is surprising how little pride country dwellers seem to take in the appearance of their premises and yards. It is probable that half the farm yards that one will see are devoid of homelike and attractive features; and very many of them are an offense to a sensitive eye. The pride in a good yard is as necessary to a fully successful farm business as pride in serviceable and attractive clothing or in a good turnout. These things all go together, being an expression of the resourcefulness of the man.

The general plan of the place ought to make for cleanliness and tidiness. If the premises are convenient and direct, and devoid of fussy features, the labor of keeping them

in presentable condition will be much reduced. These remarks apply with particular force to barnyards. One would almost think that many barnyards are arranged for the special purpose of catching water. If buildings



FIG. 300.—A common white oak, remnant of a forest alongside a creek. Compare method of branching with Fig. 299.

and yards are well planned, there will be little mud in the yard. Roof water must be carried away, the slopes properly made, the manure and barn drainage taken care of. There is little excuse for a miry barnyard.

4. *The winter landscape*

A good part of the year in New York State is leafless. We are likely to want to close our eyes to the out-of-doors when winter comes. Yet if one is to be content in his time and place, he must be in sympathy with the landscape the year round. It is essential, therefore, that we learn to know the trees and the fields and the woods in winter.

The winter aspect of trees is most interesting. The framework is all revealed and the trees seem to be nearer to us than in summer, and they will soon come to mean more to us. Trees differ remarkably in expression when the tops are bare. How they differ is suggested by the photographs that I have put in this Bulletin. Note the silhouette against the sky of a maple as compared with an oak; of an elm as compared with a maple; of a soft maple as compared with a hard maple. Follow out the curves and crooks of the branches; the method of branching and forking; the kinds of bark; the differences in the terminal spray; the colors in trunk and twig.

You will soon begin to observe the trees closely, and this will be the beginning of interest in them. The well trained man fills his moments of leisure with observation and reflection of one kind or another: as he rides to town there is something to challenge his attention. It is well to plant the home grounds with some reference to winter effects. I do not mean merely the planting of evergreens for protection, but the clumping together of red-twigged or yellow-twigged or green-twigged bushes. Even the weed stalks standing above the snow may interest you.

We are likely to think of the winter landscape as only black and white, yet it shows a great variety and depth of color. You could not paint it with black and white paint. You would need to mix in much red and other colors. By February the color in twigs and buds may begin to change: this, aside from the lengthening days, is the first indication of spring.



FIG. 301.—*The bushy part of a wild plum tree.*

5. *Making the lawn and setting the plants*

The first thing to be done in the actual making of a good yard is to grade the surface to the desired contour. Then the permanent location of

the groups and single plants should be marked out. If the yard is to be attractive, it must have a heavy and dense cover of sward. While grass will grow almost anywhere, nevertheless it is difficult to secure a first-class lawn. A lawn is composed of very many fine spears of grass, and a few straggling clumps, however good they are, may be only a detriment to the lawn if the general run is not in good condition. It is just as necessary to prepare the land thoroughly for a lawn as for a crop of wheat or potatoes. This is ordinarily done by deep plowing and then by thorough tillage until the surface of the land comes into a condition of fine tilth. Before the grass seed is sown, all irregularities should be filled up and the earth firmly stamped or settled down. The lawn is to remain indefinitely and cannot be graded over again; therefore every care must be taken to shape the contour properly. There should be slopes leading away from all foundations, if possible. The mature trees should be allowed to stand above the level of the sod, showing their brace roots, as they do when growing naturally. If there are any sour or wet spots in the area, they

should be drained with permanent tile or stone underdrains. The land should also be rich. It is advisable to plow in a good coat of manure and, if the land is not in good heart, a heavy dressing of commercial fertilizer will help. The land should be at least as rich and as well prepared for the growing of a good sward as for the raising of corn or beans.

Usually the land is graded and shaped early in the spring. Better results are often secured, however, if the rough grading is done in the fall, before the heavy rains set in, particularly if the ground is full of old roots and covered with clumps of heavy sod. The soil can be moved economically at that time. The rains and snows of winter will compact the earth, and the frost will disintegrate the harder parts. In the spring the final raking and



FIG. 302.—A well-formed evergreen. If the lower branches were removed, the tree would lose its beauty.

dressing can be given and the grass seed sown as early as possible. The earlier the seed is in the ground the better the root-hold it will secure be-

fore the hot dry weather of summer. Many persons like to sow grass seed on a very late snow. It will then be carried into the soil by the melting of the snow. It will need to be raked in, however, if the land cannot be worked soon enough in the spring to allow of such early sowing.

The seeding should be very heavy, since it is the object to secure very many fine stalks of grass. Blue-grass or June-grass is ordinarily used, and at the rate of as much as three or four bushels per acre. Some persons like white clover in their lawns. If so, one to three quarts to the acre may be sown. It is usually best to sow the grass seed without grain. However, the June-grass is likely to make a rather poor showing the first year and it may be well, therefore, to sow three to five quarts of timothy to the acre. The timothy will come up quickly, make a green cover for the first year, and will be gradually crowded out by the June-grass. In most cases the weeds will be very abundant the first year, particularly if stable manure was worked into the soil. These weeds should not be pulled, for the pulling will destroy the young grass. Most of them will be annuals and will die out at the end of the first season. The area should be kept mown all summer and this will keep the weeds down. If strong perennial weeds, as docks, come up here and there, they can be pulled at the end of the first year or the second year. It is best to mow the lawn, if possible, with a good lawn mower, since that keeps the weeds down and tends to even up the growth.

It is unusual that a lawn of any extent "catches" uniformly the first season. One must re-seed the poor spots year after year. There may be very hard and dry places, or those that are densely shaded, on which one can never secure a "catch" by mere seeding. In these cases the area may be covered with sod from an old pasture, cut in thin slices and rammed firmly into the soil. In dense shade it will be impossible to secure a good sward, and some other ground cover may be used.

The lawn should be fertilized from year to year. Thoroughly rotted stable manure may be worked into it in the fall or early in the spring. The common practice of piling raw manure on the lawn is to be discouraged. Some good concentrated fertilizer may also be very effective.

The common practice of sprinkling lawns has little to commend it. If the lawn needs water, it should be wet thoroughly. This deep wetting encourages deep rooting and enables the plant to withstand the dry weather, whereas a continued light sprinkling of the lawn probably tends to develop a shallow root system.

The borders of the groups may be marked out on the ground when the grading is done, by the end of a hoe handle. The shrubs should be planted thickly, perhaps not more than two feet apart. They will soon grow together and if the shrubbery becomes too thick, some of the specimens may be removed. Until the shrubs begin to cover the land, the earth

between them should be hoed and perhaps spaded now and then to keep it in good tilth; and a liberal application of fertilizer of some kind is to be advised. When the shrubs and trees are first planted they should be well headed back; but after they are thoroughly established very little pruning will be necessary except to correct a too rampant growth or to check an awkward tendency. In farm yards the practice of shearing bushes should be discouraged. The effect is always best when the place has a free and natural look.

FARMERS' READING-CLUBS

When a dozen or more people from the same place are reading the Farmers' Reading-Course Bulletins it is a good plan to organize a Farmers' Reading Club. Much more of value may be obtained from the Bulletins by discussing them in a Club of this kind after having read them at home. The Club meetings may be made very enjoyable social occasions, especially if a Farmers' Wives' Reading-Club is organized and carried on in connection with the Farmers' Reading-Club. Literature on the formation of Clubs and the conducting of Club meetings will be sent upon request. It is a good plan for the Secretary of the Club to send to the various Experiment Stations for the Bulletins recommended as supplementary reading. A full set of the Series of Bulletins being read will be sent to the Secretary, so that these outside Bulletins may be obtained in time.

BOOKS

It is hoped that the reading of these Bulletins may lead to the study of a few of the many good books available upon each subject. In many of the bulletins, books are recommended. The Supervisor of the Reading-Course will be glad to send information regarding the purchase of books and may be able in many cases to direct the readers to free literature. Correspondence is solicited on questions which have not been made plain; and if the Supervisor himself cannot answer the questions he will refer them to competent authority in the College of Agriculture.

CORNELL Reading-Course for Farmers

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FROM NOVEMBER TO MARCH, AND ENTERED AT ITHACA AS SECOND-CLASS
MATTER UNDER ACT OF CONGRESS OF JULY 16, 1894. L. H. BAILEY, DIRECTOR.

SERIES VI.
BUILDINGS AND YARDS.

ITHACA, N. Y.,
DECEMBER, 1905.

No. 27.
FARM YARDS.

DISCUSSION-PAPER ON FARMERS' READING-COURSE BULLETIN NO. 27

This Discussion-paper is sent out with all Farmers' Reading-Course Bulletins, for two reasons: (1) We should like to have your own ideas on these subjects. On some of these points you have probably had experience which will be interesting and valuable to us. No matter what the Bulletin says, if you have different opinions on any of these subjects, do not hesitate to state them on this paper and give your reasons. (2) We should like you to use this paper on which to ask us questions. If there are any points which the Bulletin has not made clear, or if there are any problems in your farming, whether on these subjects or others on which you think we may be able to help you, write to us on this paper.

THE NEXT READING-COURSE BULLETINS WILL BE SENT TO THOSE WHO RETURN TO US THIS DISCUSSION-PAPER, WHICH WILL BE AN ACKNOWLEDGMENT OF THE RECEIPT OF THE BULLETIN (2c. postage). *This paper will not be returned to you, but we shall look it over as carefully as we would a personal letter and write to you if there are any points about which correspondence is desirable. You may consider this Discussion-paper, then, as a personal letter to us. It will be treated as such, and under no circumstances will your remarks be made public.*

If you are not interested in this Reading-Course Bulletin, we have others on other subjects, and we shall be glad to send any of these to you on request. The titles of the six Series of the Reading-Course Bulletins now available are: 1. THE SOIL AND THE PLANT. 2. STOCK FEEDING. 3. ORCHARDING. 4. POULTRY. 5. DAIRYING. 6. FARM BUILDINGS AND YARDS. The Farmers Wives' Reading-Course, on domestic subjects, is also sent to those who desire it.

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For our own benefit we shall be glad to have you answer (on these sheets) any or all of the following questions, if you are interested in these subjects; but we do not wish you to feel under any obligation to do this.

1. How much attention is given to the care and improvement of yards in your community?
2. Do you know of any farm place that has good border-planting,—that is, heavy irregular planting on one or more sides?
3. How many persons in your neighborhood have lawn mowers?
4. What kind of trees do you prefer for planting on yards?
5. What kind of bushes or shrubs?
6. Is it practicable to have a flower-garden on a farm?

Name.....

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SERIES VI.
BUILDINGS AND YARDS.

ITHACA, N. Y.,
JANUARY, 1906.

No. 28.
PLAN OF HOUSE.

THE PLAN OF THE FARMHOUSE

BY PROFESSOR CLARENCE A. MARTIN
In charge of College of Architecture, Cornell University

Unfortunately very little thought has yet been given to the problem of the farm house. It is all very well for architects to plan "farm houses"



FIG. 303.—A compact house. This type of house makes a compact and convenient floor-plan possible. The floor-plan and the general form of the house must correlate or correspond.

for the wealthy "gentlemen farmers" and to make them ideally beautiful and convenient; but such houses are not real farm houses for real farmers. They are only elaborate country houses built more or less regardless of a cost limit, and have little more to do with the real problem of the farm house than does the Fifth Avenue residence of the same "farmer." The problem of the real farm house,—the dwelling place of the man struggling to wrest a livelihood from the soil and to make a home for his old age

wherein he may enjoy the fruits of his labor,— has not as yet been carried out to a satisfactory solution. Mr. Robert Spencer, Jr., of Chicago, has written from time to time in both popular and technical magazines on the subject of the farm house, and has made many valuable suggestions and some very clever plans for farm houses under varying conditions; but, after all, if it be fair to criticize one who has done so much more than the rest of us in the solution of a difficult problem, it seems to the writer that there is much yet to be done before the real farmer and the real architect can get together on a satisfactory working basis.

Professor Bailey has written pointedly and sensibly relative to the external aspect of the house. What he has to say in this connection is



FIG. 304.—*Another compact and condensed house. This and Fig. 303 show western styles of houses. Colorado Springs.*

applicable as well to the plan. Art, expression, and sentiment must have place in the plan as well as in the outer shell. A badly planned and inconvenient house in nowise suited to its purpose cannot be a thing of beauty or a joy to any one obliged to live in it, however thoroughly the exterior may be studied to refine and beautify it. Utility and fitness are absolutely first requisites in a building planned for any useful purpose, and no building can be really beautiful or be good architecturally when these considerations are ignored or even given secondary consideration.

The proper time to plan a house is, obviously, before it is built. The repetition of this truism might seem absurd were it not for the fact that so

large a proportion of our farm houses seem either to have been planned while in process of building or not to have been planned at all. The fact that every house should be planned as a separate and independent problem with special reference to the persons who are to occupy and use it, taking into account their habits of life, temperament, and the work to be done in the house, seems to have been entirely overlooked by the average builder of the farm house. He seems to forget that he is an individual, that his family is different in some respects from other families and has different wants, that the house has not been planned to the best advantage unless it is specially and peculiarly adapted to the needs of his family.

If a house is a model of convenience it is very likely to be satisfactory in other respects. The elements of convenience are usually directness



FIG. 305.—An eastern type of farm house, necessitating a floor plan of its own.

and simplicity, and if we have these we have the beginnings of an artistic home in the truest sense of the word. A good house, convenient in its appointments, and well arranged, is not necessarily a large house. On the contrary, it is more likely to be a small house, if for a small family where the women of the household do their own work.

There may well be a difference of opinion as to the number of rooms required on the first floor; but probably the smallest of houses calling for consideration here would have a family living room, a dining room, a kitchen, and a pantry. The other rooms to be added in amplification might be a reception room (or parlor), a laundry or wash room, perhaps a separate library or study, and, in some cases, a bed room; the order of

importance of these various additional rooms being a matter to be determined in each case by the people for whom the house is being planned.

There is at the present time a decided tendency to condemn the reception room or parlor as an altogether useless adjunct to the ordinary small house, those who take this attitude contending for the large informal family living room where "company" and family may gather on equal terms at all times. While there may be difference of opinion relative to the reception room, there can hardly be any with reference to the necessity of separate dining room, kitchen and pantry. All of these should be carefully defined in any modern house that is to be used for anything but temporary purposes.

There must, of course, be stairs leading to the second floor, and the stairs would very naturally go up from an open hall, although some mod-

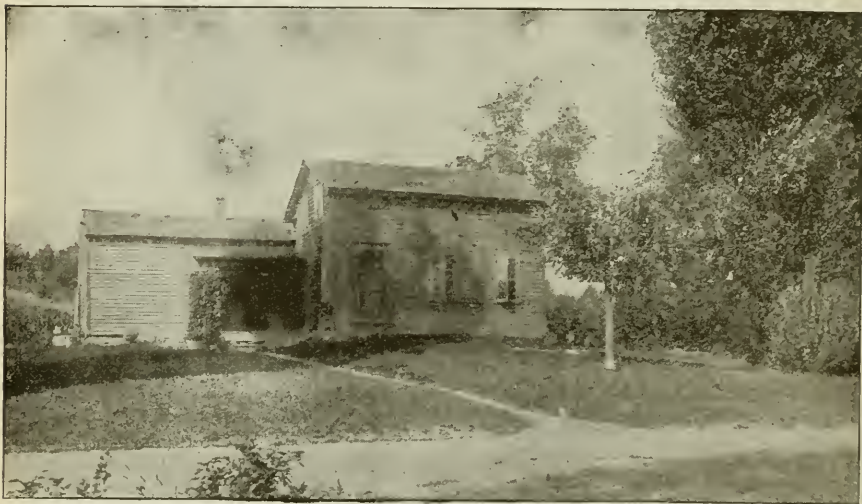


FIG. 306.—*A rambling, indirect and usually inefficient form of house. Try to construct a convenient floor plan for this house.*

ern houses combine the hall and living room and run an open stair up from one side or end of the common room, which now becomes a living hall rather than a mere hall or living room. Where the main stairs are so arranged it is necessary also to have a back stair so that those who are doing the work of the house may be able to go to the second story without passing through the living room. On the whole, this arrangement of combined hall and living room in a house to be occupied the year around is not one to be commended except with considerable reservation.

It is of fundamental importance in any house arranged with regard to convenience and privacy that every room in the house should be accessible from some sort of hall or thoroughfare without going through any other room; the only exception to this rule, under ordinary circumstances, being

the dining room in small houses where economy of space or cost of building often makes it wiser to curtail hall space and to open the dining room directly from the living room. In this case it is well to have good generous doors or openings to give an air of hospitality that might otherwise be lacking.

Another thing that has much to do with the general comfort and the artistic atmosphere of the house is the height of ceilings. A house with comparatively low ceilings is much more easily heated in winter and is much more easily furnished and made homelike than a house with very high ceilings. Of course high ceilings and high windows give much better light and air than low ceilings, and in southern climates the high ceiling



FIG. 307.—The house shown in Fig. 306, improved by a porch, but the house is fundamentally erroneous.

becomes, on that account, almost a necessity; but here in the North the low ceiling is the more expressive of comfort.

In an attempt to analyze the house and its plan it will perhaps be best to start at the principal entrance. This should be generous, dignified, and inviting, without an excess of richness that will lead to disappointment when the visitor passes through and sees the inside of the house. Whether or not there should be a vestibule depends very largely upon the climate and the exposure. With the rather severe cold and snow of New York State winters, the vestibule with doors inside and out adds much to the comfort of the house by giving a place in which one may shake off the worst of a snowstorm instead of taking it into the house with him.

If the reception room is to be included as a part of the plan it should be at the front near the main entrance. It is naturally the most formal room in the house, the room where casual callers are received when one may not care to introduce them into the informalities of the family living room; but it must also be a room for family use as well, and not the cold and forbidding "best room" of our Puritan ancestors.

The living room should need no description further than the name; but there is room for no end of thought in the design of it. First of all, it should have the best view of any room in the house; then it should have good broad windows with plenty of sunlight and yet should not be too fully exposed to the uncomfortable glare of the hot summer sun; it should have wall space for books and furniture; it ought to have a generous open fireplace with a plain simple mantel; in fact it ought to be the one place above all others where every member of the family may feel

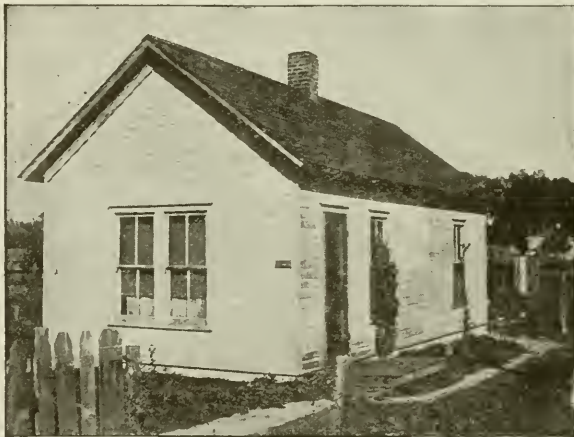


FIG. 308.—*The simplest form of house, but of good proportions. In such a house the floor plan is also elementary.*

at home and thoroughly comfortable. It should be in location and interest the central room of the house and ought to open broadly into either the dining room or the parlor, or, if feasible, into both.

The dining room, though its primary function is implied in its name, should be something more than a mere "eating box." It should be expressive of good cheer and thus conducive to pleasant thought and good digestion. It should have plenty of the early morning sunlight, which at all times of the year is welcome; and because the late afternoon sun in summer is likely to be hot and oppressive, this room of comfort should be sheltered from the low western sun. A south-east corner is the ideal place to get morning sun and afternoon shade, and such an exposure will give an abundance of light and warmth for the few green or flowering plants that the good housewife likes to have in the room.

The size of the room is important. An ordinary dining table is three and a half feet wide at least, and dining tables run from that up to four and a half feet. The table occupies the middle of the room and there must be space enough around it for chairs, and back of the chairs space for service, all of which means that even in a very small house a dining room less than ten feet wide is nearly useless for its purpose. Then too in every dining room provision should be made for seating such guests as every householder expects to entertain from time to time. A simple room ten by twelve, without any side furniture in it, would seat about eight people by crowding; and a room twelve by sixteen, not a large room by any means, might seat ten or twelve people on occasion, but twelve would crowd it and leave no place for buffet or china closets, etc. If buffet, sideboard, or other pieces of furniture desirable in such a room are to be used, space should be provided for them.

The dining room and kitchen should not open directly into each other, but should be separated by the pantry through which the meals are served. In this way odors and sounds from the kitchen may be shut out as completely as possible. The pantry, besides, serves as a clearing ground between kitchen and dining room where things may be put into proper condition for serving. The serving pantry should be fitted up with shelves and cupboards where the table service of china, cutlery, silver, etc., may be kept.

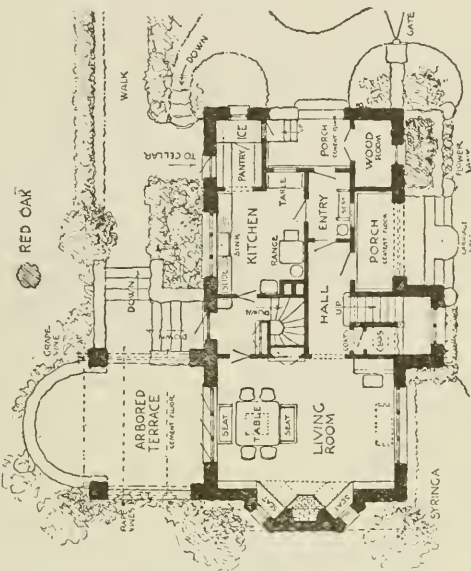
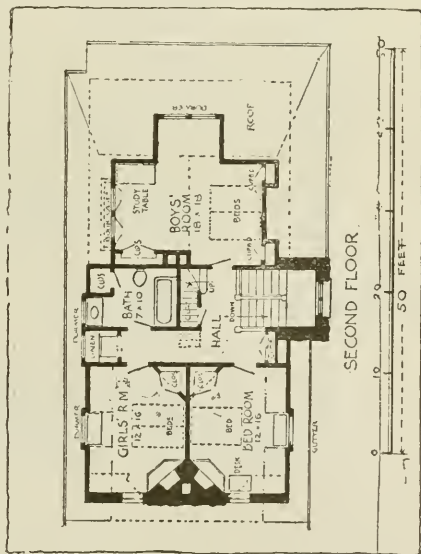
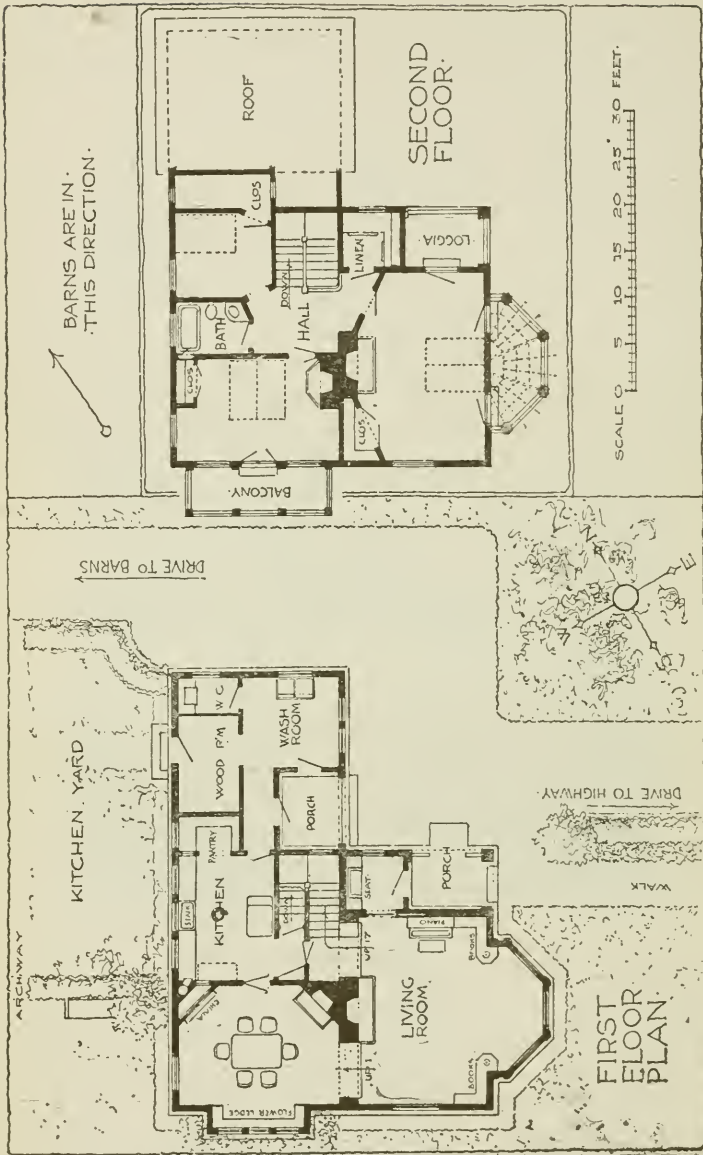


FIG. 309.—A small cottage, very compact and home-like. The first story is intended to be built of small field-stones, and the exterior, as designed by Mr. Spencer, is very attractive.





PLANS OF A SOUTHERN FARM HOUSE.

FIG. 310.—A well arranged plan without separate hall, but with stairway going up from one corner of the living room. This stairway is very compact and ideally located as a matter of convenience, but it would be quite dark unless more provision were made for lighting it than is shown on the plans.

Cupboards for either pantry or kitchen may best be in two divisions, upper and lower. The lower part of the cupboard, or dresser, as it is sometimes called, should be about 2 ft. and 8 in. or 3 ft. high and from 20 to 14 inches wide, fitted up underneath the top counter shelf with doors, shelves and drawers arranged as the housekeeper may desire. The upper part of the cupboard should be fitted with shelves and doors; and there should be an open space not less than 12 to 15 inches high between

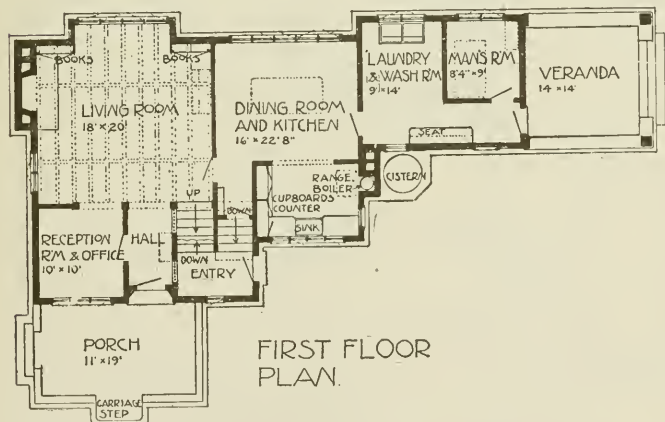
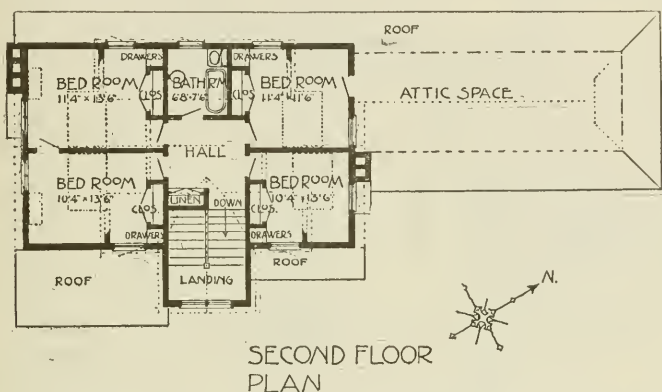
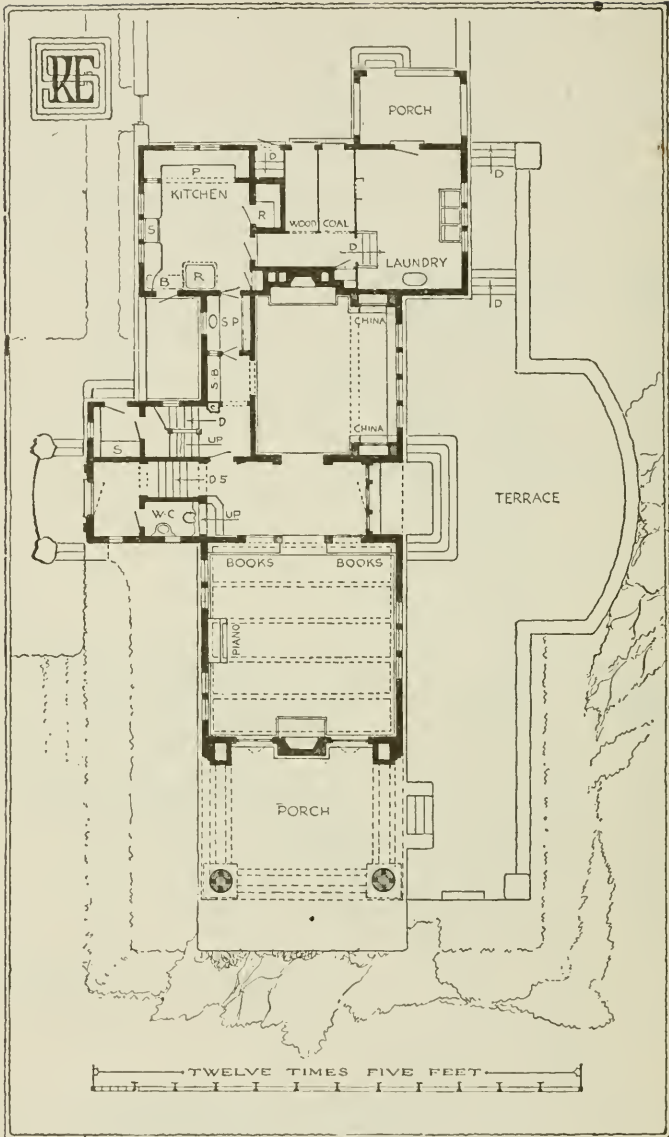


FIG. 311.—If dining room and kitchen are to be combined into one it could hardly be managed better than here, with the good light, cross ventilation, and the separation of range, sink, etc., from the main room.

the upper and lower cupboards, so that the top of the lower cupboard may be used as a table or counter shelf upon which to place the dishes in serving, clearing up, etc. The shelves of the upper cupboard should be about 12 inches wide and spaced from 10 to 14 inches apart. It is nearly always best to carry cupboards up to the ceiling of the room so that the top will not form an open shelf to catch dust and rubbish. The high



PLAN OF FARM HOUSE.

FIG. 312.—This house is planned to front on a lake, with approach and entrance at the back with all principal rooms ranged on the lake front; a good illustration of planning with reference to location and outlook.

shelves inside may be used for the storage of things used only at long intervals, such as empty fruit jars, etc.

The kitchen is in many respects really the most important room in the farm house. Instead, however, of being a model of convenience, as a little thought might make it, it is all too commonly mean and inconvenient in the extreme. Mere size has little to do with convenience, and a kitchen may be bad simply from being too large, so that too much energy is used in going from one thing to another in doing the work. A good kitchen should have the range, the work table, the sink (with running water), and the cupboard (or kitchen cabinet) so arranged and placed that the fewest possible number of steps and turnings will have to be made in passing from one to the other. Of course there are other things to be considered, such as the number of persons who are to assist in the work of the kitchen, the location of the necessary doors, windows, etc., and the space that must be allowed for the various kinds of work other than the simple cooking of meals that inevitably goes to the farm house kitchen even though it may seem to belong elsewhere.

The kitchen should be well lighted and well ventilated; with windows on two sides if possible. Unless there is some special reason for making low windows, the high windows with sills from three and a half to four feet from the floor afford a material saving in space by making it possible to place tables and sinks on outside walls in the best of light without interfering with the windows or exposing the plumbing pipes to direct cold drafts in winter.

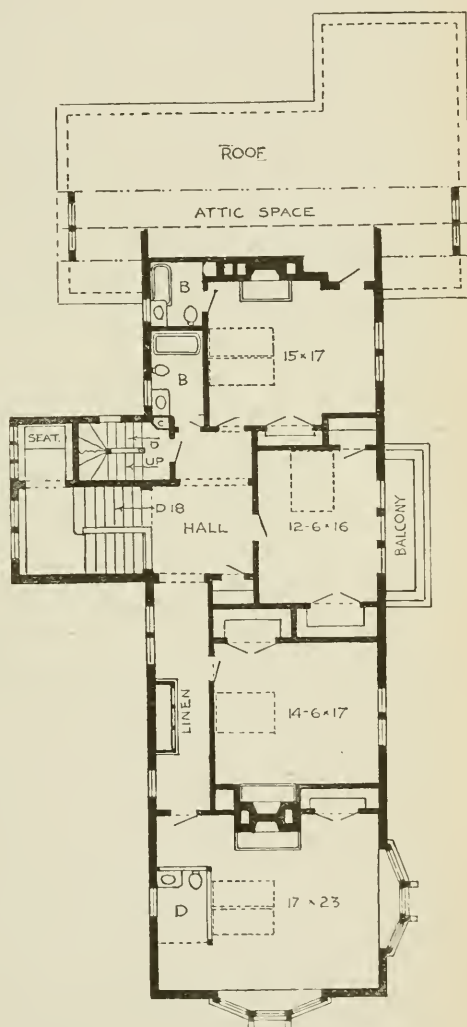


FIG. 313.—The second floor of Fig. 312.

To the writer, a farm house kitchen without a back porch is something not to be thought of. The porch need not be large, but it will bring untold comfort to the spirit of the tired worker in the kitchen on hot summer days.

The weekly washing should not be done in the kitchen if other provision can be made for it. The simplest arrangement, if a separate laundry is out of the question, would be to have a good sized wash room immediately adjoining the kitchen, where the men coming in from the field may wash and cast off their muddy boots and rougher work garments preparatory to entering the dining room, and where the Monday's wash may be done, using the kitchen stove if need be for the boiling of the clothes, etc. It would be very desirable to have this wash room so placed that the men might pass from it by way of a back hall or even the back porch into the living room or dining room without intruding on the workers in the kitchen. In fact, throughout the house everything should be planned and arranged so as to do away with all unnecessary labor and to avoid interference between persons and things that do not belong together.

If a bed room is to be given a place on the first floor,—and many people in the country insist upon it with good reason,—it must, while accessible from the hall, still be so located that it will be inconspicuous and not be mistaken for one of the public or common rooms of the house. The difficulties of satisfactorily placing a bed room on the first floor are so great, however, that most architects discourage the idea rather than accept the results usually attainable.

Before proceeding to the second floor of the house, it may not be amiss to say a word or two concerning the hall and stairway, although these have already been mentioned in another connection. A reasonably roomy hall with an open stairway is not a luxury, but a practical necessity in a good modern house. Many of the real old fashioned halls were commodious and beautiful, but the typical halls and stairways of the farm houses of a generation or two ago are crowded and cramped to such an extent that it is almost impossible to move a piece of furniture through them or even to use them as mere passage-ways with any degree of comfort. The hall is the introduction to the house and it should be so designed that the visitor who calls for the first time will feel the welcome of the home in it.

The sleeping room, or bed room, obviously ought to be designed with place for a bed, though actual examples too numerous to mention would seem to point to the prevalence of a contrary opinion. There ought to be a place for a double bed, or better yet, two single beds, a bureau, and usually a wash stand in every bed room; and furthermore, the spaces ought to be so arranged as to admit of changing the furniture about

occasionally, as one tires of having things always in the same order. A bed should stand with the head to a wall and with both sides clear so that it can be made up without being moved, as nothing ruins carpets or floors more quickly than the moving of furniture over them. The broadest wheeled castor on a heavy bed or bureau will roll a visible furrow in even a hardwood floor every time it is moved over it.

The bureau should be so placed that the person standing in front of it will have the full light of a window. If the house is provided with gas or electric light, a present luxury that will soon become a necessity even to the farmer, there should be a light near the bureau, or better still, one on each side of it.

Of course the position of windows and doors, and the way the doors swing, are all matters for careful consideration; and then we must have places where we can hang our clothing and put away the numerous odds and ends of a personal outfit. In other words, every bed room should have at least one good large clothes closet and this is hardly complete unless it has shelves near the floor for shoes and shelves above for hat boxes and a thousand other things, with plenty of coat hooks around the wall under the upper shelves.

Linen closets and broom closets are conveniences that are only beginning to be appreciated. No housekeeper who has ever enjoyed the luxury of a small closet fitted up with shelves for the household "linen," and who has had a still smaller neatly closed up closet for brooms, dust cloths, etc., could ever be persuaded to have a house without them. The linen closet would best be in the second story hall, and it need not be large. If it is only a foot or eighteen inches deep and three or four feet wide, with shelves all the way up, it will hold quantities of sheets, pillow cases, towels, etc. A broom closet ought to be on every floor and can hardly be omitted on the plea that there is no room for it. It is useful even if only large enough for one large broom and a dust brush or two. If no other place is available it can even be put within the thickness of a partition wall, though this is narrowing it down in size very close to the limit of usefulness.

No house, not excepting the farm houses, can nowadays be considered complete without at least one bath room. This should be on the bed room floor of the house and conveniently accessible from all of the bed rooms. For obvious reasons it ought not to be too publicly located, but ought rather to be away from the head of the main stairs, and with the entrance less conspicuous than the doors to the principal bed rooms.

The plumbing

The time is coming quickly when plumbing will be placed in farm houses. [The question of water supplies will be treated in Bulletin 29.]

The problem of plumbing in an ordinary farm house is altogether a serious one, not so much on account of difficulties in obtaining a water supply and disposing of the wastes, as on account of trouble from freezing and bursting of water pipes in winter. Whenever plumbing fixtures are installed it is necessary, of course, to have water supply and waste pipes, and it is imperative — unless we wish to invite disaster — to have these pipes, more especially the supply pipes, thoroughly guarded against freezing. In a house heated by a hot air furnace, steam, or hot water, this is a simple problem; but when the heating is from the more primitive stove the situation calls for the exercise of the greatest care and personal judgment rather than obedience to any possible set of rules. Placing the bath room directly over the kitchen with pipes exposed on walls and ceilings of the kitchen might be a solution in one case; or running pipes up in interior partitions and wrapping them thoroughly with hair felt or mineral wool, or placing them near a warm chimney, might offer another solution; while still another way might be to have a hot water circulating pipe from the kitchen range boiler and have this circulating pipe run close to the cold water supply pipe. This certainly would keep the water from freezing so long as there was a fire in the range; but it would also heat the water standing in the cold water pipes, which might be a disagreeable feature of the situation, especially in warm weather. This, however, might be overcome by having a stop or “shut off” in the circulating pipe to cut off the circulation whenever it might be desirable to do so.

If in taking the first steps in progress toward the “modern conveniences,” the bath room cannot be included, then a water-closet of the Philadelphia hopper type might be installed in a small outer room near the kitchen or wash room. This type of closet has the water supply and trap so arranged that the water flows only when the closet is in use and is then cut off and pipes emptied automatically to a point several feet below the floor level where they may be protected from freezing by the depth of earth or other covering.

The kitchen sink is one of the things no longer looked upon as a luxury. The cast iron porcelain enameled sink with back of the same material and with roll rim is quite cleanest and best for moderate cost work. It is, for all practical purposes, quite as good as the solid porcelain sink and is much less expensive. Even a very cheap sink of heavy sheet metal with colored enamel is better than a plain cast iron sink and will cost little if any more; but the cast iron with white porcelain enamel is by far the best investment for the housekeeper who takes pride in her work and wants to keep things looking clean and neat. A kitchen sink should not be smaller than 20 by 30 inches, while 22 by 36 inches would

be large for a small kitchen. The height of the sink from the floor may be almost anything the housekeeper wishes; 30 inches is quite low, 32 inches is a popular height, while 34 inches is preferred by many, and the writer has found at least one housewife who insisted upon having her sink set 42 inches from the floor. The cry so often made that sinks should not be placed on outside walls on account of freezing is mostly nonsense. If the pipes are kept out in the open kitchen instead of being placed in the walls, and are not run up in front of a window so as to be exposed to direct drafts, there is something radically wrong either with the construction or with the heating of the kitchen where pipes freeze. The sink should be fitted with ample drain-boards, preferably one at each end. The space under drain-boards and sink should not be enclosed, but should be left open so that it may be kept clean and sweet at all times with the least possible attention.

An ordinary bath room would usually contain three fixtures, namely, a bath tub, a lavatory, and a water-closet. There has been a great advance within the past few years in all that pertains to the art of plumbing, and in no branch of the work is this more apparent than in the fixtures themselves. The old tin-plated copper tub set in a wooden box is no longer tolerated even in the very cheapest of work, but in its place we can put a neat cast iron porcelain enameled tub at practically the same cost. This tub, like the kitchen sink, should have a roll rim, and is made to be set without any woodwork whatever either on top or around it. The standard width of the modern bath tub is 30 inches, and the length may be anywhere from 4 feet to 6 feet.

The lavatory may be a porcelain or earthenware bowl with a marble slab and back, or it too may be of cast iron enameled with white porcelain and with no joints or separate parts making crevices to catch dirt and breed bad odors. The iron enameled lavatory is smaller, more compact, and in very many respects nicer than the marble lavatory and it ought to cost less, but, unfortunately, it really does cost a bit more.

The water-closet that is now used almost universally in both cheap work and the most costly is of solid white earthenware and of the syphon acting type. Enameled cast iron closets have been in use in cheaper form for factories and institutions for a long time, but it is only within a few years that these have been so improved as to indicate that they may in time supersede the earthenware closet for some of the better work of moderate cost. There are two kinds of syphon-acting closets in common use, the syphon hopper and syphon jet. Of these two, the syphon jet is clearly the better; but it is also the more expensive, and for ordinary work a good syphon hopper-closet serves very satisfactorily. The difference in the cost of plumbing fixtures, if we start with those here recommended,

is very largely a matter of minor detail, such as enamel paint and gold stripes on the outside of the bath, fancy marble and elaborate nickel legs or brackets for the lavatory, mahogany or quartered oak seat and tank for the water-closet, etc., all of which may be well worth the cost if one has the money to pay for it.

Every separate plumbing fixture should have a separate trap in the waste pipe, and in no case should the waste from a fixture have to pass through two traps. These are fundamental rules in good plumbing and are essential to proper construction from both the sanitary and the mechanical points of view.

Another thing not at all an essential, but very desirable, is that there should be stops or "shut-offs" in the supply pipes to the separate fixtures. This makes it possible to shut off the supply to any one fixture for repairs without having to close down the whole system, a state of affairs that would be especially annoying in the country if the repairs were of such a nature as to require the services of a plumber who might have to be brought from a considerable distance. Another thing that architects preach with more zeal than they practice it, is that all pipes should, so far as possible, be kept in plain sight and not run inside of walls or between floors and ceilings where it is difficult to locate leaks or other troubles and still more difficult to correct them.

Acknowledgement. Books, etc.

For the few floor-plans accompanying this paper, writer and reader are alike indebted to Mr. Robert C. Spencer, architect; and to the publishers of *The Brickbuilder*. These houses are personal and individual, and each one has very clearly been planned, as every house should be, with reference to its particular location and to meet certain definite requirements.

It has been suggested that a proper adjunct to a discussion of this kind would be a list of books on the subject of country houses; but, unfortunately, all the books of which the writer can speak with knowledge are so unsatisfactory that he cannot find even one that he would be willing to recommend. If the reader is really interested in house building a year's subscription to *American Homes and Gardens*, a monthly magazine published by Munn & Co., 361 Broadway, N. Y., \$3.00 a year, would be vastly better than any like amount invested in books. Other monthly magazines that are helpful and full of suggestions along the lines of home building are *House and Garden*, published by John C. Winslow Co., Phila., \$5.00 a year; and *The House Beautiful*, published by Herbert S. Stone, 1326 Republic Bldg., Chicago, at \$2.00 a year. Neither of these latter, however, will give so many plans or so much information relative to houses of very moderate cost as will the first named magazine.

Supplement to

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SERIES VI.
BUILDINGS AND YARDS.

ITHACA, N. Y.,
JANUARY, 1906.

No. 28.
PLAN OF HOUSE.

DISCUSSION-PAPER ON FARMERS' READING-COURSE BULLETIN NO. 28

This Discussion-paper is sent out with all Farmers' Reading-Course Bulletins, for two reasons: (1) We should like to have your own ideas on these subjects. On some of these points you have probably had experience which will be interesting and valuable to us. No matter what the Bulletin says, if you have different opinions on any of these subjects, do not hesitate to state them on this paper and give your reasons. (2) We should like you to use this paper on which to ask us questions. If there are any points which the Bulletin has not made clear, or if there are any problems in your farming, whether on these subjects or others on which you think we may be able to help you, write to us on this paper.

THE NEXT READING-COURSE BULLETINS WILL BE SENT TO THOSE WHO RETURN TO US THIS DISCUSSION-PAPER, WHICH WILL BE AN ACKNOWLEDGMENT OF THE RECEIPT OF THE BULLETIN (2c. postage). *This paper will not be returned to you, but we shall look it over as carefully as we would a personal letter and write to you if there are any points about which correspondence is desirable. You may consider this Discussion-paper, then, as a personal letter to us. It will be treated as such, and under no circumstances will your remarks be made public.*

If you are not interested in this Reading-Course Bulletin, we have others on other subjects, and we shall be glad to send any of these to you on request. The titles of the six Series of the Reading-Course Bulletins now available are: 1. THE SOIL AND THE PLANT. 2. STOCK FEEDING. 3. ORCHARDING. 4. POULTRY. 5. DAIRYING. 6. FARM BUILDINGS AND YARDS. The Farmers Wives' Reading-Course, on domestic subjects, is also sent to those who desire it.

THESE BULLETINS CANNOT BE SENT TO PERSONS WHO RESIDE OUTSIDE OF THE STATE OF NEW YORK, AS BOTH COURSES ARE SUPPORTED BY A STATE APPROPRIATION.

For our own benefit we shall be glad to have you answer (on these sheets) any or all of the following questions, if you are interested in these subjects; but we do not wish you to feel under any obligation to do this.

1. How would you go at the planning of a house? What points or ideas would you begin with?

2. How much thought do farmers give to the floor-plan when building a house? Or do they follow custom and let the plan work out about as it will?

3. What is the floor-plan of your own residence? Perhaps you would like to make a rough outline diagram; and this may suggest questions to ask about the planning of a house.

4. What rooms, and about what size of each, do you consider to be desirable for a farm house?

5. It is good practice to draw a floor-plan of a kitchen for the purpose of determining how many conveniences you can get into a given space.

Name.....

Date.....

County, Postoffice

Note.—Your name appears on our mailing list as this Bulletin is addressed. If incorrect, please write us.

Address all correspondence to Farmers' Reading-Course, Ithaca, N. Y.

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BUILDINGS AND YARDS.
SERIES VI.

FEBRUARY, 1906.
ITHACA, N. Y.,

WATER SUPPLIES.
No. 29.

WATER SUPPLIES FOR FARM RESIDENCES

The first thing I would now do for the farm home is to put in sanitary water-works, for the care and comfort of the person. Nothing would so soon elevate the home ideals.

L. H. BAILEY, in *The Outlook to Nature*.

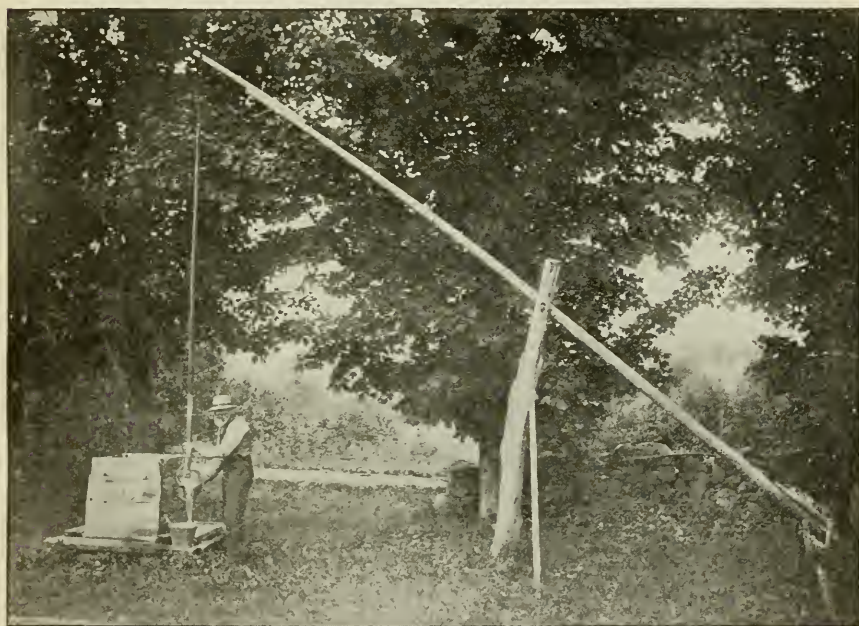


FIG. 314.—An old-time water supply, now becoming rare.

In time every good farm home will have running water in the house, with good kitchen sinks, water-closets and a bath room. The drinking water may or may not be brought in pipes. These water supplies can come by gravity from high springs or creeks; the water may be elevated by pumps of some kind; or the supply may be secured from the roof. In one or another of these ways all farm residences may have a complete water system, to lessen labor, to minister to comfort and health, to provide protection from fire, to supply water for garden and lawn.

I. ADVICE FROM THE ENGINEER

BY HENRY N. OGDEN

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It has been a sad reproach to farmers that they have paid so little attention to the needs of the house in the matter of a water supply. For the needs of the stable, or in order to economize in the regular farm work, every effort has been made to keep up with the times,—to have all the labor-saving machinery of the latest pattern, and to have the stables meet all the requirements of modern hygiene. On the other hand, after a well has been dug somewhere in the yard from which, though at a great expense of toil and exposure, water may be had, the house has been assumed

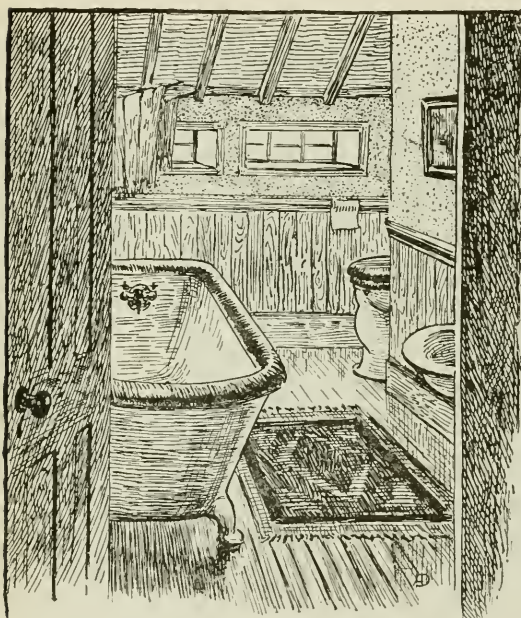


FIG. 315.—*Fixtures in a farm cottage contained in a shed addition to the main building.*

to be fully provided for. On some farms the well may be found on the back-porch or in the woodshed, which lessens the exposure but still involves pumping and carrying all the water that is used. Happily, this condition of things is passing away and on the farm, as in the city house, it is now understood that running water in the kitchen sink as well as at the barn, is only reasonable; and not a few houses have water also up stairs in a bathroom provided with all modern fixtures. It is the purpose of this article to consider the question of "Farm Water Works"

under five heads; (1) the quantity of water needed in the average house; (2) the quality of various sorts of water and their relative value; (3) methods and cost of installation; (4) plumbing; (5) methods of disposal of the fouled water.

I. Quantity

It has been said that the civilization of a community can be estimated by the quantity of soap that it consumes; and it is almost the same thing to say that the refinement of a household is measured by the amount of water it uses. The poorer and more degraded a household, the less the

water used; and the more luxurious it is, the greater the demands for an unlimited amount of water in the kitchen, laundry, bath-room, and around the yard. It is therefore not easy to say exactly how much water is needed in any house, even if the number of persons living in it is known, unless the standards of living are also known. Records of water consumption in Boston and Worcester show that the amount of water used

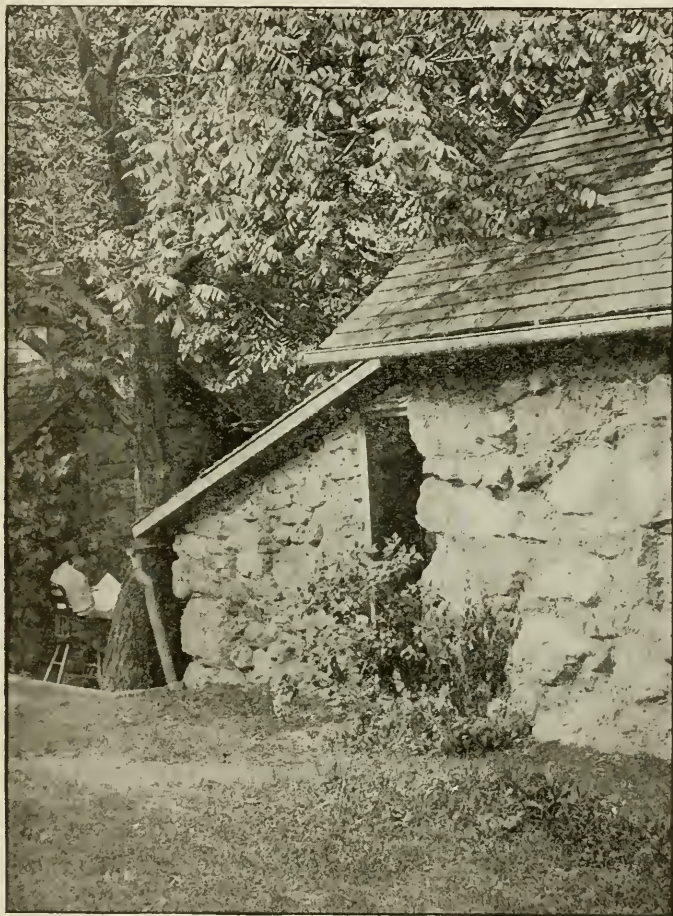


FIG. 316.—*The shed lean-to containing the bath, closet and lavatory shown in Fig. 315.*

per head per day varies from seven gallons, when there is only one faucet in the house, to fifty-nine gallons in the most fashionable of high-cost city homes. Probably with the ordinary amount of plumbing, viz.—hot and cold water in the kitchen, hot and cold water in the laundry, together with a bath-room completely furnished,—the average consumption of an

ordinary family may fairly be taken at twenty gallons per head per day. In city waterworks, one of the greatest causes of excessive consumption is the waste and leakage of the main pipes and house fixtures. The amounts given above presuppose no leakage, and if the entire system is not kept tight this amount may be doubled.

It is further to be noted that this amount is the average quantity used through the twenty-four hours, this being a convenient way of describing the amount. Practically, it is all used in twelve hours, and it is a common practice to assume that the rate at which the water is used during the day is twice that of the daily average. This is important, for instance, if water has to be pumped and the size of the pump or the size of the piping is being determined, as will be seen later.

There is still another factor which affects the amount of water, viz.—the daily and seasonal variations. Through the summer months, more water is used than in winter, and on some days in the week,—for example, on wash day,—more water is used than on other days, so that it will be wise to provide for a possible rate of flow of fifty per cent in excess of the twelve-hour average. The computation for quantity would then be as follows, assuming ten persons in the house:

10 persons at 20 gallons per day.....	200	gallons.
200 gallons in 12 hours means in 24 hours.....	400	“
And fifty per cent for excess on certain days and hours....	200	“
<hr/>		
Total maximum rate per day.....	600	“
Total maximum amount per day.....	300	“

This is about ten barrels, and would require a tank about four feet square and three feet deep for the day's supply. This doubtless seems large, and, of course, it is more water than would be used when it all has to be pumped and carried by hand, but with faucets and other fixtures it is not excessive and arrangements should be made to provide at least this quantity.

2. *Quality of water*

The quality of a water is, of course, only definitely known by chemical or other analysis, and yet common sense will be of great service in aiding one to select a proper source of water supply. No water is perfectly pure, and nature does not intend man to use chemically pure water, for certain salts and metals in solution are necessary for the human body. On the other hand, there are some kinds of pollution which are undesirable and even dangerous. The most common forms in which this pollution comes are in the form of lime or magnesia, which makes the water hard. There is no great danger in drinking hard water, so far as medical knowledge goes, although a person accustomed to soft water will probably suffer temporary discomfort on changing to the other. The chief objection to hard waters is in the large amount of soap needed with

them, the disagreeable effect of those waters on the skin, and the deposits formed by precipitation in cooking or in the laundry. Other things being equal, therefore, a soft water not affected by lime or magnesia is to be preferred. Unfortunately, there are other things which cause pollution of a worse sort,—things which, in general, are of an animal nature. Such pollution usually will be associated with human habitations and are the results, in one form or another, of human life. Surface waters, such as brooks or ponds, are most likely to be contaminated in this way, and, fortunately, the contamination can usually be recognized by even the most casual observation. If the brook flows through bottom lands, where cattle are pastured or where cultivated lands are manured, or if the brook receives the drainage from houses and barns, the quality of the water inevitably suffers. Mere contamination by animal wastes, however repulsive æsthetically, is probably not in itself dangerous; but if the drainage comes from diseased men or animals, the water may become a carrier of the disease and so cause severe epidemics. On this account, it is altogether wisest to avoid surface water which may at any time be exposed to animal or human contamination. It is not easy to pronounce on the probable pollution of wells, and they are therefore the most dangerous sources of water supply. If deep, they may furnish water which is merely hard. If shallow, drainage from privies or barnyards may make them certain sources of disease or death. Nor is it possible to pronounce by inspection of the surroundings only, on the probable purity of the water. If they are dug through a bed of clay with all chance for water to wash in over the top avoided, they are probably good. But if they are entirely in gravel, not far from a privy or drain, the water would be very suspicious. It is further to be noted that exemption from a serious disease for a period of years does not mean that a certain well water is pure, because the specific cause of a disease may not have been in the water; but if the conditions are such that a disease may be passed on from a privy through the water supply back to the household, sooner or later it will be done.

3. *Methods and cost of installation*

The simplest and best method of supplying a house with water, is to pipe the water from a spring or brook at a point high enough to cause the water to flow freely from the house faucets. If from a spring the quantity must be examined. This can be done by measuring, in pailfuls, the overflow of the spring. Not counting the water needed for the barn, it has been shown that a flow at the rate of 600 gallons in twenty-four hours is needed for a family of ten,—a flow at the rate of about two quarts per minute, or five minutes to fill a ten-quart pail. If this is just the rate of flow of the spring, there is enough water, but it may be thought that the

flow is too slow. Then a tank may be built in the barn or attic of the house into which water may run regularly to be drawn out, irregularly, at greater rates. If the flow at the time when the spring is lowest is found to be as large or larger than necessary, it need only be dug out, walled up, and covered. Wood will answer for this, but brick, stone or concrete are more permanent. The relative elevation of the spring and house must be carefully determined in order to make sure that the water will flow at the highest point desired. It requires a certain force to keep the water moving through a small pipe, and the following table shows the number of feet necessary for this purpose alone. The spring would

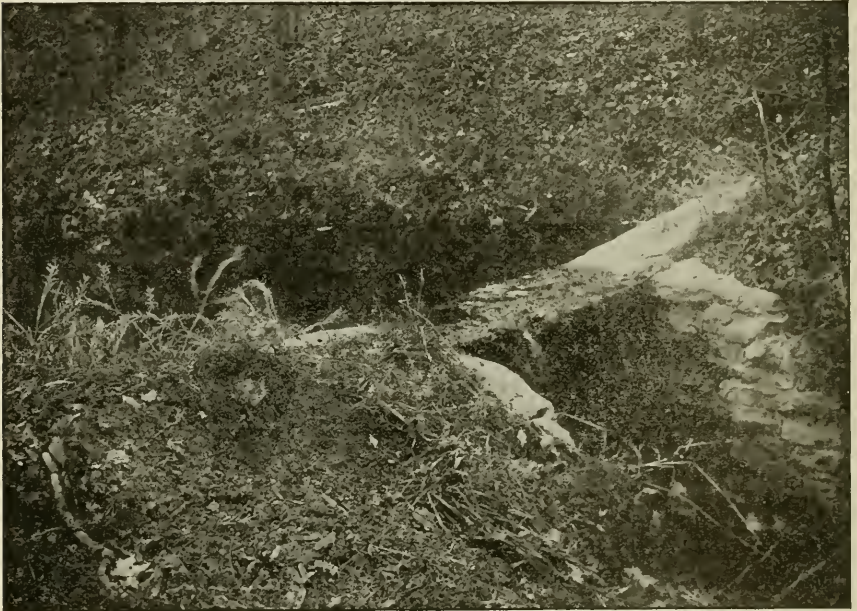


FIG. 317.—The reservoir, 2500 feet away, that supplies, by gravity, the equipment shown in Figs. 315 and 316.

have to be as much higher than the highest fixture is as shown in the table:

One-half inch pipe

Flow in gallons per minute.....	0.5	1.0	2.0	4.0	7.0	10
Head in feet lost by friction in each 100 feet of length.	4	7	17	54	140	124

One-inch pipe

Flow in gallons per minute.....	1.0				
Head in feet lost by friction in each 100 feet of length.....	0.3	0.7	1.6	5.3	9.3

This table shows that it is important to proportion the size of the pipe used to the head available. For example, suppose the spring is

fifty feet above the highest faucet, and that the flow is sufficient so that a bath-tub of water can be drawn at the rate of four gallons a minute. Then if the pipe line is 1,000 feet long, the one-half inch pipe would be out of the question, since it would take over 500 feet elevation to get that amount of water through the pipe and the pipe would not stand that pressure even if it were available. The inch pipe, on the other hand, needs but 16 feet to make the water flow at the rate given.

If the source of supply is to be a brook, whose purity has been established, it will be sufficient to lay a pipe into the brook, protect the end by a strainer (being careful to tamp the dirt back well in the trench in which the pipe is laid). It may be that the brook runs dry in the summer time and storage of the spring floods is necessary. This can readily be done, under certain conditions, as follows: Suppose the length of time during which the stream may be dry is fixed at 100 days, then the storage supply must be 300 times 100 or 30,000 gallons. In order that the water shall not become stagnant and offensive, the pond or reservoir in which the water is stored must be at least ten feet deep after this amount has been drawn off. This requires, for economy, a narrow gorge or gully in which to construct the reservoir. If a suitable site can be found, its fitness may be tested as follows: Take the average width of the gully, suppose it to be twenty feet, and multiply that by the length of the pond to be formed, suppose that to be 200 feet. The area of the pond then, with a ten-foot dam, would be 4,000 square feet, or 4,000 cubic feet for one foot depth. The storage of 30,000 gallons, or 4,000 cubic feet, will then require one foot extra depth for actual consumption. But evaporation from this water surface will take place rapidly during the summer months and it will be necessary to have about eighteen inches additional for this purpose, or two and one-half feet (above the ten feet) in all. Such a computation as the above may enable one to use a brook, even if quite dry in the summer, as a source of supply throughout the year.

The method of constructing a dam for the reservoir described above will depend on the soil, the money available, on the permanence desired and on the opportunity for overflow. If the bottom and sides of the gully are rock, then a rough stone or concrete dam, about twelve feet high, designed to allow the water to pour over the top, would be suitable. It should be at least six feet thick at the bottom, two feet thick at the top and, if logs or ice are likely to be brought down in the spring freshets, an oak timber should be bolted into the top to prevent injury to the masonry. If the banks are firm gravel or sandy loam, an earthen dam, six feet wide on the top and sloping two horizontal for each foot vertical both up and down stream, will be suitable.

Or, the ordinary field stone picked up on the farm may be dumped year after year into the brook at the point where it is decided to form the dam and the result will be a solid structure, which, if not tight at first, will soon become so from the accumulation of fine silt which will wash into the pile of stones. It may be made tight at once by planking the up stream side.

The earth dam is best made with a core wall,—a thin stone or concrete wall, eighteen inches thick, running in a trench well down into the foundation and extending along the center of the dam well into the banks on each side. If the core wall is not built, special care must be taken to tamp the dirt well and to avoid any possibility of erosion by water flowing over the top. The question of overflow is very important, for if a flood comes over the top of such a dam it is almost sure gradually to eat it all away. If possible, then, the overflow of such a dam ought to be taken around the dam in a new channel cut through the solid bank sideways, either back into the same stream or even into another valley. Otherwise a special provision for the waterfall must be provided. This may consist, if it is a core wall, of paving with cobble stones up and down both slopes a sluice-way for the running water. This paving must be well laid, the stones well set into the bank and the sides as carefully protected as the bottom. The size of this opening left for the flood water may be roughly calculated from the old rule to make the opening two feet deep and three feet long for every 100 acres of the area draining to the reservoir.

Timber also may be used for the dam and to form the sluice-way. However, unless the timber is to be always under water, it will decay in a few years so that unless both labor and time are very cheap, it is more economical in the long run to use either masonry or earth.

The pipe line from the spring or reservoir to the house may be of iron pipe, lead pipe, or wood pipe or sewer pipe. If the height of the spring is 100 feet above the highest fixture, then a three-fourth inch pipe would be sufficient, and this is the smallest size that should be used in any case. If, however, there is only ten feet above the fixture, the pipe ought to be larger and it may be that a sewer pipe four inches in diameter can be used to advantage. Wood pipe made of bored logs was used in years gone by, but now it costs more than iron pipe. If the ground slopes gradually from the spring at the start, then the sewer pipe is particularly well suited, and it can be bought for about six cents per running foot, the same price as three-fourth inch wrought pipe. If the joints of the sewer pipe are carefully made with good cement and the dirt is well tamped back around the pipes, it will stand an internal pressure of about twenty-five pounds per square inch, and, with care, it might be used for an entire line; but it is always safer to have the lower end, where the pressure is

highest, of iron. Lead pipe three-fourth inch in diameter costs about ten cents per running foot and is rarely used in these days.

Wells may be artesian, deep or shallow. (1) Artesian wells are those which reach a porous stratum, passing through an impervious stratum, the water being held under such pressure that it raises to the surface in the well pipes, often with force enough to flow into the second story. Such wells are either bored or driven. (2) Deep wells are similar except that the water does not reach the surface and has to be pumped, sometimes from extreme depths. (3) Shallow wells are driven, or merely dug, into an underground stream, the water from which is pumped by simple pumps.

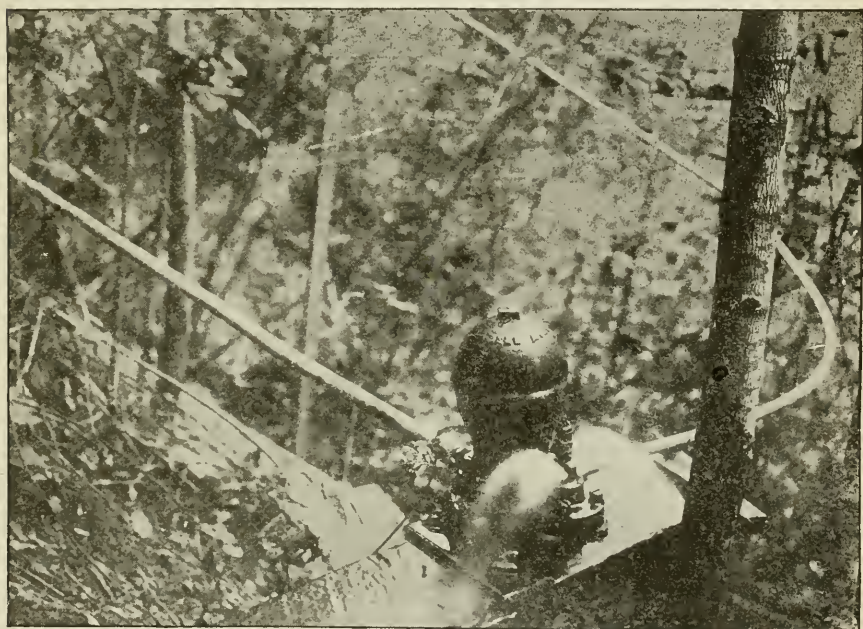


FIG. 318.—*Small hydraulic ram, pumping water brought down from a small spring. When all conditions are perfect, the ram is satisfactory.*

It is safe to say that pumping is to be resorted to only when there is no chance of getting a gravity supply of approved purity at a reasonable cost. This is true for two reasons: (1) Daily charges for maintenance are very likely to represent a large amount of capital invested. For example,—if the cost of pumping were only ten cents per day for fuel, not counting the labor, it would amount to \$36.50 a year, which, at five per cent, is the interest on \$730. It would be \$200 cheaper, therefore, to borrow \$500 at five per cent to pay for a gravity supply than to pay \$30

for a pump which costs ten cents a day to run. (2) Another reason for preferring a gravity supply aside from the cost is its greater reliability. The best machinery may break down even under expert care, and the probability is, that there would be many days in the year when, with pumps, the house would be without water on account of accidents.

Rams.—If a fall of water is available, its power may be used to work a hydraulic ram and this gives as cheap a supply as by gravity, since the occasional care required is very little, and the fall of the water does all the work. The two disadvantages are,—(1) that the fall is not always available at the right place, and (2) from accumulation of air in summer and from the formation of ice in the winter, the ram is subject to interruptions. In winter the ram may be kept from freezing by housing it and providing a small coal fire for the coldest weather. The following table gives data as to size, cost, etc., of hydraulic rams :

Size.	Flow of spring.	Drive.	Discharge.	Water pumped.	Cost of ram.
No. 2....	1 gal. per min.	$\frac{3}{4}$	$\frac{3}{8}$	$\frac{1}{7}$ gal. min.	\$ 6.00
No. 4....	5 " "	$1\frac{1}{4}$	$\frac{1}{2}$	1 " "	8.00
No. 6....	20 " "	$2\frac{1}{2}$	1	3 " "	15.00
No. 10....	50 " "	4	2	7 " "	35.00

This table is based on the assumption that the length of discharge pipe is not over 100 feet and that the head against which the ram works is not over five times as great as the fall of the stream. The drive pipe should be made always as short as possible.

Windmills.—Another cheap but unreliable source of power for water pumping is a windmill, which, while of great service in windy weather, is useless at other times. The frequency of winds of sufficient force to turn a mill varies in different localities, but it is probable that in any part of the eastern states five or six days might pass without a wind of any value. Therefore, the tank into which the water is pumped ought to be large enough to hold about a week's supply, or 300 x 7 feet; or 2,100 gallons besides the water needed for the stock (say 4,000 gallons or 500 cubic feet). This means a tank eight feet cube, or ten feet diameter and six feet deep. Then, since the wind, when it does blow, may not be strong or may last only a short time during which the tank should be filled, the mill and pump ought to be of good size. A twelve-foot mill ought to fill such a tank in about two hours, the pump working at the rate of eighteen gallons per minute. It would be foolish indeed to install a windmill, pump and tank only to find that in hot weather, when an abundant supply of water is particularly necessary, no water could be had from lack of wind.

Power pumps.—Perhaps the simplest kind of a pump worked mechanically is the Rider-Ericsson hot air engine, which is made to go by the expansive force of hot air. The fuel used may be wood, coal, kerosene oil or gas. Such a pump needs almost no attention after starting and occupies very little floor space, so that it may be placed in the corner of the cellar.

If electric current is available, either by purchase or by employment of the force in a water fall somewhere on the place, it is a convenient and satisfactory method to buy a pump and motor and run the combination by the current. It is not possible to give any estimate of the cost by this method since the conditions would all have to be assumed, and the value of the estimate would be almost useless for any particular installation.

Finally, the most elaborate method of pumping is to install in connection with a steam boiler, presumably used for other purposes on the farm, a regular steam pump, a small Worthington Duplex, for instance, which can be operated as needed whenever the boiler is fired up.

4. *Plumbing*

(See, also, Farmers' Reading-Course Bulletin No. 28.)

Supplying water to a house inevitably brings with it added desires for conveniences before impossible. Once running water is established in the kitchen, the old-fashioned privy seems sadly out of date and a modern bath-room is found to be almost a necessity. It must be frankly understood, however, that such an innovation requires a better source of heat through the winter than stoves; in fact, it almost presupposes a furnace. A kitchen in winter may be kept warm all night so that the water pipes do not freeze, and few cellars are so built that the water pipes may not safely be carried through them; but in an ordinary farm house, an attempt to have running water in any room but the kitchen, and often there also, would mean frozen pipes the first cold night of winter. A bath-room may be arranged in a room off the kitchen and kept warm thereby, or it may be in a room over the kitchen or sitting-room and kept warm by a register or a drum around the smoke-pipe, but such an arrangement will require constant care and vigilance in cold weather. It is far better to defer the bath-room until the furnace is installed. Then the full list of fixtures and piping will be as follows:

1. A tank in the attic to store water from a small pipe, providing the pipe flow or pump capacity is small; not needed, of course, if the direct supply from the source is adequate.

2. A main supply pipe from tank or from outside supply feeding the kitchen sink, the hot water boiler through the kitchen stove, the laundry-tub, the bath-tub and the water-closet tank.

3. A hot water pipe leading out of the hot water boiler to the kitchen sink, the laundry-tubs and the bath-tub.

4. The necessary fixtures, such as faucets, sinks, tubs, kitchen boiler, water-closet tank and fixtures.

A fair estimate of the cost of all this except the tank in the attic, including the plumber's bill for labor, is \$150, although this can be reduced somewhat by using cheap fixtures and by helping in the labor.

5. *Disposal of waste*

In one of the bulletins of the Farmers Wives' Reading-Course, questions were asked as to the advisability of water supplies in farm residences. One of the respondents said that she did not want water piped into the house again, because it made the kitchen so wet and untidy. Apparently there had been no adequate provision for caring for the waste.

The problem of properly disposing of the polluted water grows more serious the more water is used in the house. When this amount is brought in pailfuls from a well, the dirty water can be thrown out the back door on the ground without being very objectionable. But when the water runs in streams from kitchen, laundry and bath-room, some better method must be devised. The simplest outlet is into a running stream, provided the water is not afterward used by some neighbor for drinking or watering stock, and provided its volume of flow in the driest months is at least forty times the flow of the sewage turned into it. It is quite possible that a farm may have a large brook running through or alongside its territory, while the water supply comes from springs. Then the natural order would be from springs to house and from house to brooks.

Cesspools.— If the above arrangement is not feasible and the ground is sandy or gravelly, then a cesspool may be made. This should be about six feet inside diameter and eight to ten feet deep, walled up inside with stones without cement. Such a cesspool will allow the liquids to leach away, and the solids remaining will gradually be liquified so that a cesspool of this sort will probably last indefinitely, or at any rate, for many years. It is only permissible, however, when there is not the slightest danger of polluting well or other drinking water supplies. If the soil is heavy clay or clay loam, then a cesspool is not feasible and some sort of surface application must be resorted to.

The "complete method" of sewage disposal.—The theory on which the method of complete destruction of injurious sewage depends, is that organic matter,—that part of the sewage which decomposes and becomes offensive,—is in course of time converted into mineral salts through the agency of bacteria. Of these bacteria there are two kinds concerned. One, working in the dark, liquifies all the solid matter, such as paper, banana skins, etc., making the sewage simply a dirty looking liquid; the other kind acts in the presence of light and air to clarify and oxidize the liquid, making it clear and bright. Both kinds of bacteria are always in the sewage and require only proper surroundings to go at once to work. With this principle in mind, a properly designed treatment will include a closed dark tank of a capacity about equal to the day's flow of sewage, in which tank the required liquifaction may take place. This tank is usually built under ground to keep it warm and the sewage flows continuously in and out.

The rest of the process may take place either by allowing the effluent from this tank to flow slowly through artificially prepared beds of sand three feet deep and of sufficient extent so that there is a square yard for every fifty gallons per day, or for 300 gallons a bed of eight feet square. Since the bed would need to have the surface raked off occasionally, it would have to be made in duplicate so that one bed could be always working. The two beds should be underdrained and the outflow led away into any natural drainage. It would be better in a northern climate to build a light wooden roof over these beds, which would themselves be below ground, but this is not necessary, as such an arrangement is often run all winter, as far north as Albany, by running furrows through the beds to concentrate the sewage instead of letting it run over the bed in a thin sheet. Instead of building artificial beds, a piece of lower ground 200 to 300 feet from the house, may be used to receive the effluent of the tank. Over this the sewage would run between the beds in furrows about four feet wide, or even slowly in a thin sheet over the surface of grass land. If the appearance of the sewage is considered objectionable, the flow may be taken into small agricultural drains, laid twenty feet apart on a grade of about four inches to 100 feet, in which case the sewage will leach out between the pipes and be purified in the soil. The bacteria concerned are chiefly in the top soil, so that surface furrows or surface overflows are best; but if the drains are not more than twelve inches below the surface good results will follow, even in the coldest weather.

In all these cases in which the preliminary tank is used it must be observed that while not necessary, it secures much better results to introduce directly below the tank a receiving tank which operates at certain intervals so that the sewage may be discharged onto the beds or ground intermittently instead of in a more or less continuous small stream. The reason for this is that if the sewage trickles out on a bed it is absorbed immediately by that part of the bed nearest the inlet and the other parts of the bed do not work. On the other hand, if the flow comes out on the bed once a day, with a rush, the whole bed is covered, every part does its share and no part is overburdened. This reasoning holds true equally with furrows or with grass or with subsoil pipes. If the first tank holds about one day's supply, 300 gallons, it should be about five feet long, three feet wide and five feet deep, the extra depth being given to allow deposits to take place. The intermediate tank might be circular, four feet in diameter and four feet deep. This tank can be provided with an automatic discharging siphon so that the tank will discharge itself whenever it gets full, or it may have a simple flat valve which can be lifted by hand every morning as a regular duty of the farm. The area needed for the artificial beds has been already mentioned. The area for natural beds depends entirely on the quality of the soil. The hardest clays with only three to four inches of top soil ought to have an area 100 feet square for every ten persons in the house. If the soil is porous and the discharge takes place once a day, twenty-five feet square for each ten persons would be enough. It is not possible to get too much land ready, and, on the other hand, it is not difficult to add to the area prepared if the sewage remains on the land in pools. The fundamental principle is to bring the sewage in small infrequent quantities in contact with the surface part of the soil, letting the bacteria act and so destroying the organic matter. It should not be difficult with this in mind to arrange tanks and land areas to bring about the desired result, viz., the disposal of the fouled water in an efficient and wholesome fashion.

II. WATER SUPPLY SYSTEMS NOW IN OPERATION ON NEW YORK FARMS

House water supplies are now frequent in New York State. Accounts of a very few of these will acquaint the reader with some of the ways in which these practical problems may be met.

T. B. WILSON, HALLS CORNERS (Fig. 319).

In the attic is a tank which is supplied from the rain water off the roof. In addition, the house has a large cistern in the basement from which an extra supply may be pumped in case the rain water is insuffi-



FIG. 319.—*Fixtures in the farm residence of T. B. Wilson.*

cient to fill the tank in the attic. In the bath-room is a hand pump connecting the cistern in the basement or cellar with the tank in the attic. This system of water supply seems to be general in that section.

The attic tank is nine feet long, three feet wide and four feet deep. The framework is made of 2x4 hemlock (planed). It is lead-lined. The tank is situated in the attic of one of the wings of the house. It receives the roof water from the main building of the house, but not from

the wings. The area of this main building, however, is only about one-quarter of the entire roof system.

The cistern beneath the house is large, having a capacity of 110 barrels. This receives the roof water from the wings and also the excess of roof water, if there should be any, from the overflow from the tank in the attic. It often happens that during certain portions of the year the rainfall is insufficient to supply the tank in the attic. In order to meet this deficiency, a good hand pump has been put in the bath-room, by means of which water is pumped from the cistern below up to the tank in the attic. In the dry summer months, considerable water has to be pumped up.

The water is heated in a common cylindrical heater which stands back of the kitchen stove and is connected with it. There has been no difficulty in having warm water. The sewage is emptied into a cesspool situated twelve or fifteen rods north of the house. The cesspool is a com-

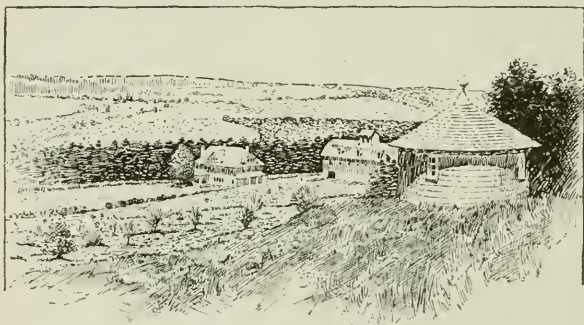


FIG. 320.—Circular storage tank on the Winters farm.
It supplies the barn and residence in the distance.

paratively large one, being fully ten feet deep and about six feet in diameter, and lined with stone.

The system works to perfection, no repairs being necessary and no trouble experienced since it was installed.

WINTERS FARM, SMITHBORO (Fig. 320).

“There are four springs supplying the larger reservoir (Fig. 320) and one spring supplying a small reservoir. One-inch lead pipes bring the water from the springs to the reservoirs and a two-inch galvanized pipe brings the water from these reservoirs to the various buildings. These systems are connected and arranged so that water can be used from both, or any one of the reservoirs in all the buildings.

“There are three fire hydrants and about two hundred feet of hose and an average pressure of about fifty pounds. I am somewhat in favor of getting water from drilled wells instead of springs. Anyone putting in

a water supply will be surprised at the amount used. It was supposed one spring and small reservoir would be all that would possibly be required. We are now using the water from five good springs. Should more be required, I imagine we will drill a well near one of these reservoirs and put up a windmill. Our system is giving splendid satisfaction.

“ We now supply water :

to our own home which contains four bath-rooms, and

I think all up to date modern equipments,

to the cow barn, accommodating over a hundred head of cattle,

to the milk room and boiler house, using large quantities of water in our certified milk work,

to the horse barn and a small cottage near by.”

“ A drilled well near by with a pressure tank in the ground, and some practical power to keep it filled would save considerable money in digging and laying pipe lines and building reservoirs, and I imagine would give excellent satisfaction.”

JOHN T. McDONALD, DELHI.

Mr. McDonald lives in the hill country in which there are abundant springs of good water on the hillsides. Springs on one of the hillsides are run into a thousand-barrel tank and from this reservoir water is carried to the buildings through a four-inch cast iron pipe with a head of about 200 feet. This supplies two bath-rooms and water-closets in the residence, and also bath-rooms and plumbing complete in three tenant houses that have been built to accommodate the farm help. The general planning and supervision of this work was done by Mr. McDonald himself. When the system is once installed it works automatically and to perfection and becomes an indispensable part of his farm equipment.

Five springs are run into the reservoir on the hill, these springs being from ten to twenty rods distant. The reservoir is built in the ground, of stone, twenty feet square and about ten feet deep. It stands nearly full of water the year around. The water as it leaves the springs has a temperature of about forty-two degrees Fahr. In warm weather it sometimes reaches as high as fifty in the reservoir and in the buildings as high as fifty-five to fifty-seven degrees. The reservoir is 100 rods from the residence. Pressure at the house is about ninety-five pounds per square inch. The supply pipe from the reservoir is laid five feet deep. The reservoir supplies the residence, creamery, stables, boiler room and three cottages. The sewerage system leads to a creek through eight-inch stone pipes. The cost of the entire plant has been about \$1,000.

GEORGE ALLEN, ITHACA.

Mr. Allen secures water from the roof. He has a tank in the second story of his house made of 2×4 s laid up and spiked together. This is lined with sheet lead. The lead is much better than copper because it will stretch somewhat if the walls of the tank spring. The copper is likely to split or seam, resulting in leakage. On the other hand, the lead lining is not safe when the water is to be used for drinking purposes. Water from the roof is caught in troughs and stored in this tank (See O, Fig. 321), which is about five feet deep and five feet square, inside measurement. The water from the parts of the roof too low to run into the tank is conducted into a cistern in the cellar of the house (B B, Fig. 21). A pump in the kitchen is so arranged that it may be used to pump water from the cistern below or from the well in front of the

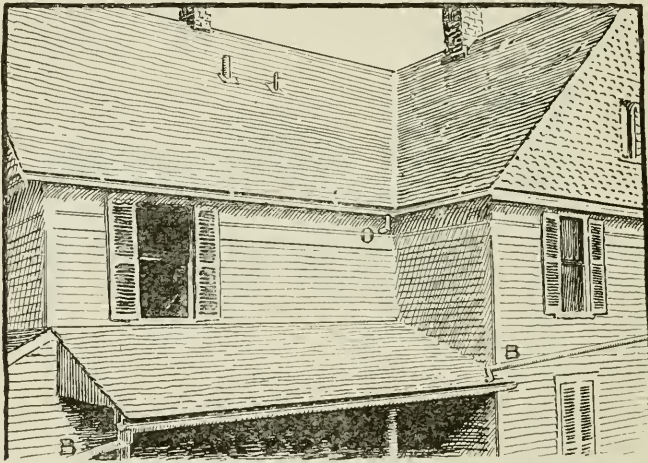


FIG. 321.—A roof water supply. The conductor supplying the tank enters at O. The water supplying the cellar tank follows the course B B. George Allen, R. F. D., Ithaca.

house into the tank above. Mr. Allen has seldom needed to use the pump for this purpose, but the pump is in constant use to pump the drinking water from the well to the kitchen. The tank on the second floor supplies water to a hot water tank attached to the kitchen stove, to a sink in the kitchen, and to a water-closet and bath, all on the first floor. The pipes have never bothered about freezing because the house is heated with a furnace. The waste water is conducted into a cesspool at the rear of the house about eight feet deep and four feet across. While the cesspool is not more than twenty feet from the house, the ground slopes abruptly from the house on this side so that the top of it is below the level of the cellar bottom. It is covered so that no odors escape. It is on the opposite

side of the house from the well and enough lower than the well to prevent contamination of the drinking water.

AN AIR-PRESSURE SYSTEM

G. W. Hosford, one of my friends, has a system of waterworks in his house which depends on air-pressure to force the air through the building. A galvanized steel tank of 200 gallons capacity is located in the cellar of the house. This is air tight and has a discharge pipe from its lowest point. A special pump is provided to pump the water from the well into the tank. By simply opening an air cock provided for that purpose the same pump may be used to force air into the tank. First, air is pumped in until the gauge registers about 10 pounds pressure. This amount of pressure is sufficient if the water does not have to be forced higher than 22 feet. The water may be carried as high as necessary merely by increasing the air-pressure. Then water is pumped into the tank until the pressure gauge registers 25 pounds. It requires 10 to 15 minutes pumping each morning to provide enough water for the family (six people). On wash days it is necessary, of course, to pump to a higher pressure or to pump more than once. If the plumbing is good and care is exercised to prevent escape of air, it is not necessary to pump air into the tank very often.

This system has proved very satisfactory. The water is kept in good condition by the action of the air upon it; being in the cellar it keeps cool in summer and is not in danger of freezing during the winter. It is much easier to support a tank in the cellar than in the top of the house and there is not as much danger of trouble from its springing a leak. The system is patented. The installation of the system in Mr. Crosby's house cost about \$200, including all plumbing.

A hot water tank attached to the kitchen stove provides hot water for laundry-tubs in the basement, sink in the kitchen, and the bath-room on the second story. In the bath-room there is a wash bowl, closet and bath-tub.

VARIOUS SUGGESTIONS

Following are practical suggestions by George Wallenbeck, Willow Creek, Tompkins Co., who makes a business of putting in farm water supplies:

Laying and protecting pipes

In laying pipes under ground a uniform grade should be secured, if possible. When the pipe follows the contour of the surface of the ground, air from the water is likely to collect at the higher points in the pipe and prevent the flow. When this happens we say that the pipe is "air bound." When it is absolutely necessary to change the grade in

going over rocks and inequalities in the ground, this trouble may be avoided to a certain extent by placing at the highest point a T and stand-pipe about one foot high with pit-cock at top. If the pipe becomes air bound, open the cock in stand-pipe and allow the air to escape. As soon as water begins to come, close the cock. The stand-pipe should be protected from freezing by a covering of soil. It may be made more accessible by placing around it a piece of tile reaching nearly to the surface of the ground. If pipe is deep in the ground, a long iron wrench may be used with which to turn the cock.

In a long underground pipe it is always well to put Ts every three hundred or four hundred feet with short stand-pipe and cock. In case the pipe becomes clogged, you may begin from the upper end and force water up through one section at a time with a force pump and thus open the pipe without having to tear it all up. Dirt collects in largest quantity at the joints of pipes where the coupling does not bring the pipes close together and where the galvanizing is not perfect. Water forced through the pipe in the opposite direction from the usual flow will often remove the obstruction.

When pipe is used to siphon water over a point higher than the source of supply, the pipe is likely to become air-bound at the highest point. Here a stand-pipe two feet high, if possible, should be provided. Valves should be placed at both ends of the pipe and a cock at top of stand-pipe. By closing valves at the ends so that the water will not escape, you can open the cock and pour water into the stand-pipe where the air has collected. Never attempt to siphon more than twenty feet higher than source.

Pipes in exposed places in buildings may be protected from freezing by wrapping with asbestos paper and then covering with plaster of paris one or two inches thick. This is more economical than a large quantity of asbestos. A wooden trough or form may be made to hold the plaster of paris around the pipes while it is hardening. The cost may be still further reduced without lessening the protection by mixing the plaster of paris with equal quantities of sawdust.

Reservoirs

Reservoirs for storage of water may be made by sinking wooden tanks of desired capacity in the soil, leaving about one foot of space around them on all sides. Fill this space with cement and leave to harden. After the cement has set, the wooden tank may be removed or it may be left until it decays. Wooden tanks may be made of clear pine, cedar or cypress. The cypress is cheapest and in most cases will last as long as the others. The average life of a wooden tank is twelve years. The

sides of the reservoir should slope outward so that if the water freezes it will not crack the cement. An arch of cement or stonework makes the best kind of cover for such a reservoir.

Tanks out-doors in exposed places may be protected from freezing by covering with a double cover and providing a dead-air space. If the heat is not allowed to escape from the surface of the water, freezing is much less likely to occur. If the covering is not sufficient protection, a box may be built around the tank large enough to allow a packing of saw-dust six to eight inches thick on all sides. Galvanized iron tanks should always be protected in this way if they are in places where freezing is likely to occur. Another way to protect outside tanks is by a small heater, which may be purchased for about \$2.50. This is put in a safe place below the tank and is so arranged that the heat from a large lamp keeps the water circulating all the time. When the surroundings are such that the water would not be contaminated, protection is often secured by allowing the overflow from the tank to go back into the well from which it is pumped and keeping the water flowing continuously.

Windmills

In order to be practicable, windmills should stand at least ten feet above all obstructions that are within a distance of three hundred feet. The black or ungalvanized towers give best satisfaction because they can be painted. Paint will not stick to the galvanized iron and in a short time some of the galvanizing is likely to come off and leave unprotected places. A windmill with an eight-foot wheel will lift water twenty-five to fifty feet and supply water through the average wind, providing a tank capacity of one barrel per animal is allowed per cow or horse, or one barrel for eight sheep. If used for house, an amount equivalent to that used by the barn should be provided.

Taking care of the waste

Waste water should be conducted to a cesspool situated at least one hundred feet from buildings. A hole eight to ten feet square and six to seven feet deep may be dug in the ground and filled with cobble stones. If possible it should be located on a gravel knoll. If hard-pan is nearer surface of ground than eight feet, stop before reaching it, inasmuch as a hole dug in this will only form a basin to catch the sewage. Dry wells may be made by digging a hole and stoning up like a well, providing soil is open enough so that water will drain away as fast as it will need to run into the well. A trap should be provided in the pipe leading from each sink and closet, to prevent the escape of odors from cesspool or well, and especially from pipe leading from house to cesspool.

Supplement to

CORNELL

Reading-Course for Farmers

PUBLISHED BY THE COLLEGE OF AGRICULTURE OF CORNELL UNIVERSITY,
FROM NOVEMBER TO MARCH, AND ENTERED AT ITHACA AS SECOND-CLASS
MATTER UNDER ACT OF CONGRESS OF JULY 16, 1894. L. H. BAILEY, DIRECTOR.

SERIES VI.
BUILDINGS AND YARDS.

ITHACA, N. Y.,
FEBRUARY, 1906.

No. 29.
WATER SUPPLIES.

DISCUSSION-PAPER ON FARMERS' READING-COURSE BULLETIN No. 29

This Discussion-paper is sent out with all Farmers' Reading-Course Bulletins, for two reasons: (1) We should like to have your own ideas on these subjects. On some of these points you have probably had experience which will be interesting and valuable to us. No matter what the Bulletin says, if you have different opinions on any of these subjects, do not hesitate to state them on this paper and give your reasons. (2) We should like you to use this paper on which to ask us questions. If there are any points which the Bulletin has not made clear or if there are any problems in your farming, whether on these subjects or others on which you think we may be able to help you, write to us on this paper.

THE NEXT READING-COURSE BULLETINS WILL BE SENT TO THOSE WHO RETURN TO US THIS DISCUSSION-PAPER, WHICH WILL BE AN ACKNOWLEDGMENT OF THE RECEIPT OF THE BULLETIN (2c. postage). *This paper will not be returned to you, but we shall look it over as carefully as we would a personal letter and write to you if there are any points about which correspondence is desirable. You may consider this Discussion-paper, then, as a personal letter to us. It will be treated as such, and under no circumstances will your remarks be made public.*

If you are not interested in this Reading-Course Bulletin, we have others on other subjects, and we shall be glad to send any of these to you on request. The titles of the six Series of the Reading-Course Bulletins now available are: 1. THE SOIL AND THE PLANT. 2. STOCK FEEDING. 3. ORCHARDING. 4. POULTRY. 5. DAIRYING. 6. FARM BUILDINGS AND YARDS. The Farmers Wives' Reading-Course, on domestic subjects, is also sent to those who desire it.

THESE BULLETINS CANNOT BE SENT TO PERSONS WHO RESIDE OUTSIDE OF THE STATE OF NEW YORK, AS BOTH COURSES ARE SUPPORTED BY A STATE APPROPRIATION.

For our own benefit we shall be glad to have you answer (on these sheets) any or all of the following questions, if you are interested in these subjects; but we do not wish you to feel under any obligation to do this.

1. Are any farm buildings in your vicinity fitted with water supplies; and are these supplies in (a) barns, (b) dairies, (c) residences?
2. Discuss the nature of these supplies: (a) where the water comes from, (b) what is it used for, (c) what sewerage system is provided.
3. How far is it practicable and desirable to install water supplies in farm residences?
4. If you have water supply problems of your own that we can help you to solve, please state them.

Name.....

Date.....

County, Postoffice

Note.—Your name appears on our mailing list as this Bulletin is addressed. If incorrect, please write us.

Address all correspondence to Farmers' Reading-Course, Ithaca, N. Y.

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SERIES VI.
BUILDINGS AND YARDS.

ITHACA, N. Y.,
MARCH, 1906.

No. 30.
BARNs.

BARNs AND OUTBUILDINGS—A DISCUSSION OF THE PRINCIPLES INVOLVED

By THOMAS F. HUNT

The old barns and outbuildings on New York farms must soon be rebuilt, or new ones erected in their places, for they are coming to that age when they are beginning to tumble down. Many of the old barns are not efficient or economical, as measured by present standards. It is important, therefore, that some of the underlying principles be discussed.

Some of the objects to be secured in the construction of barns and other outbuildings may be stated as follows:

1. To keep animals and other objects dry.
2. To maintain a proper temperature.
3. To secure pure air, with a proper degree of humidity.
4. To secure light.
5. To secure cleanliness.
6. To prevent the breeding of vermin (rats, mice, insects).
7. To preserve the manure.
8. To secure health, comfort of the animals, freedom from injury, and to prevent the spread of contagious diseases.
9. To secure economy in feeding and watering.
10. To secure economy of space.
11. To secure economy of labor.
12. To secure economy of construction.
13. To secure strength and durability.
14. To secure good appearance.

It is proposed to discuss each of the above categories, in order.

Obviously the plan of a barn for a given individual will depend on the relative importance to his conditions of these and perhaps other factors. What would be a good plan for one man's conditions might be a very poor plan for another's. An attempt is made to state some of the principles involved and to show a few pictures illustrating these principles. Because a plan here submitted shows a good principle or a bad one does not imply that the plan as a whole is either commended or condemned.

Corollary discussions on barns may be found in FARMERS' READING-COURSE Bulletins Nos. 23 and 26.

I. To keep animals and other objects dry

With respect to inanimate objects, the first purpose of barns is to keep them dry. For this reason, barns and other outbuildings are comparatively limited in regions of small rainfalls. The writer recently saw more than a thousand bushels of shelled corn lying in a pile on the ground, wholly unprotected. The fall of rain or snow was so small during the winter at this place as to cause the corn no material injury.

Certain farm products require more protection than others. Indian corn in the ear requires less protection than wheat or barley. This made possible the growth of maize by the Indians in the humid climate of America, while wheat and barley were developed in arid and semi-arid regions where they could be stored in the open without injury.

On account of their covering, domestic animals are able to resist a considerable amount of dry cold. When the animal becomes wet, his coat is not only no longer such a good non-conductor, but the evaporation of water from the body extracts an excessive amount of heat. It requires six times as much heat to evaporate a given amount of water as it does to raise the temperature from the freezing point to the boiling point.

In the high plains area of the United States between 98° and 104° West latitude, although the temperature is frequently severe, there is scarcely any fall of rain or snow during the winter. Thousands of head of cattle are fattened in the open and many practical feeders maintain that they do better entirely in the open, with perhaps a tight board fence to break the wind, than they do when given sheds in and out of which they can pass at will. The explanation seems to be that the cattle crowd into these sheds and become overheated. The steam from their bodies moistens their coats and when they go out into the open to feed, they suffer greater injury than if they had not had the protection of the shed.

The natural habitat of the horse being a cold country, he is able to stand without injury considerable amounts of cold but is particularly sensitive to dampness. Care should be taken to have the horse stables dry. It is, of course, well understood that care should be taken to protect the horse from exposure after his coat has become wet from exercise or rain.

It is not merely to protect animals from storms that barns are built. Many practical stockmen have been driven to building barns or sheds for their stock because of mud in the feed-yard.

It is important that an animal have a dry bed on which to sleep. The practical feeder recognizes that a well-bedded ox fattens better than one that does not have this essential comfort. Armsby has shown by exact experiment that a standing ox expended 24 per cent of the energy in his food in the effort of standing, which was saved when he was lying down.

A wet place, as a manure pile, is recognized to be a bad place for hogs to sleep, although it may be warm and to the hogs apparently comfortable.

II. To maintain a proper temperature

The importance of barns as a protection against heat and cold depends on the climate in which the farm is located and the character of the animals to be housed. The climate involves more than mere temperature as shown by the thermometer; it includes the movement of the air (wind), and humidity.

Horses will probably withstand more cold than mules. Mules will certainly withstand heat better than horses. Sheep will withstand cold better than hogs. Fattening cattle endure cold much better than cows in milk. Mature animals will endure more cold than young animals. The amount and character of food is a factor.

Every animal expends a certain amount of the energy of the food in masticating and digesting it. This energy manifests itself in heat, which helps to keep the animal warm. The more an animal eats the more heat is produced in this way. A much greater portion of the energy or value of hay is used in masticating and digesting it than in the case of grains. The point to get clear is that, in so far as the heat used in warming the body comes from the energy of digesting the food, it is merely incidental to the life processes and cannot be protected from waste by placing an animal in a warm barn. Arnsby, at the Pennsylvania Experiment Station, has shown that a steer fed on timothy hay and a small quantity of linseed meal, developed more heat from digesting the food than was necessary to maintain the temperature of the steer in a room at 60° F. This suggests that the steer would have been more comfortable at a lower temperature without in any way interfering with the fattening process. This further suggests the danger of keeping animals too warm while being fattened. Waters, of Missouri, has made feeding tests with steers in barns, in open sheds, and in feed yards without protection, during three winters and has found in every instance that the steers in open sheds did best, in feed yard without protection second best, while those in barns did poorest. It is not at all improbable that the cattle in the open shed did better than those in feed yards because of the protection from rain and snow rather than on account of any difference in the temperature of the surrounding air.

While cattle and sheep are successfully fattened entirely in the open by the thousands, especially in those regions where the fall of rain and snow is small, cows in milk do better when protected in winter, particularly in New York State with its humid climate.

In order to understand the construction of a barn for the purpose of maintaining a proper temperature, it is necessary to get certain conceptions concerning heat and cold. Every one is familiar with the process of cold storage by refrigeration and understands that for successful cold storage either by ice or other artificial means, it is necessary to insulate thoroughly the room which is to be kept cold. It is important to understand that if a room and its contents are cooled say to 20° F., and it were possible to insulate the room that there would be no exchange of temperature with its surroundings, the temperature would remain constant forever. The only way that the room can rise in temperature is by penetration of heat from the exterior. In the same way, if a room and its contents are heated to a temperature of 80° F., it can cool off only by the heat of the room escaping into the surrounding spaces. Further, if the outside temperature is at 50° F., the units of heat involved in lowering the temperature to 20° F., or raising it to 80° F., would be the same.

The importance of thorough insulation in maintaining the temperature of the room is therefore obvious and cannot be too thoroughly insisted on for this purpose, although, as will be shown directly, the necessity of pure dry air makes complete insulation impossible even were it mechanically possible. The exchange of temperatures between the rooms of a building and the surrounding air may be brought about in two general ways: (1) By the conduction of the heat through the surrounding walls, and (2) by an actual exchange of air between the exterior and the interior. Walls should be made of such materials and so constructed that they will both prevent the conduction of heat and also the free ingress and egress of air. Glass is a good illustration of a substance which will conduct heat rather rapidly but will entirely prevent the passage of air. Therefore, an excess of glass is objectionable because it allows the too rapid cooling of the room at night.

Since still air is a poor conductor of heat, dead air spaces are extremely desirable. This is illustrated on railway trains when double windows do not frost over as single windows do in cold weather. It is important, in order to secure the proper result, that these air spaces should be perfectly tight, so that there is no exchange of air between the spaces and the surroundings. This is perhaps the greatest fault in the construction of dead air spaces. In Farmers' Reading-Course Bulletin No. 23, Mr. Cook discussed a method of securing insulation which he has found satisfactory. Perhaps in all structures, but particularly in barns, the exchange of air, rather than conduction, is the most important reason for the change of temperature.

Even when no regular system of ventilation exists, the air sifts in around doors and window casings and through cracks and crevices often

little noticed except when extremely cold weather causes the incoming air to condense the moisture of the stable into frost where it enters. Every one has noticed the beneficial influence of a heavy snowfall in maintaining the temperature of house or barn, because it fills the cracks and crevices on window sills and about doors.

Since the exchange of air is concerned with the subject of ventilation, its effect in maintaining temperature will be discussed in connection with the next topic.

III. To secure pure air, with proper degree of humidity

While the composition of air is not constant, it may be stated approximately as follows: nitrogen, 78.49 per cent; oxygen, 20.63 per cent; water, 0.84 per cent; carbonic acid gas, 0.04 per cent. Usually there are also present slight traces of ammonia and other substances. If the weight of a given volume of air at freezing point under one atmosphere of pressure is one pound, an equal volume of nitrogen will weigh 0.9714 lb.; of oxygen, 1.1057 lb.; watery vapor, 0.6225 lb.; and carbonic acid gas, 1.5291 lb. It may be asked why these gases do not settle with the heaviest gas at the bottom and the lightest at the top. The reply is that it is the nature of gases when brought together to mix rapidly into a homogeneous mass.

It is said that a horse draws into his lungs 45 cubic feet of air per hour and exhales 6.5 cubic feet of carbonic acid. It does not follow from this fact that 45 feet of air per hour is sufficient for a horse, because the large amount of carbonic acid in the exhaled air vitiates a considerable amount of the surrounding air.

Air containing an excess of carbonic acid gas, is considered unfit to breathe, not so much because of any injury done by the carbonic acid gas, as because the carbonic acid gas is considered a measure of injurious impurities of an organic nature, and because it may replace (or take the place of) some of the life-giving oxygen. In fact, except in so far as the carbonic acid gas serves to dilute the oxygen, it is believed to be entirely harmless.

Animals not only exhale carbonic acid gas but they also excrete through the lungs and skin a considerable amount of water in the form of vapor. Two well known facts are pertinent in this connection: (1) as

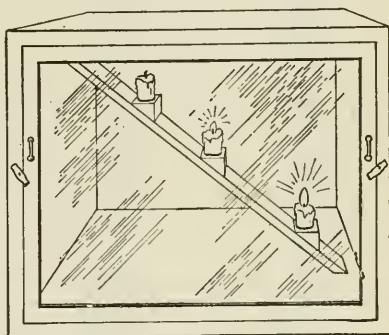


FIG. 322.—Why has the upper light gone out first in this tight box? In a few moments all will go out.

any body of air becomes colder its ability to hold water is decreased. It comes nearer the point of saturation. In popular language, we say the air has become damper; in more technical but not more scientific language, we say its relative humidity is higher. (2) An atmosphere whose relative humidity is high is more difficult to withstand in winter and less healthful in summer.

A damp building is not a healthful building. The writer was recently informed by a feeder of wide experience that he had fed cattle both in humid and semi-arid sections of the United States under similar conditions of temperature and that he secured better results from food consumed in the semi-arid sections.

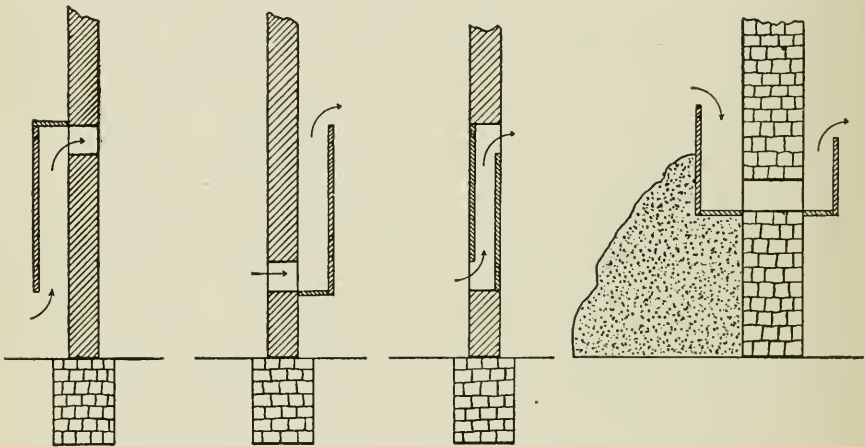


FIG. 323.—Method of admitting air into stable. One on right shows method for basement. Which one of other three is best?

When animals expel from their lungs and skin the warm vapor into the colder room, if the warm vapor is not allowed to escape it is only a question of time until the colder air will cause the vapor to condense into water. This will begin at the coldest places, which are usually the sides of the building, and thus in rooms that are improperly ventilated in cold weather the sides will be seen to be dripping with moisture. The more the vapor which comes from the animals is cooled before it is allowed to escape, the greater the condensation of moisture. Incidentally, it may be pointed out that the more the room is cooled by conduction, the more will be the condensation of moisture; and the more it is cooled by an actual exchange of air with the outside (which amounts to ventilation) the less the moisture in the room.

The warm vapor and the expelled air being warmer, rise at once to the top of the room. If an opening is made in or near the ceiling, the vitiated air and the vapor will escape. Assuming a still atmosphere on the outside, the rapidity will depend, among other things, on the size of the opening, the readiness with which other air can enter to take its place, and the difference in temperatures between the inside air and the outside air. The greater the rapidity with which the exchange of air takes place, the drier and purer the air will be; but when colder outside, the greater the exchange of air the colder the room will become.

Since in barns without artificial heat the only method of warming the room is from the heat of the animal bodies, it becomes a matter of balance between too much moisture and bad air on the one hand and too much cold on the other. The heat will be retained the longest and hence the temperature maintained the best by taking in the cold air near the top and taking out the less warm air near the bottom. This gives the cold air opportunity to become mixed with the warmest air and takes out the warmer after it has given up the largest practical amount of heat to the incoming cold air. This, however, is the least effective method so far as obtaining pure dry air is concerned. Indeed, frequently with this method, especially when the opening for the entrance and escape of air is inadequate, serious difficulty on account of dampness is encountered. If the driest and purest air is desired, allow the warm air and vapor to escape at the ceiling. The best method of securing fresh air in any case is to allow it to enter at the sides above the heads of the animals in such a way as not to cause draft on the animals and in order that it may absorb as much heat as practicable from the warmer air before descending into the room.

There remains one factor in ventilation yet to be mentioned. The wind is in many respects the most important factor in determining the purity of the air of a building or, in many cases, of a whole city or state. In the heating and ventilation of public buildings, it is not uncommon to force a given amount of tempered air per second or hour into the room, in which case a similar amount must escape; or, in other cases, a given amount of air is exhausted from the room, when an equal amount must enter. It is much like putting a rope through a knot hole. It may be pushed through or it may be pulled through. The result is the same. The point to note is that this exchange of air takes place without any reference to the relative temperature or density of the air. It takes place because it is forced to do so.

A wind passing through an opening two feet square at the rate of ten miles an hour will fill a stable 30x50x10 feet with fresh air in less

than five minutes. It would doubtless be necessary for the wind to blow more than ten miles an hour for it to enter an opening at that rate, but the principle is not different from air forced into the room by means of an electric fan.

Under these conditions the air passes out because it is forced to do so. The resistance will be slightly greater if the air is taken out nearer the bottom of the room than at the ceiling, assuming that there is no other force acting on the outlet. With a pressure equal to wind blowing ten miles an hour, the difference in resistance due to the position of the opening would probably not materially affect the results.

The wind, however, may also be made use of in exhausting the air from the building. If an outlet flue extends above the roof so that the air may blow freely across the top of it, the wind will act as an aspirator and pull the air up the flue. A familiar example of the aspirator is the hand sprayer used in spraying insecticides and fungicides. It is important that the wind blow freely directly across the top of the flue. Care should be taken so to construct the cover to the flue that the wind may cross freely from every direction. The outlet flues should not empty into the old-fashioned slatted cupola because the cupola offers an obstruction to the free passage of air across the top of the flue. It may be possible, however, to bring the outlet of the flues into a group and combine them into a cupola which will be effective. The important thing is to allow the wind to blow freely from all directions across the top of the flues.

Since in the temperate climates all conditions of weather must be dealt with, it is a matter of prudence to be able to modify the rate at which the exchange of air may take place. To those who contemplate putting in the so-called King system of ventilation (too well known to need to be described here), the writer would suggest provision for an ample exchange of air, the

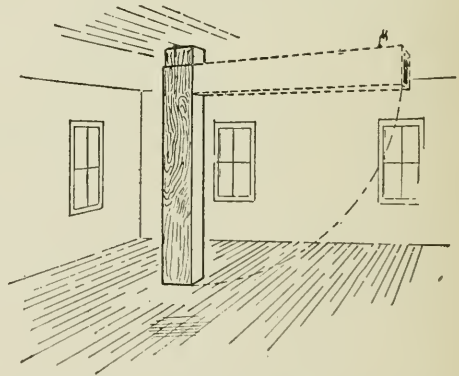


FIG. 324. —Outlet for air. This tube may be let down on cold nights and hooked up during daytime and during warm weather.

amount of which may be modified at will and also that an outlet be placed both near the floor and also near the ceiling in order that the rate of

ventilation may be modified to suit different conditions of weather. When dampers are used to cover these openings, allowance should be made therefor. In many barns the openings are so reduced by the metal of the dampers as to make them entirely inadequate.

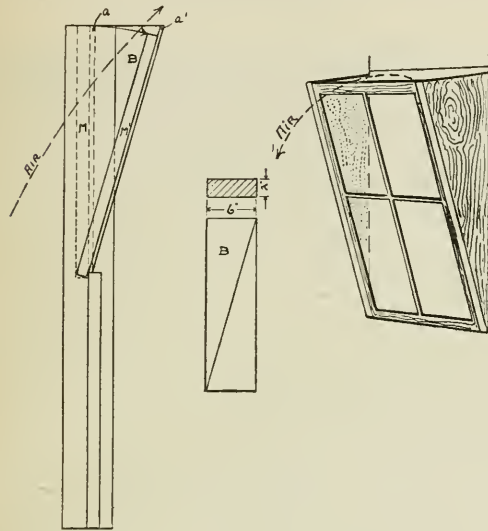


FIG. 325.—Windows arranged to allow air to enter with least amount of draft. Drawings on the left represent old windows modified by nailing on the 2x6 as indicated.

There is a popular fallacy that the opening for the outlet of vitiated air should be at the bottom, on the theory that the carbonic acid gas is heavier than the air and sinks to the floor. While it is true that cold carbonic acid gas in a perfectly still atmosphere will fall on account of its greater specific gravity as compared with air of the same temperature, it is likewise true that the carbonic acid gas exhaled from animals or produced by a lighted candle promptly goes to the top of the room. This is easily demonstrated, but any one who has occupied the gallery

of an audience room hardly needs to be told where the vitiated air is to be found.

It is obvious from what has been said that the effectiveness of any system of ventilation when applied to a cow stable will depend largely on the rate at which the wind is blowing and on the exposure of the building to the wind. It is desirable that the intakes for air should have a vertical rather than a horizontal direction in order that advantage may be taken of the force of the wind; and since the wind may blow from all directions it is desirable to have intakes on all sides of the building. In general, it may be said that a number of small intakes and few large outlets will give the best results.

The most that can be hoped to accomplish in ventilating a stable is to take the air out rapidly enough to maintain a dry atmosphere and not so fast as to lower the temperature unduly. When the wind is blowing and the weather cold, the best results will be secured by taking the air out near the bottom of the room; but when the atmosphere is warm and

still, better results will be secured by taking the air out at the ceiling, which can be done through the same flues by having two openings.

When animals are stabled in mild weather, probably no better results can be secured than by allowing the wind to pass freely through the stable



FIG. 327.—A convenient and sanitary arrangement for cow stables. Position of floor in feed alley not inconvenient and saves one foot in height of outside walls. All woodwork has been planed and treated with two coats of boiled linseed oil. See also Fig. 326.

above the animals by means of open windows adjusted as shown in Fig. 325. The passage of the air through the top of the room drives out the most vitiated air directly and aspirates out that from below in the way

already explained. When the wind blows too violently, the windows on the windward side may be closed, and those on the leeward side left open.

There is always a suction on the leeward side of the building, tending to draw the air out of the room. -

The attentive reader will have observed that there are objections to all plans of ventilation under certain conditions. Therefore, it is a matter of prudence to have different means of ventilation at hand. It is very easy to become visionary on this matter of ventilation. Thus far, faulty construction of buildings has saved both man and beast from much injury due to advocacy of theories of ventilation.

II. To secure light

Sunlight is recognized to be one of the best as well as the cheapest agents for the destruction of most forms of bacterial life. It may be well to caution the reader that intense sunlight may be injurious to higher forms of life as well as to lower forms, and that there may be times when an animal is best protected from the direct rays of the sun, entirely aside from heat produced. Four square feet of glass for each cow or horse has been suggested as a practical guide in stable construction. Within reasonable limits, the greater the horizontal extent of glass and the less the vertical extent the better. In horse and cow stables the window sill may be six feet from the floor. The exact location, however, will depend on the interior arrangement. The object should be to have the sunlight reach the largest possible part of the room at some period of the day, and especially those parts where animals stand. It is well for anyone planning a barn to determine by experiment the area that will be covered by sunlight passing through a given opening in a given position.

The larger the amount of glass in a building the warmer it will be on days when the sun shines, but the colder it will be at night on account of the greater radiation of heat from the glass than from the remainder of the wall. In a recently constructed stable in this State provision has been made for double windows. In cold climates this is a great protection from cold, for reasons already explained.

V. To secure cleanliness

There can probably be no argument as to the desirability of cleanliness in barns of all sorts, and particularly when a product as delicate as milk is produced and which enters more or less directly into human con-

sumption. There are, however, all degrees of cleanliness. Some experiments on this subject were given by Professor Pearson in *Farmers Wives' Reading-Course Bulletin No. 19*.

There are three things in the construction of a building which conduce to cleanliness: (1) Have as few interior fittings as possible; (2) have all surfaces as smooth as possible; (3) have as few horizontal surfaces as possible.

When lumber is used it should be planed. If boards are used for interior finish, they should be vertical instead of horizontal. They should never be beaded. Two coats of boiled linseed oil will cost about one-half as much as paint and will stand a large amount of washing. There is at present a tendency to use cement plaster made from one part of cement to two of sharp sand, in finishing side walls of stables. In this case boards of poorer quality are first put on and these are furred, lathed and plastered. The advantage urged for this method is that it gives an additional dead-air space and hence additional warmth, and gives a smooth surface that can be easily covered with whitewash.

Whenever projections are necessary, such as window sills, they should be as slight as may be and, when possible, they should be rounding. Quarter-round can often be used to advantage in stable construction.

Cement floors and mangers are also conducive to cleanliness. It has been demonstrated that in stables properly constructed and with a reasonable quantity of bedding, satisfactory results will be secured with all classes of domestic animals. The writer has used both wood and cement platform for milch cows and, while he believes the wooden platforms might be better, if bedding was limited, cement platforms do not require more bedding than cows should receive for sanitary reasons.

The writer has used a perfectly level platform of cement with satisfactory results. The remainder of a cement floor should have a slant of one inch in every five feet, for convenience of cleaning. The same slant in the gutter gives good results.

VI. To avoid the presence of vermin

If there is no place where rats and mice can hide, there will be no difficulty from them. Unfortunately this cannot be fully accomplished because they may hide among ear-corn, corn-fodder, hay or straw. However, if pains are taken to prevent hiding places in the structure of the

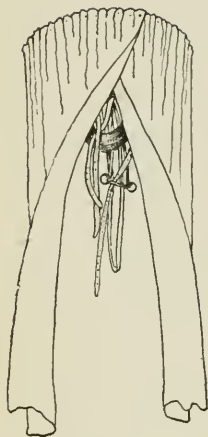


FIG. 328.—*Pieces of muslin tacked on half circle to keep harness out of the dust.*

building or under the ground floor, comparatively little trouble will be experienced. If the ground floor is made of plank, rats can be entirely prevented from working underneath by laying the floor on twelve inches of cinders. If cinders are not available, doubtless twelve inches of crushed stone would answer. Cement floors, however, will entirely prevent them. When dead-air spaces are constructed in the walls, the greatest care should be taken to see that there is no possible opening into these spaces nor any place where rats and mice can hide while making an opening into the space. The writer very much prefers exposed joists to ceilings between which and the floor above rats and mice may find lodgment. Grain bins should never have hollow walls where rats or mice can find hiding place. If grain bins are built so that there is open space all around them, and partitions are made of single

boards, rats and mice will never molest them. This remark does not apply to corn-cribs, since the ears of corn offer opportunity for hiding places. Corn-cribs should be built so that dogs and cats can have free access beneath the floor.

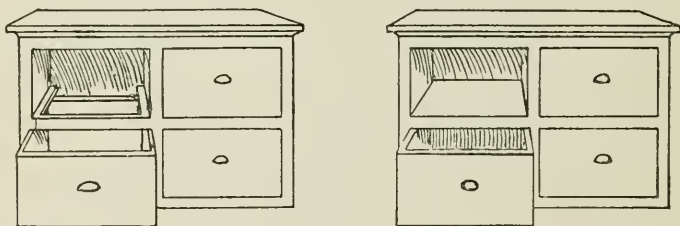


FIG. 329.—*In the chest on the left rats and mice pass readily from one drawer to the other. In the one on the right this is impossible on account of solid partition between drawers.*

In case it is necessary to have a chest of drawers in any part of the barn, and particularly if the chests are to be used for seeds of any sort, the chest should be so constructed that should a rat or mouse gain access to any single drawer, he could not escape to other drawers in the same chest. See Fig. 329.



FIG. 330.—Covered barnyard recently built by Clayton Taylor, Lawton Station, N. Y. Looking from the main barn.



FIG. 331.—Covered barnyard recently built by Clayton Taylor, Lawton Station, N. Y. Looking toward main barn.

VII. To preserve manure

Probably the least waste in manure is experienced when the manure is spread on the field as rapidly as a wagon load or sleigh load accumulates. This in many places is good farm practice and is to be advised when practicable, but, unfortunately, for climatic and other reasons, this practice cannot always be followed. The next best arrangement is a shed to protect the manure pile from the leaching of the rains. If horse manure is placed alone in such a shed the fermentation will be sufficient to cause considerable waste of the nitrogen, unless the manure is watered. This may be prevented, however, by mixing with cow manure. The writer has had some years' experience with such a shed. When the manure from



FIG. 332.—Covered barnyard recently built by Clayton Taylor, Lawton Station, N. Y. Twelve-foot post on one side and eight-foot post on the other side.

about a dozen horses and 50 head of cattle was mixed together, while bedding was used rather freely, the tendency was for the pile to be too wet rather than too dry, and artificial watering was never necessary. Something will depend, of course, on the amount of liquid manure collected on the one hand, and the extent of the use of straw or other absorbent on the other hand.

A shed open to the east or south may answer for shelter for animals during the day. The more the manure is tramped the better it will keep.

Hogs may be permitted to work it over to its ultimate advantage. A shed 30 x 80 feet has been found to answer for the storage of the manure from 50 head of cattle and 12 head of horses during the winter season.

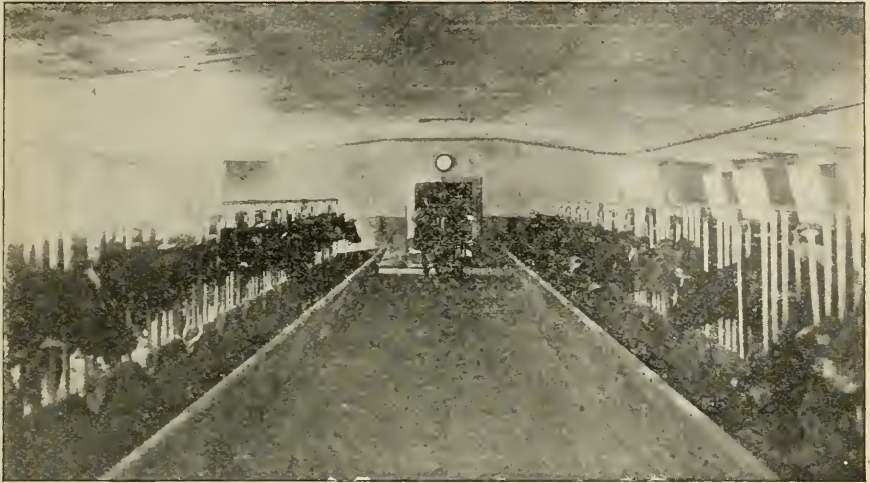


FIG. 333.—Stable recently built by J. Pierrepont Morgan, Highland Falls, N. Y. Floor, mangers, walls and ceiling all of cement. See also Figs. 334 and 335.

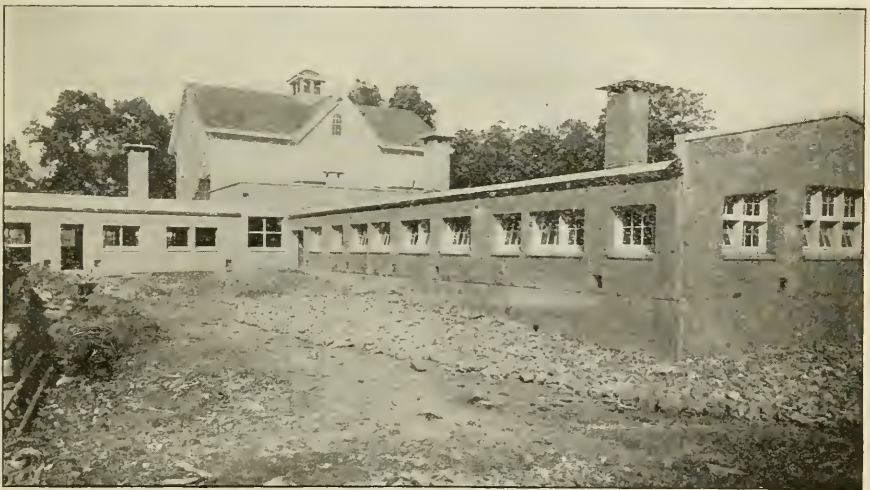


FIG. 334.—Cement stable recently built by J. Pierrepont Morgan, Highland Falls, N. Y. Stable has King system of ventilation and also windows arranged as shown in Fig. 325. See also Figs. 333 and 335.

Sometimes a space in the basement of a barn is enclosed and used both for the storage of manure and as a place for the cattle to remain during the day and sometimes even at night. Such an arrangement is

excellent so far as preserving the manure is concerned, but is not the most sanitary for the cattle. It may be stated that Cornell University has such a covered barnyard, which is 40 x 60 feet, and it accommodates about thirty head of cattle. Into this covered area the manure from eight to ten horses is dropped from above and the manure from the cattle is also placed with a minimum amount of bedding, so that the conditions are by no means ideal. Professor Pearson, however, found by appropriate test less bacteria in this room than in a milk-cooling room especially constructed for the purpose of keeping the bacteria out of the milk. This test, of course, did not show the influence from the dirt which might cling to the animals, but did show that the atmosphere was comparatively pure so far as the bacteria were concerned. The explanation probably is that the mass of manure being moist tended to keep down the dust in the covered barnyard, while the swinging doors to the milk room tended to keep the dust in motion.

In some instances, animals are given single box stalls and the voidings remain there until convenient to remove, which may be several months. The experimental data which has been collected shows clearly that the amount of nitrogen, phosphorus and potassium, as well as the total organic matter preserved, is as great if not greater than by any other method.

This is not so unsanitary as may seem at first sight. If bedding is used with reasonable freedom, better results can be secured than is frequently done in ordinary stalls. The greatest perfection in sanitary conditions will not be secured, however.

An objection to the use of box stalls is that more space per animal is required and more labor is needed in feeding, and, if milch cows, in milking. More bedding will also be required, which on many eastern farms is at present a matter of prime importance.

VIII. To secure the health and comfort of animals

There has been much controversy over the effect of keeping animals tied in stalls throughout the winter season. Some have preferred to turn the cows out of doors during the day rather than have them constantly confined, while others have used the covered barnyard. Still others have had no evil results from keeping animals constantly tied throughout the winter season.

It may be taken as a general rule that when any animal is about to become a mother, she should have opportunity to get a reasonable amount of exercise and freedom of movement. The difference of opinion on the

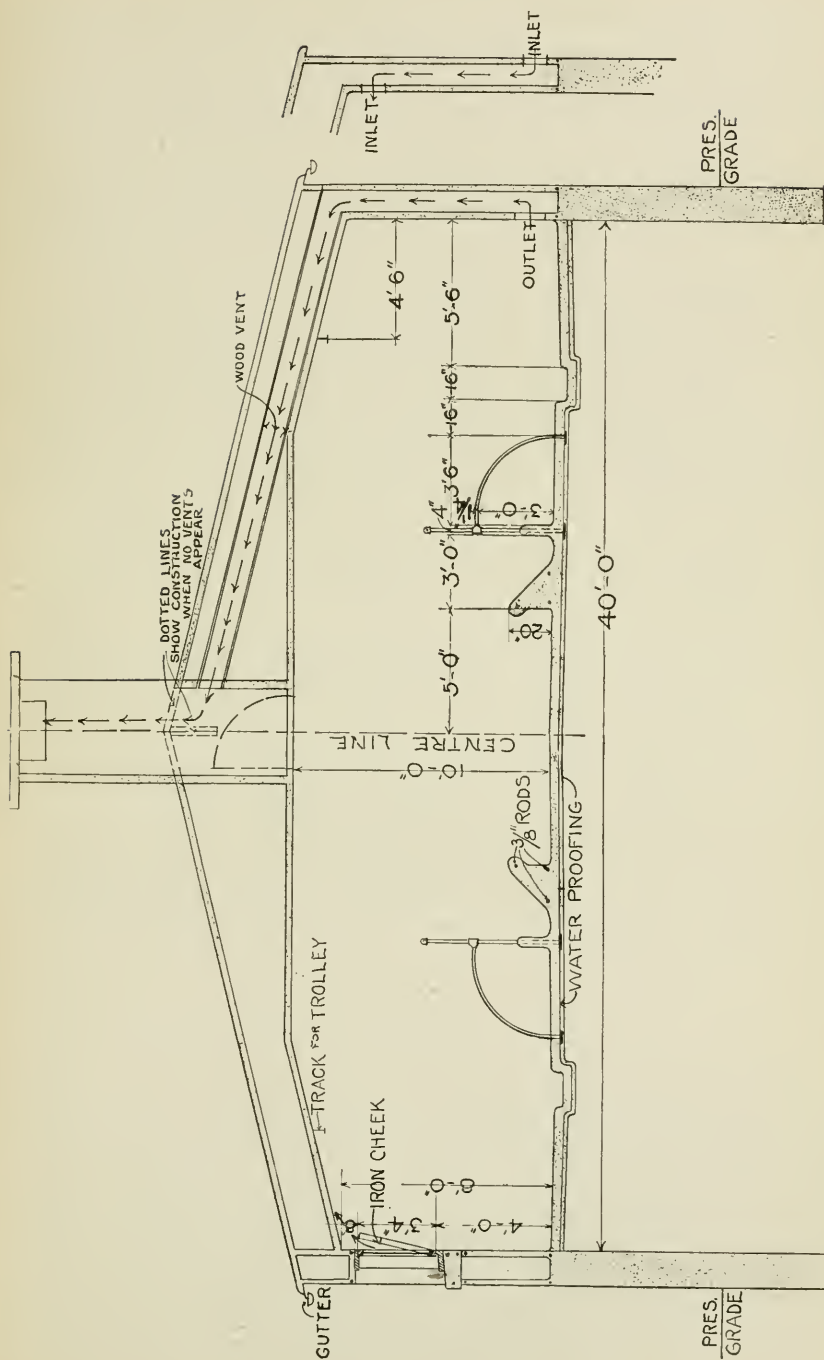


FIG. 335.—Detail of J. P. Morgan's stable showing double method of inlet and outlet of air. See also Figs. 333 and 334.

subject of the winter housing of cattle may, therefore, be frequently traced to difference in practice or management. When cows calve in the fall, they may be kept confined during the winter with comparatively little danger, while animals that are bred to calve in the spring would be better off with greater freedom of movement.

The consensus of opinion among men who keep animals especially for breeding purposes, is in favor of the largest practical freedom of movement; while among those who keep cattle merely for milk or for fattening think this of less importance.

In the case of cattle, the great plague in Northern United States is tuberculosis. While this disease is the result of a specific germ, confinement in buildings is a prime factor in its spread. Cattle reared entirely out of doors rarely contract this disease. It has frequently been noticed that when an animal having the disease is brought into a herd the animals standing on each side are the next to contract the disease. These facts suggest that in addition to the elimination of all diseased animals, care should be taken to secure, as far as may be, pure air and plenty of sunlight, the least possible place for the lodgment of germs, and means of ready disinfection.

In the case of swine, hog cholera is the plague, which, in many parts of the United States, makes the single or duplicate hog pen, which can be moved to new ground when necessary, the best arrangement for housing swine. Isolation of the well from the sick hogs, placing the well ones on fresh ground, is the best known means of combatting the disease, although even this is frequently, perhaps usually, unsuccessful.

When permanent hog pens are constructed they should be made of brick or concrete walls and partitions, and with concrete or cement floors and troughs, so that they may be thoroughly disinfected when necessary. Such a hog pen is shown in Farmers' Reading-Course Bulletin No. 23.

IX. To secure economy in feeding and watering

One of the reasons for tying animals, and especially horses and milch cows, is to provide varying amounts of feed for the needs of the different individuals. In the case of cattle, individual compartments are not necessary in order to secure this result in a practical manner, although it may be necessary for experimental purposes. The continuous trough in which hay, silage, roots and grain may be fed answers every purpose for cows tied by stanchions or similar methods. This trough may be wood or cement. The writer has found the plan shown in Fig. 326 to work well for dairy cows. This plan practically does away with one foot in the

height of the wall, and the extra height of floor is no inconvenience in feeding.

In general the freshest air in a stable is toward the outer walls. By standing animals toward the walls, they have opportunity to breathe the freshest air and do not breathe into the faces of the row opposite. This enables the cleaning out of the gutters on both sides at one time. The sunlight strikes the feed troughs and thus helps to disinfect them. On the other hand, the sunlight shines in the eyes of the animals, which may not be desirable; while if they face toward the center the sunlight bathes the backs of the animals and helps to disinfect the gutters. The feeding is done rather more conveniently when animals face the center. It must be remembered that the weight of manure removed is greater than the weight of food consumed. Economy in handling manure is probably more important than that of handling the food. It must, however, be admitted that the reasons for standing the animals either way are so evenly balanced as to permit one to follow his personal preference.

Practice, and to some extent experiment, have demonstrated that watering cattle, sheep and swine twice, and horses three times a day is sufficient. Experiments have clearly shown that water at 50° to 60° F. is as desirable as at any higher temperature. The idea sometimes expressed that, since it is necessary to raise the water to the temperature of the animal body it is cheaper to do it with coal than by the corn the animal eats, is erroneous, because, when an animal drinks the cool water, some of the heat which otherwise would have passed from the body will be used in raising the temperature of the water to the body temperature. It is this delicacy of mechanism which enables the animal in health to maintain an almost constant temperature.

When water is placed in a room it will absorb the gases from the atmosphere. In addition to this, it is extremely difficult to prevent forage and dust and dirt from finding lodgment in watering devices. Any watering device to be used in the stable should be such that it may be completely emptied and readily cleaned after cattle have been watered. When cattle are turned into the feed lot, open shed or covered barnyard, a water tank is to be preferred to most watering devices found in stables.

When it is necessary to have a watering trough at a temperature below freezing the best results will be secured when the trough or tank is relatively large and only a small part is exposed when cattle are drinking. All watering troughs should be provided with a waste pipe. The opening to this waste should be closed with a hollow plug, the height of which is less than the height of the trough. This will prevent the trough from overflowing, an extremely unpleasant procedure in the water.

X. To secure economy of space

The usual question asked by persons seeking advice about a barn is something like this: "I intend to build a barn 30 x 50 with a basement and eighteen-foot posts above. In this I intend to provide for twenty cows and four horses, ten head of young cattle, hay, grain and tools for 100-acre farm. How can I best divide up the space?"

The question should rather be as follows: I have twenty cows, four horses, ten head of young cattle, hay, grain and tools for 100-acre farm, for which I must provide. What size, shape of building and manner of construction would you suggest?

In other words, the proper method is to determine one's requirements and then seek to build the most economical structure which will provide them. Architects sometimes cut up pieces of cardboard of proper scale, say one-fourth inch to the foot, representing each of the rooms required in a building, and these they shift about until the best arrangement of space has been determined.

The amount of space to be allotted to animals should be such as is required for the bodily comfort of the animals and for the convenience and safety of the attendants. Theoretically the ventilation depends rather more on the cubic feet of air furnished than on the cubic feet of space. Large space presents drafts, gives greater opportunity for exchange of air (which always takes place in barns), and gives more opportunity for wind ventilation. With good insulation and proper provision for the intake and outgo of air greater regularity will be secured by small cubic space, because it is easier for the animals to warm the stable and thus keep a greater difference between the inside and outside air.

The floor space allotted to each horse may vary from 90 to 120 square feet. For horses the standard length of stall from rear of manger to the drop is six feet six inches. The width of manger from outside to outside may be three feet. In nature, horses eat from the ground. Mangers should not be too high nor too large. Three feet high next the stall is sufficient, and, if stall faces an alley, four feet high on the side next this alley. The width of stalls may vary from five to six feet.

Cattle may be housed with about one-half the space allotted to horses, or from forty-five to sixty square feet. The standard length of platform for cows is five feet which may be varied slightly, depending on the method of tying and the size of the animals. The tendency is to get the platform too long. The width of cow stall or space may vary from three to four feet. The gutter should not be more than eight inches deep at its deepest point, and may be twelve to sixteen inches wide. It is desirable to have it of suitable width for a flat stable shovel. The writer prefers the runway behind the cattle to be of same height as plat-

form in order that the cattle do not have to step up or down in passing over the gutter. When animals stand with heads toward the wall the driveway between gutters should be nine feet, although eight feet will answer, in case of cattle and from twelve to fifteen feet in case of horses. The space between the feed manger and the wall should be from five to six feet. When cattle face toward the center the distance from gutter to wall should be six feet; with horses eight feet. Like the amount of cubic space, the height will depend somewhat on climatic conditions. The higher the stable the more readily the air may pass through above the animals without causing draft. On the other hand, since the warm air passes to the top of the room, the position occupied by the animal in a

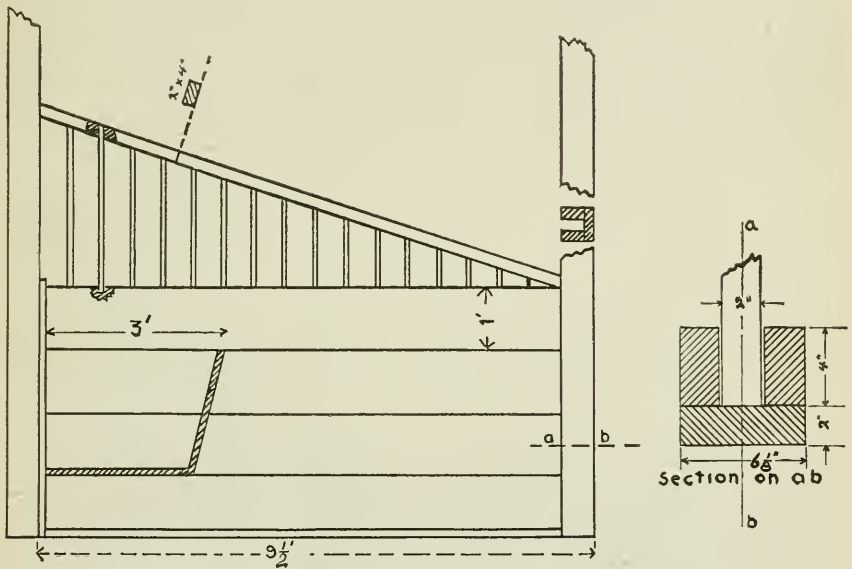


FIG. 336.—A simple, cheap and satisfactory partition for horse stalls.

high room is relatively colder than in a low room. The height of stables in temperate climates may properly vary from eight to twelve feet in the clear; probably in most cases from nine to ten feet will give the best average results.

Box stalls for horses may vary from twelve by twelve to eight by twelve. A box stall eight by twelve is to be preferred to one ten by ten. For cows eight by eight is permissible, but eight by ten is better. Pens for swine may vary from five by eight to eight by ten. A pen that is seven by nine is generally satisfactory.

In making an estimate of the space required to house properly the various farm products, average maximum estimates should be used. We

should expect to get better results than the averages shown by statistics. We can hardly expect to provide for unusual yields, but future developments and increased yields from improved methods should be considered. The following may be taken as a guide in estimating space: maize, fifty bushels per acre; wheat, twenty-five bushels; oats, forty

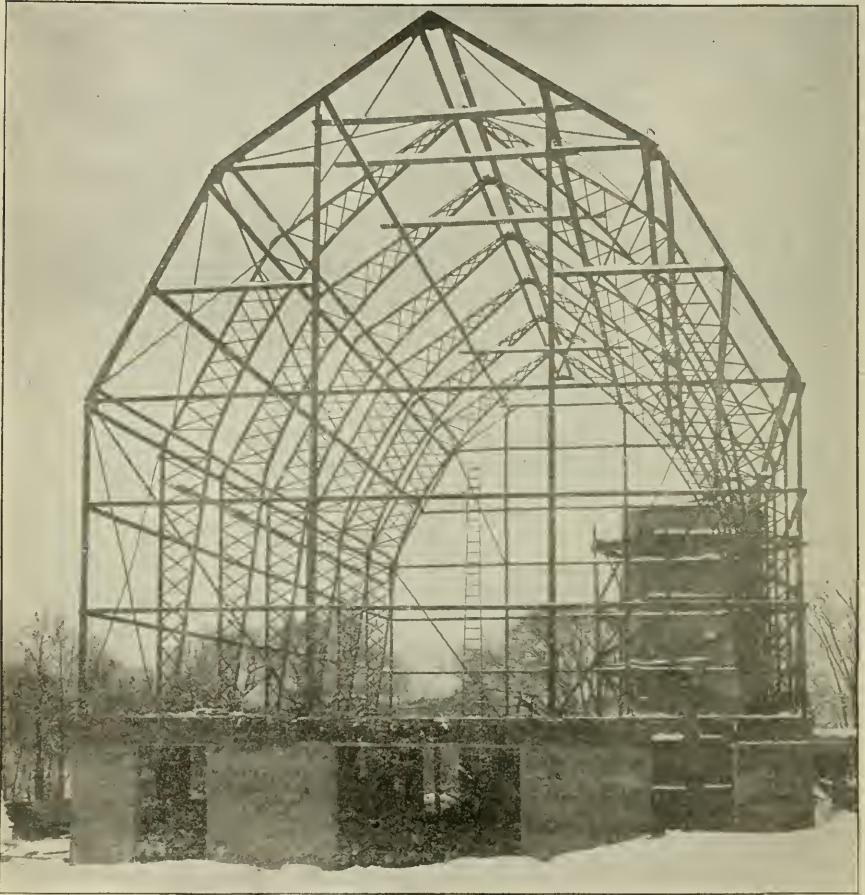


FIG. 337.—*Steel frame barn being built by F. E. Dawley, Fayetteville, N. Y. Probably the first of its kind in the United States.*

bushels; hay, two tons; silage, twelve tons per acre. A bushel of small grain occupies about 1.25 cubic feet; that of ear corn 2.5 cubic feet; a ton of hay 500 cubic feet; a ton of silage about 60 cubic feet. For each pound of wheat or oats, two pounds may be allowed for straw, although these relations vary greatly with season, soil and varieties. When planted

for grain rather than for silage, there is rather less than one pound of maize stover for each pound of shelled corn produced.

XI. To secure economy of labor

Much ingenuity may be displayed both in arranging labor-saving devices and in so arranging the various rooms or buildings as to make the least work.

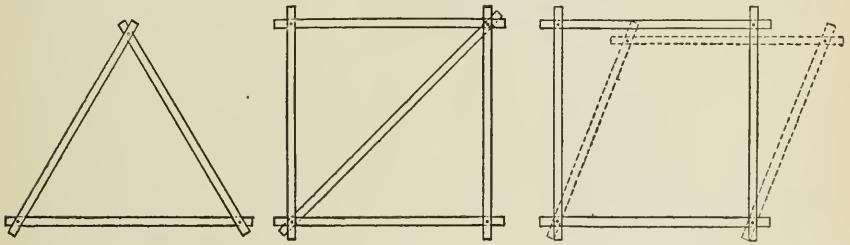


FIG. 338.—The three sides of a triangle properly fastened together form a truss.

There are two considerations which may materially affect the labor: (1) the compactness of the building or buildings; and (2) the extent to which the working parts of the barn are placed on a single floor.

If one studies attentively the different types of barns in different

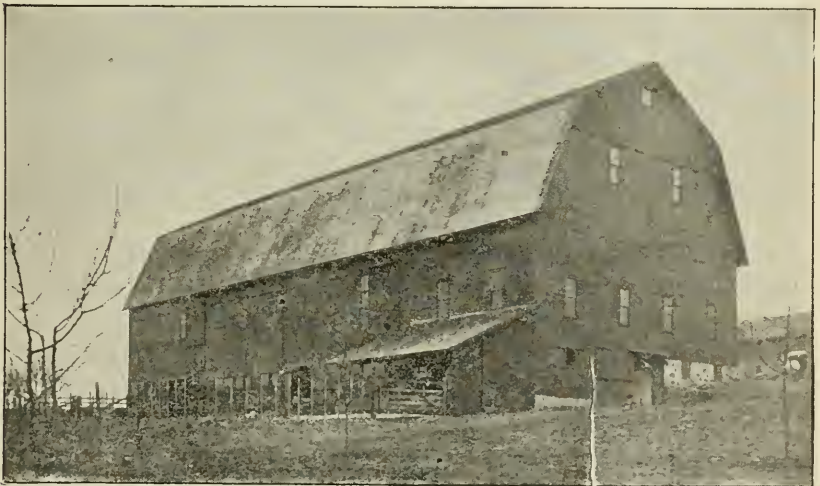


FIG. 339.—Barn of late John L. Buell, Holcomb, N. Y. Length 120 feet; width 50 feet; height 50 feet. For method construction of see Figs. 340 and 341.

countries or different parts of the same country, he must be struck by the similarity of type in the same neighborhood and the difference in type in different neighborhoods. To some extent this may be a matter

of imitation, but, on the whole, it usually represents a more or less unconscious adaptation to the climatic conditions and to the methods of farming.

In the New England States the barns are not only all connected but they are also usually connected with the dwelling. In Holland the connection is even more intimate. On the other hand, in the central and southern United States it is common to build a number of unattached outbuildings, while in England buildings are not only detached but are not infrequently distributed about the estate.

The factors entering into this problem are labor, temperature and ventilation. In many places the labor of caring for live-stock is only a small part of the total labor of the farm. In such cases, the arrangement of buildings so as to reduce the general farm labor, particularly in the busy season, will be a most important consideration. In mildly temperate climates when barns are built primarily to keep animals and objects dry, rather than for protection against great cold, large dependence must be placed on wind as a means of ventilation. In such cases the location and arrangement of the buildings is a matter of some importance.

The best situation for the barn is east or south of the dwelling. The barnyards are preferably situated either south or east of the barn. This then brings the yards farthest from the house, the least subject to observation from the house, and, as the prevailing winds of the United States are from the south and west, it is the most sanitary condition so far as the farm dwelling is concerned. The next least objectionable position would be north of the dwelling, with the yards east of the barns. The ideal location for barns is east of dwelling with the yards on the south and east. In locating a barn particular attention should be paid to the possibility of proper drainage, in order that both buildings and yards may be as dry as possible.

In the climate of northeastern United States, it is desirable that the yards and buildings should be protected from the winter winds, those from the northwest, perhaps, being the most objectionable. On the other hand, it should be borne in mind that the most difficult thing to obtain in farm buildings is ventilation, and that wind is our most effective agent in obtaining it. If a series of buildings are to be built they should be so arranged as not to interfere with the proper circulation of wind about these buildings. For this reason, the hollow square may be objectionable. While a row of buildings side by side would be less objectionable, a row placed end to end but not in a straight line would be least objectionable.

The introduction of the horse-fork and the hay-carrier and the adoption of the silo have led to radical departures in form of buildings and method of construction. It is no longer necessary to drive into the

barn to unload hay, although it may be desirable where the custom of putting grain in barn before threshing still prevails. Expense in construction may be saved in some instances by having the hay mows rest on the ground. Long, narrow, high mows save labor and economize space. It is much easier to mow away in a space thirty by eighty feet than in one forty by sixty. This difference in form will save one man in the mow.

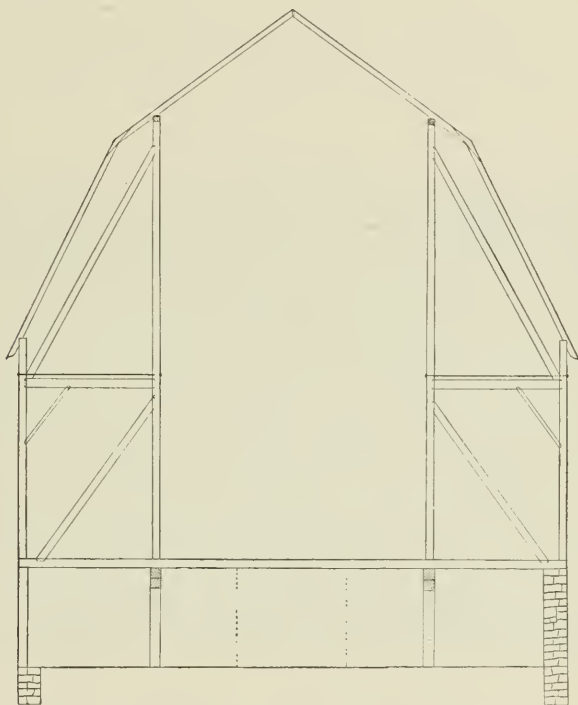


FIG. 340.—*Method of framing barn. Notice rafters overhanging plate one-fourth their length. See Figs. 339 and 341.*

XII and XIII. To secure economy of construction, strength and durability

These items involve the choice of materials. The materials used may be wood, stone, brick, concrete, or iron. The relative cost of material will depend on the locality, and their economical use will depend somewhat on the price of labor. Choice of material will also depend on the strength needed and durability desired. It is sometimes wise economy to build for greater durability not only because of the greater period of service but

because of less expenditure required for maintenance. On the other hand, there may come a point in the cost of construction when the interest on the increased investment will more than pay for maintenance.

Stone has long been used for basement work and when available is in many respects the best for such purpose. Objection is often found to basement walls because of the condensation of moisture on them. This is because the inner surface is cooled by conduction and because the stone is a good conductor of heat. The room within stone walls is less likely, however, to be cooled by an actual change of air than in the ordinary wooden construction, particularly when it is warm above ground so that the room contains relatively warm moist air with relatively cold surface walls. This condensation of moisture on the walls is not in itself harmful but rather beneficial as abstracting moisture from the air. Moist walls, however, are a symptom or indication of an improper condition of the air of the room. No benefit is secured by changing the character of the wall unless the character of the contained air is thereby changed.

In the building of the superstructure, wood is still the chief material used, although a barn has recently been constructed in this State whose frame work is of steel. (Fig. 337.)

When timber and labor were cheap, barns were built with heavy frames, dependence being placed on the direct support of the post. Such barns are thoroughly strong and rigid, but are now found expensive on account of the price of lumber and labor, and on account of the posts the space cannot always be so conveniently or economically arranged. This has led to the construction of so-called plank barns.

Two principles have been taken advantage of in the construction of plank barns:

(1) That the carrying strength of two beams are not directly proportional to their width but are proportional to the square of their depths. The carrying strength of a 4×4 is to a 2×8 as 20 is to 66. Great additional carrying strength for the amount of material used is therefore secured by using plank on edge rather than square timber. It will be observed, however, that the lateral strength of the material is lessened, and therefore not so able to withstand any lateral thrusts as when square timbers are used. For this reason plank barns, in the construction of which this fact has been overlooked, have been known to suffer from wind pressure and sometimes from the interior pressure of hay or other forage.

(2) In the construction of plank barns greater use has been made of the truss than in older barns, in doing away with interior posts and in securing strength elsewhere. The principle on which the truss is based may be illustrated by stating that if the ends of three lath are united into a triangle by the use of a single nail at each angle, the structure will

be entirely rigid, but that if ends of four lath are united into a square by use of a single nail at each angle the structure has no rigidity. Persons are often at a loss to know whether they have a true truss. The answer to the query is whether they have three sides of a triangle properly fastened together.

In building plank barns, the width of the material makes it possible to use nails in fastening the ends in place of mortise and tenon, which were necessary with square timbers. This very much reduces the amount of labor and requires somewhat less skilled labor. In building plank barns, two difficulties have sometimes arisen: the nailing has not been sufficient to stand the pull; and sufficient provision has not been made for lateral pressure.



FIG. 341.—Method of trussing roof. Truss is 1 ft. by 8 in. hard wood let into upper surface of rafters and securely nailed to each rafter.

XIV. Appearance

Were it possible to define exactly what it is that gives to structures satisfactory appearance, or, as we say, a proper architectural effect, there would not be so many unsightly buildings. Some things that contribute to this effect are adaptation to purpose and surroundings, appearance of strength, durability, good workmanship.

Nothing should be placed on the outside or inside of a building that does not have a use or meaning. In addition to first expense, it adds to the cost of maintenance. Strength and durability cost money, but money expended for the purpose of producing striking effects would, if expended on good construction, bring better architectural results.

Certain colors and combinations of colors are more pleasing than others. Some colors, such as shades of yellow, attract attention and serve to make a building prominent, while other colors, such as olive or olive-green, make a building less prominent. Choice of color should depend on the surroundings. A white building in an exposed place is unattractive, while if subdued by being surrounded by trees and shrubbery it is attractive. To those who do not care to worry about colors, outbuildings may safely be painted red with white trimmings. There is no better paint than pure boiled linseed oil and pure white lead. Venetian red is a good pigment because it is a cheap pigment that will hold to its color. One difficulty of olive and green colors is that it is difficult without high expense to obtain green pigments that will not fade.

Supplement to

CORNELL

Reading=Course for Farmers

PUBLISHED BY THE COLLEGE OF AGRICULTURE OF CORNELL UNIVERSITY,
FROM NOVEMBER TO MARCH, AND ENTERED AT ITHACA AS SECOND-CLASS
MATTER UNDER ACT OF CONGRESS OF JULY 16, 1894. L. H. BAILEY, DIRECTOR.

SERIES VI.
BUILDINGS AND YARDS.

ITHACA, N. Y.,
MARCH, 1906.

No. 30.
BARNs.

DISCUSSION-PAPER ON FARMERS' READING-COURSE BULLETIN NO. 30

This Discussion-paper is sent out with all Farmers' Reading-Course Bulletins, for two reasons: (1) We should like to have your own ideas on these subjects. On some of these points you have probably had experience which will be interesting and valuable to us. No matter what the Bulletin says, if you have different opinions on any of these subjects, do not hesitate to state them on this paper and give your reasons. (2) We should like you to use this paper on which to ask us questions. If there are any points which the Bulletin has not made clear or if there are any problems in your farming, whether on these subjects or others on which you think we may be able to help you, write to us on this paper.

THE NEXT READING-COURSE BULLETINS WILL BE SENT TO THOSE WHO RETURN TO US THIS DISCUSSION-PAPER, WHICH WILL BE AN ACKNOWLEDGMENT OF THE RECEIPT OF THE BULLETIN (2c. postage). *This paper will not be returned to you, but we shall look it over as carefully as we would a personal letter and write to you if there are any points about which correspondence is desirable. You may consider this Discussion-paper, then, as a personal letter to us. It will be treated as such, and under no circumstances will your remarks be made public.*

If you are not interested in this Reading-Course Bulletin, we have others on other subjects, and we shall be glad to send any of these to you on request. The titles of the six Series of the Reading-Course Bulletins now available are: 1. THE SOIL AND THE PLANT. 2. STOCK FEEDING. 3. ORCHARDING. 4. POULTRY. 5. DAIRYING. 6. FARM BUILDINGS AND YARDS. The Farmers Wives' Reading-Course, on domestic subjects, is also sent to those who desire it.

THESE BULLETINS CANNOT BE SENT TO PERSONS WHO RESIDE OUTSIDE OF THE STATE OF NEW YORK, AS BOTH COURSES ARE SUPPORTED BY A STATE APPROPRIATION.

This Bulletin on barns deals with principles. It is important that the reader grasp these principles and make them his own. Therefore, this discussion may well take the form of a quiz on the fourteen captions

in the Bulletin. Is there anything under these different captions that you do not understand, or on which you want more light, or with which you do not agree? Set down your doubts and enquiries in the space below, numbering your remarks to correspond with the captions.

1. How to keep animals and other objects dry.
2. How to maintain a proper temperature.
3. How to secure good air.
4. How to secure light.
5. How to have the barns clean.
6. How to avoid rats and mice.
7. How to save the manure.
8. How to conserve health and comfort of the animals.
9. How to economize time in watering and feeding.
10. How to economize space to best advantage.
11. How to economize labor.
12. How to economize in construction.
13. How to secure strength and durability.
14. What kind of a barn looks best?

Name.....

Date.....

County, Postoffice

Note.—Your name appears on our mailing list as this Bulletin is addressed. If incorrect, please advise us.

Address all correspondence to Farmers' Reading-Course, Ithaca, N. Y.

Reading=Course for Farmers' Wives

PUBLISHED BY THE COLLEGE OF AGRICULTURE OF CORNELL UNIVERSITY,
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MATTER UNDER ACT OF CONGRESS OF JULY 16, 1894. L. H. BAILEY, DIRECTOR.

MARTHA VAN RENSSELAER, *Supervisor.*

SERIES IV.

ITHACA, N. Y.,
OCTOBER, 1905.

No. 16.

**PROGRAMS FOR EVENINGS WITH FARMERS'
WIVES' READING CLUBS.**

STUDY clubs are by no means confined to the cities and towns. The farmer's wife has the same need of study to keep abreast of the times, to keep up with her children, and to preserve a joyous spirit, as does the woman living in the midst of libraries, picture galleries,



FIG. 136. *The good cheer of a meeting where the men and children are not left out.* and lecture bureaus. Her early education, like that of her city sister, needs constant polishing to keep it bright, and her sympathies need to

expand rather than to grow narrow and insignificant. The very practical nature of the farmer's wife's occupation makes it desirable to base that occupation on scientific principles as well as to relieve it with a thought of poetry, history or fiction.

The Farmers' Wives' Reading-Course is for both individual and club use. We begin the year 1905-1906 with many thousand readers. We shall aim to become better acquainted with those already enrolled, as well as to secure new readers. To this end we invite you either individually or in clubs to join with us in studying *The Economics of the Home*; to become acquainted with some of our *American Literature and History*; and to study the *Current Events* of the year. It is a broad field; the time which a farmer's wife has at her command for self improvement is short; yet her family life is richer, her outlook happier, and her field of labor by far more useful than if she pass her entire time in the performance of mere household duties.

Let some woman take the leadership, see the other women of the community and arrange to meet on a certain date, either in a home, at the school building, or in the grange hall. The meeting may be held when the men have their club meeting, or alone, as seems most practicable. Make the organization as formal or informal as you please. Allow no discussion of topics during the program hour except those selected for the evening. The President should hold all members to a stringent observance of the rules in order to make the meetings a success.

It is well to have the men present at these meetings and to ask them to take part in the program, but it is suggested that they may retire to another room and discuss agricultural subjects while the women are on the domestic problems, or that time be given to them for a discussion of their own subjects to which the women will doubtless be interested listeners. The men can doubtless throw much light on the domestic problems of the home.

Elect a chairman. Draw up a few rules by which each meeting shall be governed. These may be added to as the occasion demands. Each club will need to be governed by its own local conditions.

Adopt a constitution which may read somewhat as follows:

ARTICLE I.

The club shall be known as the _____ Farmers' Wives' Study Club.

ARTICLE II.

The object of the club is to study the most scientific ways of conducting the home work in order to economize strength and preserve the health of the family; to discuss the best expenditure of money, in order to secure the highest conditions of home life; to broaden the outlook of the home and family life by the cultivation of the mother of the household; to encourage a social spirit while working together for the good of the home and family; to consider the home also as a part of the community and therefore having relations with church, school and social well being; to elevate the character of farm life to the end that the farm home shall be the best in America and most attractive to the rising generation.

Any person interested in the foregoing objects for study is eligible for membership.

ARTICLE III.

The officers shall be a President, a Vice-president, a Secretary, a Treasurer, and a Corresponding Secretary.

The duty of the President shall be to preside at all meetings and to call extra sessions whenever practicable.

The duty of the Vice-president is to act for the President in the absence of the latter or whenever she is unable to attend to her duties.

The duties of the Secretary and Treasurer shall be to keep the minutes of the meetings, and to care for the finances of the club if there be any.

The Corresponding Secretary shall give notice of meetings, conduct the correspondence of the club, report the meetings to the Extension Department of Cornell University, and write for State and government bulletins which shall aid in the study of the club.

ARTICLE IV.

The majority of the members present at a meeting shall constitute a quorum.

ARTICLE V.

The officers of the club shall constitute an executive council which shall determine the place of meeting, the time and the number of meetings (not less than ten), and arrange for the year's program.

ARTICLE VI.

The club shall be under the Bureau of Extension of the College of Agriculture, Cornell University, and shall have as a basis of work the Bulletins of the Farmers' Wives' Reading-Course with whatever related work may be deemed advisable. The club is to have correspondence with that department in lines which shall be of helpful interest to the club.

At least half of the members shall answer the questions of the discussion papers in the Farmers' Wives' Reading-Course, and they shall be forwarded regularly to that department.

ARTICLE VII.

"Roberts' Rules" (or others) shall be the guide to parliamentary usage.

NOTES ON THE PROGRAMS SUGGESTED IN THE FOLLOWING PAGES.

Perhaps there is more in these programs than is needed. Take that which pleases you most.

Register as a club at once by addressing Farmers' Wives' Reading-Course, Cornell University, Ithaca, N. Y.

Have the Secretary keep the club in close touch with the University.

Possibly the Supervisor of the Course may be able to visit the club at a regular meeting.

A traveling library will be quite indispensable to the carrying out of this schedule, unless you prefer to buy the books. Apply soon for the library. It is not connected with this Extension Department, but with the Department of Education, Albany, N. Y., Libraries Division, where application should be made and fee sent. The library may be kept six months, and a fee of \$1 for ten books pays transportation both ways.

Traveling Library for Farmers' Wives' Reading-Clubs, 1905-1906:
Whittier's Poems.

Grandfather's Chair, Hawthorne.

Literary Leaders of America, Richard Burton.

Abraham Lincoln, Schurz.

Principles of Home Decoration, Candace Wheeler.

The Great World's Farm, Selina Gaye.

How to Keep Bees, Anna B. Comstock.

Among Green Trees, Julia Ellen Rogers.

Story of Bacteria, Prudden.

Power Through Repose, Anna Payson Call.

SUGGESTED PROGRAMS FOR FARMERS' WIVES' CLUBS.

First November Meeting.

I. *Preliminary or Introductory Exercises.*

Music.

Quotation by the President, 1st verse, 19th Psalm.

"The Heavens declare the glory of God; and the firmament showeth His handiwork."

Quotations on Nature from Whittier, committed, not read, by each member.

Recitation or reading, The Corn Song—Whittier.

Paper, Whittier's Early Life, by _____

Birth—Date and Place, Parentage;

Early Home—Farm, House still stands.

School Life—District School, Academy.

Discussion, led by _____

Reading—

II. *Main Part of the Meeting.*

Discussion of Farmers' Wives' Bulletins.

A. For Readers of the First Year, *Saving Steps*, Farmers' Wives' Bulletin No. 1.

The housewife must first learn to save her time and her strength before she can do much toward other improvements. This subject, therefore, is introduced for the first month's lesson.

Following is an outline for discussion:

1. Suggestions contained in letters published in Lesson I.
2. Household improvements for saving steps, as sinks, drains, ice and window boxes, arrangement of shelves and cupboards.
3. Useful utensils for saving time and strength, as trays, high stool, iron dish-cloth, etc.
4. How to save time and strength in setting and clearing the table, dish washing, cleaning, etc.
5. How to plan work so as to save time and steps.

B. For Readers of the Second Year, *The Rural School*, Bulletin No. 6.

Read and discuss the questions given in the quiz.

Consider the desirability of the attendance of women at the school meeting. If it has never done any good in the district, what can you propose as a means of effecting good results?



FIG. 137. *An attractive modern school building, but, lacking the finish of trees and shrubbery, it loses much value.*

To what extent can the school be made a social center for the inhabitants of the school district?

A problem in arithmetic — If the valuation of a school district is \$40,000, and a man's property is assessed at \$2,000, how much would his taxes be increased each year if the district buy \$10.00 worth of books for its library?

C. For Readers of the Third Year, *Home Sanitation*, Bulletin No. 11.

Discuss questions 1-6 of the discussion paper.

Further subjects for discussion:

1. What can a woman do for improved sanitation?
 2. Discuss the water supply of the neighborhood.
 3. Discuss impurities of the soil about a dwelling and danger therefrom.
 4. Consider the best location for sleeping rooms.
- D. For Readers of the Fourth Year, *Farmers' Wives' Bulletin* No. 16, *Bread Making*.

Consider first half of questions on discussion paper.



FIG. 138. Flowers grown by the children at school. Large returns for a slight effort.

Do women of today make as good bread as did the women of forty years ago?

What flour makes the best bread?

III. Concluding Program.

Current Events: Discuss the most important news items of the month.

Light refreshments.

Second November Meeting.

I. *Introductory Exercises.*

Music.

Quotation, by the President—Isaiah 41, 17-20.

Quotations from Whittier, committed and recited by the members.

Reading from "Snow Bound," _____

Paper by _____

Whittier's Early Literary Career;

His Anti-Slavery Work;

His Later Life and Death.

Discussion, led by _____

Questions to ask one's self after studying the life and work of Whittier.

Do Whittier's poems throw any light upon his home life?

Did Whittier's struggles for an education add to his success as a poet or did it hamper him?

What poem refers to his early home? What to his school life?

Do any of his poems suggest a romance in his own life?

What did he do for the abolition of slavery?

What is his greatest poem?

References for further reading:

Always have some useful and pleasant book ready to take up in the "odd ends" of time.—Bishop Potter.

Homes of American Authors (Whittier), H. T. Griswold.

Poets of America, E. C. Stedman.

II. *Main Program.*

A. For First Year Readers, further study of *Saving Steps*.

1. Consider the questions found on discussion paper, Bulletin No. 1.
2. Cost of saving time and steps in a household.
3. Is it a waste of time to stop and rest?
4. How to secure from help a saving of time and strength.
5. Discuss plans for a house in regard to convenience, especially the relation of dining-room, kitchen, china closet and pantry.

B. For Readers of Second Year, further discussion on *The Rural School*.

1. What can be done in your district to improve the interior?
2. What are the advantages and disadvantages of the consolidation of school districts?
3. Are the studies taught in the school calculated to help your children to become better farmers and better home keepers?



FIG. 139. *Substantial but bare. The picturesque finish of vines is needed.*

4. Can agriculture as a study be introduced into your school?
5. Should the school building be used for any purpose other than the teaching of children in the day time?
6. To what extent can the parents and teachers co-operate for the good of the children, the parents, the teacher?

C. For Readers of Third Year, further discussion of *Home Sanitation*.

1. Is there any public or neighborhood nuisance which threatens the health of the neighborhood? Is there to be any preventative?
2. Discuss the best means of ventilating the rooms in a home?
3. Are the children exposed to any danger from disease in the surroundings at school? Appoint, if necessary, a committee to investigate this. Can individual drinking cups be supplied in the school? Are the floors of the schoolroom kept free from dust? Do the children sit in draughts? Are the outbuildings in a sanitary condition?

D. For Readers of the Fourth Year, Farmers' Wives' Bulletin No. 16.

Consider the last half of questions on the discussion paper.

Is it wise to keep both bread and pastry flour?

What is the best kind of yeast to use?

With bread at five cents a loaf, which is the cheaper, considering the value of labor, to make or buy the bread?

III. *Concluding Program*.

Current Events: Discuss items of news, or important editorials of the month.

Refreshments.

Home reading for November:

*"There breathes no being but has some pretence
To that fine instinct called 'Poetic sense'."*

—Oliver Wendell Holmes.

Read during the month of November from Whittier:

Snow Bound (nature). Toussainte L'Ouverture (freedom).

Thy will be done (religious). Maud Müller (narrative).

First December Meeting.

I. *Introductory Exercises*.

Music.

Quotation, by the President—

*"The earth is the Lord's and the fulness thereof; the world,
and they that dwell therein."*

Quotations from Hawthorne, 1804-1864, by the members.

Paper by _____

Life of Hawthorne—Early Life, College Life, Literary Career, Family Life, Public Life.

Reading from "Grandfather's Chair" or some other one of Hawthorne's works, by _____

II. Main Program.

A. For Readers of the First Year, *Decoration in the Farm Home*, Farmers' Wives' Bulletin No. 2.



FIG. 140. "O for childhood's time of June."

1. Consider first half of questions on discussion paper.
2. What are the best flowers to raise for interior decoration?
3. Has any particular picture hung in a home had any strong influence upon you?
4. Discuss appropriate decorations for the children's rooms,

B. For Readers of the Second Year, "*Boys and Girls on the Farm*," Farmers' Wives' Bulletin No. 7.

Sing or read, "The Old Oaken Bucket."

Compare the life of the children in the city and in the country.

- (a) Its temptations, (b) For physical development, (c) For cultivation of manners, (d) School opportunities.

Are there any better opportunities offered of which you can avail yourselves than to send your boys and girls for a free short course to the State College of Agriculture?

Instruct your secretary to send for circulars concerning these courses of study.

C. For Third Year Readers, *Germ Life*, Bulletin No. 12.

"No other factor that can be named as a conservator of the public health can equal woman intelligently guarding her home from the noxious seeds of disease and death and in her proper sphere of mother and teacher, educating the coming generations of men and women in the knowledge of how their lives may be made healthy and happy and extended into years of usefulness."—Hon. Frank Weils.

Readings from *The Story of Bacteria*, by Prudden, by a member appointed at the preceding meeting.

D. For Readers of the Fourth Year, Farmers' Wives' Bulletin No. 17, *The Care and the Selection of Food*.

Consider the first half of questions on discussion paper.

What evidences have come in common experience to show that food is adulterated?

Is not the farmer doing more to furnish pure foods than the manufacturer?

III. Concluding Program.

Current Topics.

Light Refreshments,

Second December Meeting.

I. *Introductory Exercises.*

Music.

Quotation, President—

"She seeketh wool and flax and worketh willingly with her hands. She is like the merchants' ships; she bringeth her food from afar."

Roll call of members. Each responding by telling what to her is the most interesting book she ever read.

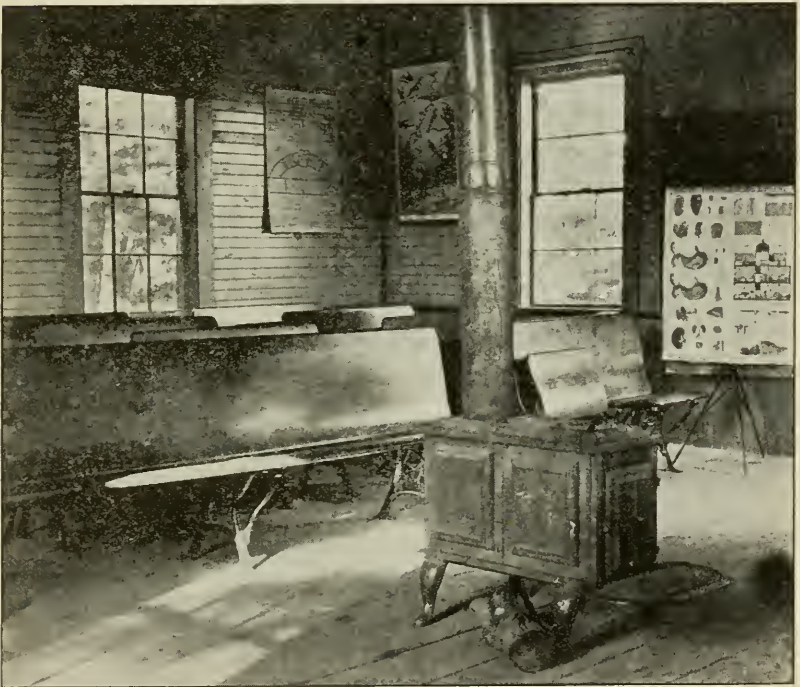


FIG. 141. *Better than most school-room interiors, but there is still opportunity for home touches.*

Reading from Hawthorne's "Tanglewood Tales" or "Grandfather's Chair."

Hawthorne as a writer, paper by _____.

A. First Year Readers, further discussion of *Home Decoration*.

Consider last half of questions on discussion paper.

Will you have a parlor or a large, comfortable, living room as the place to receive company?

What have you found to be the best way to treat your floors?

What are the desirable furnishings for the guest room?

B. For Readers of Second Year, further discussion of *Boys and Girls on the Farm*.

Consider the remaining questions of the discussion paper. Invite the teacher and the children to this meeting. Join with them in playing a live, interesting game.

Invite the entire family, teacher and all, occasionally.

C. For Readers of the Third Year, further discussion of *Germ Life*. Consider the remaining questions of the discussion paper. What dangers are there to health in the careless handling of milk?

How can women aid in a reform against public exposure of foods, expectoration in public places, the wearing of skirts in a way to collect dangerous germs?

D. For Readers of the Fourth Year, *Farmers' Wives' Bulletin No. 17, Care and Selection of Food*.

Consider last half of questions on the discussion paper. Discuss the best method of preparing dairy products for market.

Does the buyer owe it to the farmer to prefer the seller of the cleanest farm products?

III. *Concluding Program.*

Current Topics—Subject selected by the leader appointed.

Light Refreshments.

Hawthorne wrote for children:

Grandfather's Chair,
Biographical Stories,
The Wonder Book,
Tanglewood Tales.

During the month of December, read from Hawthorne—

References.

Yesterdays with Authors (Hawthorne), James T. Fields.
A Study of Hawthorne, George T. Lathrop.

Home Life of the Brook Farm Association, Atlantic Monthly, October and November, 1878.

Hawthorne, English Men of Letters Series.

Nathaniel Hawthorne and his Wife; Julian Hawthorne.

Some questions to ask one's self after reading Hawthorne's Life:

Do Hawthorne's works show a sad or a joyous childhood?

What experiences in his early life will account for some of Hawthorne's eccentricities as a man?

What was Brook Farm of which Hawthorne writes in "The Blithedale Romance"?

Was it his need of a steady income or was it his liking for public work which led him to accept appointments under the Government?

What great men were contemporaneous with Hawthorne, and inspired him to high literary effort?

Upon what book does his fame rest?

First January Meeting.

I. *Introductory Exercises.*

LINCOLN, 1809-1865.

Music, America.

Quotation, President—

"Let reverence of the law be breathed by every mother to the lisping babe that prattles on her lap; let it be taught in schools, seminaries, and colleges; let it be written in primers, spelling-books, and almanacs; let it be preached from pulpits and proclaimed in legislative halls, and enforced in courts of justice; in short, let it become the political religion of the Nation."

Quotations from Lincoln's Sayings, by Members.

"He is the author of a multitude of good sayings, so disguised as pleasantries that it is certain they had no reputation at first but as jests; and only later, by the very acceptance they find in the mouths of millions, turn out to be the wisdom of the hour."

— Ralph Waldo Emerson.

Reading — Lincoln's Gettysburg Address.

(*A masterpiece of English prose.*)

Lincoln's Early Life. Paper by _____.

II. *Main Program.*

A. For First Year Readers, discussion of *Practical Housekeeping*, Farmers' Wives' Bulletin No. 3.

1. Consider first half of questions on discussion paper.
2. In the economy of the farm home, what occupations now found there can be better cared for outside of the home? Consider the advisability of a public laundry at the creamery or factory.
3. "A penny saved is a penny earned." Mention ways in which this is illustrated in housekeeping.
4. Let each person give a list of the best ten conveniences in kitchen furnishing.

B. For Second Year Readers, Discussion of *Reading in the Farm Home*, Bulletin No. 8.

Consider first half of questions on discussion paper.

"Nothing can supply the place of books."

— Channing.

"A home without books is like a room without windows."

— Beecher.

Consider first half of questions on discussion paper.

Let each person give a description of the best book she has read this year.

C. For Third Year Readers, Discussion of *Human Nutrition*, Bulletin No. 13.

1. Consider first half of questions on discussion paper.
2. (a) Discuss the meaning of Protein, Carbohydrates, Fats.
(b) Consider what foods furnish these ingredients.
(c) What proportion of each is needed for the proper diet?
3. Apply the principles to the daily fare generally used in the home.
4. Discuss what substitutes may be had for meats to provide protein and necessary nourishment.
5. Consider the effect upon the system of carbohydrates and fats.

D. For Fourth Year Readers, Farmers' Wives' Bulletin No. 19,
Meat, Fish and Eggs.

Consider first half of questions on discussion paper.

What variety of meats can profitably be used on the farm table?

Do women know as much as they should in regard to the cuts of meat and how to prepare them for the table?

Can salt or fresh fish be made a more common article on the farm table?

III. *Concluding Program.*

Current Events for January.

"Almost any man, under the usual stimulus of the camp, can stand fire. Is it not time that the point of honor should undergo some change, that some glimpses, at least, of the true glory of a nation should be caught by rulers and people?"—William Ellery Channing.

Discuss what the State and National Government are doing for the farmer; for the woman in her relations to her family; for education in the legislation of the present winter.

Light Refreshments.

Second January Meeting.

To which men may be invited.

I. *Introductory Exercises.*

Music — "Yankee Doodle."

Quotation, President —

"We are thankful that God gave to Abraham Lincoln the decision and wisdom and grace to issue that proclamation, which stands high above all other papers which have been penned by uninspired men."

Quotations from members, each giving an anecdote concerning Lincoln.

Reading — Second Inaugural Address.

Discussion — Which was the greater statesman, Washington or Lincoln?

Appoint Leaders.

II. *Main Program.*

A. For First Year Readers, *Practical Housekeeping*, Bulletin No. 3,
Farmers' Wives' Reading-Course.

1. Consider the last half of the questions on discussion paper.
2. Is the keeping of household accounts essential to the good management of the home?
3. How may they be kept with the least labor?
4. Name ten of the best utensils for the kitchen which are not essential but which really add to the convenience of doing work.
5. Does it pay to can vegetables and fruits in preference to buying them ready canned, taking into account the labor employed.

B. For Readers of the Second Year, *Reading in the Farm Home*,
Farmers' Wives' Bulletin No. 8.

Discuss last half of questions contained in discussion paper.

C. For Readers of the Third Year, *Human Nutrition*, Farmers'
Wives' Bulletin No. 13.

1. Discuss last half of questions upon discussion paper.
2. Discuss the amount per week, necessary for feeding each person in the family. Can this amount be lessened and furnish necessary nourishment?
3. Can cooking be done with less time and labor without detriment to the bill of fare?
4. Discuss the dietary for different members of the family.
5. How can good food habits be secured in children? Discuss the question of school lunches.

D. For Readers of the Fourth Year, Farmers' Wives' Bulletin
No. 19.

Consider the last half of questions on the discussion paper.

Let each member explain the making of a good egg dish.

What are the best means of preserving eggs.

How does the expense of eggs on the table, when they are the highest, compare with that of meat?

III. *Concluding Program.*

Current Topics.

A further discussion of the acts of the present session of Congress and Legislature as they affect the farmer.

Light Refreshments.

Home Reading for January.

Abraham Lincoln, by Schurz.

Abraham Lincoln, by Emerson, at the funeral services held in Concord.

Abraham Lincoln, by Lowell, an essay.

Addresses of Lincoln.

These are found in one volume in the State traveling library.

A book desirable through the entire course is, *Literary Leaders of America*, by Richard Burton.

First February Meeting.*Nature.—Birds.*I. *Introductory Exercises.*

Music.

Quotation, by the President —

“Go to the ant thou Sluggard; consider her ways and be wise.”

Roll Call of members.— Answer by quotations on Nature.

Reading—The Bob-o-link, by William Cullen Bryant:

Merrily swinging on brier and weed,
Near to the nest of his little dame,
Over the mountain-side or mead,
Robert of Lincoln is telling his name:
Bob-o'-link, bob-o'-link,
Spink, spank, spink;
Snug and safe is that nest of ours,
Hidden among the summer flowers.
Chee, chee, chee.

Robert of Lincoln is gaily drest,
Wearing a bright black wedding-coat;
White are his shoulders and white his crest.
Hear him call in his merry note:
Bob-o'-link, bob-o'-link,
Spink, spank, spink;
Look what a nice new coat is mine,
Sure there was never a bird so fine.
Chee, chee, chee.

Robert of Lincoln's Quaker wife,
 Pretty and quiet with plain brown wings,
 Passing at home a patient life,
 Broods in the grass while her husband sings
 Bob-o'-link, bob-o'-link,
 Spink, spank, spink;
 Brood, kind creature; you need not fear
 Thieves and robbers while I am here.
 Chee, chee, chee.



FIG. 142. "Merrily swinging on brier and weed."

Modest and shy as a nun is she;
 One weak chirp is her only note.
 Braggart and prince of braggarts is he,
 Pouring boasts from his little throat:
 Bob-o'-link, bob-o'-link,
 Spink, spank, spink;
 Never was I afraid of man;
 Catch me, cowardly knaves, if you can!
 Chee, chee, chee.

Six white eggs on a bed of hay,
 Flecked with purple, a pretty sight!
 There as the mother sits all day,
 Robert is singing with all his might

Bob-o'-link, bob-o'-link,
 Spink, spank, spink;
 Nice good wife, that never goes out,
 Keeping house while I frolic about.
 Chee, chee, chee.

Soon as the little ones chip the shell
 Six wide mouths are open for food;
 Robert of Lincoln bestirs him well,
 Gathering seeds for the hungry brood.
 Bob-o'-link, bob-o'-link,
 Spink, spank, spink;
 This new life is likely to be
 Hard for a gay young fellow like me.
 Chee, chee, chee.

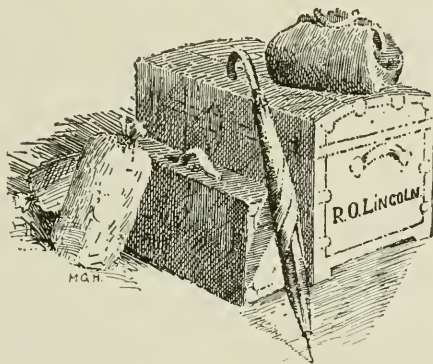


FIG. 143. "*Robert of Lincoln come back again.*"

Robert of Lincoln at length is made
 Sober with work, and silent with care;
 Off is his holiday garment laid,
 Half forgotten that merry air:
 Bob-o'-link, bob-o'-link,
 Spink, spank, spink;
 Nobody knows but my mate and I
 Where our nest and our nestlings lie.
 Chee, chee, chee.

Summer wanes; the children are grown;
 Fun and frolic no more he knows;
 Robert of Lincoln's a humdrum crone;
 Off he flies, and we sing as he goes:
 Bob-o'-link, bob-o'-link,
 Spink, spank, spink;
 When you can pipe that merry old strain,
 Robert of Lincoln, come back again.
 Chee, chee, chee.

Professor Bailey in his "Nature-Study Idea" says: "I have always wished that the poet had told the whole story. The poem tells us of the life of the bobolink; but after the breeding season is past, the birds gather in flocks in the rice-fields and reeds of the South and are then known as rice-birds and reed-birds. In great numbers they are slaughtered for the market, and thereby the bobolink



FIG. 144. *Young crows, interesting and mischievous.*

does not become an abundant species in the North. May we not add:

Far in the South he gathers his clans,
 Nor thinks of the regions of ice;
 Too early yet for housekeeping plans,
 He rev'ls and gluttons in fields of rice.
 Rice-bird, bob-o'-link,
 Spink, spank, spink;
 Hunter is waiting under the bloom,
 Robert of Lincoln falls to his doom.
 Chee, chee, chee.

Spring comes: swinging on brier and weed,
 Near to the nest of his little dame,
 Over the mountain-side and mead,
 Another proud groom is telling his name:
 Bob-o'-link, bob-o'-link,
 Spink, spank, spink;
 The meadow belongs to wife and me —
 Life is as happy as life can be.
 Chee, chee, chee.

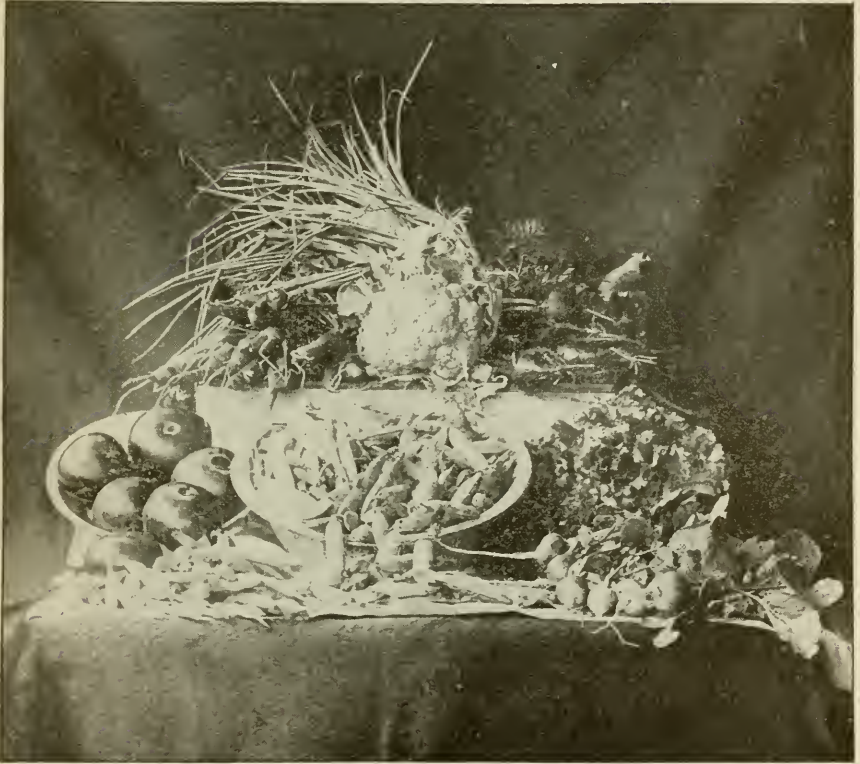


FIG. 145. *Good vegetables mean less meat and less pastry.*

Paper — Natural Laborers in the Great World's Farm.

(See, *The Great World's Farm*, by Selina Gaye.)

II. *Main Program.*

A. For First Year Readers, *The Kitchen Garden*, Farmers' Wives' Bulletin No. 4.

I. Consider first half of questions on discussion paper.

2. Should the Kitchen-Garden belong to the domain of the woman exclusively, or should she occupy an advisory position only?
3. What is the best location for the garden from the housewife's standpoint? Should suitability of soil or convenience be first considerations?
4. What should the garden contain?



FIG. 146. *A temporary home for a captured swarm.*

B. For Readers of Second Year, *Home Industries*, Farmers' Wives' Bulletin No. 9.

"Blessed is that man who has found his work; let him ask no other blessedness."

1. Consider first half of questions on discussion paper.
2. Any farm industry for women may be discussed, but it is suggested that the book, *How to Keep Bees*, by Anna Botsford Comstock, be the subject for the evening.

C. For Readers of the Third Year, *Food for the Farmers' Family*,
Farmers' Wives' Bulletin No. 14.

1. Consider first half of questions contained upon discussion paper.
2. Let each woman tell in what she is most successful in the preparation of food.
3. In what ways are we dependent upon the insect world for food?

D. For Readers of the Fourth Year.

Readers of the Fourth Year will find an outline for club discussion in the February Bulletin.

III. *Concluding Program.*

Current Topics.

What can the farmers do to encourage legislation for education in Agriculture and Home Economics in the State?

Light Refreshments.

Second February Meeting.

Nature.

I. *Introductory Exercises.*

"Of all the wonderful things in the wonderful universe of God nothing seems to me more surprising than the planting of a seed in the black earth and the result thereof. Take a poppy seed, for instance: it lies in your palm, the merest atom of matter, hardly visible, a speck, a pin's point in bulk, but within it is imprisoned a spirit of beauty ineffable, which will break its bonds and emerge from the dark ground and blossom in a splendor so dazzling as to baffle all powers of description."

Music.

Quotation, by the President —

"The ants are a people not strong, yet they prepare their meat in the summer."

Reading. From the *Great World's Farm*, chap. vi, pp. 82 to 98.

II. *Main Program.*

A. For First Year Readers, *The Kitchen Garden*, Concluded.

1. How and where are seed and plants best secured?
2. How can you best obtain the co-operation and assistance of the head of the house and your children?



FIG. 147. Examining the brood frames.



FIG. 148. *Hiring a swarm of bees and looking for the queen.*

3. Cite instances of successes and failures in kitchen gardening.
4. Discuss methods of culture, and the quality of different kinds of vegetables.
5. The lesson does not take up the storing of vegetables for winter use, nor the canning of small fruits. These subjects might be properly considered.



FIG. 149. *A good yield for the home market. The consumer is in the window.*

B. For Second Year Readers, *Farm Home Industries*, Concluded.

1. Consider last half of questions in discussion paper.
2. Poultry raising for women.

Is it practical?

Can it be improved for the good of the market and the good of the woman who engages in it?

3. Cite personal experiences in success and failure.
4. Have the secretary write for Farmers' Bulletins on poultry issued at Cornell University so that each member may have the reading of them before the time of meeting.

C. For Third Year Readers, *Food for the Farmer's Family*, Concluded.

1. Consider the last half of questions on discussion paper.

2. Which are the most expensive, animal or vegetable foods?
3. Which are the more beneficial to health?
4. Can you furnish sufficient protein to your family without giving much meat and in what way?
5. How can you simplify the meals so as to furnish just as much nourishment and as appetizing food and have less work to do in their preparation?

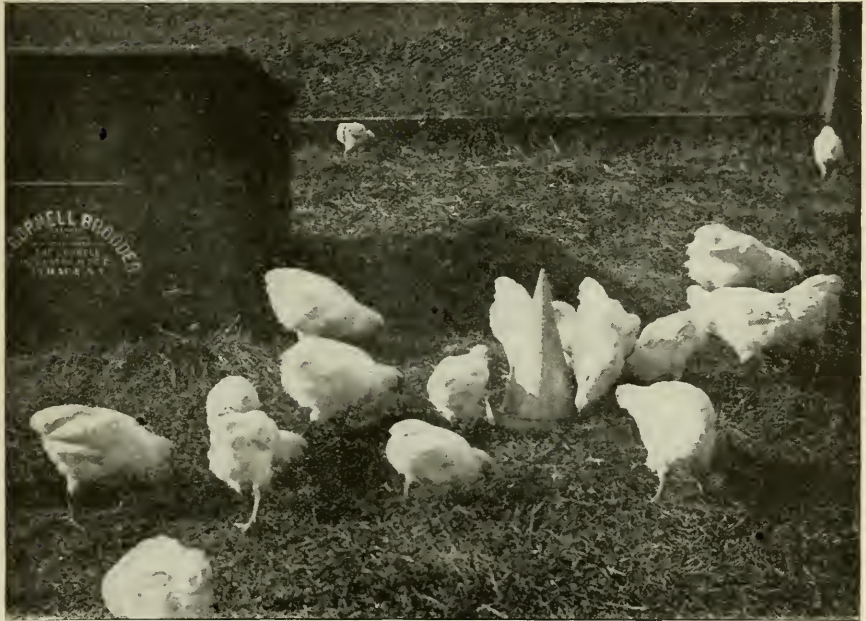


FIG. 150. *Fine young fowls, a pride when growing and a profit when marketed.*

D. For Readers of the Fourth Year.

Readers of the Fourth Year will find an outline for club discussion in the February Bulletin.

III. *Concluding Program.*

Current Topics.

What is the government and what are individuals doing to make a more honest administration of affairs of state and public and private commercial interests?

Light Refreshments.



FIG. 151. *The love of the woods. An attractive place on which to carve one's name.*



FIG. 152. *The love of the trees. Good old field pines, "worth their weight in gold."*

First March Meeting.

*Nature — The Trees.*I. *Introductory Exercises.*

"Aye, keep plantin' a tree, Jock; it'll be growin' while you're sleepin'."

Music.

Quotation, by the President —

"And out of the ground made the Lord God to grow every tree that is pleasant to the sight, and good for food; the tree of life also in the midst of the garden, and the tree of knowledge of good and evil."

Reading — Planting the Appletree, by William Cullen Bryant; or Why Trees Die, page 55, Among Green Trees, by Julia Ellen Rogers.

Paper, On the Trees of the Neighborhood, by _____.
Their kinds, uses and proper care.

II. *Main Program.*

A. For First Year Readers, *The Flower-garden*, Farmers' Wives' Bulletin No. 5.

"Wayside songs and meadow blossoms; nothing perfect, nothing rare; Every poet's ordered garden yields a hundred flowers more fair; Master-singers know a music richer far beyond compare."

1. Consider first half of questions on discussion paper.
2. Consider advisability of giving the children a plot of ground which they may call their own where they may raise flowers.
3. Can you do anything to aid the teacher to have flowers growing at school?

Froebel wrote, "If the boy cannot have the care of a little garden of his own, he should have at least a few plants in boxes or flower pots, filled not with rare and delicate or double plants, but with such as are common, rich in leaves and blossoms, and thrive easily. The

child, or boy, who has nursed and cared for another living thing, although it be of a much lower order, will be led more easily to guard and foster his own life. At the same time the care of plants will satisfy his longing to observe other living things, such as beetles, butterflies, and birds, for these seek the vicinity of plants."

B. For Second Year Readers, *Insect Pests of House and Garden*, Farmers' Wives' Bulletin No. 10.

1. Consider first half of questions on discussion paper.
2. What has been your experience in the use of insecticides prescribed in the Farmers' Wives' Bulletin?
3. Let one member tell the life history of a fly, another of the mosquito, another of the clothes-moth.

C. For Readers of the Third Year, *Saving Strength*, Farmers' Wives' Bulletin No. 15.

"To resist with success the frigidity of old age, one must keep the body, the mind, and the heart, in parallel vigor. To do this one must exercise, study, love."

—Mme. De Stael.

D. For Readers of the Fourth Year.

Readers of the Fourth Year will find an outline for club discussion in the March Bulletin.

1. Consider the first half of questions on discussion paper.
2. Try at intervals exercises prescribed on pages 9-10-11, Lesson III, *Saving Strength*. Note carefully to keep the weight forward on balls of the feet, chest high, hips back and the chest and bust in advance of the abdomen. Exercises taken in improper attitudes are worse than none since they bring strain upon the organs and lead to unnatural attitudes.
3. Do not omit the rest and relaxing exercises; yawn, stretch and laugh. These all aid in digestion, prevent insomnia, nervous exhaustion and nerve tension. They add to the normal, healthful condition of mind and body.
4. Discuss the application of these exercises to attitudes taken in housekeeping.

III. *Concluding Program.*

Current Topics.

How can we best improve the management of our local government?

Light Refreshments.

Second March Meeting.*Nature — The Trees.*I. *Introductory Exercises.*

Quotation, by the President —

“And God said, Behold, I have given you every herb bearing seed, which is upon the face of all the earth, and every tree, in the which is the fruit of a tree yielding seed; to you it shall be for meat.”

Quotations, on Nature by Members.

Reading — The Life History of a Maple, Page 3, Among Green Trees.

Discussion.

1. The trees of the school grounds or church yard. What can be done to improve them?
2. Where more trees are needed.
3. What trees should be cut down.
4. Destroying the trees for electric wires. Is it wise?

II. *Main program.*A. For First Year Readers, *The Flower-Garden.*

1. Consider last half of questions on discussion paper.
2. Discuss the advisability of offering the children a prize for the best plants or flowers raised by them.
3. Have the secretary correspond with the State College of Agriculture for helps on Children's Gardens.

B. For Second Year Readers, *Insect Pests of House and Garden.*

*“And there's never a leaf nor a blade too mean
To be some happy creature's palace.”*

1. Consider last half of questions on discussion paper.
2. Have given a synopsis of Farmers' Bulletin No. 155, Experiment Stations, U. S. Department of Agriculture,

How Insects Affect Health in Rural Districts. This may be had by writing to Washington, D. C.

C. For Readers of Third Year, *Saving Strength.*

*"The best is yet to be!
The last of Life
For which the first was made."*



FIG. 153. A "border" of flowers.

1. Consider last half of questions on discussion paper.
2. Discuss methods and times for rest in the daily program of housework.
3. Read from "Power through Repose," a chapter of interest on this subject at the meeting. Discuss and apply it.
4. It would be well to use these exercises at each meeting, appoint a leader and, if possible, secure someone who has given special attention to the study. Avoid an undue amount of muscular strain as some of these

exercises will call into use muscles unused to work. They may be gradually strengthened, however, to serve in the work of the house, and to save strain upon the spine.

D. For Readers of the Fourth Year.

Readers of the Fourth Year will find an outline for club discussion in the March Bulletin.

III. *Concluding Program.*

In place of the Current Topics, discuss the benefits derived from the year's study, and think of suggestions to make either personally or through the secretary for another year.

Light Refreshments.

A WINTER-COURSE FOR FARM WOMEN.

The College of Agriculture at Cornell University is establishing a Winter-Course of eleven weeks in Home Economics for the benefit of farmers' wives and daughters. The Reading-Courses of this College have aimed to take the College to the farmer and his family; there is also a long course of agriculture extending over four years; there are also special courses; but it is now intended to add one more facility for the benefit of farm women in the shape of this Winter-Course in Home Economics. The College of Agriculture already gives four Winter-Courses, viz., in General Agriculture; Dairying; Poultry; Horticulture. This course for women will make the fifth. The course opens January 2nd and closes March 20th, 1906. It is free of tuition to all residents of the State. The only expenses are the personal outlays of living and traveling. For the present winter this course is to comprise a series of lectures by the leading women in the field of householding, domestic science, and economics as applied to the home. About twenty women have been secured to give these lectures and demonstrations. It will probably be the most distinguished gathering of its kind that has yet been held in this country, and it is an opportunity that residents of the state cannot afford to miss. Among those who will take part are Mrs. Ellen H. Richards, Institute

of Technology, Boston; Dean Marion Talbott, of the University of Chicago; Miss Isabel Bevier, of the University of Illinois; Miss Abby L. Marlatt, of Providence, R. I.; Mrs. Alice P. Norton, of the University of Chicago; Mrs. James Hughes, of Toronto, Canada; Miss S. Maria Elliott, Simmons College; Miss Anna Barrows, Boston; Miss Helen Kinne, Teachers' College, New York, and others of national reputation.

Application for this course may be made to the Director of the College of Agriculture, Cornell University, Ithaca, N. Y., or to Miss Martha Van Rensselaer, Supervisor of the Farmers' Wives' Reading-Course, Ithaca, N. Y.

A full printed program will be ready about the 1st of December, 1905, giving all particulars.

"We have reached the point where no woman dares say that her education is finished."

Reading=Course for Farmers' Wives

PUBLISHED MONTHLY BY THE COLLEGE OF AGRICULTURE OF CORNELL UNIVERSITY,
FROM NOVEMBER TO MARCH, AND ENTERED AT ITHACA AS SECOND-CLASS MATTER
UNDER ACT OF CONGRESS OF JULY 16, 1894. L. H. BAILEY, DIRECTOR

MARTHA VAN RENSSELAER *Supervisor.*

SERIES IV.
THE FARM TABLE.

ITHACA, N. Y.,
NOVEMBER, 1905.

No. 17.
FLOUR AND BREAD.

FLOUR AND BREAD.

BY ANNA BARROWS.

THE assertion of the Psalmist that "all flesh is grass" is very nearly literally true, even when we restrict the word "grass" to what the botanists know as the grass family of plants; for to this family may be traced the origin of all the cereals, wheat, rice,



FIG. 154. *Bread ready for the tins*

corn, oats, barley, rye and millet and even the sugar cane. Foods of animal origin are chiefly but secondary products from the grass family, since our domestic animals subsist mainly upon the grasses.

Our word cereal is directly derived from the name of the Greek goddess of agriculture, Ceres. This origin indicates the importance of the grains even in ancient time. The ready growth of some member of this family of plants in all inhabited parts of the world has made the cereals the main dependence for food of both man and beast from time

immemorial. Because of their abundance they are relatively inexpensive and must be used freely when the expense of living cannot be large.

From one-half to one pound of meal and flour together, may be allowed for each member of a family daily. The varying amount depends somewhat on the age and occupation of the individual, but especially on the other foods consumed. For example, when many potatoes are used, less starch food in the form of grains is required. About one barrel of flour, or over four bushels of wheat, is estimated to be the average annual consumption of each person in the United States.

Probably mankind first ate the raw kernels of grain, and perhaps accidentally discovered the improvement in flour made by roasting or parching them. The crushing of the grains between stones must indicate a higher degree of civilization.

Modern methods of agriculture have developed many forms or kinds of cereal grains which were unknown to our primitive ancestors; but all our boasted civilization can hardly improve the flavor of the ear of sweet-corn roasted over a camp-fire, nor can it devise a more palatable and wholesome luncheon than popped corn.

The mushes doubtless were a much later invention than the simpler forms of bread, for their manufacture implies the use of some form of kettle and that indicates a higher degree of civilization than the thin shapes of bread which could be cooked on hot stones or before an open fire. The many packages of grain combinations ready for the table which are found now on the grocery shelves, tend to make us forget the good flavor of well-cooked cracked wheat and the varied forms in which corn mush or "hasty pudding" may be served.

I. THE NECESSARY INGREDIENTS.

The general term "bread" is applied to a wide range of foods of different forms and flavors. Its history is interwoven with that of the human race and in its variations it has truly been the "staff of life" for generations.

The earliest forms of bread were doubtless those still made by primitive people, or where conditions are crude, as in camp life; examples of such breads are the tortillas of the Mexicans, the Gaelic bannock, and the hockcake of the negro. These types show us the few essential ingredients for any dough — (1) flour or meal, (2) liquid, and (3) usually salt.

Each new cook book presents such a bewildering variety of recipes for bread, cake and similar mixtures that an inexperienced housekeeper naturally looks upon cookery as a most complex art. But the woman who studies domestic affairs closely is able to classify her recipes in much the same fashion in which the scientist groups plants and animals. If we recall the formulas in daily use in our own kitchens, or if we glance over the recipes for doughs in any cook book we may happen to possess — even those given away with patent foods or medicines — we may learn much that will be of practical use in simplifying the processes.

Beside the essential materials already mentioned — flour or meal, liquid and salt — another thing is now-a-days considered necessary, although the primitive forms of bread were made without it. This is what the

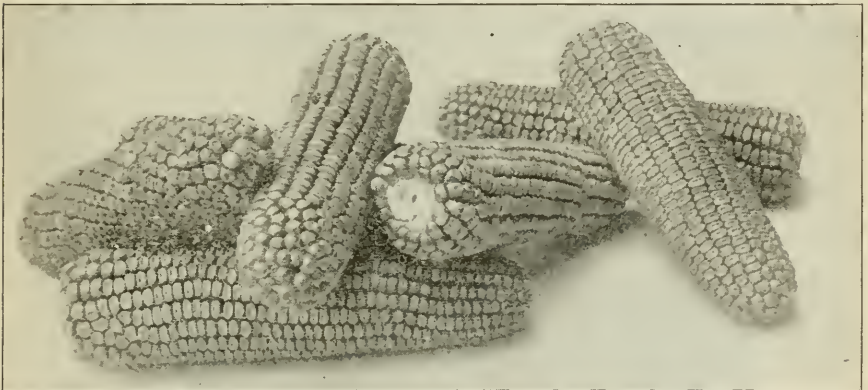


FIG. 155. *Corn, an important cereal, suggests corn meal mush, Indian meal pudding, Johnny cake.*

old-time housekeeper, for want of a better name sometimes called “lightening” — that is, something to separate the solid substance in a loaf, fill it with air, and make it light and porous and thus give it greater palatability and digestibility. The other types of material which produce variation in these mixtures may be briefly described as shortening, sweetening, and seasoning.

All the ingredients then, which, by being combined in different proportions and served in different shapes, give us so many kinds of food, may be reduced to these classes — (1) flour, (2) liquid, (3) air, (4) shortening, (5) sweetening, and (6) seasoning. Let us consider each of these from the standpoint of the housekeeper.

Not many generations ago each household provided itself with flour and meal. Wheat, corn and rye were grown near home, carefully stored and as needed were taken to the grist mill in small lots, because the ground product did not keep so well as the whole grain. Every housekeeper soon learned the quality of the product and the way it would work in her cooking.

Modern milling is a complicated art and each kind of grain may be treated in several ways to adapt it to different purposes. Since the consumer is not now the producer, longer time elapses between grinding and use and there may be losses of flavor not always compensated for by convenience and a finer texture of the finished product. For example, corn is usually kiln-dried to prevent souring after grinding, and thus modern meal has not the good flavor of the freshly ground meal of our grandmothers' time. Because of this change in milling and because it requires long, gentle cooking in any form to be palatable and digestible, we seem to be using corn meal less and less.

Our Pilgrim foremothers discovered that a bread made from a blend of corn and rye meals had certain advantages over that made from either alone, the corn being dry and crumbly, and the rye soft and sticky; and the true Boston brown bread still consists mainly of these two meals.

This brief discussion will suggest many problems to the wide-awake housekeeper, but the subject cannot be pursued in detail here. Several bulletins published by the U. S. Department of Agriculture at Washington, D. C., and various experiment stations, furnish so much valuable information on the subject of flour that it is not necessary to give much space to it now. Some of the publications are as follows:

Bread and Principles of Bread Making, by Helen W. Atwater, Farmers' Bulletin No. 112, U. S. Dept. of Agriculture, Washington, D. C.

Studies on Bread and Bread Making, by Harry Snyder and L. A. Voorhees, U. S. Dept. of Agriculture, Washington, D. C., Office of Experiment Stations, Bulletin No. 67. 10 cents.

Studies on Bread and Bread Making at University of Minnesota. 1899 and 1900. By Harry Snyder, U. S. Dept. of Agriculture, Washington, D. C., Office of Experiment Stations, Bulletin No. 101. 5 cents.

Investigations on Digestibility and Nutritive Value of Bread, by Chas. D. Woods and L. H. Merrill, U. S. Dept. of Agriculture, Office of Experiment Stations, Bulletin No. 85. 5 cents.

Studies on the Digestibility and Nutritive Value of Bread at the Maine Agricultural Experiment Station, 1899-1903, by C. D. Woods and L. H. Merrill. Bulletin No. 143, Office of Experiment Stations, U. S. Dept. of Agriculture, Washington, D. C. 5 cents.

Studies on the Digestibility and Nutritive Value of Bread at the University of Minnesota in 1900-1902, by Harry Snyder, 1903. Bulletin No. 126, Office of Experiment Station, U. S. Dept. of Agriculture, Washington, D. C. 5 cents.

Cereal Breakfast Foods, by L. H. Merrill and E. R. Mansfield. Bulletin No. 84. Agricultural Experiment Station, Orono, Maine.

2. THE FLOUR.

Bread is best made of wheat flour because the grain contains so much gluten, a substance which when moist catches and holds the gas formed



FIG. 156. *The best flour is the most economical. If the bread is poor, let flour take the blame.*

by the growth of yeast, much as beaten egg whites entangle air. Meal is grain coarsely ground; flour is a fine product.

Our average markets offer us four types of meal and flour made from wheat:

Pastry flour is made from the soft, starchy, winter wheat of the Southwest, and is often called "St. Louis" flour. It is best adapted to any doughs which we wish to be especially "short" or tender. Pastry flour feels smooth and soft, and if clasped firmly in the hand will retain its impression,

Bread flour is made from the hard spring wheat of the Northwest by the new or patent process, a modification of the Hungarian system which was introduced in this country about 1870. By means of this process most of the valuable constituents of the wheat remain in high grade white flours. Bread flour has a creamy tinge and a granular texture and will not retain the shape if held in the hand.

Graham meal derives its name from Sylvester Graham, a food reformer of the first half of the nineteenth century. The whole grain is ground and the coarse bran may be used with the rest or separated by sifting.

Whole or entire wheat flours contain more of the outer coatings than white flours, but are finer than graham meal.

The relative merits of these varieties of flour are indicated in the following statements by unprejudiced authorities:

“Graham flour as found in the market is likely to have been made from a soft, winter wheat and will carry much less protein than the Graham made from hard, spring wheat. The entire wheat flours vary with the kind of wheat from which they are made and usually carry one-half per cent less protein than a graham flour would from the same wheat.

“There are imitation graham and imitation entire wheat flours on the market which are made by blending some of the poorer kinds of low grade flours, usually from soft, winter wheat with 25 to 30 per cent of wheat offals.”—*Bulletin 103, Maine Experiment Station.*

“The nutritive value of flour, in so far as the quantities of digestible protein, fats, and carbohydrates, and available energy are concerned, is not increased by milling the wheat in such a way as to retain large proportions of bran and germ.

“The differences in the amounts of total nutrients furnished the body by the various grades of flour are, however, relatively small, all grades being quite thoroughly digested.

“The coarser flours have a tendency to increase peristaltic action and are on this account especially valuable for some persons.

“Judged by composition and digestibility, all the flours are very nutritious foods, which experience has shown are wholesome as well. The fact must not be lost sight of that using different grades of flour for bread making offers a convenient method of adding to the variety of the

daily diet, a matter which is of undoubted importance."—*Bulletin No. 126, Office of Exp. Stations.*

3. THE LIQUIDS.

The liquids for mixing flour into a batter or dough are usually water or milk, or a mixture of the two. Skim-milk may be used for this purpose. Milk makes a more substantial bread than water. The crust of a dough made with milk is browner and tenderer than of one made with water. The measure of liquid is generally taken as the means of determining the number of loaves of bread to be made, because of the variability of the flour. Eggs supply liquid for mixing some cakes. Molasses

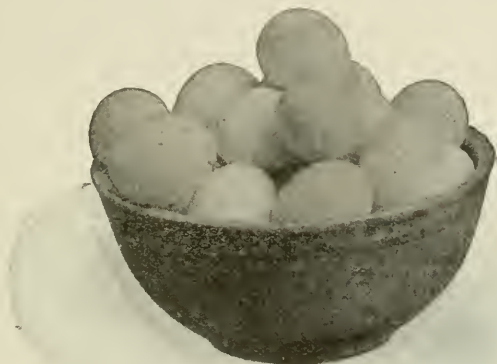


FIG. 157. *Fresh eggs are the cook's delight.*

in a dough must be counted on the side of liquids, though, being denser, it will make a much stiffer dough than the same amount of water.

One test for the strength of a flour is the amount of liquid it will take up. Bread flours will absorb more than pastry flours. In bread making, it usually requires four times as much pastry flour as liquid to make as stiff a dough as would be secured with three measures of bread flour to one of liquid.

4. THE LIGHTENING.

The agencies used to make doughs "light," to introduce air or gas through a mixture of flour and liquid which would be solid and indigestible, are few, but they differ so much in their characteristics that they afford one of the best means of classifying our many recipes for bread, muffins and cakes. Here we shall consider them in the order in which they seem to have been discovered by the human race.

The processes of making bread light are of three general kinds: (1) by means of yeast; (2) by means of working air into it mechanically; (3) by means of bicarbonate of soda.

4a. Bread-making with yeasts.

Yeast or leaven appears to be the most ancient article used to make doughs light, and, like many another necessity of the present day, its power probably was discovered by accident. Perhaps some primitive cook left some of her dough of meal, water and salt unbaked from one day to the next and thus the ferments or wild yeasts of the air had a chance to begin their work upon it. The result would be a more palatable dough than that household had known before, and that plan would naturally be followed thereafter.

From such experiments were derived the processes known as "salt rising," and "milk emptins," which are still extant in some sections of our country, but which are seldom managed in a way to result in whole-

some bread. The leaven of the Israelites mentioned in the Bible appears to have been a portion of the raw dough kept to start fermentation for another baking. From the wild yeasts and from leaven, our modern home-made and commercial yeasts have been evolved.

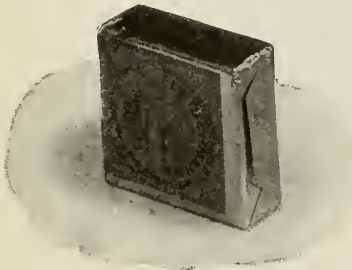


FIG. 158. *The modern yeast cake.*

Many housekeepers still make the liquid yeast which was the dependence of all a generation or two ago. The foundation of this yeast is a starchy fluid made from flour, or boiled and mashed potatoes, or raw potatoes grated and scalded with boiling water. Hops or ginger were often added to this, probably with the effect of preventing undesirable fermentation, but later recipes depend principally upon salt for this purpose. A small amount of sugar was added to aid the growth of the yeast. When the mixture had cooled to a point at which there was no danger of destroying the efficiency of the yeast, a small portion of the previous lot was added and the whole kept in a warm place until it became "lively."

The dry yeast cakes which still have a place in country grocery stores were devised to keep yeast for a longer time than was possible in a liquid form. These are usually made by stirring corn meal into a good liquid yeast until it can be shaped into cakes, and these are allowed to dry.

To use dry yeast, the most satisfactory way is to make a cupful of flour paste or of potato like that for liquid yeast, and start it with a portion of a dry cake. When that is foaming, use like liquid yeast. To rise over night, a half pint of good liquid yeast may be used with one quart of milk or water—for a shorter time equal quantities of yeast and other liquid may be combined.

At the Centennial Exhibition in 1876 a bakery was established by a foreign firm to show the excellence of its bread and yeast; and thus indirectly, the square yeast cakes, solid, but so moist that it is necessary to protect them by wrapping in tinfoil, were introduced in the United States. To-day this form of yeast is used mainly in the large cities, and even in small villages it may be found fresh at least once a week. Some isolated housekeepers who cannot secure it nearer home, have had it mailed to them from the nearest large town, considering its uniform good quality and the convenience worth all it cost them. The action of this type of yeast is so rapid that it is often difficult for those accustomed to slower methods to learn to use it, but the quality may be varied according to the time available.

To use yeast intelligently, we must realize that it is a form of plant life and if we wish it to grow, it must be treated as a plant—that is, it must be supplied with moisture and warmth. When the yeast has done its work and filled the dough with a gas given off in its development, it should be promptly killed by the heat of the oven. The chief objection ever brought against the use of yeast is that loaves are often made so large or baked so quickly that the yeast is not fully killed in the oven and further fermentation interferes with digestion.



FIG. 159. *Yeast plants highly magnified.*

interferes with digestion.

The yeast plant is a fungus somewhat allied to the molds, but microscopic. It still retains life in a dry or quiescent state, as in yeast cakes. Under the influence of heat and moisture it grows rapidly, giving off gas that puffs up or "raises" the dough.

To insure satisfactory growth of the yeast, the temperature should be as uniform as possible and be kept near 70° F. Therefore, both flour and liquid may be warmed before mixing, especially in winter. If the room is cold, the pan of bread should be set in another of warm water, to which more hot water may be added from time to time to keep an even heat.

A small amount of sugar helps the action of the yeast, while more sugar or much salt retards the process. Shortening is not essential, especially when the liquid used is whole milk. When shortening is to be used, melt it in the warm liquid instead of rubbing it into the flour, for nothing is gained by that process and time and strength are lost.

The flour may be put in until we have a dough stiff enough to knead, using about three times as much flour as liquid; or half the flour may be stirred in at first and when that "sponge" has risen until foamy, the remainder of the flour is added. This is often a convenient division of the process for a busy woman: she may mix a sponge before breakfast when she would not have time to finish a stiff dough, the mixture thus getting a better start than if nothing were done until after breakfast; later in the day, the remainder of the flour may be worked in and when that dough has risen until double in bulk, the loaves or rolls are shaped and put in the pans to rise again before baking. With one compressed yeast cake to a pint of liquid and three pints of flour, the whole process may be accomplished inside of five hours. The time must be extended in proportion to the reduction of the yeast and the lowering of the temperature.

The patent bread mixer is a helpful device when large quantities must be made. The housekeeper can put in the deep pan the right proportions of salt, sugar, lukewarm liquid and yeast and measure out the sifted flour in another pan. Then stronger hands than hers are often ready to turn the handle and thus mix the dough.

Other raised doughs conform to the same general rules. Bread flour should be used in preference to pastry flour when yeast is called for.

Entire wheat flour may be used like bread flour. Graham meal or rye meal are better mixed with bread flour than when used alone. The addition of much sugar or shortening tends to retard the rising process, hence a larger proportion of yeast may be used in such cases.

To secure uniform results of the highest type, a thermometer is as useful to the bread maker as to the butter maker. Bread making is a simple process, and it may be adapted to tastes and conditions without seriously affecting the nutritive value or digestibility of the result. Yet there is too much guess work about bread making due to lack of knowledge of its foundation principles.

4b. Mechanical means of lightening.

The second general means of securing lightness in doughs is that of beating or "folding" in air. The colder the air thus introduced in a batter or dough, the more it will expand when put in a hot oven. Light snow wrapped up in a batter which is cooked on a griddle at once, produces a fairly light griddle cake, but this is more satisfactory if there is also some egg in the batter. Eggs alone produce the lightness of angel cakes and others. The Maryland beaten biscuit and pastry or pie-crust are other examples of doughs in which air is folded in.

The process of making pastry is almost directly opposite to that of bread making. Flour, liquid, fat, and everything which is to come in contact with the dough, should be kept as cold as possible.

The very richest pastry requires equal weights of butter and flour, and this by measure means twice as much flour as butter. Many housekeepers must use a less expensive fat than butter, at least in part; and a good pastry for average use may be made with one measure of fat to four of flour provided it is carefully handled throughout. Half the fat is to be rubbed into the flour, which then is mixed into a stiff dough with ice water, using about one-fourth as much water as there is flour. This dough should then be rolled out and spread with the remaining fat, all at once or with a "folding" between. The cold air folded in with the fat is expanded by the heat of the oven and lifts the dough in flaky layers. Pastry may be kept several days in a cold place before baking, but should be put in a closely covered dish or a dry crust will form on the outside. A hot oven is required for baking pastry.

The capacity of eggs (especially of the whites) to entangle air makes them a valuable aid in making doughs light — popovers, cream puffs, soufflés and many cakes are made light by eggs alone. Many beaters have been devised to help in this process. Some mixtures, however, such as cream puffs, require no separate beating of eggs, only a thorough incorporation with other ingredients. Success in baking this group of doughs depends upon a very moderate oven, since egg hardens at a low temperature and if the oven is too hot a crust forms before the dough has time to rise. But such things must not be taken from the oven until the moisture is well dried out.

4c. Chemical means.

The third way of making doughs light results from the chemical union of bicarbonate of soda with an acid. This is a comparatively modern achievement. Those of us who have inherited our great grandmothers' cook books probably will search in vain for any reference to baking powder. This material, like the modern yeast cake, is an evolution from more primitive substances. Even soda is rarely mentioned in old cook books, but saleratus and pearl-ash are common terms. Some who read this may have heard narratives of the old pioneer days when the housekeeper scraped up the pearl-colored ashes from her fire-place, stirred them up with a little water and after it had settled used the alkaline solution to neutralize the acidity of sour milk in making her "Johnny cake" or doughnuts.

Modern cook books deal so little with sour milk and soda that young, city-bred housekeepers do not realize what good results may be attained by its use and how much of it is wasted. Nor is this as uncertain a process as some would have us think, for the acidity of thick or clabbered sour milk is not very variable. Experience has taught us that one level teaspoon of soda will neutralize the acidity of one pint of sour milk. It has been the common custom to stir the soda into the sour milk and then mix it with the flour, but less of the gas escapes if the soda is sifted into the flour and then the milk stirred in. Every bubble of gas that breaks when the soda is first mixed with the milk leaves just so much less to puff up the mass of dough.

Molasses, notwithstanding its sweetness, is also acid and usually

requires about the same proportion of soda to neutralize it as does sour milk. Some samples require even more. Therefore, in molasses gingerbread, or whenever a considerable quantity of molasses is used, no egg or baking powder is required.

Another acid substance commonly used with soda is cream of tartar. To neutralize each other completely, about nine parts of cream of tartar are required to four of soda; hence, the common rule to use half a level teaspoon of soda with one slightly rounding teaspoon of cream of tartar. When these two substances are mixed together to form baking powder, a little flour or starch is added to keep them apart; therefore it usually requires two or even three teaspoons of baking powder to do as much work in "lightening" a dough as would be accomplished by the rounding teaspoon of cream of tartar and the half level teaspoon of soda.

We may buy "prepared flour," which is pastry flour with baking powder sifted through it. Some housekeepers take a hint from that and prepare flour for themselves, ready for use in a hurry. Three or four level teaspoons of baking powder to each pint of flour is ample when no other raising agent is to be used — when eggs are to be added the proportion should be reduced. All doughs of this type should be cooked as soon as mixed, as the gas escapes if the mixture is allowed to stand.

5. THE SHORTENING AND OTHER INGREDIENTS.

Since we have briefly reviewed the ways in which doughs are made light, let us now see how they are affected by shortening. We grease a pan that the pudding or whatever is cooked in it may not adhere. A similar effect is produced when grease is mixed with flour and other ingredients in a dough — the particles separate readily after cooking or break off short and make a "tender" biscuit or cake.



FIG. 160. *Assorted cakes.*

When no fat is used, the bread or muffin has more elasticity and must be pulled apart and we say it is "tough."

The shortening power of different fats varies somewhat; butter contains water and curd and is proportionately less efficient than an equal weight of lard. The harder a fat is at ordinary temperatures, the less apparent it is in a dough.

Sour cream must be neutralized with soda, like sour milk, and other fat in the dough decreased in proportion to the thickness of the cream. The colder the fat is kept in any mixture containing a large quantity, the more readily the dough may be rolled. Warm fat sticks to anything with which it comes in contact.

Sweetening has already been referred to; it tends to make a dough dense, and retards the action of yeast. Many cakes are made "heavy" by an excess of sugar.

Mainly by changes in "seasoning" do we secure the many variations of the fundamental processes already described. Under this head may come all the spices, extracts, dried fruits and nuts.

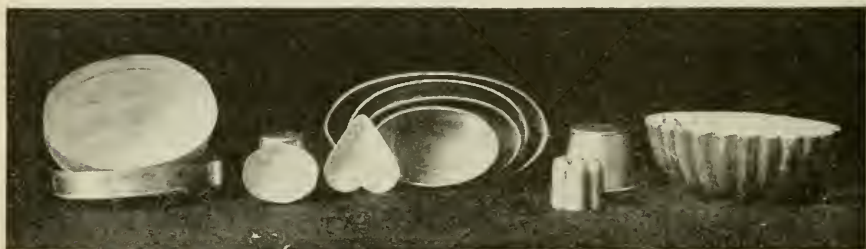


FIG. 161. *Fancy moulds.*

Every housekeeper sometimes has occasion to modify recipes to adapt them to the size of her family and depth of her purse. Too often this is done by guess with poor results; but it is another matter to use "judgment," a favorite word with our grandmothers, meaning the ability to apply the skill acquired by experience.

6. KNEADING AND SHAPING THE LOAVES.

A most important part of the making of batters and doughs is the shaping and handling necessary to secure the familiar forms in which they appear on our tables. Proper manipulation is just as essential as the right proportion of ingredients, and this cannot be learned from a printed formula, however full it may be. Such skill is acquired only

by actual practice and is as necessary to secure good results in this field as with any musical instrument. Skilled hands can produce toothsome results from meagre materials. This explains how a woman too ignorant to be able to read a recipe may, through long continuous practice, secure



FIG. 162. *Moulds from old tin cans. Good shapes for puddings.*

more appetizing results than those from the hands of the college graduate who understands the fundamental chemical theory but has had no opportunity to train her hands. Deft hands can shape a soft dough, while untrained ones constantly work in more flour; and the stiff dough



FIG. 163. *Bread case for meat pie.*

requires a larger proportion of shortening and of baking powder, if that be the raising agent used.

The form in which a cake or pudding is to be cooked has an influence on its composition. If it be put in individual pans or thin layers, the mixture need not be so stiff with flour as if all is put in one deep pan.

The cooking of doughs is another important process. In general, the larger the shape the more gradual should be the application of heat. Yeast doughs which are well risen before they are put in the oven, should there meet heat sufficient to check at once all fermentation; but loaves should not have so hot an oven as rolls or the outside may be burned before the heat penetrates the center. Too great heat may cause loaves to crack; and a thick crust acts as a non-conductor of heat and the center of the loaf is liable to be soggy. Rolls placed close together in a pan are much the same thing as a loaf, so far as the penetration of heat is concerned; but when buns or rolls are some distance apart on the pan, currents of hot air can pass between them and the baking is shorter and more thorough.

The same principle applies to crowding an oven — there should be some space between loaves of bread and cake for the heated air to circulate. For long periods of baking — loaves of fruit cake for example — new pans absorb less heat, paper linings act as non-conductors; and to lower the temperature of the oven still more a pan of water may be placed in it. Such cakes are often steamed because the temperature is then lower than that of an oven. On this account it is wise to use small shapes for puddings and brown bread that are to be steamed. These cook through more quickly and there is less danger of settling from jarring the stove or if the kettle stops boiling for a moment.

Frying is another interesting process for doughs, but here the danger is that the fat may be too hot and the dough will not have time to rise enough before a thick crust forms, or if the fat is not hot enough that it will be absorbed by the dough.

7. GATHERING THE FRAGMENTS.

If we count the labor involved in the cultivation and milling of grains as well as in their preparation in our kitchens for the table, we shall realize that it is wrong to allow such food to be wasted, as it is in some households. The garbage carts in any large city contain many large portions of loaves, beside smaller bits of bread. In the country such scraps are not wholly lost for they are fed to chickens, but even this means a waste of labor.

The trained cook knows the value of dry bread for many purposes: a paste of white crumbs softened in milk or starch is the basis of delicate puddings and soufflés; the bit of crisp toast is a welcome addition to many meats and vegetables; cases cut from bread are more wholesome than those of pastry for serving creamed meats, etc.; crisp golden brown croutons are acceptable with soups; and all the crumbs and crusts may be used for crumbing croquettes or as a finish for scalloped meats, fish and vegetables. Let us gather up these fragments.

8. TABLES OF COMPOSITION.

That the composition and nutritive value of bread may be studied, the following tables are quoted from bulletins published by the Office of Experiment Stations, United States Department of Agriculture:

Digestibility of Different Kinds of Bread.

*Comparison of nutrients digested and energy utilized in different kinds of bread.*¹

KIND OF FOOD.	Number of experiments.	NUTRIENTS DIGESTED.			Energy utilized.
		Protein.	Fat.	Carbo-hydrates.	
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
White bread alone	4	82	70.7	98.4	92.2
White bread with milk	9	88.3	66.6	98.2	94.8
Graham bread with milk	6	77	58.1	92.4	88
Entire-wheat bread with milk	5	86.6	46.2	97.2	94

¹ Maine Ste. Rpt. 1898, p. 207.

Chemical Composition.

The chemical composition of the finished loaf differs somewhat from that of the original ingredients. The following table shows the difference in composition between flour and bread:

*Average composition of white bread and of the flour from which it was made.*¹

	Water.	Protein.	Fat.	Carbo-hydrates.	Ash.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Bread	35.3	9.2	1.3	53.1	1.1
Flour	12.0	11.4	1.0	75.1	.5

¹ U. S. Dept. Agr., Office of Experiment Stations, Bulletin 28 (rev. ed.).

Comparison of the Composition of Breads and Other Foods.

To show the difference in the proportions of the different food ingredients in various foods, it may be well to compare the analyses of bread and other foods as given in the following table:

Composition of various food materials.¹

	Number of analyses.	Refuse.	Water.	Protein.	Fat.	Carbo-hydrates.	Ash.
		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
Corn bread (johnnycake).....	5	.....	38.9	7.9	4.7	46.3	2.2
Rye bread.....	21	.....	35.7	9.0	.6	53.2	1.5
Rye and wheat bread.....	1	.....	35.3	11.9	.3	51.5	1.0
Wheat bread, "gluten".....	6	.....	38.2	9.3	1.4	49.8	1.3
Wheat bread, "graham".....	27	.....	35.7	8.9	1.8	52.1	1.5
Wheat bread, "rolls".....	20	.....	29.2	8.9	4.1	56.7	1.1
Wheat bread from high-grade patent flour.....			32.9	8.7	1.4	56.5	.3
Wheat bread from regular patent flour.....			34.1	9.0	1.3	54.9	.7
Wheat bread from bakers' flour.....			39.1	10.6	1.2	48.3	.9
Wheat bread from low-grade flour.....			40.7	12.6	1.1	44.3	1.3
Wheat bread, average, all analyses..	198	.....	35.3	9.2	1.3	53.1	1.1
Whole wheat bread.....	12	.....	38.4	9.7	.9	49.7	1.3
Crackers.....	71	.....	6.8	10.7	8.8	71.9	1.8
Beef, ribs:							
Edible portion.....	15	.....	55.5	17.5	26.6	.....	.9
As purchased.....	8	16.8	39.6	12.7	30.6	.....	.6
Veal, leg:							
Edible portion.....	19	.....	71.7	20.7	6.7	.....	1.1
As purchased.....	18	11.7	63.4	18.3	5.8	.....	1.0
Mutton, leg:							
Edible portion.....	15	.....	63.2	18.7	17.5	.....	1.0
As purchased.....	15	17.7	51.9	15.4	14.5	.....	.8
Cod steaks:							
Edible portion.....	1	.....	79.7	18.7	.5	.....	1.2
As purchased.....	1	9.2	72.4	17.0	.5	.....	1.0
Hens' eggs:							
Edible portion.....	60	.....	73.7	13.4	10.5	.....	1.0
As purchased.....		11.2	65.5	11.9	9.3	.....	.9
Butter.....			11.0	1.0	85.0	.....	3.0
Milk, whole.....			87.0	3.3	4.0	5.0	.7
Potatoes:							
Edible portion.....	136	.....	78.3	2.2	.1	18.4	1.0
As purchased.....		20.0	62.6	1.8	.1	14.7	.8
Apples:							
Edible portion.....	29	.....	84.6	.4	.5	14.2	.3
As purchased.....		25.0	63.3	.3	.3	10.8	.3
Chocolate, as purchased.....	2	.....	5.9	12.9	48.7	30.3	2.2

¹ U. S. Dept. Agr., Office of Experiment Stations Bull. 28 (rev. ed.).

Chemical Composition of Milling Products.

The accompanying tables show the chemical composition of various milling products and American wheat flours:

*Analyses of wheat and the products of roller milling.*¹

	Water.	Protein.	Fat.	CARBOHYDRATES.		Ash.
				Starch, etc.	Crude fiber.	
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Wheat as it enters the mill.....	9.66	14.18	2.61	69.94	1.70	1.91
First break.....	8.23	14.18	2.68	71.56	1.62	1.73
Sixth break.....	7.66	16.28	5.34	59.42	5.60	5.68
Bran.....	10.91	16.28	5.03	56.21	5.98	5.59
Tailings from reduction No. 5.....	12.12	16.63	3.85	63.93	1.18	2.29
Second germ.....	8.75	33.25	15.61	35.19	1.75	5.45
Entire-wheat flour.....	11.4	13.8	1.9	71.0	.9	1.0
Graham flour.....	11.3	13.3	2.2	70.5	.6	1.8
Patent roller-process flour.....						
Bakers' grade.....	11.0	13.3	1.5	72.0	.7	.6
Family and straight grade.....	12.8	10.8	1.1	74.6	.2	.5
High grade.....	12.4	11.2	1.0	74.7	.2	.5
Low grade.....	12.0	14.0	1.9	70.4	.8	.9

¹ U. S. Dept. Agr., Division of Chemistry Bull. 13, pp. 1226-1228, and Office of Experiment Station's Bull. 28 (rev. ed.), pp. 57, 58.

It is of interest to know something of the composition of the grain from which flour is made. Not only is the skill of the miller a factor in the making of good flour, but the character of the grain has much to do

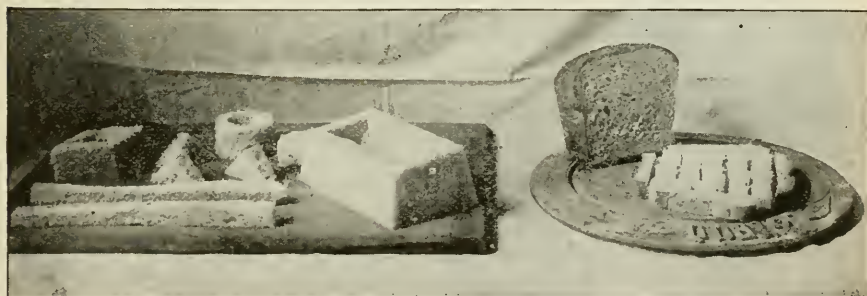


FIG. 164. *Ways of using stale bread.*

with the quantity and quality of the flour. The expert miller determines the quality of the flour not only from the color of the grain, but from the amount of gluten.

Notice in Fig. 165 the section of a grain of wheat showing the outer layers which are separated by the miller into "bran." This bran, although rich in some nutritive materials, contains so much fibrous substance that it is not easily digested by the human being, but the lower animals derive much nutriment from it. The use of flour containing bran is to be commended to some extent, for it hastens peristaltic action. It is also true that the nutritive salts of the wheat are contained largely in the bran, and for this reason it is well at times to eat bread which contains some bran. If too much is used, the hurried peristaltic action hastens the food through the system before the nutriment is fully absorbed.

The kernel called the endosperm (d) contains much starch, some sugar, and also the gluten which is a valuable nitrogenous substance.

In the starch of the wheat lies much of the nutritive ingredients of bread.

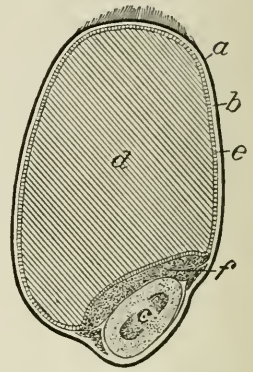


FIG. 165. Section of grain of wheat: a, skins and testa; b, membrane; c, embryo; d, endosperm; e, cereal or aleurone layer; f, scutellum. Figs. 159, 165 and 166 from U. S. Dept. Agric.

The germ or embryo (c) is the active part in germination. If present in the flour, the commercial value is lessened, as it gives a dark color. Rich in fat, it may cause the flour to have a rancid taste.

The grains of related cereals are in a general way not much unlike the wheat. Their layers differ in thickness. The corn (Fig. 166) is richer in fat and poorer in protein than the wheat. While it makes good Johnny cake and corn bread, it does not contain the essential characteristics to make a good raised bread, and is deficient in bone-making material.

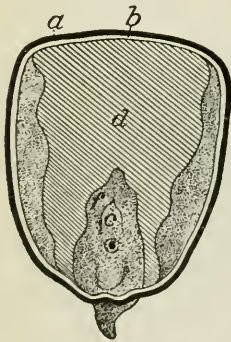


FIG. 166. Section of grain of corn: a, skin and testa; b, membrane; c, embryo; d, endosperm; f, scutellum.

SUPPLEMENT TO
CORNELL

Reading-Course for Farmers' Wives

PUBLISHED BY THE COLLEGE OF AGRICULTURE OF CORNELL UNIVERSITY,
FROM NOVEMBER TO MARCH, AND ENTERED AT ITHACA AS SECOND-CLASS
MATTER UNDER ACT OF CONGRESS OF JULY 16, 1894. L. H. BAILEY, DIRECTOR.

MARTHA VAN RENSSELAER, *Supervisor.*

SERIES IV.
THE FARM TABLE.

ITHACA, N. Y.,
NOVEMBER, 1905.

No. 17.
FLOUR AND BREAD.

DISCUSSION=PAPER.

To be returned to Farmers' Wives' Reading-Course, Cornell University, Ithaca, N. Y.

This Discussion-paper, accompanying the Bulletin on Flour and Bread, may be returned with answers to the question and with any suggestions and questions of your own. While the answering of these questions is not absolutely necessary, a much greater benefit will be derived if you give to others the benefit of your own experience. As a member of the Reading-Course you will be credited by us with the work done. It will also help us to understand your point of view.

As this is the fourth year of the Reading-Course for Farmers' Wives, it is time for very sincere work on the Bulletins. Anything short of the answering of the questions of the Discussion-paper and more or less research work will not be satisfactory, I am sure, to the reader. Read carefully the Bulletin on Farmers' Wives' Clubs (No. 16), and see if you cannot associate with you some one or more persons who will study the same Bulletins. Be sure to let us hear from you. You may desire to ask questions regarding your own experience in home work, or the application of principles set forth in the Bulletins.

With best wishes for a pleasant and profitable year, I am,

Very cordially yours,

MARTHA VAN RENSSELAER,
Supervisor Farmers' Wives' Reading Course.

- I. Give a list of the different forms of cereal foods used on your table for the past six months.

2. Estimate the amount of meal and flour consumed by each member of your household during one week or month.
3. In your home, how does the expense of this type of food compare with that of meats?
How would you compare the labor of preparation of the two classes of food?
In which do you find most pleasure?
4. To what extent do you use mushes, rice, macaroni, as substitutes for bread and potatoes?
5. Which way of making doughs light do you find most satisfactory for your own use?
6. When and how may we economize in the use of shortening?
7. When are eggs essential and when may they be omitted in batters and doughs?
8. If you have any bits of bread, cold mush, etc., left over, how do you turn them to good account?
9. How do you proceed when you wish to introduce to your family a new food?
10. Where and how have you secured the recipes which are most useful in your household?

Name.....

Address.....

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SERIES IV.
 THE FARM TABLE.

ITHACA, N. Y.
 DECEMBER, 1905.

No. 18.
 DUST AS RELATED TO FOOD.

DUST AS RELATED TO FOOD.

Every garden has its weeds. Where the seeds all come from is a never-failing mystery to the gardener. These weeds are all large enough to be seen, and one can destroy them with the rake or the hoe. There

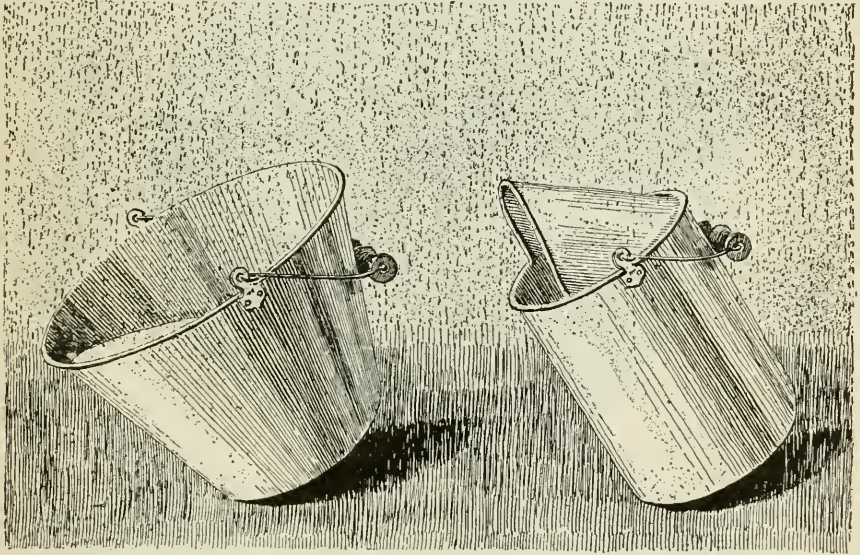


FIG. 167.—How dust gets in the milk with the old-fashioned milk pail, and how it is kept out by the new-type covered pail.

are other weeds, however, that are nearly or quite invisible, and the gardens in which they grow may be food on our tables. The germs from which these weeds arise may be floating in the air, so small that we cannot see them. They cling to the particles of dust, and when the dust falls they are planted. Let us study these dust-gardens.

I. THE DUST-GARDEN.

By S. MARIA ELLIOTT;

Glass boxes fitted loosely with glass covers through which much that goes on inside may be seen are shown in Figs. 168 and 169.

One day they served as garden beds. The soil was a kind of beef-broth jelly. The seed was ordinary dust from an ordinary room.

The covered box had been baked for over an hour in a very hot oven. The jelly had been steamed a number of times, until no possible living thing could be therein.

Fig. 168 shows a dust-garden planted after the room had been carefully swept.

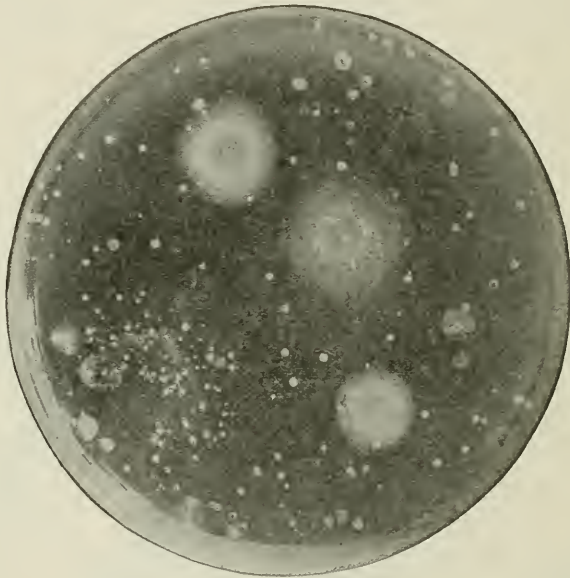


FIG. 168.—*What grew in a dust-garden.*

When the cover was removed and the dust, raised by the broom into the air, was allowed to settle on the soft sticky jelly, something happened.

In about twenty-four hours little specks appeared which rapidly or slowly grew larger and developed different colors. Unfortunately, the photograph does not give the delicate greens, yellows and blues which the different spots showed. As they grew larger, some spots showed a feathery or velvety surface, and, like the one at the left side, a dark center with dust flying from it.

The other spots were shiny, wet or waxy in appearance, and never showed any increase in height, or any dark, dusty center,

Every housewife who has seen mold on her bread, her jelly, in her pickle jar, or possibly on shoes and books, will mistrust that the velvety, dark-centered spots are of similar nature. Molds spread their cells over the food supply, occasionally sending a few cells down into the substance, and others upward. From the tops of the upright cells grow others and in or on them are formed the thousands of dust-like specks called spores. Each of these may start a new bed of mold.

The infinitely tiny spores falling upon some soft substances as cheese or bread will send their invisible lacy threads down into the substance, while on books, leather, wood, cloth, they may grow only over the surface and may remain visible.

The other spots in the dust-garden are colonies of bacteria. Each spot shows where one plant or cell touched the jelly. This fed, and



FIG. 169. — *Another dust-garden.*

divided itself in the middle. These two repeated the process until perhaps there were a hundred or more. Then a tiny pin-point speck became visible. No one ever saw, with the naked eye, a bacterium or a mold spore.

A dust-garden is shown in Fig. 169 with soil exactly like that in Fig. 168, but the dust which planted it was thrown into the air by using a feather duster.

Dust-gardens everywhere

We will now transfer our attention to the dining-room and the kitchen. The dust that is thrown into the air by a wrongly used, dry broom, or by a feather duster, will grow nearly as well in our milk, apple-

sauce, on our jelly or bread as in this glass box. If, however, the dust is wiped off the floor, tables, chairs, etc., into a cloth where it is held until washed out, it will never reach the sauce and other foods. If the cloth be slightly damp or oiled, it will take and hold the dust much better.

The pictures do not show a third kind of plant which, especially in the country, is often present in house dust. This is yeast — also a single cell, but reproducing by little buds which swell out from the parent cell and may or may not break off later on. Those which float freely in the air, both inside and outside of the house, are called "wild yeasts." So far as shape, size and method of reproduction is concerned, they are little different from the cultivated yeast plants which are used to raise bread or to give the "sparkle" to sweet fermented liquids, as beer.

As the invisible yeast plants can remain alive for a long time without moisture, we may have them furnished to us in dried cakes as well as in the fresh compressed form.

Today, even with the cultivated yeasts, the housewife who mixes her sponge in a dusty room, in dusty utensils, with old yeast,— or, with everything clean and fresh, if she lets the sponge rise too long or keeps it too hot,— is likely to have sour bread. The bacteria can grow well when and where the yeast cannot, so that acid will be made out of the alcohol which the yeast makes out of sugar. The yeast plants grow best at a medium temperature, about 75° to 90° F., which is an average "summer heat." Above 90° F. they cannot grow so well, but the bacteria grow better.

The little yeast plant, although so small and simple in structure, is endowed with many of the powers of the trees and vegetables or such higher plants. It requires food, has a certain range of temperature in which it grows best, will be injured or killed by too high or too low temperature, or by too little moisture. If it be given the conditions which are favorable, it will feed, grow rapidly, and reproduce itself by swelling out one portion into a bud which may or may not break away from the mother cell. The most favorable temperature for the rapid growth of yeast plants, as already said, is from 75° F. to 90° F. Below this it will not grow rapidly and therefore cannot do much work. At much above 90° it will be killed and dead plants cannot work any more than dead animals.

The work of the yeast plants is to change the sugar in the sponge into two substances — alcohol, and a gas which is called carbon dioxide. The millions of little bubbles cannot break through the sticky gluten of the flour, so they raise the whole mass. When the bread is baked the gas is dissipated, the gluten walls of these bubbles are hardened and the little holes remain, filled only with air. The alcohol, too, is driven out by the heat.

It is very difficult to keep weeds out of the vegetable garden because their seeds are carried to the soil in so many ways. When they have sprouted or grown a little, they may be pulled up easily. In the bread-garden we want only yeast to grow, but it is very difficult to have this, when neither the good plants nor the weeds ever become visible.

The chief enemies are the bacteria. They are in the dusty air of the kitchen, on the bread pan, the spoon, the cup, in the milk,— yes, and in the yeast, too, whether it is the dry or the compressed.

The wise housekeeper will be careful not to sow many bacteria in her yeast garden. She will scald the milk or boil the water, letting it become cool before she puts it with her yeast. She will have clean dishes in which to measure and to mix her bread. She will not sweep nor do any dirty, dusty work in the room just before she mixes it, because the bacteria will be raised into the air and then settle. She will carefully cover the dough while it is rising, to keep out the dust. With all her care there will always be some bacteria present, but these do not like the sugar solution very well and they want a higher heat than the yeast plants, but they do like the alcohol which the yeast makes, so that the dough should be kept at about summer heat only long enough for the yeast to make a sufficient amount of gas. If the dough becomes too hot so that the yeast cannot work well, or if it is allowed to stand too long, the bacteria will feed on the alcohol and turn it into an acid—the acid which is in vinegar. Then the housewife has sour bread.

There are poor kinds of yeast, and if a poor kind gets in it will make a bad tasting bread.

Do any of you still make the “ salt rising ” bread or “ milk emptins,” which years ago our grandmothers made? The “ barm ” made delicious bread, but “ it never kept well.” No, because it was then, and is now, made to rise by the wild yeasts, but the bacteria with the yeasts fell into it from the air, or perhaps were in the milk, and they soon made it sour or even putrid.

The yeast plants perhaps do more work which the housewife likes than either molds or bacteria, but she must not suppose that these last are enemies only. She owes much to both of them, because their chief work in the world is to feed on and, by so doing, decompose or break up useless, organic substances. Bacteria, especially, are scavengers, and molds soften hard parts and make the work of the bacteria easier and more thorough. When organisms work on material which we are glad to be rid of, we appreciate the result but do not give them the credit. But whether these extraneous organisms are directly injurious or not, many of them are no proper part of our food and should be looked on as a contamination.

Because they go on with their appointed work when and where we do not want them to, we think of them as only enemies. Bacteria do sour our milk, taint our meat, rot our potatoes and apples, while molds spoil our bread, our cheese, soften the cucumbers waiting to be pickled, and possibly spoil the best tablecloth laid in the dark, warm drawer; but we owe to bacteria our vinegar, our June-flavored butter, and the "retted" flax from which the tablecloth was made.

The molds: larger forms of plant growth

There are other invisible plants besides the bacteria and yeasts in the air. These are the molds, and they will get into the dough, also. If the bread be baked long and thoroughly, all these plants are killed, but if not, some will be left alive in the middle of a thick loaf and they may sour or mold the bread even then.

The writer once cut a new loaf of Graham bread bought from the baker and found a large spot of mold when she reached the center slice. She felt sure that the bakery or the dishes and meal were not clean. She knew that it was not sufficiently baked. The mold spores are so tiny and light that the air almost always has some of them in it.

No wonder the bread or cake left some time uncovered on the table becomes moldy when it is finally put into a dark box or jar! It will not mold if it is perfectly clean and dry; so that if we want to keep bread for crumbs, we dry it thoroughly in the oven or on the back of the stove. But while here it should be covered with at least one thickness of cloth to keep off the dust.

Molds will find moisture enough almost anywhere to help them start into growth. They and the wild yeasts are in numbers on the skins of fruit. If we put the apples, lemons, oranges, etc., in warm places, the mold plants will grow and soften the skins so that they are easily broken. Then the bacteria or more molds can reach the inside pulp and the fruit decays or rots.

The grapes on a bunch touch each other, so there is less air and more moisture between them in such places. Here the mold plants start first, and from one such place enough spores will be made to spoil a whole basketful of fruit in a short time. Lemons and oranges, as well as other fruits, may be kept for weeks, even in dogdays, if each is wrapped in paper and put in a cool place.

Apples or any other fruit may be preserved much longer if they do not touch each other. This is possible with small quantities. With large quantities in a mass there must be greater care to keep them from "sweating." They need to be kept as cold as possible and yet kept from freezing.

The woman who finds her cucumbers softening either before or after they are in vinegar may well think how she could have prevented the molds from settling there. Possibly, if she scalds the vinegar and pours it back over the pickles, she may kill the plants which are doing such work.

We cannot expect to be able to keep bread from molding in the jar or box which is not frequently scalded and sunned. The mold spores, ready for work, will lurk in the corners and the angles.

All food storage places should be kept as free from dust as possible, dry, cool, and supplied with fresh air, if we do not wish to lose the food by mold or decay.

If the drops of milk, gravy, molasses and other liquids, crumbs of bread, bits of meat, grains of sugar, etc., are not wiped from the shelves and floors, bacteria and molds will soon be so plentiful in such rooms that no foods can be kept there long without souring, fermenting, molding, or becoming rancid.

One common place for the storage of food supplies is the house cellar. If the cellar were always light and dry, sunny and well aired, there would be much less danger from molding squashes, rotten potatoes, turnips, cabbages, apples, onions or other vegetables and fruits; but too often this hole in the ground has only an earth floor with boards put down to walk on, possibly no windows, or a small one closed in winter by the "banking" outside. Never a ray of sunshine to kill the bacteria and molds — fortunately the wild beasts do not like such dismal quarters! The decaying vegetables in these cellars are thus constantly "weaving shrouds for the upper chambers." The farmer has these vegetables in such quantities that he does not always feel his loss of food supply, but this is joined with dangerous conditions for the health of himself and family. Sometimes the conditions are so bad that from the open cellar door there always comes the smell of rotting potatoes, squashes or carrots. This, then, is not only wasteful, but criminally careless of human lives and health. We ought either to keep such supplies away from our house cellars or keep the cellars in such condition that these dust plants cannot thrive. They love darkness, and their deeds are always evil under such conditions. Some of the foreign cheeses which "smell to Heaven" are really made to putrefy in similar damp, dark, mold-infested caves.

Suggestions as to cleanliness and germ-prevention

All spores are so light that a slight wind will blow them about; but they are heavier than air. They will therefore settle, and in settling will be caught by any exposed surface. This shows us how foolish we are when we sweep the floor just before we take the bread or pies from the

oven, the sauce from the kettle, or just before we lay the table for a meal. We cannot sweep a floor with a stiff, dry broom without stirring up some of these invisible kinds of molds and bacteria, and a number of them, few or many, will certainly be caught by the food. Some of them may be distinctly injurious to health. It is dust-plants in the air which seed plentifully our food supplies.

Of course the dishes and tables, the hands and all utensils have germs on them; and so, when canning we must be careful to have the work done in a room as dust-free air as possible; thoroughly to scald or boil the fruit, the jars and the covers; to keep the fingers from touching the inside of cover or edge of the jar's mouth. Even the sugar, if not cooked with the fruit, may carry the yeast cell, the mold spore or the bacterium which will later spoil the contents. That rhubarb and cranberries may be canned raw and not spoil is because they have so much acid that the dust-plants do not like them. If sugar is added, there comes danger. The yeast plants may then ferment the fruit to alcohol, and a bacterium be able to make the alcohol into vinegar.

Given food, moisture and warmth, these little plants multiply with almost infinite rapidity. If food is scarce, if drought or cold come, many of them can accommodate themselves to the hard times by contracting their already minute bodies into still smaller space and thus they can survive for long periods. Life is present, and as soon as fortune smiles on them in the shape of warmth, moisture and food, they return to their former condition, feed, grow and multiply as before. The active forms are often easily killed, while these resting-spores may resist even boiling or freezing. Thus nature, the kind mother, protects and preserves her children, for each has an important work to do in the world. These innumerable, invisible plants form her army of scavengers which feed upon animal and vegetable matter that is either dead or has lost its normal vigor and therefore tend to threaten the welfare of man.

We can, however, put obstacles in the way of nature's operations. When forewarned, it is, indeed, a careless housewife who will let the enemy gain the advantage. Knowledge is certainly power here. As the plants that work the most harm love darkness, we will flood the house with light; as they must have moisture in order to grow, we will keep everything dry, especially the corners, cupboards, closets, storerooms and boxes that are dark. As they grow best in a warm place, we will keep perishable material as cold as possible. If we let light into such places, they will not only be drier, but we can see their condition. The first point of inoculation may be a damp dishcloth, towel, floor-mop or other damp fabric put under the sink to be "out of sight," in the clothes hamper, or in the "cellarway." It may be a few drops of milk, a little gravy or

sauce spilled on the stairs or on the cupboard shelf, and not soon wiped up. Dust is always present in the house; bacteria and molds are seldom absent from that dust. Bacteria with the greasy dampness, soon produce a sour or rancid dishcloth; mold and moisture produces the mildewed towel; the moldy shelf will soon fill the cupboards with odors. All such articles furnish food for these dust-plants.

II. THE CONTAMINATION OF MILK BY MEANS OF DUST.

PROFESSOR R. A. PEARSON.

Modern sanitation tries to eliminate dust, and to remove lodging places for it. Dust-laden moldings and draperies are being eliminated from houses. (See Reading-Course Bulletin 12, for Farmers' Wives.) These ideas are now extending to the barns, and are beginning to revolutionize barn construction and barn management. The first attention should be given to the protection of milk. Dust is not only "dirt," but it also carries germs or bacteria; and all bacteria contaminate the milk and many of them may produce distinct disease or disorder in the milk user.

Very few and often no bacteria are found in the air over large bodies of water. There is very little or no dust in such places. After a prolonged fall of rain or snow which has caused dust to settle, the air is found to be almost or quite free from bacteria. In other words, bacteria are most abundant in the air when dust is present. It is probably safe to say that every particle of dust which floats in the air is carrying a greater or less number of bacteria, just as a raft floating in the water may carry a greater or less number of men. Tyndall suggested this long ago, and the idea is called his "raft-theory."

As has been shown, there is less dust (and therefore fewer bacteria) over water surfaces than over land surfaces. There is little dust and few bacteria at very high altitudes. A French investigator found no bacteria in 100 liters of air at the top of Mount Blanc. But the examination of air in an observatory at that point showed a small number of bacteria.

There are fewer bacteria in country air than in city air. The reason for this is understood when we remember the enormous traffic and the continuous action taking place in the streets and elsewhere in the city. Dust is being stirred up all the time. Furthermore, city dust is likely to carry more objectionable kinds of bacteria than are carried by dust in the country.

There is more or less dust floating in the air of houses and stables, and this dust is constantly settling. When it falls into milk it carries bacteria with it. If the milk is warm, these bacteria increase very rapidly; if the milk is cold, they may develop slowly but will be ready for rapid

growth as soon as the temperature is raised. The production and care of good milk depend very much on the care taken to prevent dust from getting into it, and the maintaining of a low temperature after it is drawn.

Last summer, Walter E. King, of the State Veterinary College, and myself, made a number of tests to determine the importance of different sources of milk contamination. In most of these tests, a definite quantity of sterilized milk at 98° F. was exposed to some one kind of contamination that we wished to test. The milk was then examined, and in that way we could get a fairly accurate idea of what this particular kind of contamination amounted to. Some of the experiments and their results are as follows:

1. *Exposure to air in the stable.*—Two liters (about two quarts) of sterilized milk were placed in a sterile pail and exposed seven minutes to the stable air in a passageway behind the cows. This stable was doubtless cleaner than the average and the air contained less dust than is often found in places where milk is being handled. Immediately after this exposure, the milk was “planted” and we found it to contain 2,800 bacteria per cubic centimeter (about fifteen drops); in other words, between 5,000,000 and 6,000,000 bacteria had fallen into the two liters of milk in this short time.

2. *Pouring milk.*—When milk is poured from one vessel to another, a very large surface is exposed to the air and great numbers of bacteria are swallowed up. The following tests illustrate this point: About five liters of milk were poured from one can to another eight times in the stable air. It was found, after pouring, that this milk contained practically 100 bacteria per cubic centimeter more than it contained before pouring; in other words, about 600,000 bacteria had gotten into the milk on account of this exposure.

In another similar experiment, when there was a little more dust in the air, the contamination due to pouring eight times was two and one-half times greater than in the preceding experiment.

The importance of pouring milk as little as possible from one vessel to another has suggested to Dr. J. Roby of the Rochester Health Department that milking pails should be made larger than those now used and immediately closed after the cow has been milked. The milk should then be cooled and delivered in these same pails without further exposure. In some ways this suggestion is a most excellent one, and it may be that under certain conditions, the disadvantages of this method of handling milk would exceed the advantages.

3. *Contaminated utensils.*—Much contamination of milk results from putting it into dishes that have been cleaned and then exposed where dust can fall into them. In experiments to determine what this

kind of contamination amounts to, it has been found that when little care is taken to protect the dishes, the milk will often contain several hundred times as many bacteria as when the utensils were protected from dust. In order to illustrate this point, two pails were carefully washed and sterilized. One of them was covered with sterile cloth to keep dust from falling into it. The other was left exposed to the air of a clean creamery for only a few minutes. A small quantity of sterile milk was then put into each pail, rinsed around and then examined for the number of bacteria. It was found that the milk in the pail which was not protected from dust, contained 1600 more bacteria per cubic centimeter than the milk in the protected pail.

4. *Contamination from the cow's udder and body.*—Great numbers of bacteria fall into the milk when it is being drawn from the udder, because the milking pail is directly under the udder which is being shaken more or less by the milker's hands. This kind of contamination may be reduced by cleaning the udder. For example, it was found that sterile milk exposed under the udder as long as it takes to milk a cow and while the udder was being shaken about the same as when milk is being drawn, contained 19,000 bacteria per cubic centimeter. In this case the udder had been wiped off with a dry cloth much in the same way as is done in fairly good dairies.

In a similar test, the udder was wiped with a damp cloth and then the number of bacteria was reduced to 4,500 per cubic centimeter. In a third experiment the udder was wiped with a cloth dampened in a 4 per cent carbolic acid solution; then the number of bacteria was 3,200 per cubic centimeter. In cases in which no particular care is taken to clean the udder, the bacteria getting into the milk from this source may run up into the hundreds of thousands or millions.

5. *Importance of small openings in milk pails.*—Thus it is seen that it is impracticable to clean the udder or free the air from dust so perfectly that *no* bacteria will fall into the milk. The next question is, how can we reduce the number of those that will fall in spite of all reasonable precautions? The easiest way known is to use a small top milking pail. Reduce the opening through which dirt can fall into the pail. An experiment was carried on to illustrate this point, and it was found that milk drawn in an ordinary milking pail contained 1,300 bacteria per cubic centimeter, while that drawn in a pail with opening about one-half as wide, contained only 320 bacteria per cubic centimeter. This is just what we would expect when we compute the number of square inches through which dust can fall into the different kinds of pails. For example, a pail having a top 14 inches in diameter has an opening of 153.86 square inches; a pail with 12-inch top has an opening of 113.04 square inches;

one of 10-inch top has an opening of 79.79 square inches; a pail with an opening of six inches in diameter has an exposure of 28.26 square inches. Figs. 167, 170.

Milkers should get into the habit of using the small top pail as it is one of the easiest of all ways for reducing the number of bacteria that fall into milk.

6. *Contamination by flies.*—A fly or a bit of hay or straw or a piece of saw-dust or a small hair may carry enormous numbers of bacteria into milk as is shown by the following experiments:

A living fly was introduced into 500 c.c. of sterile milk. The milk was shaken one minute and it then contained 42 bacteria per c.c. After 24 hours at room temperature, it contained 765,000 bacteria per c.c., and after 26 hours 5,675,000.



FIG. 170.—Diagram showing size of openings in various kinds of milk pails. The large circle at the left represents the common milk pail. The others show the perpendicular exposure in the new kinds of pails.

7. *Dirt in the milk.*—A piece of hay about two inches long was placed in 500 c.c. of sterile milk. The milk was shaken one minute and it then contained 3,025 bacteria per c.c. After 24 hours at room temperature it contained 3,412,500 bacteria per c.c.

One piece of sawdust from the stable floor was put into 500 c.c. of sterile milk. The milk was shaken one minute and its bacterial content was then found to be 4,080 per c.c. After 24 hours at room temperature it was 7,000,000 per c.c.

A hair from a cow's flank was put into 500 c.c. of sterile milk. After shaking the milk for one minute it contained 52 bacteria per c.c. After 24 hours at room temperature it contained 55,000 per c.c., and after 36 hours, over 5,000,000 bacteria per c.c.

III. FURTHER NOTES ON CARE OF FOOD.

BY THE EDITOR.

A knowledge of germs as given in Bulletin No. 12 of the Farmers' Wives' Reading-Course and in the foregoing pages of this Bulletin, makes us stop to consider what opportunity there is for these little enemies to do their work. The most painstaking housewife needs to have her faith shaken occasionally in her own carefulness concerning foods. Thoughtfulness, with a knowledge of results of careless habits, will bring many things to our notice to which we have closed our eyes. Yet it is not wise to become finicky or too fearful lest we shall get something which we should not, thus destroying our peace of mind. It is harmful dirt we need to shun. Probably the guest who stood on an upper balcony of a hotel and saw an employee come into the kitchen, remove his pipe, lift a spoonful of preserves to his mouth, place the spoon back in the dish and resume the pipe, would have been happier had she not seen the episode. She was not in a position to remedy the difficulty, as she might in her own home.

Sometimes difficulties must assume large proportions before we are much aroused to the necessity for reform. If only the mouse gets into the flour it can be got along with; but the *cat!* For illustration, this story is told in a New York paper: "A prominent politician has a wife who is a model of domestic carefulness. She has a talent for making bread, and takes great pride in having her loaves turn out well. One evening she had set the batch of dough to rise in the kitchen, and was reading in the parlor, when her six-year old boy came running to her, saying: 'Mamma, Mamma! There's a mouse jumped into your bread pan.'

"The good woman sprang from her seat.

"'Did you take him out?'" she asked, frantically.

"'No'm, but I done as good. I threw the cat in, and she's digging after him to beat the band.'"

The moral is that one uncleanly habit should not be used to correct another.'

The milk was not looking quite right and the housekeeper interviewed the milkman. Many hairs and much dirt in the milk was the complaint. "Oh well," he said, "I have to hire my milking done and you know how it is, they won't always be careful; I have told the man if the cow stepped into the pail to throw the milk away, but he won't always do it unless he is watched."

The baby whose mother chews the cracker before putting it into the baby's mouth is still the loving and trusting infant, even if he is imposed

upon. Older grown, there is a repugnance for having the same family cough medicine bottle, from which each takes direct from the bottle, or for the testing of soup and other eatables and putting the spoon back into the dish. Germs are easily transferred from person to person by such thoughtless habits.

Care of the animals.

It is a great thing to be a producer of clean products. The farmer and his wife hold the key to the health not only of their own family, but to that of those who consume the produce of the farm. Some advertising firm says, "Tell me what you eat, and I will tell you what you are." We may to some degree say this of the hen or pig. A hen fed on good wholesome food has better meat and lays better eggs than those that pick in the compost-heap; and a pig that is kept clean as to surroundings and is given wholesome food is better eating than if it is allowed to wallow in the dirt to eat only refuse. Really, a pig would be a clean animal if given a chance.

Although the horse is notably clean in its habits and feeds on grains, we eschew horse flesh; but we eat pork, which, if not grown in a clean place and given clean food, should not be appetizing. The limit of dirty food is expressed by the saying, "It is not fit for hogs." Pork is unobjectionable when the flesh is produced by clean feeding, but even then it should be used under proper limitations of quantity and season.

The cow needs not only wholesome food, but to be kept clean. From the time the milk leaves the udder there is danger of contamination.

Look first on this picture.—A milkman dressed in clothes brushed clean, his hands washed in soap and water, not simply rinsed at the trough, finger nails short and clean, the cow curried, the udder washed, the pail covered until necessary to milk, the stable clear of all dirt. *And then on this picture:*—The cow lying in her own dirt over night, udder soiled, milkman dressed as he has been while doing all sorts of work, the cow's tail switching and the dirt flying, flies bothering the cow until she kicks,—if not into the pail, it is only by careful management that she is prevented from doing so.

Milk produced in this latter way is hardly worth buying, while for that of the first milkman we can afford to pay a good price,—enough to encourage a man to keep clean and to have clean stables and cows. Pay enough to allow the farmer to secure cement floors, tight ceilings, good ventilating devices, and general cleanliness. Then he will scrub his floors and hang up his milking suit to use only for that purpose.

"We always strain our milk, and the dirt and hairs are removed," say some. Yes, but we do not like to eat bread that the mouse ran in,

even if the mouse has gone. A good part of the dirt is soluble and cannot be strained out. Throw away the first half pint of milk, or run the risk of giving it to the cat. A diseased cow! We think it not profitable to throw away milk, but consider the danger of infection to human beings! It is safe to watch the cow in order not to use the milk of one that is diseased.

The water a cow drinks should be clean and pure. It should be free from disease germs, for these may get on the utensils and into the milk. We have only to think of the infants whose only food is milk, and of the diseases which may come from bacteria in impure milk — cholera infantum, typhoid, scarlet fever, tuberculosis, diphtheria, and countless cases of indigestion.

Care of utensils.

The thorough washing of pans, kettles and cans, makes housework and cooking far from easy. It is not so difficult to do the cooking when someone else does the cleaning up. The fewer the creases in a cooking utensil and the more they are scalded, the better. Sun and hot water are most beneficent agencies for the safe care of these articles of kitchen warfare. The housekeeper who cans fruit is extremely careful to sterilize her cans in order that the fruit may keep. With something of the same spirit she will keep her milk pails, cans and pans in like condition.

The utensils introduced of late for the care of milk are most interesting. This is especially true of milk pails. Instead of open pails, there are pails with covers and small openings to receive the stream of milk. Sterilized bottles, on account of being closed, are a very safe receptacle for the milk intended for market. All of these precautions in regard to milk are well worth while, for milk being drawn from an animal is very easily subjected to dirt, and it is an excellent breeding ground for germs. Neither do we boil the milk as we do most other foods.

Who does not remember in the old fashioned regime of housekeeping, the rows of pans nearly filled with milk, which were set on the pantry shelves? In the light of our knowledge of dust and its dangers, we are glad this has passed; it has given place to smaller surfaces to receive the dust, or no exposed surface at all.

The refrigerator might be called upon to tell many tales of the life history of germs, for its recesses hide a multitude of secrets. Slime left where the ice was melted points to need of care. The spilling of food on the shelves is another source of trouble. Ice should be well washed before being placed in the refrigerator. All bits of food should be removed from the shelves and crevices, the refrigerator often washed and scalded, and some antiseptic, as washing soda, used.

Food exposed to the air.

The exposure of food both in the home and in the market to flying dust is much to be condemned. While it may be difficult to cover all the left-overs and the food in process of preparation, one has only to think again of dust and its dangers to realize that the surfaces of this food will catch many flying particles and germs which we would rather not have made a part of our diet. It merely means thoughtfulness on the part of the housekeeper to correct some of the habits to which we have become accustomed and habitually follow. Probably if the bread were not left unprotected, the mouse would not have jumped in; but we can see the mouse in time to avoid making him a part of our meal, whereas the obnoxious germ is so small as to escape attention. A table filled with left-overs, waiting to be prepared for the next meal, is a veritable dust-garden, and who knows what additions have been made to our diet?

Uncovered meat and groceries delivered in an open wagon through the dusty streets are not very clean when they reach the kitchen. Of course sufficient heat applied to them may kill anything dangerous, but again we are led to think that we do not want dirt in our food even from which the germs have been killed. Patronize a covered delivery wagon and a grocery in which provisions are kept under cover in preference to those in which the provisions are exposed to the air. This will pay in our peace of mind as well as in the safety of the food.

Programs for Evenings with Farmers' Wives' Reading Clubs.

Those of our readers who are interested in Farmers' Wives' Reading-Clubs should send for Bulletin No. 16, which gives suggestions for programs for two meetings for each of the five winter months.

Study clubs are by no means to be confined to the cities and towns. The farmer's wife has the same need of study to keep abreast of the times, to keep up with her children, and to preserve a joyous spirit, as does the woman living in the midst of libraries, picture galleries, and lecture bureaus. Her early education, like that of her city sister, needs constant polishing to keep it bright, and her sympathies need to expand rather than to grow narrow and insignificant. The very practical nature of the farmer's wife's occupation makes it desirable to base that occupation on scientific principles as well as to relieve it with a thought of poetry, history or fiction.

Let some woman take the leadership, see the other women of the community and arrange to meet on a certain date, either in a home, at the school building, or in the grange hall. The meeting may be held when the men have their club meeting, or alone, as seems most practicable.

Make the organization as formal or informal as you please. Allow no discussion of topics during the program hour except those selected for the evening. The President should hold all members to a stringent observance of the rules in order to make the meetings a success.

It is well to have the men present at these meetings and to ask them to take part in the program, but it is suggested that they may retire to another room and discuss agricultural subjects while the women are on the domestic problems, or that time be given to them for a discussion of their own subjects to which the women will doubtless be interested listeners. The men can doubtless throw much light on the domestic problems of the home.

Elect a chairman. Draw up a few rules by which meetings shall be governed. These may be added to as the occasion demands. Each club will need to be governed by its own local conditions.

Register as a club at once by addressing Farmers' Wives' Reading-Course, Cornell University, Ithaca, N. Y.

Have the Secretary keep the club in close touch with the University.

Possibly the Supervisor of the Course may be able to visit the club at a regular meeting.

A traveling library will be quite indispensable to the carrying out of this schedule, unless you prefer to buy the books. Apply soon for the library. It is not connected with this Extension Department, but with the Department of Education, Albany, N. Y., Library Division, where application should be made and fee sent. The library may be kept six months, and a fee of \$1 for ten books pays transportation both ways.

Traveling Library for Farmers' Wives' Reading-Clubs, 1905-1906:
Whittier's Poems.

Grandfather's Chair, Hawthorne.

Literary Leaders of America, Richard Burton.

Abraham Lincoln, Schurz.

Principles of Home Decoration, Candace Wheeler.

The Great World's Farm, Selina Gaye.

How to Keep Bees, Anna B. Comstock.

Among Green Trees, Julia Ellen Rogers.

Story of Bacteria, Prudden.

Power Through Repose, Anna Payson Call.

SUPPLEMENT TO
CORNELL

Reading-Course for Farmers' Wives

PUBLISHED BY THE COLLEGE OF AGRICULTURE OF CORNELL UNIVERSITY,
FROM NOVEMBER TO MARCH, AND ENTERED AT ITHACA AS SECOND-CLASS
MATTER UNDER ACT OF CONGRESS OF JULY 16, 1894. L. H. BAILEY, DIRECTOR.

MARTHA VAN RENSSELAER, *Supervisor.*

SERIES IV.
THE FARM TABLE.

ITHACA, N. Y.
DECEMBER, 1905.

No. 18.
DUST AS RELATED TO FOOD.

DISCUSSION-PAPER.

To be returned to Farmers' Wives' Reading-Course, Cornell University, Ithaca, N. Y.

This Discussion-paper accompanying the Bulletin on Dust as related to Foods may be returned with answers to the questions and with any suggestions and questions of your own. While the answering of these questions is not absolutely necessary, a much greater benefit will be derived if you give to others the benefit of your own experience. As a member of the Reading-Course you will be credited by us with the work done. It will also help us to understand your point of view.

As this is the fourth year of the Reading-Course for Farmers' Wives, it is time for very sincere work on the Bulletins. Anything short of the answering of the questions of the Discussion-paper and more or less research work will not be satisfactory, I am sure, to the reader. Read carefully the Bulletin on Farmers' Wives' Clubs (No. 16), and see if you cannot associate with you some one or more persons who will study the same Bulletins. Be sure to let us hear from you. You may desire to ask questions regarding your own experience in home work, or the application of principles set forth in the Bulletins.

*With best wishes for a pleasant and profitable year, I am,
Very cordially yours,*

MARTHA VAN RENSSELAER,
Supervisor Farmers' Wives' Reading-Course.

1. What effect has sunshine upon the cellar or upon places where provisions are stored so far as dust gardens are concerned?

2. Which costs the more, ice for the preservation of food, or the loss of food by mold?

3. In counting the cost of food do we consider the waste from delay and the loss of energy to the system from using injurious foods?

4. Why is it necessary sometimes to scald the sauce more than once to prevent its spoiling?

5. What is the principle of drying fruits to make them keep?

6. Does the healthful dusting of a room admit of the use of a feather duster?

7. Why should not warm milk be covered?

8. What conditions might prevent the bread from rising, or give it a sour taste?

9. Which molds the more easily, bread well done or partly baked?

Name.....

Address.....

Reading=Course for Farmers' Wives

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SERIES IV.
THE FARM TABLE.

ITHACA, N. Y.
JANUARY, 1906.

No. 19.
THE SELECTION OF FOOD.

THE SELECTION OF FOOD.

ALICE PELOUBET NORTON.

The food problem is one that constantly presents itself to the housekeeper. Three times a day the family must be fed, summer and winter, year after year. It is not strange that we become tired of thinking " what

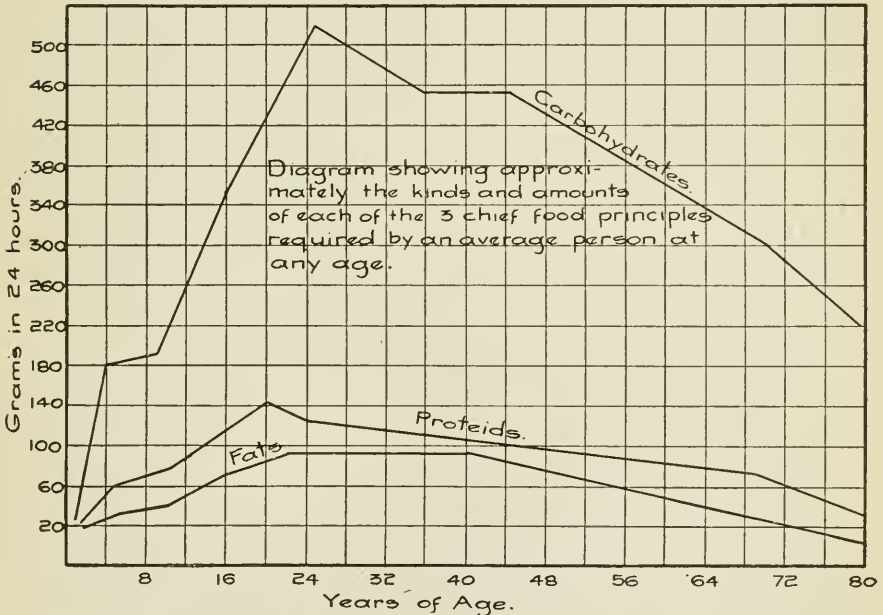


FIG. 171.—Chart showing the variation in food requirements at different ages.

to have for dinner," and that in the newspaper or magazine we often turn first to the " home department " in the hope that among the new recipes or suggestions something may be found applicable to us. "

The food problem to-day is a very broad one. Our increasing knowledge has brought with it new responsibilities. Twenty-five years ago the most intelligent housekeeper could do nothing more than to provide for

her family something palatable, and presumably wholesome, in sufficient abundance, and at a cost within her means. To-day the same intelligence implies a knowledge not only of the cost but of the nutritive value of food materials, and the proportion of different food ingredients necessary for perfect nourishment. The housekeeper must be able to choose from a great variety of foods those that will be digestible and those that will give the highest food value for the money she can expend. She must study how to adapt the food to growing children, to the out-of-door worker and to the aged; she must learn to avoid adulterated and contaminated articles, and she must know how to prepare the food so that its flavor shall be developed, its digestibility increased rather than diminished, with as little waste as possible, and if she is wise, with the greatest saving of labor.

The housekeeper sometimes questions the value of the new knowledge that is offered, and feels that the old ways are sufficient. She remembers the good housekeeping of her mother or her grandmother; she recalls how "good" things tasted when she was a child, she thinks of her own robust health, and sees no reason for new methods. But the notable housekeeper of the past was not the average housekeeper. For one capable woman who kept house well there were dozens who kept house poorly. Often the child who grew up strong and well was one of a family whose other members were ailing or delicate. New conditions have come to make new knowledge more necessary. Greater choice of food, the preparation of many articles, such as canned goods outside the house, less familiarity with the raw material on the part of the housekeeper and different living conditions have brought new needs.

Mrs. Abel, in the "Rumford Kitchen Leaflets," has given a little fable that illustrates excellently the relation of knowledge to taste in the matter of food.

King Palate is represented as absolute ruler of a vast kingdom, paying as little heed to law as such kings are prone to do. After years of undisturbed peace, enemies were discovered lurking in the kingdom, such as Indigestion, Dyspepsia, and others of their kin. The wise men of the realm tried in vain to drive these imps away. Daily they grew more powerful and more bold, until at length a young man named Knowledge appeared, who was able to hold them in check. Without pretence to the throne, or attempt at usurping, he gave wise counsel to King Palate. This old monarch did not always heed the counsel, but whenever he failed to do so the imps became so troublesome that he was forced to ask advice. At last Knowledge was made prime minister, and King and minister working together, succeeded in subduing the enemies, with a fair prospect of soon driving them from the kingdom altogether.

Now, it is quite true, as the king in the story said, that Knowledge is

“always weighing and considering” and has “even been known to change his mind,” but we can no longer afford to live without such help. Science, building upon the experience of the ages, is giving us the means of solving many a difficult problem, and is making possible healthier, happier life than was within our reach before.

I. STANDARD DIETARIES.

The most difficult question in regard to the selection of food is how to choose the amount of different kinds necessary to supply our daily needs, and how to vary this for different conditions, such as different ages and different amounts of work. To help us in this the “standard dietaries” have been given. These dietaries have sometimes been called experimental, and sometimes statistical, according to the methods used in formulating them. An experimental dietary is the result of careful observations of the effect of different proportions of food nutrients upon an individual. The statistical dietary is the outcome of the study of the actual ration of large numbers of people. Each of these has its drawbacks. In the first case it is difficult to decide how far the result is due to individual peculiarities, and a large number of experiments must be tried. In the second case it is difficult to determine whether some variation in the diet might not produce better results. But from a careful comparison of dietaries made up in these two ways certain standards have been determined upon.

The standard dietaries for Americans are given us as follows:

	Proteid.	Fat.	Carbo- hydrate.	Total Ozs.	Calories.
	<i>Ozs.</i>	<i>Ozs.</i>	<i>Ozs.</i>		
Woman with light exercise.....	2.8	2.8	10.7	16.4	2,300
Man with light exercise.....	3.5	3.5	12.8	20.0	2,815
Man at moderate work.....	4.4	4.4	16.0	25.0	3,520
Man at hard work.....	5.3	5.3	17.8	28.5	4,060

A man of moderate work therefore would require about $4\frac{1}{2}$ ozs. of proteid, $4\frac{1}{2}$ of fat, and nearly a pound of carbohydrate daily.

The diet of children varies with their age. It differs from that of the adult in being less in amount, and with different proportions of the food elements. For example, the growing child needs a much larger proportion of proteid in its food than does the grown person. The variation in diet at different ages has been illustrated by the chart on the first page (Fig. 171).

This chart agrees with the experience of the mother who has brought up several children. The amount eaten by the little child increases rapidly till he is about four years old, then very slowly till he is nine or ten, then it takes a sudden jump till it seems difficult to provide enough food to satisfy it. If he can be induced to masticate his food properly the mother

need not be alarmed by this sudden access of appetite. After a person passes middle age, the amount of food taken is gradually diminished.

If we are beginning to study the matter, the first question to present itself will probably be how we are to know what foods will give us these proportions, and to help us, careful tables are given by the government showing the composition of the different foods. The composition of a few of the commonest foods is given here:

	Water.	Proteid.	Fat.	Carbo- hydrate.	Ash.	Calories.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	
Beef (loin).....	60.6	18.5	20.2	.....	1.	1,190
Bread.....	35.	9.1	1.6	53.3	1.	1,225
Potatoes (as purchased, refuse about twenty per cent.).....	62.6	1.8	1.	14.7	.8	310
Oatmeal.....	7.3	16.1	7.2	67.5	1.9	1,860
Rice.....	12.3	8.	.3	79.	.4	1,630
Milk.....	87.	3.3	4.	5.	.7	325
Sugar.....	.....	.....	.....	100.	.....	1,860
Butter.....	11.	1.	85.	.....	3.	3,605

In order to get the amount of different nutrients from these foods one might use in a day the following selections:

	Proteid.	Fat.	Carbo- hydrates.	Calories.
	<i>Ozs.</i>	<i>Ozs.</i>	<i>Ozs.</i>	
Meat, $\frac{3}{4}$ pound.....	2.22	2.4	.....	918
Bread, 1 pound, a small loaf.....	1.46	.26	8.52	1,225
Potatoes, 1 pound (2 large potatoes).....	.31	.01	2.35	310
Oatmeal, 1 ounce.....	.16	.07	.68	116
Rice, 2 ounces.....	.16	.....	1.58	204
Milk, $\frac{1}{2}$ pound (1 cup).....	.26	.32	.4	163
Sugar, 2 $\frac{1}{2}$ ounces.....	.....	.....	2.5	290
Butter, 1 $\frac{1}{2}$ ounces.....	.01	1.28	.....	338
Totals.....	4.58	4.34	16.03	3,564

This would give very nearly the required proportion for a man at moderate work. The difficulty of getting the right amount from one food is shown by the following statements. If meat be supplied containing eighteen per cent of proteid, a fair average, a little more than a pound and a half will be required to furnish the necessary proteid for one day, provided it is all obtained from the meat. The meat would vary in fat, but estimating the per cent as twenty, the pound and a half yields 4 $\frac{8}{10}$ ounces, more than enough for the day, but there would be no carbohydrate. Bread contains about nine per cent of proteid, and it would require three pounds to furnish the same amount yielded by the pound and a half of meat. Nearly two pounds and a half of eggs, or about twenty, would be required to give the same amount of proteid as the pound and a half of meat, or three pounds of bread, and there would be no carbohydrate. The three pounds of bread would furnish also more

than a pound and a half of carbohydrates, a great excess over the required amount.

2. PRACTICAL SUGGESTIONS ON THE CHOICE OF FOODS.

Our experience has taught us, and we instinctively use a mixed diet. All this seems somewhat complicated and perplexing to the busy house-keeper and the questions arise, How far is it practical and necessary for us to make use of this balanced ration in our housekeeping? Shall we see to it that at every meal we provide the right proportions of proteid and fat, of sugar and starch? Should we ever have time to cook the food if we must take time to calculate this?

The common-sense answer certainly is that it is only in a general way that we are to do this. Even if we provided a most carefully planned meal, it would be impossible to be sure that each member of the family ate his proper proportion. We must trust to a large extent to the choice and taste of the individual as a guide. A few suggestions are practical and helpful; and these we will now consider.

1. *In planning our meals, we may so choose our food that one dish supplements another.* Instinctively we have done this to quite an extent. We use potatoes or rice with their large amount of starch with meat, with its proteid and fat. Bread and milk, bread and eggs, bread and cheese, give us the same kind of combinations. The same principle carried farther, means that for dinner the hearty pudding or the mince pie is used for dessert when fish or a light meat is the main dish, or when perhaps the meat is less in amount than usual, while the lighter dessert, or the pudding made with fewer eggs, or the fruit pie, or better still, the fresh or stewed fruit is used with the heartier meat. It means that a meal salad, like chicken with its mayonnaise or boiled dressing, is used as the main dish at a meal, and that if salad is used for dinner it is one of vegetables, perhaps lettuce or celery; unless again it is needed to take the place of part of the meat. It means that nuts are to be used in place of part of the meat, not in addition to a hearty meal. Even a slight study of food charts helps us in this way.

2. *While it seems to be true that the healthy normal appetite is a fairly good guide in eating, there are often members of the family who have not this healthy normal appetite.* One child will not take milk or objects to meat, or refuses all vegetables, or has little appetite for any food. Perhaps he is too thin, or overfat, or has frequent attacks of indigestion. Before appealing to the doctor, or under the doctor's direction, a study of his food should be made. The too fat child may be found to be eating too much starch or sugar. The lean child may be taking too little. The lack of appetite may be due to lack of fresh air and of exercise, or it may come from a habit of eating sweets before meals and so

satisfying the appetite quickly without providing the material for growth, or from other mistakes in diet.

3. *A study of the food helps us in avoiding waste.* If, for instance, an over amount of nitrogenous food, as meat, fish, eggs, cheese, and milk are used in the course of a month or of a year, one of two things may be true: Either the family is having too much proteid or there is unnecessary waste and the problem for the housekeeper is to find out which is the case.

4. One of the questions that is considered more and more frequently in discussions of food problems is that of *the relative value of animal and vegetable foods.* An increasing number of people are confining their diet largely, if not exclusively, to vegetable products, and such animal substances as milk and eggs that do not imply the taking of life, while a smaller number exclude anything of animal origin. Is a mixed diet essential for health, or may we at will choose from the animal and vegetable kingdom? Certain broad distinctions immediately present themselves. As a rule animal foods are richer in nitrogenous matter, while vegetable foods are the chief source of carbohydrates. This becomes much more evident if we compare the foods in a dried condition. Milk, for example, makes a poor showing in proteid compared with dried peas or even with rice, but if we take the solids of the milk as a basis of comparison, the case is quite otherwise. This is the fairer method, for the dried peas and rice absorb many times their weight in water in the process of cooking, so that the composition of the raw material is quite different from that of the cooked food. Hutchison gives the following composition of a few typical dried foods:

100 parts of dried lean beef	contain 89 parts of proteid.
100 parts of dried fat beef	contain 51 parts of proteid.
100 parts of dried pea flour	contain 27 parts of proteid.
100 parts of dried wheat	contain 16 parts of proteid.
100 parts of dried rice	contain 7 parts of proteid.

Another difference between animal and vegetable foods is found in their cost. Under most conditions animal food is more expensive than vegetable. This is not difficult to understand when we remember that our animal food has been put through a further process of manufacture than the vegetable. If the grain raised, instead of going directly to man as food, is used to feed cattle, which in turn are slaughtered to furnish nourishment for human beings, the process necessarily adds to the cost of the food.

As a rule, animal foods are more easily digested than are vegetable. With the addition of milk, butter, cheese and eggs it is not difficult with care to provide a satisfactory diet without the use of meat. The case is

different when vegetables form the only source of food supply. Because of the excess of carbohydrates and the presence of indigestible matter in the form of cellulose, a great bulk of food must be taken in order to get the necessary proteid.

5. *The cost of food is another most important element in its selection.* After we have decided what amount of money may be expended in food directly or indirectly, it is not always easy to know whether a certain food is economical or not. We must consider not only the first cost of the food, but the amount of waste, the time and labor spent in the preparation of the food, and the cost of the fuel used in cooking. For example, two brands of salmon might be offered. The difference in price might be simply that the more expensive was in larger, more attractive pieces. In this case the cheaper would serve many purposes exactly as well as the more expensive. If, on the other hand, the cheaper brand contained a large proportion of skin and bones it might be cheaper in the end to buy the more expensive. Again, beans baking in the oven, or a cheap meat stewing in the oven, while ironing is going on, would when coal or wood is the fuel used add practically nothing to the cost of the material; while if a fire must be maintained for the purpose, or if gas is the fuel as in many places, the additional cost of fuel might make a cheap food more expensive than the one of higher original cost.

Time and labor are too frequently not considered, because the time of the housekeeper seldom has a definite money-value, but it should be most carefully taken into account.

6. *The purity of the food must be considered in selecting it.* While some adulterated foods are injurious to health, many more are a drain upon the purse, since they mean paying a high price for a cheap article. Cream of tartar for instance is expensive. If it, or the baking powder made from it, is adulterated with starch, a very cheap substance, the consumer is being cheated. In the case of the baking powder a certain amount of starch is allowable as it is needed to keep the ingredients dry, but more than this is often found, and a baking powder containing a large per cent of starch is expensive, even if sold at a low price, since so much is required to do the work. A simple test is the boiling in water for a minute of a teaspoonful of a suspected brand, and the comparison of the thickness of the resulting liquid with that of an equal amount of a reliable brand mixed with an equal amount of water and boiled for a minute.

Often the lack of solubility in a substance tells the story of its adulteration. Sugar is seldom adulterated now, but if a sample is suspected, as powdered sugar often is, its solubility in water will determine its purity, at least so far as the traditional adulterants of starch, clay, etc., are concerned.

7. Not only the purity but the *quality of the food* must be considered. Sometimes we unwisely pay simply for appearance. The ideal bread flour is yellowish with a slightly granular texture and a tendency to cling together so that it shows the impress of the hand when pressed in it, but some of the darker colored flours may be as nutritious though not as attractive, and the very white flour, though excellent in appearance, may have less food value and make poorer bread. Prunes furnish a good example of money paid for appearance. One may often see them in the same store varying from five to eighteen cents a pound. The difference in price is largely though not wholly one of size. A cheap rice again usually has not so large grains as the best, and sometimes these are broken, but for many purposes the cheaper is as good.

At other times the money invested in a first-class article is good economy. A flour that yields poor bread is not economical at any price. A cheap canned fruit that must be recooked with the addition of sugar may prove more expensive than the higher priced article. Experience alone can be the guide in such cases.

The selection of food, then, is by no means a simple matter. It demands the best intelligence of the housekeeper. While from one point of view—that of catering to taste alone—it may easily become too important, from another—that of increasing the health and efficiency of the family—its importance can scarcely be overestimated.

ANOTHER VIEW OF SELECTION OF FOODS.

GERTRUDE SOBER CHURCH.

Mrs. Richards begins her book on "Food Materials and their Adulterations" with this sentence: "The prosperity of a nation depends upon the health and morals of its citizens; and the health and the morals of a people depend mainly upon the food they eat and the homes they live in." Then although, at present, at least, women cannot cast the ballot, they are the moulders of the nation; on them rests the responsibility of furnishing this good food and true homes for its people.

For several years Professor Mumford and his associates at the Illinois Agricultural Experiment Station have been conducting a series of experiments to ascertain the best ration for feeding cattle during the period they are being fattened for market. They are studying the ration from an economic standpoint. They can weigh the steer at the beginning of the term, and at the end, figure what was paid for his feed, how much he brought in market, and then compare the cost of this steer with others fed on different rations for the same period. Similar experiments are

being carried on to determine the best ration for a dairy cow. Professor Dietrick, also of the Illinois Agricultural Experiment Station, has recently finished a most valuable series of experiments with swine. The accompanying illustration (Fig. 172) shows the results of part of his work. The two pigs are from the same litter and were exactly alike when put on the experiment at three months of age. The picture is taken after three and one-half months' feeding. The pig on the left shows the result of being fed on a balanced ration; the other pig was fed an unbalanced ration, though he had all he wanted of corn meal.

If, then, it is so important to study the feeding of animals, (and men have long appreciated this) ought we not to study the feeding of the human animal? To ascertain the ration best adapted to the needs of the human being is no easy task, since his demands are so varied. The putting on of flesh is not the point. We must eat the food that will pre-

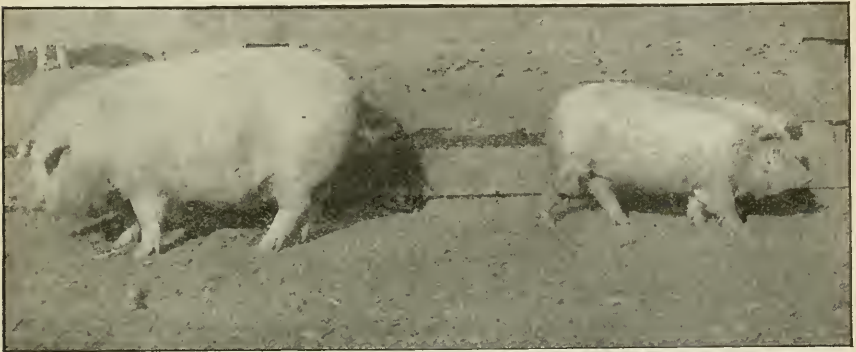


FIG. 172.—*The result of good feeding and poor feeding with pigs.*

pare us for the most efficient work in whatever lines that work may be, be it physical or mental energy expended. Poorly nourished men and women will suffer in clearheadedness, bodily strength, and in the case of children, in bodily development. Professor W. O. Atwater and his associates of the Middletown Experiment Station have devised a method for studying the income and outgo of man, even measuring the energy expended as heat.

In considering the choice of food we must take note of the economic selection, dietetic selection, and if you will permit me, the hygienic selection, though the dietetic and hygienic are almost inseparable. One can but hint at the points to be considered, and first of all we must have some understanding of the food requirements of the human being. This was discussed in Bulletin 13 of series III, Farmers' Wives' Reading-Course. Those who have not this Bulletin at hand should send for it,

Cereals.

Cereals occupy first rank as human food, though they lack fat. We have learned this and combine butter with bread, cream on breakfast cereals, etc.

The following table gives the percentage composition of some of our important cereal foods:

	Proteid.	Fat.	Carbo- hydrates.	Mineral matter.
Fine white flour.....	11.	1.1	74.9	0.5
Entire wheat flour.....	13.8	1.9	71.9	1.0
Graham flour.....	13.3	2.2	71.4	1.8
Wheat bread.....	8.8	1.7	56.3	0.9
Oat meal.....	14.7	7.1	68.4	2.0
Corn meal.....	9.2	3.8	70.6	1.4
Rice.....	7.4	0.4	79.4	0.4

In comparing the composition of these three most important cereal grains in the forms they are most commonly used there are points of comparison that are at first misleading, for example, the graham, entire wheat (so-called) and fine wheat flour or patent flour. We must not alone consider the chemical analysis, but the digestibility of bread made from these three flours. Both the Maine and Minnesota Agricultural Experiment Stations have been working on this problem. The results have been in favor of the patent flour. Though the other two show a higher protein content, the protein is not so completely digested, owing to the coarser particles. To choose intelligently we must understand something of the nature of the flours. So far as nutritive value alone is considered we should say that the fine ground flours stand first. The coarser flours have a tendency to increase peristaltic action, and are on this account especially valuable for some persons.

Graham Flour.

Graham flour is the whole grain, ground after cleaning, 100 pounds of wheat yielding nearly 100 pounds of flour. Our graham is often made from inferior wheat and so is really lower in food value than the so-called patent flour. The grinding is carelessly done, and sometimes the quality of graham would lead one to suspect it is a mixture of poor grade flour and bran.

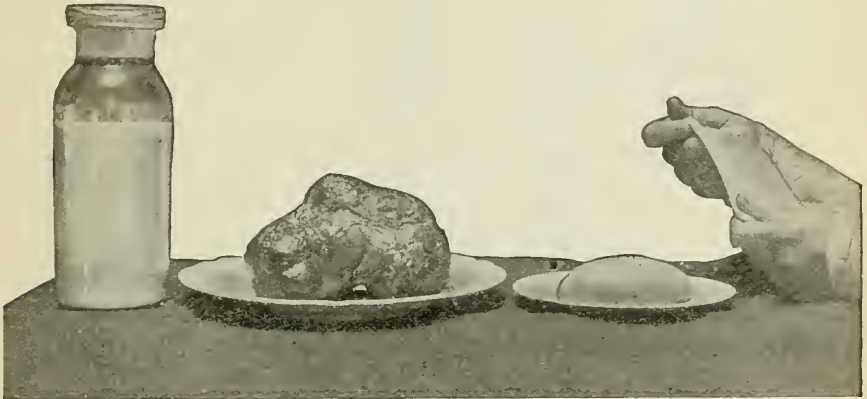
Whole Wheat, or Entire Wheat Flour.

Whole wheat flour is theoretically the kernel, ground after the husk has been removed. Some firms assert that this husk is removed before the grain is reduced to flour. Microscopic study of the bran and flour shows this is not so; bran is found in the flour — even the outer layer with the beard. Again, the bran contains portions of the layers said to be

retained in the flour. From 100 pounds of wheat about 85 pounds of whole wheat is obtained and 15 pounds of bran.

Patent Flour.

This grade of flour is made from the endosperm or inner part of the wheat kernel. This contains the starch and true gluten, valuable for bread making and as nutrients. In the modern process of milling, the wheat passes through successive sets of rollers, or rolls set nearer and nearer together as milling proceeds. The flour from each set of rolls is removed by sifting, and the unreduced portions are passed on to another set. The bran passes on through successive rolls and bolting machines until all the adhering flour is removed, or until the cost of further reducing it equals the value of the flour. From 100 pounds of wheat about 75 pounds of patent flour is obtained.



1 lb. Flour Baked Gluten in 1 lb. Flour Gluten in 1 lb. Flour Gluten stretched

FIG. 173.—Result of experiment with flour.

Economically compared, as well as dietetically, for ordinary consumption the patent flour stands first. Although more entire wheat flour is obtained from a pound of wheat than patent flour, the cost of one-quarter barrel is one dollar eighty for the former and one dollar and thirty-three cents for the latter. And in most cases, at least, we are safe in saying the cost of manufacture is in favor of the whole wheat.

We often hear it said that the protein (gluten) is all removed from the patent flour, that it contains only a starch. There is nothing more convincing than facts.

Gluten in Flour.

Secure one pound of patent spring wheat and mix it with water to a stiff dough; let it stand an hour, then try to stir it. You will note

low elastic it has become. Put the dough in a fine sieve (soup strainer), take a large basin of water, put the dough down into the water and wash it by working with the fingers while the dough is in the water. The water becomes milky and a fine powder settles down to the bottom of the basin. The fine powder is the starch or carbohydrates of the grain. Provide fresh water and continue washing the dough until the water is practically clear. The remaining ball is the gluten. By taking different grades of flour and comparing the gluten a great difference in color and elasticity is perceptible. The best gluten for bread making should be creamy white and elastic. The stretched piece in the picture was about the size of the ends of the two thumbs taken together. If you have a reading circle a most profitable afternoon might be spent by taking up the study of flours. Let each woman bring a sample of gluten from some flour and try to have all grades represented. Have also someone bake some gluten to show the difference in color and expansive power. When a smaller quantity of flour is used, one-half a measuring cup will do. Each one should take the same quantity to compare results.

Bread.

Use only good flour; but good yeast should be used to insure good bread. The most satisfactory yeast is the compressed yeast, providing, always, it is fresh. If we remember that yeast is a plant, and our flour is the soil in which it is planted, breadmaking would become much simpler because we would have less so-called "bad luck." We all know that compressed yeast that has become soft is no longer fit for use. For those who live some distance from market, when going to town a pound brick can be purchased and kept in cold water in a pint can. If no ice is available it can be lowered in a deep well or kept in a cold cellar. You may say your grocer does not keep fresh compressed yeast. If the women in a neighborhood demand it, he will keep it. The trouble with dry yeast is, we have to set our bread over night or else have the bread around in the afternoon, and as we cannot govern the elements, our little delicate plants may become chilled or too warm. The yeast is in a dormant state in the dry yeast, so has to be given more time to grow, like plants from the seed; while in the compressed yeast the plants are merely transplanted.

Breakfast Foods

There are so many different forms into which our grains are worked and under so many different names, we hardly know what we are eating. Some claim to be vegetable iron, the only scientific preparation, the only food for brain and muscle, a predigested food, etc., etc. The Maine Sta-

tion has issued a bulletin on Cereal Breakfast Foods that every house-keeper ought to read. The conclusion they make after studying fifty or more foods at different years is, you pay dearly for the predigested, pre-prepared, fancy article, though they contain no more nutrients than the simple grain. But some say it saves cooking. Women no longer have to weave the cloth, knit the stockings, nay even make the men's clothes or their own, then are we not willing to put our cereal over in a double boiler and let the fire do the rest? Of course there may be cases where an invalid needs predigested foods, but it is better for the normal man that his stomach should have something to do. The difference in cost is astonishing. The new article "Puffed Rice" costs a little more than twenty cents a pound, while rice is from five to eight cents. The difference is even greater in some other prepared breakfast foods.



1, bottle containing 1 qt. milk. 2, water in qt. milk. 3, 1 qt. milk after separating fat, whey and curd. 4, proteid in 1 qt. milk (as casein). 5, fat in 1 qt. milk. 6, carbohydrate (as milk sugar). 7, fat in 1 qt. milk.

FIG. 174.—Showing the amount of different foods required to furnish an equal amount of nutrient.

Milk.

As was suggested in a previous bulletin—No. 14, Series III, February, 1905,—milk is an important article of diet. In many countries, especially Norway and Sweden, Switzerland and the Tyrol, the peasants live for a large part on milk, drinking from four to seven pints a day. Skim milk contains a larger percentage of proteid than whole milk. We all know how good skim milk is for pigs and calves—how it makes them grow. Sweet skim milk can be purchased at the creameries for one cent a quart, and it is indeed a valuable addition to our diet.

Meats.

It must be remembered that though meat is still considered a valuable source for our proteid, it is not deemed so essential to the workingman as formerly — at least not in so large quantities. Professor Atwater has proven by actual experiment with man, in his series of experiments, that a workingman consumes more fat and carbohydrates than his less active companion, while the proteid consumed is about the same. And we must also realize that the needed proteid can be and is obtained from other sources — bread, milk, beans, cheese, eggs — and it must be remembered that there are objections in the waste products of flesh food which we do not find in vegetable food.

In general it is safe to say the nutrients of the different cuts of the same animal are about the same, so that we obtain as much food from the cheap cuts as from the more expensive, and if they are properly

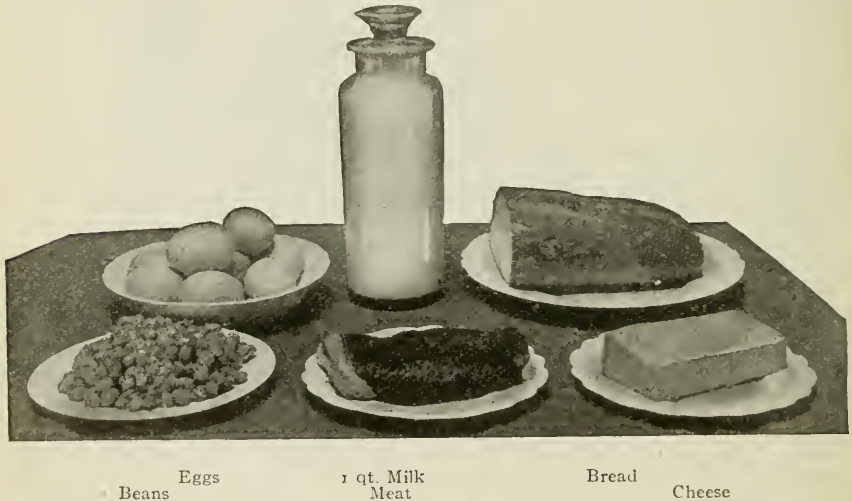


FIG. 175.—Amounts containing equal total nutrients.

prepared, they are quite as palatable. In one case the difference between the cost of the meat of lamb chops and round steak was twenty-two cents. Of course when women take all these points into account and would then rather please the palate to the extent in question than save that money for the general betterment of her family, she is to be the judge. The only point we want to make is that it is woman's duty to *know* whether money is spent to the best purpose for all concerned. Every woman ought to know the comparative values of different cuts, by their "ear marks." One butcher, whom I know, used to sell a certain cut of round for a chuck steak, and he said his women customers did not know the difference. Few distinguish between loin and rib chops, or know which is more economical.

Preservatives in Food.

In the day of so much canned goods — both meats, fruits and vegetables — and when fresh meats, fruits and vegetables and eggs are kept so long, the housekeeper must not fail to understand the value of knowing what she is using if that is possible. Nearly every state has its pure food laws, and its pure food commissioner, whose duty it is to investigate the class of goods offered for the public. Wisconsin is making its laws felt by examining meats, canned goods, extracts, baking powders, and in many cases prosecuting the offenders. In many cases the consumer is to blame, for she demands a catsup redder than even tomatoes, so they use aniline dyes; bologna sausage must be red, so the same device is resorted to. She demands that things be cheaper than reason can demand, so cheap cans are used and preservatives added to cover up poor quality of work. There are cases when actual harm has resulted from inferior goods.

To sum up, let me put before you some articles of food containing the same total nutrients and the cost of each.

Milk is taken as a standard, and the quart contains 4.47 oz. of total nutrients, or a little over one-fourth of a pound. The weight of cheese required to furnish an equal amount of nutrient is 6.4 oz.; of *baked* beans 10.43 oz.; of meat 14 oz.; of eggs 18 oz. or about 9 eggs; of bread 7 oz.

The following table will show how the per cent of total nutrient is figured:

Food.		Proteid.	Carbo- hydrates.	Mineral matter.	Total nutrient.	Cost.
Milk.....	3.6	4.0	4.7	7.0	13.0	\$0.5 to 0.7
Cheese.....	28.3	35.3	1.8	4.2	69.6	0.6
Baked beans.....	6.9	2.5	19.6	2.1	31.1	?
Meat.....	20.5	10.1	.....	1.2	31.8	0.14
Eggs.....	14.0	10.0	.....	0.8	24.8	0.21
Bread.....	9.6	1.4	51.1	1.4	63.5	0.2½

Glancing at the table we can see that bread is cheap, and we know it is wholesome. Eggs at 28 cents a dozen and meat at 16 cents a pound are the most expensive, while milk and cheese at 16 cents a pound are about the same. Cheese might be used very profitably in place of meat to a greater extent than we do. Our friends across the water know its value much more than we do; they also know how to eat it and prepare it with food. But this is not within the province of this paper.

PROGRAMS FOR EVENINGS WITH FARMERS' WIVES' READING-CLUBS.

Those of our readers who are interested in Farmers' Wives' Reading-Clubs should send for Bulletin No. 16, which gives suggestions for programs for two meetings for each of the five winter months.

Study clubs are by no means to be confined to the cities and towns. The farmer's wife has the same need of study to keep abreast of the times, to keep up with her children, and to preserve a joyous spirit, as does the woman living in the midst of libraries, picture galleries, and lecture bureaus. Her early education, like that of her city sister, needs constant polishing to keep it bright, and her sympathies need to expand rather than to grow narrow and insignificant. The very practical nature of the farmer's wife's occupation makes it desirable to base that occupation on scientific principles as well as to relieve it with a thought of poetry, history or fiction.

Let some woman take the leadership, see the other women of the community and arrange to meet on a certain date, either in a home, at the school building, or in the grange hall. The meeting may be held when the men have their club meeting, or alone, as seems most practicable. Make the organization as formal or informal as you please. Allow no discussion of topics during the program hour except those selected for the evening. The President should hold all members to a stringent observance of the rules in order to make the meetings a success.

It is well to have the men present at these meetings and to ask them to take part in the program, but it is suggested that they may retire to another room and discuss agricultural subjects while the women are on the domestic problems, or that time be given to them for a discussion of their own subjects to which the women will doubtless be interested listeners. The men can doubtless throw much light on the domestic problems of the home.

Elect a chairman. Draw up a few rules by which meetings shall be governed. These may be added to as the occasion demands. Each club will need to be governed by its own local conditions.

Register as a club at once by addressing Farmers' Wives' Reading-Course, Cornell University, Ithaca, N. Y.

Have the Secretary keep the club in close touch with the University. Possibly the Supervisor of the Course may be able to visit the club at a regular meeting.

A traveling library will be quite indispensable to the carrying out of this schedule, unless you prefer to buy the books. Apply soon for the library. It is not connected with this Extension Department, but with the

Department of Education, Albany, N. Y., Libraries Division, where application should be made and fee sent. The library may be kept six months, and a fee of \$1 for ten books pays transportation both ways.

Traveling Library for Farmers' Wives' Reading-Clubs, 1905-1906:

Whittier's Poems.

Grandfather's Chair, Hawthorne.

Literary Leaders of America, Richard Burton.

Abraham Lincoln, Schurz.

Principles of Home Decoration, Candace Wheeler.

The Great World's Farm, Selina Gaye.

How to Keep Bees, Anna B. Comstock.

Among Green Trees, Julia Ellen Rogers.

Story of Bacteria, Prudden.

Power Through Repose, Anna Payson Call.

Reading-Course for Farmers' Wives

PUBLISHED BY THE COLLEGE OF AGRICULTURE OF CORNELL UNIVERSITY,
FROM NOVEMBER TO MARCH, AND ENTERED AT ITHACA AS SECOND-CLASS
MATTER UNDER ACT OF CONGRESS OF JULY 16, 1894. L. H. BAILEY, DIRECTOR.

MARTHA VAN RENSSELAER, *Supervisor.*

SERIES IV.
THE FARM TABLE.

ITHACA, N. Y.
JANUARY, 1906.

No. 19.
THE SELECTION OF FOOD.

DISCUSSION-PAPER.

To be returned to Farmers' Wives' Reading-Course, Cornell University, Ithaca, N. Y.

This Discussion-paper accompanying the Bulletin on The Selection of Food may be returned with answers to the questions and with any suggestions and questions of your own. While the answering of these questions is not absolutely necessary, a much greater benefit will be derived if you give to others the benefit of your own experience. As a member of the Reading-Course you will be credited by us with the work done. It will also help us to understand your point of view.

As this is the fourth year of the Reading-Course for Farmers' Wives, it is time for very sincere work on the Bulletins. Anything short of the answering of the questions of the Discussion-paper and more or less research work will not be satisfactory, I am sure, to the reader. Read carefully the Bulletin on Farmers' Wives' Clubs (No. 16), and see if you cannot associate with you some one or more persons who will study the same Bulletins. Be sure to let us hear from you. You may desire to ask questions regarding your own experience in home work, or the application of principles set forth in the Bulletins.

With best wishes for a pleasant and profitable year, I am,

Very cordially yours,

MARTHA VAN RENSSELAER,
Supervisor Farmers' Wives' Reading-Course.

1. Give a plan for one week's meals.

2. What do you consider the value of a written plan for meals?

3. For how many meals can you plan ahead?

Name.....

Address.....

CORNELL

Reading=Course for Farmers' Wives

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SERIES IV.
THE FARM TABLE.

ITHACA, N. Y.
FEBRUARY, 1906.

No. 20.
CANNING AND PRESERVING.

CANNING AND PRESERVING.

MARIA S. PARLOA.

Although every housewife on the farm knows how to can and preserve fruits, she may not know the reasons for the various processes and there may be many points of practice on which she is greatly in doubt.



FIG. 176.—*Ready for canning.*

In order to answer the enquiries and to suggest better methods, this simple Bulletin is written. It is not a treatise and does not cover the subject; but it is hoped that it will set the reader right on some of the fundamental problems and then lead her to the reading of good books on these and similar subjects.

I. WHAT CAUSES FRUIT TO SPOIL.

Through investigation, it has been proved that the oxygen of the air has no injurious effect on food. But in these investigations it was found that there are three kinds of living organisms that may cause the

decomposition of animal and vegetable substances. These little organisms are a low order of plant life, and are known as bacteria, molds and yeasts. They have different effects under different conditions. Every housekeeper is familiar with yeast and molds. When molds are growing they are visible to the naked eye, as for example, when they form on cold potatoes, bread, cake, fruit, preserves, etc. One can easily see the results of the action of yeast when it is used to raise the bread, but it is necessary to have a microscope to see the growth of the plant;



FIG. 177.—A convenient preserving kettle.

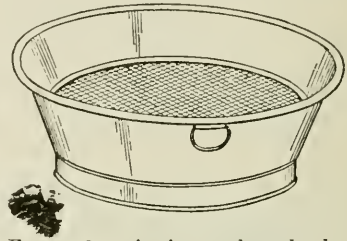


FIG. 178.—A sieve to keep back the seeds.

this action is beneficial to the dough. It is also possible to note the action of bacteria on various substances and in foods. To see the little organisms themselves a very strong microscope is necessary. These organisms are sometimes called microbes. The bacteria, yeasts, and molds, as well as their spores, are usually in the air, in the soil, in water, and on all animal and vegetable substances. Some of the features of these minute plants have been explained in earlier Bulletins of the



FIG. 179.—A colander for all sorts of straining.

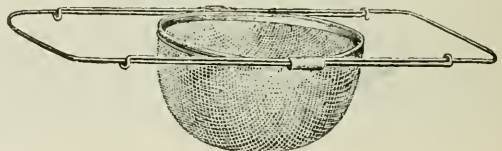


FIG. 180.—Extension strainer, convenient to place over kettle.

Farmers' Wives' Reading-Course, but it will be well to review them in relation to their bearing on canning and preserving of fruits.

Some Characteristics of Yeast.

For growth the yeast plant requires moisture, warmth, oxygen and sugar. The temperature most favorable is between 80 and 90 degrees, Fahr.

The method of growth is what is known as budding. When the yeast plant finds itself where conditions of temperature, moisture and food are favorable, it begins to grow. A little plant starts from the side of the growing plant, and soon is about as large as the parent.

This process of growth continues as long as there is abundant food and oxygen, and the temperature is favorable. Reducing the temperature to near the freezing point, or raising it to near the boiling point, will stop the growth of the plant. In the processes of growth the yeast causes fermentation, and changes part of the sugar into carbonic acid gas and alcohol. Yeasts will grow in thin or thick mixtures of flour and water, or flour and other liquid. They will grow in all kinds of fruit juice, in light syrups, in fruits prepared with small quantities of sugar, in molasses, maple syrup, etc. Yeasts will not grow in syrups made very rich with sugar, or in fruits made rich with sugar, as when preserved "pound for pound." They will not grow without moisture.

Molds and Bacteria.

Mold spores are very light, always floating in the air, and liable to be on fruit and utensils. If one of these spores falls on a warm, moist food, it will germinate, send fine, thread-like filaments over and into the food, and the substance is soon covered with the mold. In canning, preserving and jelly-making it is necessary that the food should be protected from mold spores. The spores are killed if exposed for ten or fifteen minutes to a temperature ranging from 150° to 212° , especially when moist.

Bacteria grow in all kinds of food, but multiply most rapidly in nitrogenous foods, such as milk, meat, fish, soups, beans, peas, etc. By their growth in a food, some cause fermentation and some putrefaction. They do not flourish in acids, or in fruits to which a great deal of sugar has been added. Therefore, canned and preserved fruits are not so liable to be injured by bacteria as by yeasts and molds. Most kinds of bacteria are destroyed by an exposure of ten or fifteen minutes to a temperature of 212° degrees. Spores must be exposed to this temperature for an hour or more.

Spores answer the purpose of dried seeds to yeasts, molds and certain bacteria. They, like the dried seeds of any plant, have greater power or resisting heat and cold than do the plants themselves, and will stand without injury a temperature that would kill the plants. The spores of some bacteria have a very great power of resistance, and they are destroyed only after being exposed for two hours or more to a temperature of 212° . It is for this reason that foods, such as meats, peas, beans, corn, etc., in which bacteria grow freely, are so difficult to can. If one could be sure that there were no spores in these foods, the time of cooking could be very much shorter and the food would be very much better. It sometimes happens that in canning fruit or vegetables



FIG. 181.—A convenient pan for use in canning.

one or two cans out of a batch will spoil, and the housekeeper cannot understand how this is possible, since they were all treated alike. The



FIG. 182.—Use the wire basket to plunge the fruit into water.

secret probably is that at the last moment a spore got into the fruit in some way. The canning of fruit is a simple and sure process, if the cans are perfect and absolute cleanliness and sterilization have been secured. The greatest care may have been taken in all things but one, and the neglect of that one thing may cost many jars of fruit. For example, the utensils and fruit may have been sterilized perfectly but a soiled towel for handling utensils and jars used. Spores

from this soiled towel may have fallen on the utensil or fruit. In a few days they germinated in the fruit juice, and as they grew, they produced fermentation or molds, depending on the kind of spores. One bit of carelessness caused the loss of valuable labor, time and material.

Methods of Sterilization.

We have found that there are three kinds of very small vegetable organisms which injure food by growing on it, or in it. We have also



FIG. 183.—A flat skimmer.



FIG. 184.—A convenience in filling the cans.

found that nearly all these organisms produce spores, which may be likened to the seeds of plants. We all know that we can keep some kind of seeds for years, and that as soon as they are planted and watered, a change begins to take place. They germinate and begin to grow, and in time become plants like those which produced the seed. During all the months and years in which the seeds had been resting they retained the germ of life, and they only needed moisture, warmth and other proper conditions to start this germ into life. Once started, if the conditions are all right, growth is continuous and rapid, until the plant matures. If, however, there should be a drought and no one waters the plant, it will die. Or if there should be a hard freeze, and there is no way of protecting the plant from the cold, it will die if the freeze continues long enough. Extreme heat, too, will kill the plant. The little plants that we know as yeasts, molds and bacteria are destroyed by extreme heat or cold,

and they will die if deprived of moisture and food. But the spores, like the seeds of plants, will live for a long time without moisture or food. Extreme cold may not kill them. Extreme heat will destroy the life in the spore, the same as it does in the seed of the plant. There are some plants and seeds that will stand great heat and cold without injury. Among the bacteria there are some kinds that are killed by a temperature as low as 160° , while there are others that must be kept at a temperature of 212° for an hour or more, to make sure of destroying all life. When we sterilize a substance we destroy all life or sources of life in and about it. We have seen that living and growing plants are killed by extreme cold, but more surely and easily are they killed by extreme heat. This is also true of yeasts and molds and of many kinds of bacteria. We know that seeds of plants, when dry, are not injured by extreme cold, but the germs may be killed by boiling, steaming, or baking for some time. The spores of yeasts, molds, and bacteria, like the seeds of plants, are not injured by cold, but they may be killed by boiling, steaming or baking.

Bacteria, yeast and mold plants and spores are liable to be on and in all food, and on all utensils. We now know that these little organisms spoil food by growing in or on them, and that if we wish to keep foods for any length of time we must protect the foods from them. We could dry the foods and as long as they were kept perfectly dry the little plants could not injure them, because, for want of moisture, they could not grow on or in the food. But canned food is more like the fresh article, and so nearly everyone prefers this method of preserving foods, particularly fruits and vegetables. So we kill the live plants, and the spores that are on and in the fruit, and on the surface of the jars and utensils. In large establishments, where there is an abundance of steam, all the utensils are thoroughly steamed. The food is treated with heat in various ways. In the farm house the utensils can be sterilized by boiling them. The food may be sterilized by boiling, baking or steaming. To sterilize jars and utensils, have large stewpans washed clean. Fill them with fruit jars and their covers. Put on the stove and put in enough cold water to cover them. Heat gradually to the boiling point, and boil ten or fifteen minutes. The jars must be taken one by one from the boiling water at the moment they are to be filled. The covers of the jars are to be taken from the boiling water just as they are to be put on the jars. Jelly tumblers are to be sterilized the same as the fruit jars. All the utensils employed in the work may be sterilized by putting them into boiling water and boiling ten or fifteen minutes.



FIG. 185.—A graduated measure.

Knowing, as we do that the plants and spores of bacteria, yeasts and

molds float in the air, rest in the dust on shelves, tables and floors, and that they are set in motion by every current of air, we will be careful to have the kitchen swept and dusted before we begin the work of canning or preserving. We know, too, that the towels and our own clothing must be perfectly clean. The hands and nails must be cleaned before we begin to prepare the fruit.

Nearly all kinds of fruits can be sterilized in ten or fifteen minutes, counting from the time the syrup or juice becomes nearly boiling hot.

II. THE NECESSARY UTENSILS.

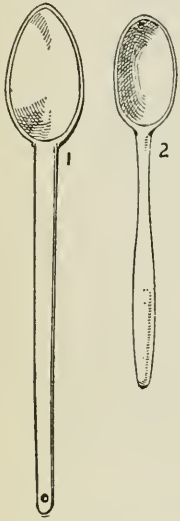
Suitable tools make work easy and pleasant. The utensils needed in canning, preserving and jelly making are not many, but it is important that they should be of the right kind. Remember that iron and tin should not be employed for cooking fruits of any kind. The acid of the fruit attacks these metals and the fruit acquires a metallic taste and a bad color.

FIG. 186.—*Wooden spoons.*

Nearly any of the enameled wares, porcelain lined iron kettles, or aluminum may be used. The preserving kettles should be rather shallow and broad, as only a layer of fruit a few inches deep should be cooked at one time (Fig. 177). The shape of the kettle should be considered. If the kettle is large it will be easier to handle it if there is a bail handle across the middle, and a fixed handle at the back. In selecting such a kettle test it to see that it is well balanced. The side handle is convenient and satisfactory on small kettles. One deep kettle holding two or more gallons will be found useful for cooking fruits, the juice of which is to be canned, or made into jelly.

Strainers of different kinds are necessary in jam and jelly making. In making jams with small seeded berries, it is wise to remove as many of the seeds as possible, and for this there will be required a strong sieve with meshes fine enough to keep back the seeds (Fig. 178). An enameled colander may be used for all sorts of straining (Fig. 179). A fine meshed extension strainer which may be placed over a large bowl will be found useful (Fig. 180).

For jelly making, a flannel straining bag will be necessary. Besides the utensils already named there will be required: several earthen bowls into which prepared fruit may be put, and fruit juice strained; dish pans and milk pans, for use in washing and sorting fruit, sterilizing, etc. (Fig. 181); a wire basket into which to put peaches and tomatoes, when they are to be plunged into boiling water for a few minutes (Fig. 182);



a flat skimmer (Fig. 183); a funnel, for filling fruit cans (Fig. 184); a graduated quart measure and a graduated half pint measure (Figs. 185); some wooden spoons and a wooden vegetable masher (Figs. 186 and 187); several yards of cheese cloth and some towels complete the list of really necessary things, and practically the whole list is to be found in any well equipped kitchen. There are a few labor-saving devices that are desirable if it is possible to have them. These are a grape seeder, a cherry stoner, a fruit juice press and a strawberry huller. Weighing is more accurate than measuring, and therefore scales would be desirable, although not actually necessary (Fig. 188).

If the canned fruits are cooked in the oven some asbestos sheathing will be required. This comes in sheets and is sold by the pound. It costs ten cents a pound and may be had in the hardware stores and by plumbers. One pound will be ample if it is used with care. It should be folded to make two or three thicknesses. If the canned fruits are cooked in a boiler, it will be necessary to have a wooden rack that will fit loosely in the bottom of the boiler.



FIG. 187.—A wooden vegetable masher is handy.

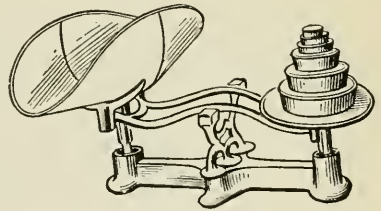


FIG. 188.—Scales more accurate than measuring.

III. THE SELECTION AND PREPARATION OF THE FRUIT.

Fruit that is to be canned or preserved should be fresh, crisp and free from decay. It is a great mistake to use inferior fruit for canning or preserving. Imperfect fruit may be used for jams and jellies by cutting out the defective portion. Peaches and pears should be ripe or very nearly so before being canned or preserved. There is a quality in ripe fruit that cannot be given by cooking. In fact the less the fruit is cooked the more natural and fine flavored it will be. If you have peaches on your place, watch closely so as to pick and can them as they ripen. If you must buy them, do not be tempted by green ones. They will soften, it is true, by keeping, but they will not develop a fine flavor. The peach should ripen on the tree. Pears, on the other hand, are better for being picked while hard and allowed to ripen in a cool, dark place. Early pears ripen very rapidly after being picked, and so must be examined each

day. Plums should be canned or preserved just before they are dead ripe. Quinces should have turned a rich yellow before being cooked. They are finer if they ripen on the trees than if picked green and kept until yellow.

All the small fruits, except gooseberries, which are generally used green, should be just ripe and perfectly fresh. There are fewer seeds in the small fruits that come early in the season than in those that come later. Therefore they should be preserved as early in the season as possible.

Fruits that are intended for jellies should be picked just before they are perfectly ripe. If over ripe, the pecten begins to lose its jelly-making quality. This is particularly true of the small fruits. Small fruits that are to be employed for jelly should not be picked directly after a rain, as they will then contain too large a percentage of water for jelly making. Cherries for canning may be sweet or sour, but for preserving, the large, red, sour ones are best.

The Preparation of the Fruit.

Knowing as we do that the fruit is liable to be covered with bacteria, mold, and yeast spores, as well as dust, the first care will be to clean it. Small fruits like strawberries, raspberries, blackberries and currants are spoiled if allowed to soak in water. If they require washing, put a few at a time into a colander and pour over them quickly some cold water, then turn them into a sieve to drain. Always wash small fruits before they are hulled or stemmed. Quinces must be rubbed hard with a coarse cloth before they are washed. Pears and apples should be washed and drained before paring. Peaches are put into boiling water to loosen the skins and this cleans them also. Tomatoes are, like peaches, put into boiling water to loosen the skins, but as they sometimes rest on the ground they should be washed before being put into the boiling water. If you have a large wire dish drainer you can drain the large fruits in it after they have been washed. Do not wash or otherwise prepare any more fruit than you can put up in a short time. The pared fruits turn dark quickly, and the small fruits lose juice and crispness.

You have, of course, cleaned the kitchen before beginning to prepare the fruit. Now to do the work easily and successfully you must have a system. Here is a good one to follow. 1. Decide on the amount of fruit you will cook at one time, then sterilize the jars and utensils. Have plenty of fresh hot water on the range, for it will be required for making syrup and other purposes. 2. Get all your working appliances together. 3. Weigh or measure the amount of fruit you are to cook at one time, or some smaller, convenient part of it, which will equally divide the whole, as for example, if you have fixed upon eight pounds or eight

quarts, weigh or measure two pounds or two quarts and put in a bowl that will just about hold it. This will save future weighing or measuring, and, of course, much handling of the fruit, as it may be dropped into the bowl as fast as it is prepared. Have the corresponding weight or measure of sugar in another bowl.

When fruit is to be cooked in the cans the weighing or measuring is not necessary, as the fruit should be dropped into the cans as it is prepared. 4. Make the syrup if the fruit is to be cooked in the cans or in syrup. 5. Prepare the fruit. Strawberries, raspberries, and blackberries are to be hulled. Currants are to be free from leaves and stems. The stem and blossom end should be removed from gooseberries. Cherries, when preserved, should be stemmed and stoned. Many people prefer to can them unstoned.

If the small, seedy fruits are to be used for jams they should be heated slowly to the boiling point and then simmered for ten minutes. After this mash them in the kettle, and finally rub through the strainer. It takes time and strength to do this. Use the wooden masher for the crushing and rubbing. To prepare grapes for preserving or for marmalade, stem them, press out the pulp and drop it into an earthen bowl. Drop the skins into another bowl. Cook the pulp about five minutes and then run through the coarse sieve, to remove the seeds. Add the skins to the strained pulp. Pears, peaches, quinces, apples, etc., after being pared, become discolored on exposure to the air, even for a very short time. If for any reason these fruits cannot be added to the sugar or syrup at once they should be dropped into cold water to which has been added one tablespoonful of lemon juice for each quart of cold water. Steel knives discolor fruit; when possible, use plated fruit knives for paring.

Peaches, plums and tomatoes are pared quickly and smoothly if they are put into *boiling* water for a few minutes. Have a kettle about half full of *boiling* water. Fill a wire basket with the fruit or vegetable and lower it gently into the *boiling* water. If the fruit is ripe, two or three minutes will loosen the skin. Lift the basket out and plunge for a moment into *cold* water, then peel.

To lower the basket into the boiling water and to lift it out, put a strong, long-handled spoon under the handle of the basket.

IV. METHODS OF CANNING.

The method employed by all housekeepers for preserving their principal supply of fruit is canning. This method is economical, easy and sure, if the work is properly done. The success of canning depends upon perfect sterilization and the thorough sealing of the jars to exclude

microbes. There are several methods of canning, but the principle is the same in all cases: that is absolute sterilization and the exclusion of the microbe-laden air from the sterilized food. There are three methods of canning which are convenient for the housekeeper. After studying them carefully, each one will decide as to which is best suited to her condition.

Canned Fruit Cooked in the Oven.

Cover the bottom of the oven with two or three thicknesses of asbestos sheathing. Fill the jars with fruit and hot syrup, and place them in the oven. Be careful not to have the jars too near the fire box. There must be a little space between the jars which are uncovered. The oven must be moderately hot. The fruit is to remain in the oven until the syrup boils. If the jars and syrup were hot at the start the cooking of nearly all kinds of fruit would require about ten minutes. Take out the jars, one at a time, and place on a board. Fill up with boiling syrup. Put on the sterilized rubber and cover. Be careful not to have the jars in a draft. A fruit jar holder will be necessary for putting them into and taking them from out the oven.

Canned Fruit Cooked in a Water Bath.

Put a wooden rack into the bottom of a wash boiler. The rack must fit loosely and sit perfectly level in the boiler. There must also be space for the water to circulate between the slats. Put in enough warm water to come about four inches above the slats. Put the fruit in the jars, then fill up with syrup which may be hot or cold. Put the covers on, but do not fasten them. Place the jars in the boiler. Pack wads of cotton between the jars, to prevent them from striking one another when the water boils. Cover the boiler. Note when the water begins to boil and continue the cooking for ten minutes from this time. Then draw the boiler to a cooler part of the range and take off the cover. Place a shallow pan of *boiling* water at the side of the boiler. When the steam passes off take out the fruit, one jar at a time. Fill up with boiling syrup and seal. Put the jars on a board and out of a current of air.

There is on the market a very convenient arrangement for canning by steam. This canner comes in various sizes, from that holding one jar, up to one holding four jars. It is a great saver of time and labor.

Stewed Canned Fruit.

By this method the fruit is stewed with or without sugar or syrup and is at once put into the sterilized jars and sealed. Have the jars and covers sterilized while the fruit is cooking. Sterilize the spoons, knife,

cups and funnel. Place a shallow milkpan, partially filled with boiling water, near the boiling fruit. When ready to put the prepared fruit into the jars, slip a broad skimmer under a jar and lift it carefully from the boiling water. Drain the jar and set into the milkpan, then fill with the boiling fruit. Slip the blade of the silver plated knife also sterilized around the inside of the jar. This will pack the fruit and juice more solidly. Dip the rubber ring into boiling water and put it smoothly into place. Put on the cover and fasten. Place the jars on a board and out of a current of air.

All three of the foregoing methods give slightly different results. In the last method the fruit does not hold its shape well. This is particularly true of the small fruits.

In filling the fruit jars from the preserving kettle there is the chance of floating spores dropping onto them and later germinating in the jar. The second method is better. The fruit holds its shape and there is hardly a shadow of a chance of the spores reaching the sterilized fruit. There is one objection to the second method. The jars are covered while the fruit is being cooked. The gases developing in cooking have no means of escape and are therefore reabsorbed by the fruit. Such fruit will not be as fine flavored and digestible as fruit that has perfect ventilation while being cooked.

By the oven method the fruit holds its shape and the gases pass off; the sterilized rubber band and the cover are put on as soon as the fruit leaves the oven; the labor of putting the jars into the oven and taking them out is slight when compared with getting the boiler ready and packing the jars for safety; the flavor of the oven-cooked fruit is much finer than that by either of the other two methods.

Hard fruits, such as quinces, must be simmered gently in clear water, then drained well before being put into the jars with the syrup. If such fruit is desired rather rich, a rich syrup must be added, and the cooking in the jars be continued for thirty instead of ten minutes. *Tomatocs* must cook in the jars for thirty minutes.

Points on Jars, Sealing, etc.

Among the makes of fruit jars there are two that are in general use. In one both jar and cover are glass. When the rubber ring and the glass cover are put on, a wire band is drawn over the cover and the jar is sealed. The other make has a metal top lined with porcelain. This top is screwed on the jar. This must be done as soon as the cover is put on. But the heat has expanded the glass and the cover cannot be screwed perfectly tight until after the glass has cooled and contracted. When using this kind of jar make it a rule to screw on the covers as tight as

possible while the jar is hot and to tighten the covers after the jars have cooled. Before using a jar or cover examine each carefully. Reject any that are chipped or cracked. Be sure that the rubber rings are fresh, soft and elastic. When putting them on the jars be careful to have them lie flat and not bulge out beyond the covers.

How much Sugar to use with Fruit.

Tastes differ as to the degree of sweetness liked in fruit or any other food. Fruits differ as to the amount of sugar required to bring out and fix the best qualities of the fruit, therefore no hard and fast rules, as to the proportion of sugar to fruit, can be made. A good general rule is to use only as much sugar as shall bring out and fix the pleasant flavor of the fruit. Raspberries, blackberries, blueberries, sweet cherries, sweet plums, peaches and pears require very little sugar, while strawberries lose shape, color, and flavor if preserved with much less than a pound of sugar to a pound of fruit. The following table gives the proportions of sugar to fruit, which has been found to give satisfactory results.

Because of season, climate, etc., fruits vary as to the amount of sugar they contain and the proportions of sugar may be changed to meet these conditions. As for example, in a cold season, the fruit will not be so sweet as in a warm, sunny season, and a little extra sugar should be added.

Syrup for Canned Fruit.

(1) One pint of sugar, and two pints of water. Use for peaches, pears, raspberries, blackberries, blueberries, sweet plums, grapes. If the fruits are acid use No. 2 or 3.

(2) Two pints of sugar and three pints of water.

(3) Two pints of sugar and two pints of water. Use for sour cherries, sour plums, green gooseberries, crab-apples, quinces.

To make the syrup, put the sugar and water into the preserving kettle and place on the back part of the range. Stir frequently until the sugar is dissolved. Then heat slowly to the boiling point. Boil gently for twenty minutes. Skim the syrup, if necessary. A pint of syrup will be required for each quart jar of large fruits, such as quinces, crab-apples, plums, peaches, pears. The small fruits will require a little over half a pint. Fill the sterilized jars loosely with the fruit, then fill up with the syrup.

In the case of very juicy fruits, such as berries, the product is much finer, if instead of water the juice of the fruit be used in making the syrup. From six quarts of berries take one quart. Put in a preserving kettle and heat slowly to the boiling point, crush with the wooden

masher. Spread two thicknesses of cheese cloth in the colander and place over a bowl. Press out all the juice. Mix half a pint of water with what remains in the cloth and squeeze again. Measure the liquid and add enough water to make three pints, then proceed as in making syrup with water. When the syrup boils skim carefully.

When the fruits are stewed before being put into the jars, the sugar may be added directly to berries, grapes and cherries. In this case no water is added. All the other fruits should be cooked gently in the prepared syrup. Be careful to keep the stewing fruits well skimmed. Quinces must be cooked in clear water until tender, before being cooked in the syrup. Strain the water in which they were cooked and use in making the syrup.

Where the pronounced flavor of the quince is not liked, equal quantities of the cooked quince and pared and quartered apples may be cooked together in the syrup. Fall pippins are the best for this purpose.

V. PRESERVES.

Until methods of canning were known, and glass jars were invented with covers and rubber rings to make them air tight, fruit was preserved either by drying or by being cooked with nearly its own weight of sugar. The fruits cooked with a large quantity of sugar have always been known as preserves. Nearly every housekeeper likes to put up a small quantity of preserves, but not always as rich as a pound of sugar to a pound of fruit, and with the fruit jars it is no longer necessary to use so much sugar. Strawberries to be in perfection should be preserved pound for pound. Very sour cherries and white and red currants are delicious when preserved like strawberries. Of course, such rich preserves are to be served in very small quantities and on rare occasions. When preserving these small fruits the fruit and sugar are put into the preserving kettle in alternate layers, beginning with the fruit. The depth of fruit and sugar should not be more than four inches, for it is important that fruit should not be crushed or broken. The contents of the kettle must be heated slowly to the boiling point, and boiled gently for ten minutes, counting from the time it begins to boil. Skim carefully. At the end of ten minutes the fruit may be put into jars and sealed at once. Or it may be poured into meat platters and placed in a sunny room for two days. In that time the syrup will have thickened and the fruit have grown plump and firm. It may now be put into small jars or tumblers, covered and put away.

All these small fruits, except the strawberries, may be preserved with half a pound of sugar to a pound of fruit and sealed while boiling hot.

The large fruits must be cooked gently in the syrup until tender. The cooked pieces of fruit should be taken from the syrup and put into the jar and the strained syrup poured over them. Put a piece of cheese cloth in the funnel and pour the syrup through it into the jar. A syrup made with one quart of water and two quarts of sugar is suitable for peaches, plums and quinces.

Pears, peaches, apples and sweet plums may be preserved in boiled grape juice. Boil the grape juice in an open preserving kettle until it is reduced one-third. Cover the fruit generously with the boiled grape juice and cook gently until clear and tender. Put boiling hot into sterilized jars.

Boiled cider may be used in the same manner for preserving sweet apples and pears. Without sugar it gives a very tart preserve. Remember that the grape juice and cider must be perfectly fresh and *sweet* when it is put on to boil.

VI. JAMS.

Jams are made with the pulp of the fruit and sugar. The finer the fruit, the finer will be the quality of the jam. Gnarled and bruised fruit may be used, if all the imperfect parts are cut out. Large fruit should be washed, pared, cored and quartered. A great many people when making jam with berries, do not remove the seeds. A very seedy jam is not appetizing, besides so many small seeds make trouble in the digestive tract. If the labor of removing the seeds is too great, do not use the small fruits for jams. Better press out the juice and can it for drinks, frozen dishes, and various other desserts. To make the jams, measure the sugar and the prepared fruit, allowing one quart of sugar to two quarts of fruit. Rinse the preserving kettle with cold water, that there may be a little moisture on sides and bottom. Put in alternate layers of fruit and sugar, having the first layer fruit. It does not matter how thick the layer is, since the fruit is to be broken up fine during the process of cooking. Heat slowly, stirring frequently and being careful to scrape the bottom each time the mass is stirred. From time to time crush the fruit with the spoon. Cook about two hours. When done, the jam should be a smooth mass. There is always danger of the jam getting scorched unless watched and stirred very carefully. If the kettle can be set on a tripod or any iron stand, the danger of burning will be greatly reduced. When the jam is done, put it in small sterilized jars.

VII. JELLIES.

Pectose and pectase always exist in the unripe fruit. As the fruit ripens the pectase acts upon the pectose, converting it into pectin. It is because of the pectin in the fruit that we are able to make jelly. Pectin

is at its best when the fruit is *just ripe* or a *little* underripe. If the fruit is allowed to become overripe the pectin will undergo changes which will weaken its gelatinizing power. If the juice of the fruit ferments or the cooking continues too long, the pectin undergoes a change and loses its power of gelatinizing.

When equal quantities of fruit juice and sugar are combined (and the mixture is heated to the boiling point for a short time,) the pectin in the fruit gelatinizes the mass. The small juicy fruits such as currants, raspberries, strawberries, blackberries and grapes when just ripe or a little underripe contain about the right proportion of water for jelly making. When water-soaked during a rain, they contain too much water and should not be picked until the superfluous water has evaporated or been changed under the influence of the sun. Dry fruits such as barberries, apples, peaches, pears, quinces, plums, must be boiled gently in water until soft. The strained liquid will contain the pectin and flavoring and coloring matter. With these explanations and a few general rules any woman should find it easy to make good jellies.

Jellies Made With Juicy Fruits.

Have the fruits clean and free from leaves, stems, and hulls. Put them into the preserving kettle. Crush with wooden masher. Heat slowly, stirring frequently. When the fruit is boiling hot, crush well with wooden masher. Put a strainer or colander over bowl. Wring a double square of cheese cloth out of water and spread in the bowl. Pour the fruit and juice into the cheese cloth and let it drain as long as the juice drips. Do not use any pressure. When the fruit stops dripping, change the strainer and fruit to another bowl. Bring the ends and twist and press out as much juice as possible. This juice may be used to make a second quality of jelly. The clear juice may be strained through a jelly bag or it may be made into jelly at once. When the juice is passed through the flannel bag, the jelly made from it will be clear and sparkling. To make the jelly, measure the juice and pour it into the preserving kettle. For each cupful of juice use a cupful of granulated sugar. Heat slowly, stirring often until the sugar is dissolved. Watch carefully and when the mixture boils, draw the kettle back and skim. Move the kettle back to the hot part of the range and when the liquid boils again draw back and skim. Boil and skim a third time and then pour into hot sterilized glasses. Put the glasses on a board, cover with a cloth, and place the board in a sunny window, where there is no dust. As soon as the jelly is set and cold, cover with disks of white paper which have been dipped in brandy or alcohol; and if the glasses have covers put them on. If there are no glass covers, the glasses may be covered with thick white

paper which has been brushed with the white of egg or olive oil. Or the jelly may be covered with paraffine which has been broken into small pieces and put into a cup. Place the cup in a pan of warm water on the back of the range. Cover the jellies with the melted paraffine, having it about one-fourth of an inch thick. Paste the labels on the jellies and set away in a cool dry place.

Jellies Made with Fruits that Require Water (a Second Method).

All the large fruits, green grapes, crab-apples, plums and barberries come under this head. The stems and blossom ends of the fruit, and all imperfections must be removed. Then the fruit must be washed. Quinces must be rubbed with a coarse towel, to remove the "down" before being washed. Remove the core from the quinces, and cut the fruit fine. Measure the fruit and put it in the preserving kettle. Cut apples, pears and peaches in quarters. Do not pare. Add the water, heat slowly to the boiling point and simmer gently for two hours. Drain the juice and proceed as for jellies made with juicy fruits. The proportion of water required by the different fruits varies with the kinds of fruit. The following table gives about the right proportion. Apples, eight quarts, water, four quarts. Crab-apples, eight quarts, water, four quarts. Quinces, eight quarts, water, four quarts. Green grapes, eight quarts, water, four quarts. Plums, eight quarts, water, one quart. Barberries, water to barely cover them; this will be about three quarts of water to eight quarts of the fruit.

In all cases the fruit is to be cooked with the kettle uncovered. Remember that the fruit must simmer for two hours.

A second quality of jelly may be made with the parings, cores and broken pieces of such fruit as quinces, pears, and apples.

Acid fruits make the most satisfactory jelly to serve with meats.

Why Jellies "Candy."

Sometimes when jelly boils rapidly, particles of it are thrown on the upper part of the sides of the kettle. These particles often form crystals. If these crystals are stirred into the jelly they may in time cause the mass to crystalize.

Another cause of crystals in the jelly is too much sugar in the preparation. In a season when there has been a great deal of sunshine and heat there will be more sugar in the fruit than in a cold wet season. In such a case use less sugar. Three cupfuls of sugar to four cupfuls of fruit juice will be enough.

When the fruit juice and sugar refuse to jelly and the mixture becomes thick and ropy, it is useless to cook it any longer. The thick ropy

condition shows that it has already been cooked too much. The trouble at the beginning was probably that the fruit was too ripe, or that it was water soaked. If jelly does not show any indications of solidifying when it has boiled the given time, do not continue the boiling. Pour the preparation into hot sterilized jars. Put the jars in a sunny window and cover with sheets of glass. In a few days it will have gelatinized.

Juice from grated young carrot may be added to cause it to solidify.

Canned Fruit Juice.

The juice of all kinds of fruit may be prepared the same as for jellies. After it is strained it must be boiled for about ten minutes, and then be put into sterilized jars or bottles and sealed. The fruit juice may be canned with or without sugar. However, it holds its color and flavor better if some sugar is cooked with it. Grape juice and the juice of the small seedy fruits are particularly valuable. They may be employed in making a great many light, cool desserts, such as jellies made with gelatin, cornstarch, tapioca pudding, sauces, etc. Combined with water they make most refreshing and healthful summer drinks.

NOTE.—*Special attention is called to questions 6 and 7 in the accompanying discussion paper.*

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DISCUSSION-PAPER.

To be returned to Farmers' Wives' Reading-Course, Cornell University, Ithaca, N. Y.

This Discussion-paper, accompanying the Bulletin on Canning and Preserving Fruit, may be returned with answers to the questions and with any suggestions and questions of your own. While the answering of these questions is not absolutely necessary, a much greater benefit will be derived if you give to others the benefit of your own experience. As a member of the Reading-Course you will be credited by us with the work done. It will also help us to understand your point of view.

As this is the fourth year of the Reading-Course for Farmers' Wives, it is time for very sincere work on the Bulletins. Anything short of the answering of the questions of the Discussion-paper and more or less research work will not be satisfactory, I am sure, to the reader. Read carefully the Bulletin on Farmers' Wives' Clubs (No. 16), and see if you cannot associate with you some one or more persons who will study the Bulletins at the same time. Be sure to let us hear from you. You may desire to ask questions regarding your own experience in home work, or the application of principles set forth in the Bulletins.

With best wishes for a pleasant and profitable year, I am,

Very cordially yours,

MARTHA VAN RENSSELAER,
Supervisor Farmers' Wives' Reading Course.

1. With what fruits have you had most success in canning?

2. Is there any economy in doing your own canning in preference to buying canned goods, if you have a good market for your fresh fruit?

3. Have you had success in canning and preserving in ways not mentioned in the Bulletin? If so, will you explain the method?

4. Have you found that canned fruit placed in the dark keeps any better than in the light?

5. If you have tried the processes given in this Bulletin for canning, which do you find most successful?

6. Does the reading of these Bulletins stimulate you to read more or less of books or journals?

7. Whether or not you are accustomed to return the discussion paper, will you not answer these questions: Of how much value is the Reading-Course to you? Give your reason for not returning the discussion paper. Are we to infer that the failure to return the discussion paper is because the course is of no special interest to you?

Name.....

Address.....

Home Nature = Study Course

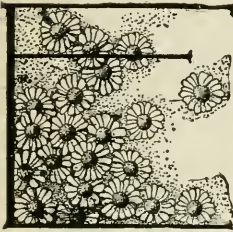
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ANNA BOTSFORD COMSTOCK, Editor

New Series. Vol. II. ITHACA, N. Y., OCTOBER-NOVEMBER, 1905

No. 1

NATURE-STUDY ON THE FARM



EVERYONE who owns a foot of land has Nature for a partner. If the land is not cultivated Nature sows there her own crops; reaps them and sows them again. If the land is cultivated Nature helps as willingly to raise the crops which please her partner — Man. But she still favors her wild and hardy plants and finds place for their seeds even on cultivated soil. Whether the plants be cultivated or not, she brings her insects to feed upon them. Then she brings her birds to feed upon the insects and the seeds; she is always busy doing something upon this land, which she owns in partnership. The farmer works only during the day time; Nature works night and day. The farmer does little work during the winter; Nature keeps at it steadily all the year round.

The best farmer is the one who keeps this busy partner of his working for his own interests day and night, summer and winter. But he can never do this until he understands Nature's ways — how and why she does her work. He must go out into the fields and ask of Nature, "Why have you planted here this tree? Why have you sown there those weeds? Why have you brought here these insects to destroy our orchards or our grain? Why do you not bring more insects which are friendly to the crops I wish to grow? Why are there not enough birds to kill the insects which are ruining our harvest?"

The most successful farmer of the future will not allow on his premises plants, insects, birds or animals without knowing why Nature placed them there and whether they are there for the benefit or detriment of his estate.

This year the work of the Home Nature-Study class will consist of going into the fields and asking of Nature "why" and "how." Every school teacher in New York State if she has pupils from the country, should be able to teach them how to study and understand the ways of Nature, that busy, silent partner of the farmer, the gardener, and the orchardist.

SOME EXPERT OPINIONS ON THE RELATION OF NATURE-STUDY TO
AGRICULTURE

“If the farmer as he trudges down the corn rows under the June sun sees only clods and weeds, and corn, he leads an empty and a barren life. But if he knows of the work of the moisture in air and soil, of the use of air to root and leaf, of the mysterious chemistry of the sunbeam, of the vital forces in the growing plant, of the bacteria in the soil liberating its elements of fertility; if he sees the relation of all these natural forces to his own work; if he can follow his crop to the market, to foreign lands, to the mill, to the oven and the table; if he knows of the hundreds of commercial products obtained from his corn or the animals that it fattens; he then realizes that he is no mere toiler; he is marshaling the hosts of the universe, and upon the skill of his generalship depends the life of nations.” — *David Felmley, President of the Illinois State Normal School.*

The art of agriculture and nature-study may overlap so that part of nature-study may rest entirely upon agriculture. Indeed agriculture is so vast that enough subject-matter may be drawn from it to constitute an entire course of nature-study. Then this course would be agricultural nature-study. It would be the method of nature-study applied to the teaching of agriculture, but that would not make nature-study and agriculture identical any more than a selection of the subject-matter for nature-study solely from the field of mineralogy would make mining and nature-study identical. Nature-study is broad, inclusive, comprehensive. It is an invaluable aid in the teaching of agriculture. It opens the way to agriculture in the schools, by awakening interest and quickening observation, and creating a love for all out-doors, but it is not agriculture.— *Professor F. L. Stevens, Professor of Botany, North Carolina College of Agriculture and Mechanic Arts.*

“The pupil should be taught to follow from effect to cause and from cause to effect; to classify objects; to correlate activities and ideas; to observe in detail, and also to view the general relation of things. As the personality of the teacher is the most important element in the school-room, so the development of individuality in the pupil is the most important element of school work. The objects, the activities, and the personal contact with the teacher which comes from nature-study, often prevent the narrowing effect in methods of thought of mere book teaching and avoids suppressing individual initiative. Nature-study may not result in such apparent accumulation of facts as mere book work does; its greatest function is to prepare the pupil to acquire facts in after life as they are needed.” — *W. M. Hays, Assistant Secretary, United States Department of Agriculture.*

Some years ago we received at Cornell a letter from a Canadian farmer boy, and in this letter he says, "I have read your leaflet entitled 'The Soil, What it is,' and as I trudged up and down the furrows every stone, every clump of earth, every sandy knoll, every sod hollow had for me a new interest. The day passed, the work was done, and I at least had had a rich experience." Who would doubt that such a man having such thoughts would plow a straighter furrow than he who sees only the earth he turns and the horses, which he perchance swears at as he goes on his dull routine, blinder than the mole whose wonderful galleried house his plow disturbs." — *The Cornell Countryman*.

"The nature-study idea is fundamental to the evolution of popular education. Therefore it may be applied — in fact, must be applied — to all branches of education. It is bound to have a tremendous influence in carrying a vital educational impulse to farmers. The accustomed methods of education are less applicable to farmers than to any other people, and yet the farmers are nearly half our population."

"The ideals of nature-study are everywhere the same; but the methods and means are capable of endless modification. There is always danger that too much emphasis will be placed on mere "learning" on the part of the child or the pupil. The real value of the extension work with the young, lies in interesting, enthusing, inspiring them. Mere information, however valuable, will not cause a person to be a farmer, nor incline him to live in the country. Of course the work must be practical — that is, it must be truthful, direct, forceful, and must put the child into intimate contact with his own life. It must aim to give him power and enterprise rather than assorted facts — although the facts may be so handled that they become the means and not the end." — *L. H. Bailey*.

It should be the object of all nature-study work to put the pupil into touch and sympathy with the natural world in which he lives, and to use the objects and phenomena in this environment as a means of education.

* * * *

The best nature-study lesson is that which has relation to something normal or native to the environment. The kind of tree that grows in the school yard or along the road, the birds that frequent the school yard and adjacent fields, the brook, the hills, the character of the soil, any unusual or striking feature in the neighborhood — all these are proper subjects for nature-study work.— *Report of the Committee on Industrial Education in Schools for Rural Communities to the National Educational Association, July, 1905*.

FOR THE PUPILS OF THE HOME NATURE-STUDY COURSE

You are advised to take up only two lines of study. If you choose tree-study, for instance, it will be better for you to become familiar with as many different species of trees in your neighborhood as is possible instead of scattering your energies over several lines of study.

Fill out the lessons on the enclosed supplements and return to us as soon as possible.

If you wish, duplicate supplements will be sent to you so that you may retain one set and return the others to us to keep on file.

A supplement will be sent to you for each tree, plant, bird, insect or fish studied.

A certificate will be granted to those who satisfactorily complete a year's work.

Address all communications to the editor.

Supplement to

Home Nature = Study Course

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ANNA BOTSFORD COMSTOCK, Editor

New Series. Vol. II. ITHACA, N. Y., OCTOBER-NOVEMBER, 1905

No. I

FISH STUDY



There may be more than cattle in this stream.

The Minnow hath, when he is in perfect season and not sick, which is only presently after spawning,—a kind of dappled or waved color, like to a panther, on his sides, inclining to a greenish and sky-color, his belly being milk-white, and his back almost black or blackish. He is a sharp biter at a small worm, and in hot weather makes excellent sport for young anglers, or boys, or women that love that recreation.

IZAACK WALTON.

Fill out the blanks in this supplement with answers to the questions and return to us. If you cannot answer all of the questions, answer as many as you can. A supplement will be sent to you for each fish studied.

OUTLINE FOR THE STUDY OF FISH

The form and adaptations of the fish: Catch a fish in a brook near-by and put in a mason jar or pail of water and answer the following questions about it:

1. What is the general shape of the fish? Is it wide or thin?
2. How does its shape assist it in moving rapidly in the water?
3. How many fins has the fish?
4. There are four of these fins which are in pairs; where are they?
5. How do these paired fins help the fish to swim?
6. How does the fish push itself through the water?
7. Where does it rest when not swimming?
8. What does the fish eat and how does it catch it?
9. Has a fish any eyelids?
10. Why does it keep opening and shutting its mouth all the time?
11. How does it breathe?
12. Why and how does the fish die when taken out of the water?

13. What do you suppose is the benefit the fish derives from being dark colored above and light colored beneath?

14. What are the enemies of the fish?

15. Were there ever any speckled trout in the streams near you?

16. If so, why are they not there now?

17. Can you procure State aid in stocking your stream with trout?

18. What are the game laws about fishing for trout and bass, or any other game fish in your streams?

19. Can you give any reason why fishing is permitted only during certain months?

In almost every stream of the United States there are several kinds of fish: pumpkin seeds, shiners, chubs, dace, "minnies," sticklebacks and perhaps Johnny darters. In the larger streams and lakes there is a still greater variety. The way to learn the different kinds of fish in your neighborhood is to encourage the boys of the school to bring in all of the kinds they can catch either with hook or net. They should be placed as soon as caught in a pail of water which should be changed at least twice

a day so that the fish will not smother. Make the following notes on each kind of fish caught:

20. What is the color above?

21. What is the color along the sides?

22. On the lower side what color?

23. What is the color of the line that runs along the side of the body?

24. Are there any spots on the fish? If so, what color and where?

25. What is the length of the fish, its width and its height?

26. Describe or sketch if you can the fin that extends along the top of the fish's back.

27. If you or any of your pupils can sketch or make a drawing either in pencil or color of the fish to send to us, it will aid us in identifying the species for you.

28. Describe any peculiarities of the fish not covered by the questions?

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New Series, Vol. II. ITHACA, N. Y., OCTOBER-NOVEMBER, 1905 No. 1

INSECT STUDY



A Tussock caterpillar.

It costs the American farmer more to feed his insect foes than it does to educate his children.—(Bulletin from United States Department of Agriculture.)

Fill out the blanks in this supplement with answers to the questions and return to us. If you cannot answer all the questions answer as many as you can. A supplement will be sent to you for each insect

OUTLINE FOR INSECT STUDY

The object of this outline is to study any insects which are injuring the fruit or crops in your neighborhood. In general if you find an insect feeding upon any plant answer the following questions:

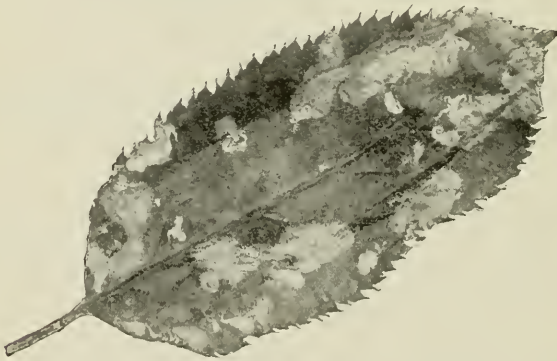
1. What is the plant upon which it is feeding? Either describe or send specimens.

2. Is the insect a caterpillar or grub, or has it wings?

3. If it is a caterpillar describe the colors and size.

4. If it has wings catch specimens and send to us for identification.

As most insects are getting ready to go into winter quarters, I suggest that you look for some of the following species in your neighborhood. If you find any of them, it will be part of the winter and spring work to learn how to get rid of them.



THE TRUMPET MINER OF THE APPLE

This year the leaves of the trees of many orchards of our State have been attacked by a little insect that lives between the upper and lower surfaces of the leaves. Leaves thus injured may be distinguished because the injury shows only on the upper side and takes the form of long trumpet-shaped, brown blotches. By opening the dead surface the little caterpillar may be found within; it is very small, less than one-eighth of an inch in length, and not larger around than a pin. If the leaf is held up to the light, the little caterpillar may be seen wriggling around

within the mine. Bring leaves thus infested into the schoolroom and put them into a box with a closed cover and describe the moths which issue, in your spring lesson.

5. If you find this leaf miner please make a sketch of an infested leaf or send one to us.

6. How will the ravages of this small insect affect the orchards?

7. How does it pass the winter?

8. What could be done in the fall or the winter to rid the orchards of this pest?

THE GRAPE BERRY MOTH

Look at the grapes growing in your neighborhood. If you find several of the grape berries fastened together with a web and you can see a hole in the side of one of the berries, which may have a little fine dirt projecting from it, take such a bunch and put it in a box with a tight cover. Place in the box with it some grape leaves that have not been injured in any way, putting their stems in water so that they will remain fresh.

9. Observe the way these insects make cocoons in the leaves.

10. Describe how they pass the winter.

11. What should be done in a vineyard to kill these insects before spring?

Keep the box closed during the winter and describe the moths and when they emerge in your spring lesson.

THE CODLING-MOTH

12. Do you find any wormy apples in your neighborhood?
13. In which end of the apple is the hole and what part of the apple is eaten?
14. What does this larva change into finally?
15. How does it pass the winter?
16. What must be done to keep the apples free from the attack of the codling moth?
17. Tie an old rag around the trunk of an apple tree now and a month later take it off and examine it for the codling-moth cocoons and give results.

HAIRY CATERPILLARS

The tussock moths are hairy caterpillars which have brushes or hairs extending out like tassels on either end of the body. These are most mischievous insects and should be studied and exterminated if possible.

18. Describe any tussock moth which you may find giving its color along the back and sides, and the color of the brushes of hairs which extend out beyond the rest?
19. Put any such caterpillar that you may find in a pasteboard box with a tight cover with some chips or sticks in it and describe how the insect changes to a pupa.

The Isabella Caterpillar or the "woolly bear" is smoothly clipped and has no brushes of hairs extending out upon it. It is reddish brown with black at both ends and is quite harmless, and makes an interesting little companion for the children.

20. Place any of the woolly bears which you may find in a box with plenty of grass and note when it changes to a pupa. Keep the box closed and in the spring study the moth which comes from it.

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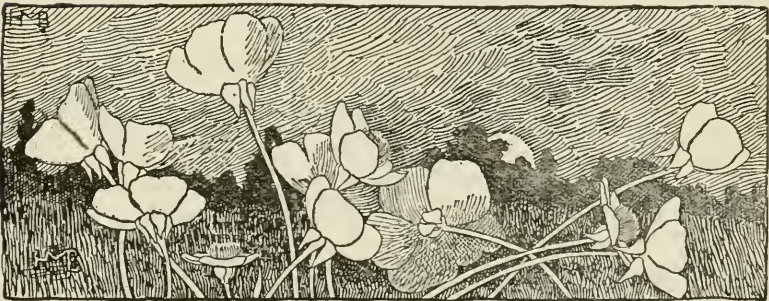
New Series. Vol. II. ITHACA, N. Y., OCTOBER-NOVEMBER, 1905 No. 1

PLANT STUDY

Every schoolhouse in village or country is set amid a great variety of plants. Somethimes these are cultivated but more often they are of Nature's own planting. These plants flourish and struggle for room for their roots in the ground and for their leaves in the sunshine; they blossom and sow their seeds. Let every teacher learn how many and what plants are growing in the schoolyard and along the roadside near her school. Let her regard the schoolhouse as the center and get to know her nearest plant neighbors and their ways.

I like these plants that you call weeds,—
Sedge, hardhack, mullin, yarrow,—
That knit their roots and sow their seeds
Where any grassy wheel-track leads
Through country by-ways narrow.

—*Lucy Larcom.*



If possible make a drawing on this page of a leaf of the plant studied and its blossom or fruit. If you cannot draw fasten a pressed leaf and flower or fruit to the page.

Fill out the blanks in this supplement with answers to the questions and return to us. If you cannot answer all the questions, answer as many as you can. A supplement will be sent to you for each plant studied.

OUTLINE FOR PLANT STUDY

If you know the name of the plant write it here.

1. Does the plant grow in the open fields or woods?
2. How high is it?
3. What shape is its leaf?
4. Do the leaves grow at the base or along the stem?
5. In the latter cases are they opposite each other or alternate?
6. Are all the leaves the same shape and size?
7. What is the length and width of the largest leaf you can find on the plant?
8. Is there a single stem or are there many stems?
9. Do the stems branch, if so how? (Describe or show by sketch.)
10. Give the size, shape and general description of the flower.
11. Do you find any insects visiting the flowers? If so, what kind are they?

12. What is the use of the flower to the plant?
13. Is the seed scattered by wind, water, birds, animals or how?
14. What is the shape of the root of the plant?

WEEDS

15. What is a weed?
16. If the plant you have been studying is a weed describe how it manages to drive out cultivated plants.
17. How does its seed get planted in cultivated places?
18. How is its roots adapted to keep it alive despite our efforts to kill it?
19. What effect does rotation of crops have on this weed?
20. How would you get rid of this weed?

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New Series. Vol. II. ITHACA, N. Y., OCTOBER-NOVEMBER, 1905

No. 1

TREE STUDY

They've cut the wood away,
The cool green wood,
Wherein I used to play
In happy mood.

The woodman's axe has cleft
Each noble tree,
And now, alas, is left
No shade for me.

The brooks that flow in May
Are dry before
The first hot summer day,
And flow no more.

The fields are brown and bare,
And parched with heat ;
No more doth hover there
The pine scents sweet.

No more his note is heard
To blithely ring
Where erst the woodland bird
Would sit and sing.

No more the wood-flowers
bloom
Where once they bloomed
Amid the emerald gloom
Of ferns entombed.

Fled, now, the woodland sights,
The scented air !
Fled, all the sweet delights
That once were there !

And fled the gracious mood
That came to me,
When to that quiet wood
I used to flee !

—*Author Unknown.*



If possible make a drawing of the leaf and fruit of the tree studied, on this page. If you cannot draw, press a leaf and paste it to the page.

Fill out the blanks in this supplement with answers to the questions and return to us. If you cannot answer all the questions, answer as many as you can. A supplement will be sent to you for each tree studied.

OUTLINE FOR TREE STUDY

Take the tree nearest your schoolhouse for this study.

1. What is the general shape of the whole tree?
2. Does the tree grow naturally in the forest or in the open field?
3. About how far from the ground are the lowest branches?
4. Does the bole or trunk divide into branches or continue straight up?
5. Are the branches many or few?
6. Of what use to the tree are the trunk and branches?
7. Is the bark rough or smooth?
8. If rough are the sutures close together or wide apart?
9. If smooth does it peel or roll?
10. On what part of the branches are the leaves borne? Why is this so?

11. Are the leaves placed opposite each other or alternate on the twigs?

12. Is the leaf stem (petiole) long or short?

13. Is the leaf simple like that of the maple or oak or is it made up of several leaflets like the hickory or locust leaves?

14. Is there anything between the petiole and the twig where the two join? What will this develop into next year?

15. Of what use to the tree are the leaves?

16. What color are the leaves of this tree this autumn?

17. What use is made of the lumber of this kind of tree in your locality?

18. Describe the roots of the trees as far as you can see them.

19. Of what use are the roots to the tree?

20. Describe the fruit of the tree.

21. Tell how the seeds are scattered.

22. Give the name of the tree if you know it.

Supplement to
Home Nature = Study Course

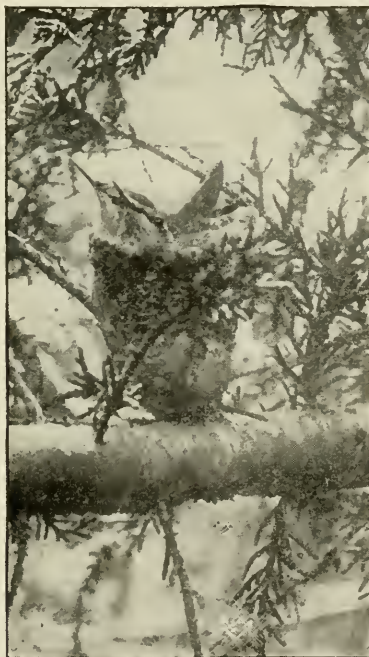
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New Series. Vol. II. ITHACA, N. Y., OCTOBER-NOVEMBER, 1905

No. 1

BIRD STUDY



Do you know where the
humming birds pass the winter?

Make on this page any drawings you choose of the bird studied. If you cannot draw, write here any observations you may have made which are not included in the questions.

Fill out the blanks in this supplement with answers to the questions and return to us. If you cannot answer all of the questions, answer as many as you can. A supplement will be sent to you for each bird studied.

OUTLINE FOR BIRD STUDY

Take this paper with you and put down the answers as you observe them.

1. Where do you find the bird? Is it in orchard, meadow, woods, bushes, on the fence or along the border of a stream, in a marsh or on the water?

2. What is it doing?

3. Is it alone or with other birds?

4. If it is with a flock were all the other birds in the flock like it?

5. What is the color of:

(a) top of the head

(b) the back

(c) the breast

(d) the wings

(e) the tail

6. When the bird is flying do you see upon it any white markings? If so where are they?

7. Is the body long and slender, or short and stocky?

8. Can you see if the bill is long and slender or short? Is it straight or hooked?

9. If you hear its song, describe it as nearly as possible?

10. Do you see the bird feeding? If so, what is its food and how does it get it?

11. What in general do birds feed upon?

12. Why do birds migrate to warmer countries for the winter?

13. Do they nest in the tropics while they are gone?

14. If it is the cold that drives the birds to migrate, why do the chickadees, blue-jays, woodpeckers and crows remain North during the winter?

15. Do you know where the robin, the blue-bird, the oriole, the bobolink, the meadow lark, the humming bird, the goldfinch, the owls and the hawks spend the winter?

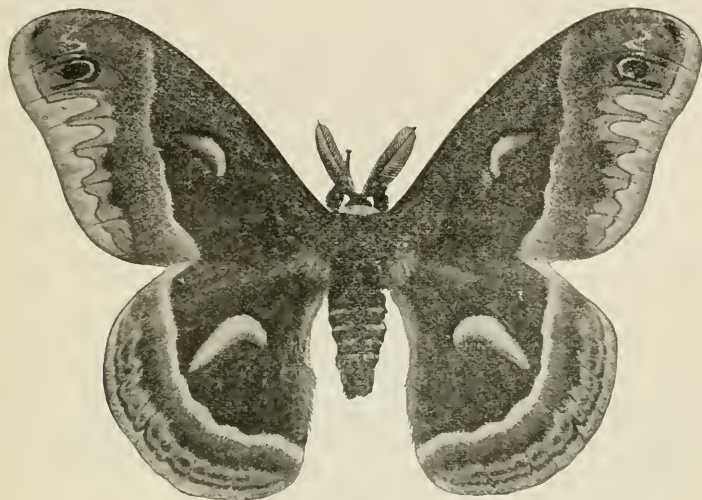
16. Which birds do you think are of greatest value to the farmer and why?

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New Series. Vol. II. ITHACA, N. Y., DECEMBER-JANUARY, 1905-6 No. 2



Cecropia moth.

INSECT STUDY

THE AMERICAN SILK-WORMS

ILLUSTRATED FROM PHOTOGRAPHS TAKEN BY PROF. M. V. SLINGERLAND

The silk-worm that gives us the silk of commerce has been domesticated for centuries in China. Because of this domestication it is willing to be handled and is reared successfully in captivity, and has thus come to be the source of most of our silken fabrics. However, we have in America native silk-worms which produce a silk that is stronger and makes a more lustrous cloth than does that made from the Chinese species. But we have never had the time and the patience here in America to domesticate these giant silk-worms of ours, and so they are, as yet, of no commercial importance.

The names of our common native silk-worms are: the cecropia, promethea, polyphemus, and luna. In all of these species the moths are large and beautiful, attracting the attention of every one who sees them. The caterpillars are rarely found, as their varied green colors render them inconspicuous among leaves on which they feed. None of the

caterpillars of the giant silk-worms occur in sufficient numbers to injure the foliage of our trees to any extent; they simply help nature do a little needful pruning. All of the moths are night flyers and are, therefore, seldom seen except by those who are interested in the visitors to our street lights.

The cocoons afford the most ready means of finding and rearing these moths; they may be gathered during the months of November and December. They should not be kept in the hot and dry schoolroom, but should be placed in boxes outside the windows where they may have the moisture of the atmosphere and the temperature which is natural to them. Cocoons kept thus should be brought into the house early in April so that the moths may be watched when emerging and captured for study. Miss Mary E. Hill, who has had excellent success in raising cocoons kept in the schoolroom all winter, dips them at least once a week in a dish of water, letting them remain a few moments and thus keeping the silk from getting so dry and hard, that the moths cannot push their way out before their wings harden and cripple them.

The reason we have chosen these silk-worms for a leaflet is, that they are the most common and valuable subjects for nature-study, and yet but few people know the species apart or know their life histories. They illustrate well all of the phases of insect life, and the children never tire of the miraculous appearance of these magnificent creatures as they issue from the cocoons.

THE CECROPIA (*Samia cecropia*)

This is the largest of our giant silk-worms, the wings of the moth expanding sometimes six and one-half inches. It occurs from the Atlantic Coast to the Rocky Mountains.



Cecropia eggs enlarged.

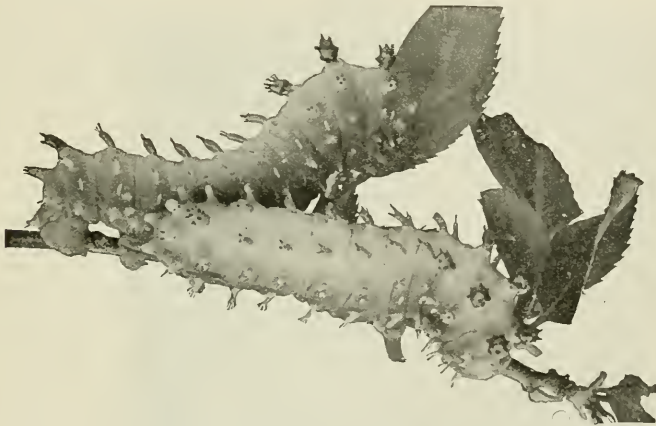
Food Plants.—The caterpillars of this moth are general feeders living on over fifty species of our common trees. They occur very commonly on apple and plum trees and also on the wild cherry.

Eggs.—The moth which issues from the cocoon in the spring lays its eggs upon the young leaves of the tree on which the caterpillar is to feed. The eggs are cream white, and are laid in small clusters of short rows, sometimes on the lower and sometimes on the upper sides of the

leaves. Just before hatching the eggs turn grayish; they hatch from ten

to fifteen days after they are laid, but the hatching may be retarded by cold weather.

Caterpillar.—When the caterpillar hatches from the egg it is about a quarter of an inch long and is black; each segment is ornamented with six spiny tubercles. Like all other caterpillars, it has to grow by shedding its horny, skeleton skin, the soft skin beneath stretching to give more room at first, then finally hardening and being shed in its turn; this shedding of the skin is called molting. The first molt of the cecropia caterpillar occurs about four days after it is hatched, and the caterpillar which issues looks quite differently than it did before; it is now dull orange or yellow with black tubercles. After six or seven days more of feeding, the skin is again shed and now the caterpillar appears with a yellow body; the two tubercles on the top of each segment are now larger and more noticeable.



Cecropia caterpillars fully grown.

They are blue on the first segment, large and orange-red on the second and third segments, and greenish blue with blackish spots and spines on all the other segments except the eleventh, which has on top, one large, yellow tubercle, ringed with black, instead of a pair of tubercles. The tubercles along the side of the insect are blue during this stage. The next molt occurs five or six days later; this time the caterpillar is bluish-green in color, the large tubercles on the second and third segments being deep orange, those on the upper part of the other segments yellow, except those on the first and last segments, which are blue. All the other tubercles along the sides are blue. After the fourth molt it appears as an enormous caterpillar, often attaining the length of three inches and is as large through as a man's thumb; its colors are the same as in the preceding stage. There is some variation in the colors of the tubercles

on the caterpillars during these different molts; in the third stage it has been observed that the tubercles usually blue are sometimes black.



Cecropia caterpillar shedding its skin.

After the last molt the caterpillar eats voraciously for perhaps two weeks or longer and then begins to spin its cocoon.

The cocoon.—This is the cocoon found most often on our orchard and shade trees, and is called by the children



Cecropia caterpillar spinning its cocoon.

the "cradle cocoon," since it is shaped like a hammock and hung close below a branch; it is a very safe shelter for the helpless creature within it. It is made of two walls of silk, the outer one being thick and paper-like and the inner one thin and firm; between these walls is a matting of loose silk, showing that the insect knows how to make a home that will protect it from winter weather. It is a clever builder in another respect, since at one end of the cocoon it spins the silk lengthwise instead of crosswise, thus making a valve through which the moth can push as it issues in the spring. It is very interesting to watch one of these caterpillars spin its cocoon. It first makes a framework by stretching a few strands of silk, which like all other caterpillars, it spins from a gland opening in the lower lip; it then makes a loose net work on the supporting strands, and then begins laying on the silk by weaving its head back and forth leaving the sticky thread in the shape of connecting M's or figure 8's. Very industriously does it work, and after a short time it is so screened by the silk, that the rest of its performance remains to us a mystery. It is especially mysterious since the inner wall of the cocoon encloses so small a cell that the caterpillar is obliged to compress itself in order to fit within it. This achievement would be something like that of a man who built around himself a

and is called by the children

of loose silk, showing that the insect knows how to make a home that will protect it from winter weather. It is a clever builder in another respect, since at one end of the cocoon it spins the silk lengthwise instead of crosswise, thus making

box only a few inches longer, wider and thicker than himself. After the cocoon is entirely finished the caterpillar sheds its skin for the last time and changes to a pupa.

The pupa.—Very different indeed does the pupa look from the brilliant colored, warty caterpillar. It is compact and brown, oval and smooth with ability to move but very little when disturbed. The cases which contain the wings, which are later to be the objects of our admiration, are now folded down, like a tight cape, around the body and the antennae like great feathers are outlined just in front of the wing cases. There is nothing more wonderful in all nature than the changes which are worked within one of these little, brown, pupa cases, for within it processes go on, which change the creature from a crawler among the leaves to a winged inhabitant of the air. When we see how helpless this pupa is, we can understand better how much the strong silken cocoon is needed for protection from enemies as well as from inclement weather.

The moth.—In the spring, usually in May, after the leaves are well out on the trees, the pupa skin is shed in its turn, and out of it comes the wet and wrinkled moth, its wings all crumpled, its furry, soft body very untidy; but it is only because of this soft and crumpled state that it is able to push its way out through the narrow door into the outer



Cocoon of cecropia.

world. It has on each side of its body just back of the head two little, horny hooks that help it to work its way out. It is certainly a sorry object as it issues, looking as if it had been dipped in water and some one had squeezed it in his hand. But the wet wings soon spread, the bright antennae stretch out, the furry body becomes dry and fluffy, and the large moth appears in all its perfection. But though it is so large, it does not need to eat; the caterpillar did all the eating that was necessary for the whole life of the insect; the mouth of the moth is not sufficiently perfected to take food.

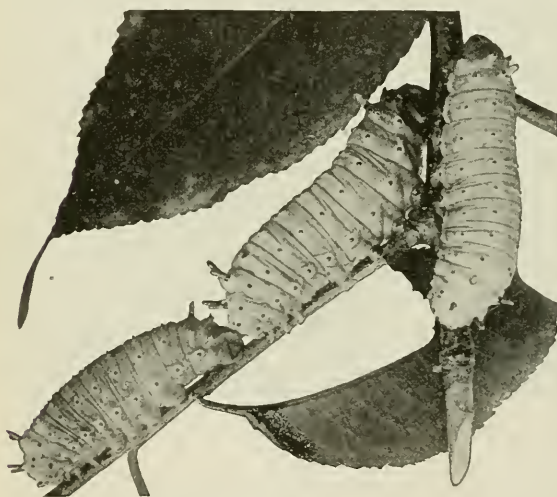
PROMETHEA (*Callosamia promethea*)

The promethea is not so large as the cecropia, although the female resembles the latter somewhat. It is the most common of all of our giant silk-worms.

Food plants.—Wild cherry, lilac, ash, sassafras, buttonwood and many other forest trees.

The eggs.—These are whitish with brown stain, and are laid in rows, a good many on the same leaf.

The caterpillar.—The caterpillars, as they hatch from the eggs, have bodies ringed with black and yellow. They are sociable little fellows and live together side by side amicably, not exactly “toeing the mark” like a spelling class, but all heads in a row at the edge of the leaf where each is eating as fast as possible. When they are small the caterpillars remain on the under side of the leaves out of sight. In about five days, the first skin is shed and the color of the caterpillars remains about the same.



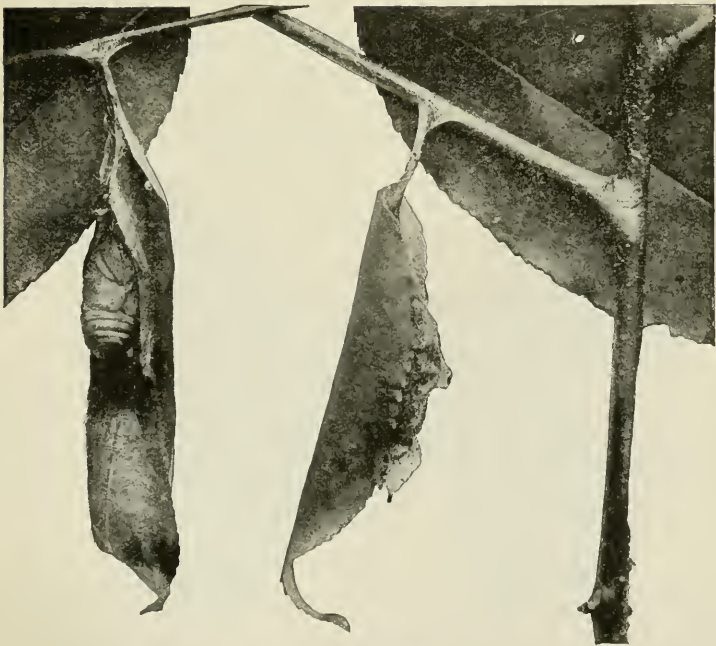
Promethea caterpillars fully grown.

Four or five days later, the second molt occurs, and then the caterpillar appears in a beautiful bluish-green costume with black tubercles, except four large ones on the second and third segments, and one large one on the eleventh segment, which are yellow. This caterpillar has an interesting habit of weaving a carpet of silk on which to change the skin; it seems to be better able to hold on while

pushing off the old skin if it has the silken rug to cling to. After the third molt, the color is a deeper greenish-blue and the black tubercles are smaller, and the five big ones are larger and bright orange in color. After the fourth molt, which occurs after a period of about five days later, the caterpillar appears in its last stage. It is now over two inches long, quite smooth and prosperous looking. Its color is a beautiful light, greenish-blue, and its head is yellow. It has six rows of short, round black tubercles. The four large tubercles at the front end of the body are red, and the large tubercle on the rear end of the body is yellow.

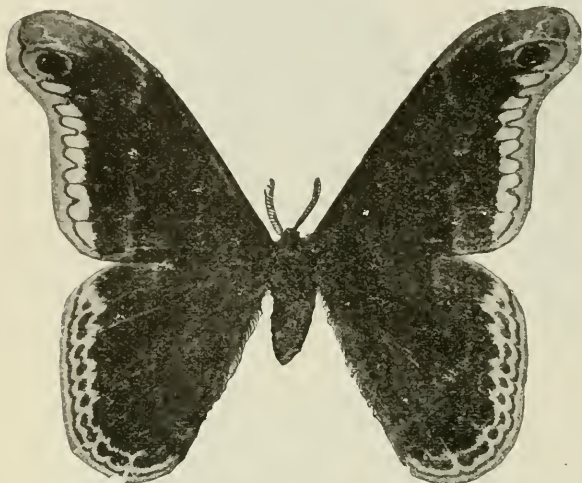


Promethica moth, female.



Promethica cocoons, one cut open to show the pupa.

The cocoon.—During the winter, leaves may often be seen hanging straight down from the branches of wild cherry, lilac and ash. If these leaves are examined each one will be found to be wrapped around a silken case containing a pupa of the promethea. It is certainly a canny insect which hides itself during the winter in so good a disguise, that



Promethea moth, male.

only the very wisest of birds ever suspect its presence. When the promethea caterpillar begins to spin, it selects a leaf and covers the upper side with silk, then it covers the petiole with silk fastening it with a strong band to the twig, so that not even most violent winter winds will be able to tear it off. Then it draws the two edges of the leaf about itself like a cloak as far as it will reach, and inside this folded leaf it makes its cocoon, which always has an opening in the shape of a conical valve at the upper end, through which the moth may emerge in the spring. This caterpillar knows more botany than some people do, for it makes no mistake in distinguishing a compound leaf from a simple one. When it uses a leaflet of hickory for its cocoon, it fastens the leaflet to the mid stem of the leaf and then fastens the stem to the twig.

The pupa.—The male pupa is much more slender than that of the female. The moths do not issue until May or June.

The moth.—The moth works its way out through the valve at the top of the cocoon. The female is a large, reddish-brown moth with markings resembling somewhat those of the cecropia. The male is very different in appearance, as its front wings have very graceful, prolonged tips, and both wings are almost black bordered with ash color. The promethea moths differ somewhat in habit from the other silk-worm moths in that they fly during the late afternoon as well as at night.

ANGULIFERA MOTH (*Callosamia angulifera*)

This is very much like the promethea in appearance except that the white markings of the wings are much more angular in shape, and the males and females are nearly alike in form and color. The caterpillars of this species do not invariably fasten the petiole of the leaf to the twig,

but make the cocoon within the leaf and drop to the ground when the leaf falls.

THE CYNTHIA (*Philosamia cynthia*)

This beautiful moth is an Asiatic species; it is very large and olive green in color with lavender tints and white markings; there are white tufts of hairs on the abdomen. It builds its cocoon like the promethea fastening the petiole to the twig. It lives upon the ailanthus tree, and is found in our State only in the region about New York City, where the ailanthus has been introduced as a shade tree.

THE POLYPHEMUS (*Telca polyphemus*)

This large, yellowish-brown moth is the one of all our species of American silk-worms which would be used for the production of silk if we were deprived of the product of the Chinese species. Its silk is strong and smooth, very lustrous, and extremely durable. Each cocoon gives about eight hundred feet of unbroken silk.

Food plants.—Oak, elm, maple, chestnut, walnut, beech, birch, apple, pear, wild cherry and many others.



Polyphemus eggs, enlarged.

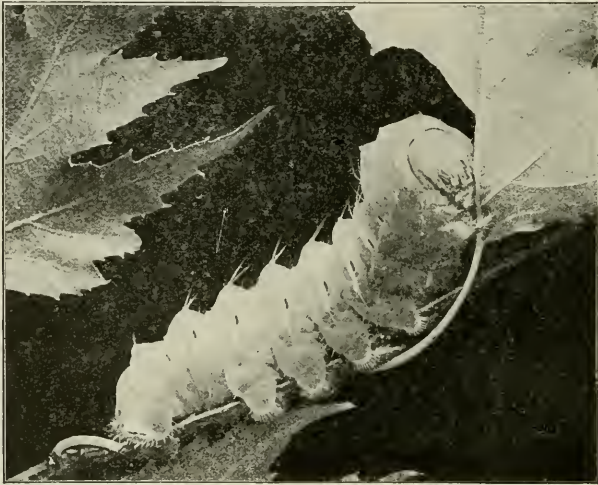


Polyphemus moth.

The eggs.—These are flat and round like a lozenge; the top and bottom are white and the sides brownish. They are laid in clusters, usually

on the under side of the leaf. They hatch from ten to fifteen days after being laid.

The caterpillar.—When first hatched the caterpillar has a large, reddish head and the body is yellow. Later the body turns green, the back being bluish in tint; the tubercles are yellow. It changes its skin at intervals, as do the other silk-worms, but the color of the body does not change noticeably. When the caterpillar has reached its full growth, its body is green with oblique yellow stripes on each of the abdominal segments. The tubercles are orange, sometimes red. The shield on the rear end of the body is edged with brown and the head is reddish-brown. The segments of the body are deep and sharp at the edge. The caterpillar has a way when resting, of drawing itself up so that its segments



Polyphemus caterpillar fully grown.

look like a half shut accordion. It will erect the front part of the body if disturbed and hold itself thus motionless for a long time and undoubtedly thus escapes notice, as it resembles a serrate edged leaf.

The cocoon.—This is quite different in shape from that of the cecropia or promethea. It is a broad, blunt oval and is spun within at least two leaves and often with other leaves in the vicinity attached. Usually when the leaves fall the cocoons go with them and lie safely under the snow all winter. However, during recent years we have found many polyphemus cocoons fastened to twigs and remaining on the tree all winter. Whether this is a chance happening or the beginning of a new habit, we are unable to say. The cocoon is very solid, and is not double walled, like that of the cecropia.

The pupa.— This is almost globular in shape and shows the antennae and the wing pads very plainly.

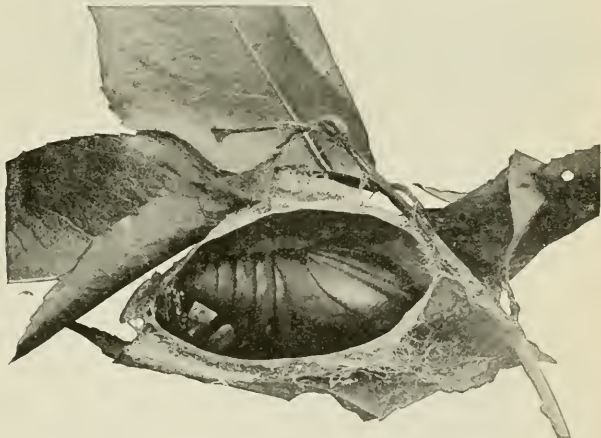


Polyphemus cocoon.

The moth.— When the moth breaks open the pupa skin, it finds no valve or opening as does the cecropia and promethea. However, it masters the situation and gets out of its compact case by wetting the cocoon with an acid liquid, which it secretes in its mouth for the purpose, and then pushes its way out between the threads. It can be readily distinguished from all the other moths, as it has what the children call “a window pane” in the middle of each wing. This transparent spot consists of thin membrane; in the hind wing it is the “eye” of the large, decorative eye-spot.

THE LUNA (*Tropæa luna*)

Of all the beautiful silk-worm moths the luna is far the most graceful in form and the most



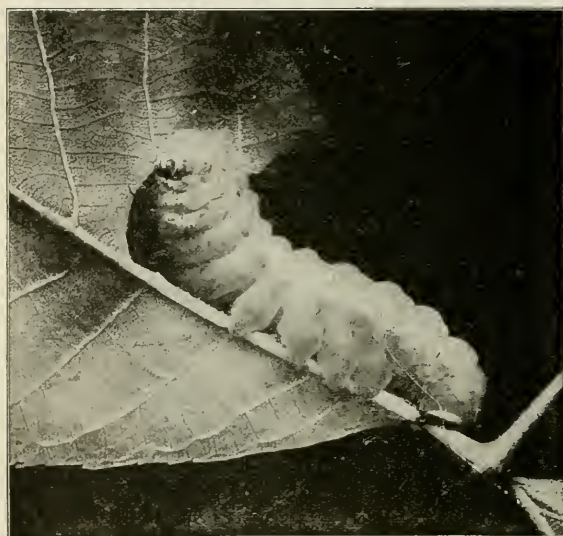
Polyphemus cocoon cut open showing the pupa. The wing-cases and antenna show plainly.

exquisite in color. It may be seen flying about electric lights during May and June, and has been likened to a “great, white ghost of a bird appearing for a moment then vanishing in the darkness.”

Food plants.— Hickory, birch, oak, butternut, walnut and others.

The eggs.—These are white and are laid a few in a row on the leaf of a food plant. They hatch in about a fortnight after being laid.

The caterpillar.—This resembles very much the caterpillar of the polyphemus. It is green when it hatches, but the head is not entirely brown like that of the polyphemus. There is no noticeable change after the molts, except that after the fourth molt, a yellow broken line may be seen running along each side of the body showing on the hind half of each segment. The tubercles vary from red to rose color and yellow, and the abdominal tubercles are sometimes blue. This caterpillar varies much in markings and colorings. It is usually distinguished from the



Luna caterpillar fully grown.

polyphemus because it lacks the oblique yellow lines on the abdominal segments, and has instead a line along each side of the body; but we have had caterpillars that showed this lateral line so set on edge along the segments, that we were very much surprised when luna instead of polyphemus moths issued from the cocoons.

The cocoon.—The caterpillar spins its cocoon by drawing two leaves closely together around it. The cocoon resembles that of the polyphemus very much, and like it, it usually falls to the ground with the leaves. However, luna caterpillars have been found on the ground under the tree weaving their cocoons among the fallen leaves.

The pupa.—This resembles very much that of polyphemus.

The moth.—The delicate, exquisite green of the luna's wings is set off by the rose-purple, velvet border of the front wings, and the white fur on the body and inner edge of the hind wings. Little wonder that it has been called the "Empress of the night." The long swallow tail of the hind wings gives the moth a most graceful shape, at the same time probably affords it protection from observation. During the day time the moth hangs wings down beneath the green leaves, and these long projections of the hind wings folded together resemble a petiole, making the insect look very much like a large leaf.

THE PUPILS IN INSECT STUDY WILL PLEASE WRITE AN ESSAY COVERING AS MANY OF THE FOLLOWING POINTS AS POSSIBLE AND SEND IT TO US. BE SURE AND SIGN YOUR NAME.

Have you ever reared any of these moths from the cocoons? If so, describe the experience.

Have you ever reared many small flies from a cocoon instead of one large moth? If so, explain this phenomenon.

What is the difference in method of silk spinning between a caterpillar and a spider? To what different uses is the silk put by these two little creatures?

What are the characteristics by which you distinguish these four kinds of moths from each other?

Fill out the lessons on the enclosed supplements and return to us as soon as possible.

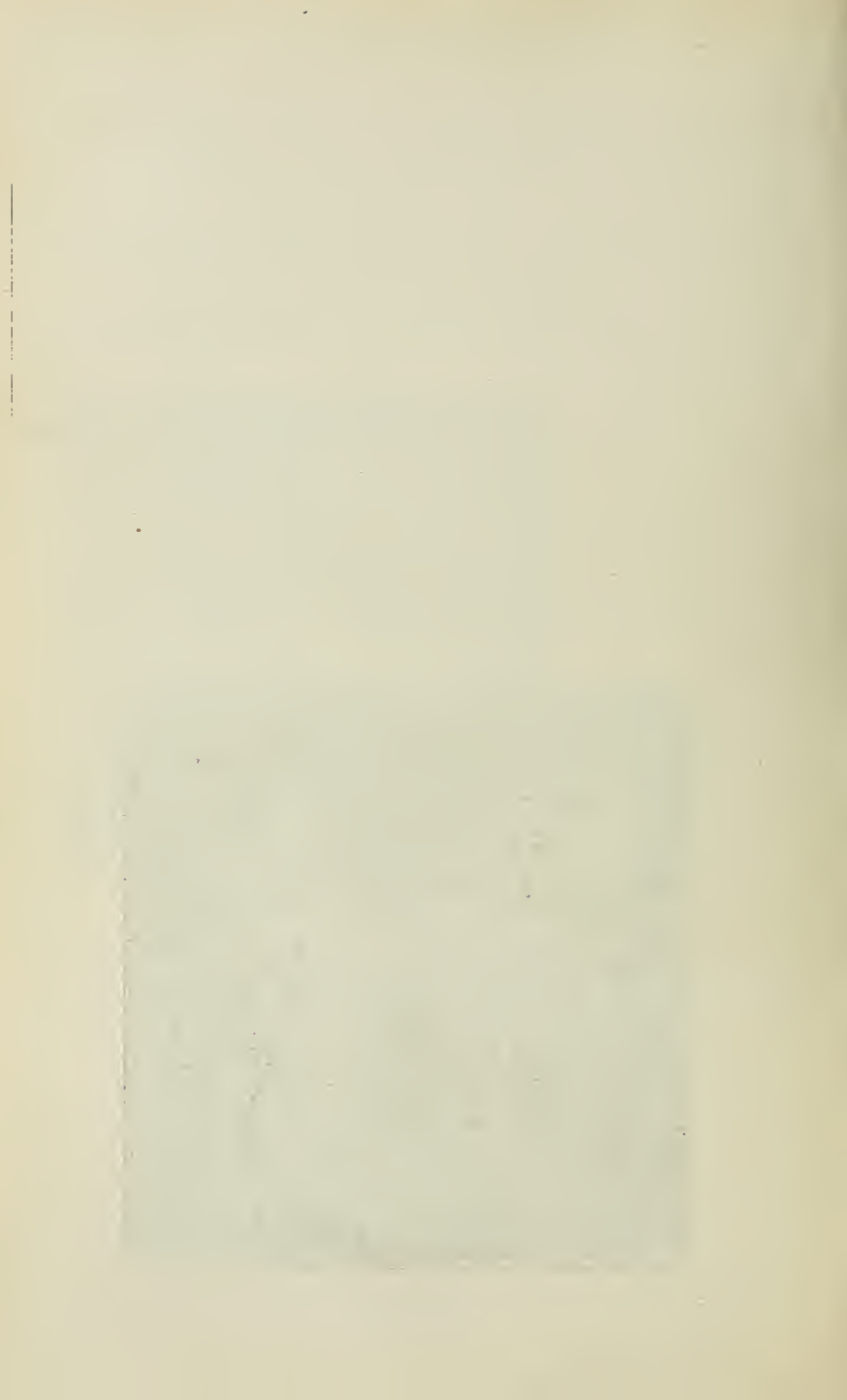
Duplicate supplements are sent to you so that you may retain one set and return the other to us to keep on file.

A certificate will be granted to those who satisfactorily complete a year's work.

Address all communications to the editor.



Luna moth.



Home Nature = Study Course

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ANNA BOTSFORD COMSTOCK, Editor

New Series. Vol. II. ITHACA, N. Y., DECEMBER-JANUARY, 1905-6 No. 2

FISH STUDY



Photographed by Verne Morton.

“Up and down the brook I ran,
Where, beneath the banks so steep,
Lie the spotted trout asleep,”

— Whittier.

THE FORM OF A FISH

To many of us the idea of catching a fish in January may seem impossible. Few of us have even asked ourselves where the fish are and what they are doing while the brook and ponds are covered with ice. Those who are able to find a sheltered pool with a muddy leaf-covered

bottom may be able to answer in part at least. It may be necessary to cut a hole through the ice, but if we dip with our net from the very bottom of the pond, being careful to bring up some of the leaves and sediment, we shall probably be rewarded by finding among the mass one or two little fishes. They may be almost any of the little, fresh water fishes such as chub, dace or minnows. Like many other fishes, they have buried themselves in the mud and leaves to sleep through the winter.

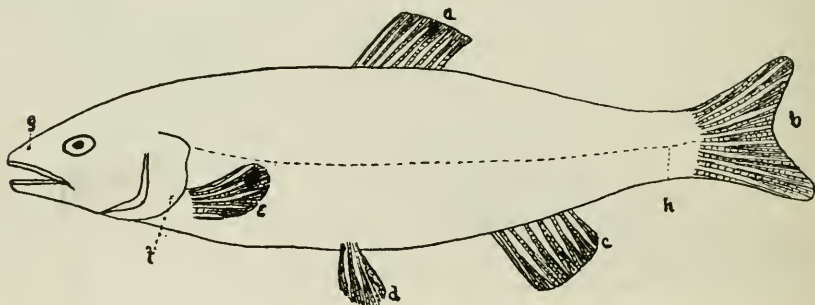
Having been fortunate enough to find a fish, let us take him home and place him in a glass can or jar of water in order that we may see how he is made.

THE SHAPE OF THE BODY

After watching a fish for a short time we cannot help being convinced of his perfect adaptation to a life in the water. The boat-shaped form, tapering gradually toward the head and tail, enables the fish to part the water readily and swim with great rapidity. Fishes not having this general form depend for protection on some other means of escape than by fast swimming.

THE FINS

The normal fish has seven fins. The one on the middle line of the back is the dorsal; it may be divided into two or three parts. In that



a, dorsal fin. b, caudal fin. c, anal fin. d, ventral fin. e, pectoral fin. f, gill-cover. g, nostril. h, lateral line.

case they are spoken of as first, second or third dorsal fins. The tail fin is called the caudal fin. The fin on the lower middle line is the anal fin. Like the dorsal fin it may be divided. Besides these unpaired fins are two pairs of fins which correspond to the limbs of higher animals. The first pair, or pectorals, are directly behind the gill openings. The second pair are called ventrals, and are situated below and behind the pectorals. Fins are made up of both soft and bony rods or rays connected by a membrane. The soft rays are flexible and many jointed. The bony rays are usually stiff spines and are never jointed. Not all fishes possess spines. When they are present in a fin they precede the soft rays. The

caudal fin never contains spines. Some fishes, like the stickle-back, have the dorsal fin preceded by free spines, that is, spines not connected by a membrane.

HOW A FISH BREATHES

In order to understand how a fish breathes we must examine his gills. In the throat just above the entrance of the gullet are several bony arches, each bearing two rows of pinkish fringes. These are the gill arches and the fringes are the gills. Into each fringe runs a tiny blood vessel. As the water passes over the gills, the oxygen contained in it is absorbed through the thin skin and the impurities of the blood are permitted to pass out in the same manner. Since a fish cannot make use of air unless it is dissolved in water, it is very important that the water in an aquarium jar should often be replenished.

The gill arches also bear a series of bony processes called gill rakers. Their function is to prevent the escape of food. They vary in size according to the food habits of the fish. A fish living upon minute forms of life has long, fine gill rakers, which are placed close together.

THE TEETH

The shape, number and position of the teeth vary according to food habits of the fish. Some fishes feed upon plants, others upon plants and animals, and still others upon animal life alone. Most fishes, however, feed upon other fishes. The commonest type of teeth are fine, sharp, short ones arranged in pads. Such ones are found in the bullheads. Some fish have blunt teeth suitable for crushing shells. Herbivorous fishes have sharp teeth with serrated edges, while those living upon crabs and snails have incisor-like teeth. One fish may have several types of teeth. In some groups of fishes, teeth are entirely absent. Teeth are borne on the jaws, roof of the mouth, on the tongue and also in the throat.

THE SENSES

With the exception of smell the senses are not highly developed in fishes. The sense of smell is located in the nostrils, the openings of which may be seen on either side of the snout. The nostrils have no connection whatever with the work of breathing.

Fishes are usually near-sighted; they have no eyelid, but the eyeball is movable. This often gives the impression that the fish has winked.

Extending along the side of the body from head to tail is a line of modified scales containing small tubes connected with nerves; it is called the lateral line. It is believed to be connected in some way with the sense of hearing. The fish has no ear-shaped hearing organs.

The tongue of the fish is either bony or gristly and immovable. There is very little sense of taste developed in it.

QUESTIONS ON THE FORM OF A FISH

1. What protection to fishes are the dorsal spines?

2. Of what use to a fish is the absence of a neck?

3. Why does plant life in the aquarium aid in keeping the water pure?

4. Describe or draw a scale of a fish. Of what use are scales to the fish? Do all fish have scales? What are the exceptions that you know of?

5. Is the lateral line always present on fish?

6. How can you tell by examining the mouth and gills of a fish the nature of its food?

7. Have you a fish in an aquarium for study?

Name.....

Address.....

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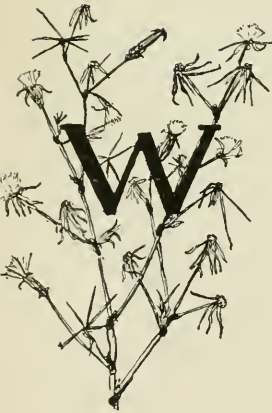
New Series. Vol. II. ITHACA, N. Y., DECEMBER-JANUARY, 1905-6 No. 2

PLANT STUDY

All day it snows: the sheeted post
Gleams in the dimness like a ghost;
All day the blasted oak has stood
A muffled wizard of the wood;
Garland and airy cap adorn
The sumach and the wayside thorn,
The clustering spangles lodge and shine
In the dark tresses of the pine.

The ragged bramble, dwarfed and old,
Shrinks like a beggar in the cold;
In surplice white the cedar stands,
And blesses him with priestly hands.

—J. T. Trowbridge.



We are wont to think of the winter largely as a human problem. It is a time when we are obliged to take greater care of ourselves lest we suffer from cold; and the long months when we can be out-of-doors comparatively little without hardship, are a serious drain upon our vitality. The winter is also a drain upon the purse, for we are obliged to clothe ourselves more warmly and, therefore, more expensively; and the coal bills or the getting of the winter wood is no small item in the economy of any household in this country of long winters.

Few of us realize that to the plants of all this region also winter has proven a problem, which they have been obliged to solve or die. Certain it is that the wild plants have been obliged to adapt themselves to this long period of cold and inaction in order to preserve their species; their success is measured in one direction by their ability to cope with winter.

In general there are two kinds of plant adaptations developed to meet this problem. One where the roots live on safely in the ground unaf-

fect by the frost, which ruthlessly destroys the leaves; such plants we call perennials. Another adaptation is when the whole plant dies with the frost and trusts to the scattering of its many seeds to keep its species alive; these we call annuals. Between these two come the fleshy-root plants, like beets, carrots and turnips which live as roots during one winter, and then die trusting to their seeds for survival the next winter; these are called biennials.

Although December and January are scarcely considered good months for plant study, yet this is the best time for finding out how our common plants manage to live during this crucial winter period; and if we give them a little attention we will find many interesting things.

HOW DO THE FOLLOWING PLANTS PASS THE WINTER?

Please state what you discover about the plants named as follows:

- (a) Do the seeds cling after the snow falls?
- (b) Are the seeds distributed by wind or by attaching themselves to animals, or through being food for birds or other creatures?
- (c) Does the plant survive the winter through its roots as well as by its seeds, or does the plant die completely from cold?

Plantain.—

- (a)
- (b)
- (c)

Wild Carrot.—

- (a)
- (b)
- (c)

Goldenrod.—

- (a)
- (b)
- (c)

Dandelion.—

- (a)
- (b)
- (c)

Aster.—

- (a)
- (b)
- (c)

Cat tail.—

- (a)
- (b)
- (c)

Burdock.—

- (a)
- (b)
- (c)

Sticktight.—

- (a)
- (b)
- (c)

Milkweed.—

- (a)
- (b)
- (c)

Clovers.—

- (a)
- (b)
- (c)

Mayweed.—

- (a)
- (b)
- (c)

Wild Rose.—

- (a)
- (b)
- (c)

Barberries.—

(a)

(b)

(c)

Witch-hazel.—

(a)

(b)

(c)

Dogwood.—

(a)

(b)

(c)

The grasses which are weeds in the garden.—

(a)

(b)

(c)

Pigweed.—

(a)

(b)

(c)

Mullein.—

(a)

(b)

(c)

Note how mullein is fitted to live under the snow.

Life-everlasting.—

(a)

(b)

(c)

Name.....

Address.....

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Photographed by Verne Morton.

TREE STUDY

IN THE WOOD-LOT

The up-to-date farmer is thinking as much about his wood-lot and what is in it as he is about the fields which he sows to wheat or plants to corn. With the destruction of our forests, wood and lumber have become very expensive. The products of the wood-lot are a source of certain income to the farmer, and at the same time if properly harvested do not deplete the forest. The kinds of trees growing in the wood-lot; the proportions of soft and hard woods; which trees to let grow and which to cut out; and what sort it pays to plant, are questions which, if decided wisely, add much to the cash value of the farm.

It is for the sake of getting the children and the young people inter-

ested in this problem, that we shall ask the pupils of the Home Nature-Study Course to study the wood-lots in the vicinity of the schools this winter, and decide if they are managed to the best advantage and if not, why.

To begin this work we shall take up the study of the evergreens, and find what kinds we have growing in various portions of the State, their condition and their value. We shall also study the evergreens planted for shade trees and learn more about them, and decide whether they are ornamental and useful, or whether they are injurious to the farm home by keeping out the sunshine, for it has become a well established fact that the sun is a great exterminator of some injurious germs.

THE EVERGREENS IN THE FIELDS AND WOOD-LOTS

Questions

1. How many kinds of evergreens do you find in your neighborhood?
2. How many kinds of pines are there among these?
3. How do the leaves of these pines differ from each other in:
 - (a) Number in a bundle
 - (b) Length of needles
4. How many spruces do you find?
5. How do the leaves of these kinds of spruces differ as to shape and length?
6. Compare a spruce tree with a hemlock as to:
 - (a) Shape of leaves
 - (b) Arrangement of leaves on the twigs.
7. How many cedars do you know? Describe or figure two or three leaves of cedar

8. Compare and describe differences in the cones of the pines, spruces and hemlocks in your vicinity in the following respects:

(a) Size.

(b) Number of scales.

(c) Where the cones are borne on the tree; *i. e.*, are they on the tip of the branches or along the side? Do they stand up or hang down?

9. Compare and describe the differences in the bark of the hemlock, pine and spruce?

10. What is the special use of hemlock bark in your vicinity?

11. Compare the relative usefulness of the pines, the hemlocks and the spruces of your vicinity as to:

(a) Building material.

(b) Fire wood.

12. What would be the market value if sold as lumber or wood of the largest hemlock tree and the largest pine tree in your vicinity? Get some farmer or carpenter to estimate this.

13. Which grow the more rapidly, white pine, hemlock, spruce, or oak, maple, ash, hickory?

14. Which of these trees would be the more profitable to plant?

15. Are there any tamaracks in your vicinity? If so, describe the trees, and the kind of soil you find them in.

PLANTED EVERGREENS

16. There are three kinds of evergreens commonly planted throughout our country: the Norway spruce, the balsam fir and the arbor vitæ. Compare these trees and describe their differences in leaf, cone and shape of tree.

17. On which side of the house should evergreens be planted?

18. Which evergreen would you plant for shade? for protection from wind? for ornamental purposes?

19. How would you prune evergreens?

20. How would you transplant evergreens? At what time of the year?

GENERAL QUESTIONS

21. What birds do you find seeking shelter in evergreen trees?

22. Of what use is resin to the tree? What are the manufactured products of resin of pine and spruce?

23. Do evergreens shed their leaves? If so, when?

24. Which is the most destructive to evergreens, the wind or the snow?

25. Which of all the evergreens that you know shed snow most successfully?

Name.....

Address.....

Fill out the blanks and return one copy of this leaflet to us.

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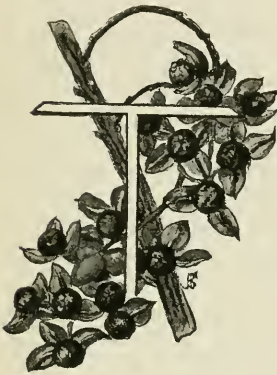
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ANNA BOTSFORD COMSTOCK, Editor

New Series. Vol. II. ITHACA, N. Y., DECEMBER-JANUARY, 1905-6 No. 2

BIRD STUDY

FOUR BIRDS THAT WILL GLADLY ACCEPT AN INVITATION TO CHRISTMAS DINNER



HE farmer and the horticulturist have finally learned that hospitality is a good investment when offered to certain birds. For when these birds are invited to dine they always stay and "help do up the work." The most acceptable dinner to offer them is suet, taking that part of beef fat which is stringy and tough; they also like fresh fat pork. The most acceptable way to spread the table is to take a strip of the suet or pork about five inches

long and about two inches thick, and bind it to one side of a convenient branch of your favorite shade or orchard tree. In binding it the string should be wound around many times, so that it will stay as long as a scrap is left.

If several pieces of suet be put in the orchard, there will be no need of issuing special invitations to the birds, nor will there be much need of spraying the orchard for pests next spring. The first birds to find the banquet thus spread will soon convey the news to the others, and very soon your premises will be full of happy, little, feathered guests, which will come day after day and look over all your trees very carefully to find any hibernating insects hidden there.

Place suet on a tree convenient to watch from your school window and study the following visitors: the downy woodpecker, the nuthatch and the chickadee.

FRIEND DOWNY

This is the name which this little bird has earned because of its good work for all of us who are interested in trees. Watch it as it hunts each crack and crevice of the bark for cocoons or insects which are hiding there for the winter, and you will soon be willing to accord it

the name of "friend." The male downy has a bright red cap on the top of his head, but the female shows no such decoration.

If you are living near large woods, it is possible that the woodpecker known as the "hairy" will visit your suet. Its colors are so like those of the downy that you will hardly be able to distinguish the two. However, the hairy is one-third larger than the downy, being as large as a robin; while the downy is no larger than the English sparrow. The hairy is also a much wilder bird than the downy, and its actions show great alertness and fear.

QUESTIONS FOR YOU TO ANSWER FROM PERSONAL OBSERVATION

1. How does "friend downy" climb a tree? How does it use its tail in climbing?

2. How does it go down a tree? Did you ever see it go down head downward?

3. Is the downy's beak long or short, and how does it use it for getting food?

4. Do you know the shape of the woodpecker's tongue, and its use in pulling a grub out of the hole?

5. How are the downy's toes arranged; and how does this arrangement assist it to hold on to the side of a tree while it chops wood with its beak?

6. Why does "friend downy" stay here during the winter, while its relatives, the flicker and the sapsucker, go south?

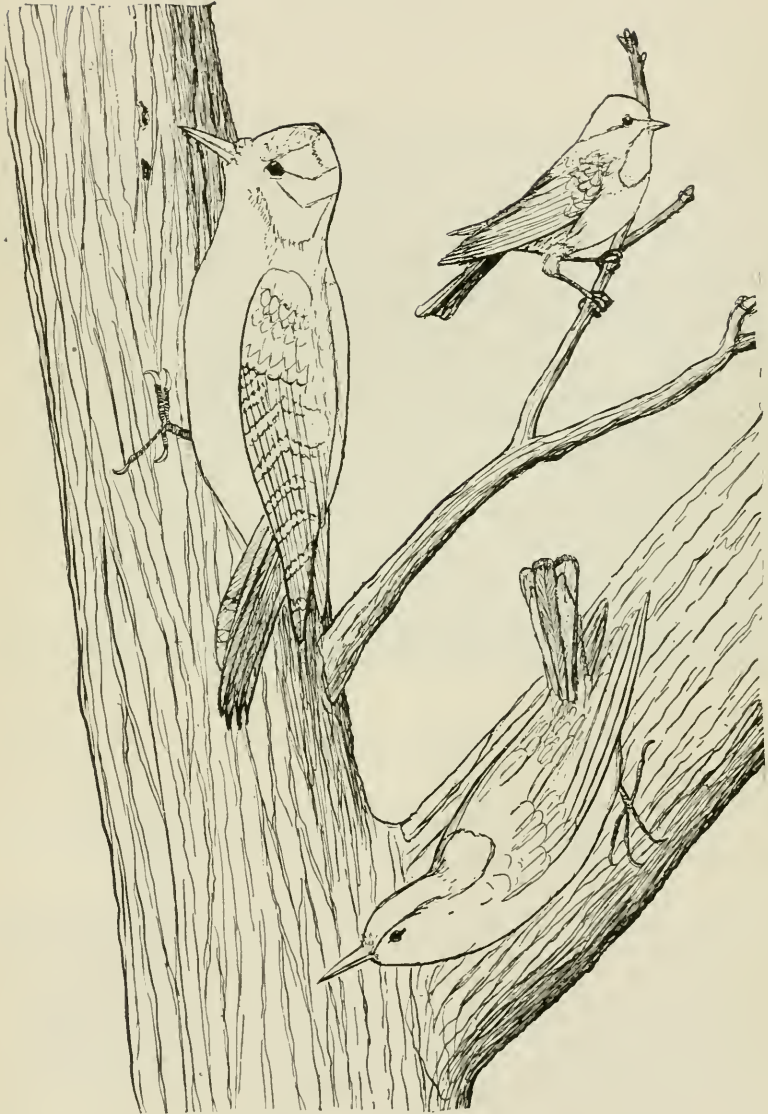
THE WHITE-BREASTED NUTHATCH

This cheerful little bird with a song and a beak like a woodpecker's and a taste for the pleasing society of the chickadees, is often a puzzle to the beginner in bird study. It is neither a woodpecker nor a chickadee, but has an individuality all its own and habits that distinguish it readily from both.

QUESTIONS TO BE ANSWERED BY OBSERVATION

1. Where does the nuthatch ordinarily alight? Head up or down?

2. What is there in its actions that has won for it the name of "tree mouse?"

*Friend Downy.**Nuthatch.**Chickadee.*

Color this outline according to your own observation on the markings of these birds. Use inks or water colors.

3. Does it ascend a tree in a spiral?
4. What distinguishes it in coloring from the chickadee?
5. How does it benefit the farmer and orchardist?

THE CHICKADEE

Of all the winter birds the chickadee is easily the favorite. No matter how cold or gloomy the day, its cheerful song and delightful little personality charms us, and makes us forget that there is anything in this world that is disagreeable. It not only seems friendly, but *it is* friendly, for it devotes its entire energies all winter to hunting for insect eggs or hibernating insects. It makes a great specialty of cankerworm eggs, and an experiment made by the Massachusetts State Board of Agriculture, demonstrated that orchards to which chickadees were enticed during the winter were almost entirely free from this insect, while neighboring orchards were destroyed by it. It is estimated that one chickadee will destroy five thousand five hundred insect eggs in one day.

QUESTIONS TO BE ANSWERED FROM OBSERVATION

1. What is the chief difference in markings and coloring between the chickadee and the nuthatch?
2. Do the chickadees frequent the same portions of the tree that the nuthatch does?
3. Compare the beak of the chickadee with that of the downy and tell why it is better adapted to the needs of its owner.
4. The chickadee has another common note besides the familiar "chick-a-dee-dee-dee;" what is it?
5. Why is the chickadee especially valuable to the horticulturist?
6. Have you put suet on your trees this winter to feed the birds?

Name.....

Address.....

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ANNA BOTSFORD COMSTOCK, Editor

New Series. Vol. II. ITHACA, N. Y., FEBRUARY-MARCH, 1906

No. 3



Photographed by Verne Morton.

PLANT STUDY

THE FERNS



The walking fern.

HE one who knows how to get the greatest happiness out of the days as they come and go, is sure to take advantage of the first thaw of winter which usually occurs in February, and go to the woods to inquire how his woodland neighbors are coming on. There is more of life to be found in the woods at this period than most people think; many little tracks upon the snow reveal the presence of the four-footed; a hibernating butterfly may be seen fluttering about in the sunshine or settled on the south exposure of a tree sucking sap; the sharp note of the woodpecker or the call of a hopeful crow give evidence of bird life; mounds covered

with moss decorated with the brilliant red squaw berries on their vines

offer here and there a green footstool for some great tree; and whatever the locality we may surely discover at least two species of ferns, their beautiful green fronds pressed flat beneath the snow-blanket. One of these is called the Christmas fern, and is first cousin to the Christmas fern which is reared in pots as a house plant; it has one row of finely notched leaflets along each side of the stalk. Three leaves or fronds of this fern are shown in the lower part of the picture on the first page. The other species is far more graceful and beautiful as its leaves are divided into smaller leaflets, each leaflet being sharply notched so that as one passes the hand over them, he feels the many little spiny points; so this fern is called *Spinulose* fern. It is especially with these two species that we shall begin our study of ferns. That the pupils of the Home Nature-Study Course may understand something of the wonderful life of a fern, I will tell the story of the life of one species.

THE STORY OF A CHRISTMAS FERN

In the winter this fern consists of several long, thick, green leaves or fronds each of which grows from a rootstock. There is something very peculiar about the creeping rootstock of ferns; new leaves are produced at the growing end of it each year, while the other end after having borne its leaves dies away. Thus when we find a large and vigorous clump of these ferns, we may know that this plant began its life

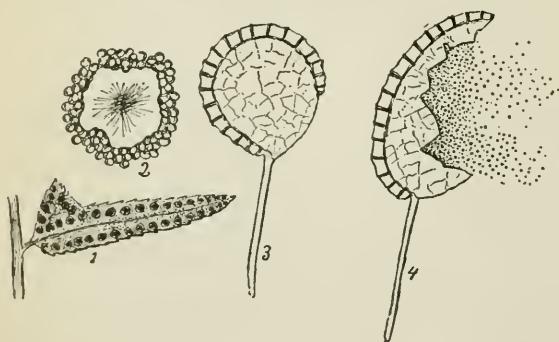


FIG. 1.—1. Fertile leaflet of Christmas fern showing indusium and spore cases. 2. An indusium and spore cases enlarged. 3. A spore case enlarged. 4. A spore case discharging spores enlarged.

perhaps several feet from the place where we find it; each year it pushes on farther and develops more leaves. The tree ferns which we see pictured in tropical scenes are not so different from our own ferns, except in two particulars; one their size, and the other the fact that the rootstock instead

of creeping along year after year underground lifts itself in the air. As

with our own ferns, the part bearing the fronds is at the growing tip, and the rootstock of the past years instead of dying stands as a trunk for the tree fern.

If we were to study the story of one of our Christmas ferns we should begin before mid-summer. Then we would find in our fern clump several fronds which have the leaflets toward the tip considerably smaller than the others; and we would find on the lower side of these leaflets what would seem at first like rows of pale blisters. Later these blistery-looking spots would turn brown and if looked at with a lens would show a depression in the center. Later the edges of each little brown disc would be pushed up by some tiny masses of round, brownish bodies not larger than pin points. These push out in such profusion that they make the complete lower side of each leaflet look brown and fuzzy (Fig. 1.1).

If we examine under a strong lens or a microscope just one of these little globular grains, we will find it to be a very strong little mechanism for the protection and distributing of "fern dust" or spores; it is a spore-case nearly globular in form, and it has a little stalk which fastens it to the fern leaf (Fig. 1.3). Continuing as a part of the stalk around the edge of the spore-case is a thicker portion divided into segments; this does not reach completely around. When the spores are ready to be scattered, this stiff part acts like a spring and straightens out tearing apart the spore-case and setting the spores free (Fig. 1.4). The spores or "fern dust" are brown bodies, so very small that we can see them only when they fall in masses, and then they look like dust. If any fern in the fruiting stage be laid upon a sheet of white paper with the lower side next to the paper and left there out of a draught for a day or so and then taken up, its exact form will be left on the paper outlined in this "dust;" that is, the spores will fall on the paper from every part of the fern leaves, and thus make a picture of the fern. Some people call these little spores the seeds of ferns, but this is not true any more than that the pupa of a moth in the cocoon in which it passes the winter is the egg of the moth. The spores of a fern will retain their vitality for a long time, and if they do not find conditions favorable for their growth when they are shed, they wait until such conditions come and then grow; thus the spores constitute a stage of fern-life which may be called a "waiting" stage. When a spore finds dampness and warmth it begins to grow and first develops a tiny, rounded leaf which does not in any respect resemble a fern; this little, leaf-like structure develops rootlets at one side and also on its lower surface two kinds of pockets.



FIG. 2.—*Prothallium* greatly enlarged, showing the two kinds of pockets and the rootlets.

One kind of pockets are round and the other are long; in the round pockets are developed bodies which may be compared to the pollen grains of higher plants, and in the long pockets are developed what may be compared to the ovules of flowering plants. This little, leaf-like structure with its roots and pockets is very small in most species of ferns, often not larger than the head of a good-sized pin, but in some species as large in diameter as a small pea. This leaf-like first stage is called the *prothallium* (Fig. 2) and it cannot be developed from the spore unless

it has plenty of moisture. The prothalliums may be found sometimes in numbers on a mossy log, or on the banks of a stream, but they are so very small that unless the eye is trained to find them they are rarely discovered. Water is needed also for the carrying of the pollen-like



Photographed by Verne Morton.

FIG. 3.—An evergreen fern. The common polypody.

bodies, which grow in the round pockets to the ovule-like bodies, which grow in the long pockets. Among the flowering plants the pollen is car-

ried by insects or by wind, and sometimes in the case of aquatic plants, by water. In the case of the ferns it is always carried by water. From the fertilized germ which is developed in one of the long pockets a little fern starts to grow, and from this develops what we know as the fern, although it may be two or three years before it is sufficiently mature to grow large fronds and develop leaves with fruit dots on them. Thus we see that the story of the fern is not unlike that of the butterfly, which has two very distinct lives—that of the caterpillar and that of the winged insect; the one life of the fern being a tiny rounded leaf and the next a beautiful, graceful mass of ferns all springing from a root-stock.

HOW TO STUDY THE FERNS

Although the ferns do not belong to the flowering plants yet the way each species develops its fruiting organs affords characters for distinguishing them. There are in most localities in New York State from ten to twenty species of ferns. With a good book any one can learn readily to know these species apart and understand something of the life and characteristics of each. As ferns are easily pressed and are lovely objects when they are mounted on white paper, the making of a fern herbarium is a most delightful pastime. Some people interested in ferns have made blue prints of all the species in the neighborhood, thus having an album which is at once beautiful and instructive. The blue prints are made simply by pressing the fern against the ordinary blue print paper and exposing it to the light.

In the case of those ferns which bear the fruiting organs on the lower side of the leaves the species are distinguished not only by the shape of the fronds or fern leaves, but also by the position on the leaf of the fruit dots, and also by the shape of the little membrane which covers the fruit dot, and which is called the *indusium*. This indusium is round in some species like the Christmas fern (Fig. 1.2); in some species it is long as in the silvery spleenwort (Fig. 4.2); and sometimes it is horseshoe shaped as in the evergreen wood fern (Fig. 5); and sometimes it is cup shaped as in the boulder fern (Fig. 4.1). In some species the indusium does not appear but the spore-cases are

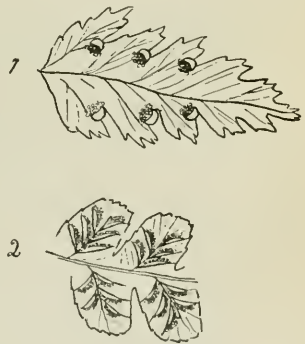


FIG. 4.—1. *Fruiting leaflet of the boulder fern enlarged.* 2. *Fruiting leaflet of spleenwort enlarged.*



FIG. 5.—Fruiting leaflet of evergreen wood fern.

grouped under the folded-over edge of the leaf as is the case with the delicate maiden hair (Fig. 6.1) and the great brake or bracken (Fig. 6.2) which grows large, triangular fronds in fence corners.

Not all ferns bear the fruit dots on the back of the leaf as does the Christmas fern. Some, like the ostrich fern (Fig. 10) which covers quite large areas in more open places, sends up a special fruit-stalk, while others, like the interrupted fern (Fig. 7), has a few of the leaflets of the frond constricted until they do not look at all like their neighboring leaflets above or below them. If we could smooth out any of these separate fruit-bearing



FIG. 6.—1. Fruiting leaflets of the maiden-hair fern, enlarged. 2. Fruiting leaflet of the bracken, enlarged.

leaflets, we would find them made on the same pattern as the other fronds of the species, only they are very much smaller and are curled up to protect the spore-cases.

One of the prettiest of nature-study lessons is the watching of a young fern leaf unfold. These young coiled-up fern leaves are called "fiddleheads" or more properly *crosciers*. When they first appear above ground they are wrapped in furry scales; and not only is the main stalk coiled like a watch spring but every leaflet is coiled and every division of every leaflet is also coiled. It affords one of the best instances I know of the skillful way Nature does up her packages.

BOOKS OF REFERENCE: Gray's *Manual of Botany, Our Ferns in Their Haunts*, by W. N. Clute. *How to Know the Ferns*, by Mrs. Parsons. *The Ferns*, by C. E. Waters.



FIG. 7.—The interrupted fern showing the three pairs of fruiting leaflets and a bit of one of these leaflets enlarged. This fern often has leaves four or five feet high.

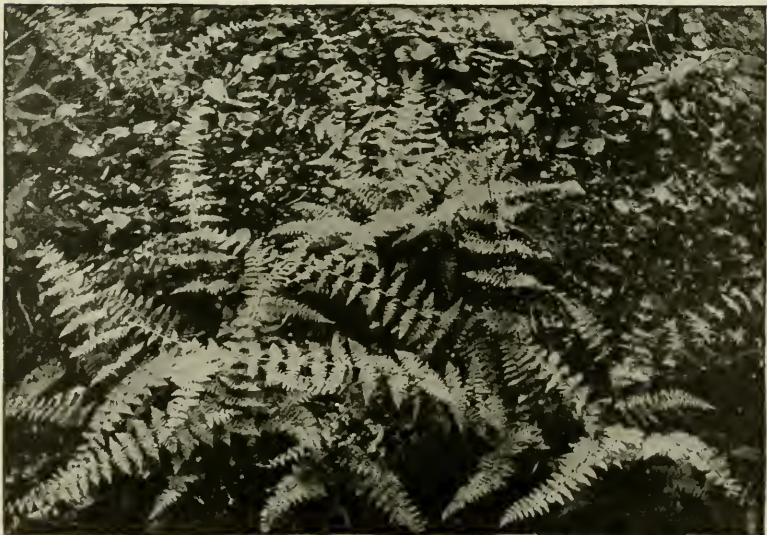
LESSON ON THE CHRISTMAS FERN OR ANY OTHER FERN WHICH YOU MAY BE ABLE TO OBSERVE.

Describe the central stalk, its color, appearance, covering, length, and the distance between the lower leaves and the root-stalk.



Photographed by Verne Morton

FIG. 8.—*The crosiers or fiddle-head. Young ferns unfolding.*



Photographed by Verne Morton

FIG. 9.—*The bulb-bearing bladder fern. This beautiful fern clothes the banks of ravines. It has in addition to fruiting organs, buds on the stem, which take root.*

Describe or make a sketch of one of the leaflets of the fern noting especially the edges, lobes, the forking of the leaf veins, the differences in color between the upper and lower sides and whether it is set close to the central stalk or has a little stalk of its own.

Describe the fern as a whole.

Describe the rootstock if possible.

If you can pot a fern and place it in a warm room and give it plenty of moisture, you may be able to watch a frond unfold. Describe this process in length of time and in detail.



Photographed by Verne Morten

FIG. 10.—*The ostrich fern.* This species has separate fruiting leaves or fronds, which are much contracted and look very different from the fronds shown in the picture.

Name.....

Address.....

Fill out the blanks and return this leaf to the editor.

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No. 3



Photographed by Verne Morten

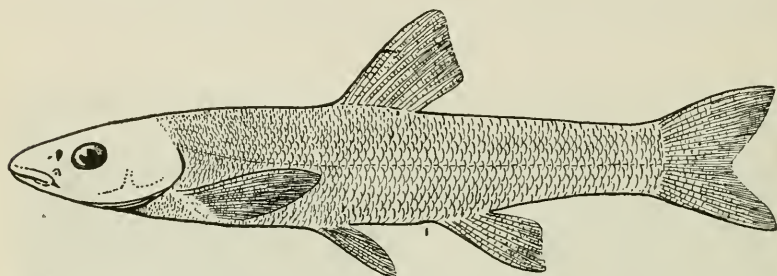
FISH STUDY

"I wind about, and in and out,
With here a blossom sailing,
And here and there a lusty trout,
And here and there a grayling."

The Brook.—TENNYSON.

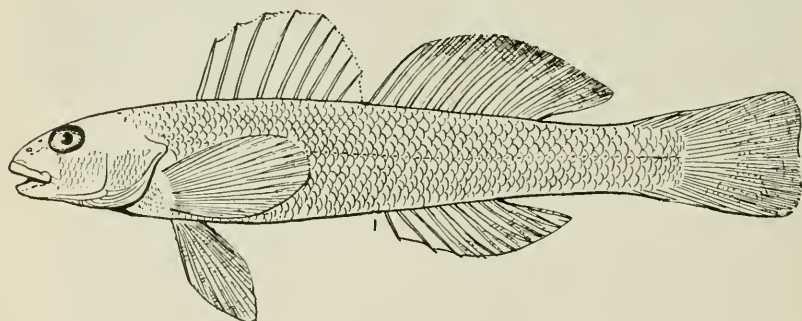
Mid-winter is hardly a favorable time to go fishing; however, spring will soon be here and the answers to this leaflet need not be sent in until the streams are clear of ice and the species herein described may be studied.

The work of the pupils of the Home Nature-Study Course is to complete these pictures of fishes given in outline by adding the colors and markings according to your own observation. You may use water color, pencil or ink. If you are not able to find all these fishes, you can at least find two or three of them, and a careful study of the ones you find will be considered satisfactory.



Black-nosed Dace.

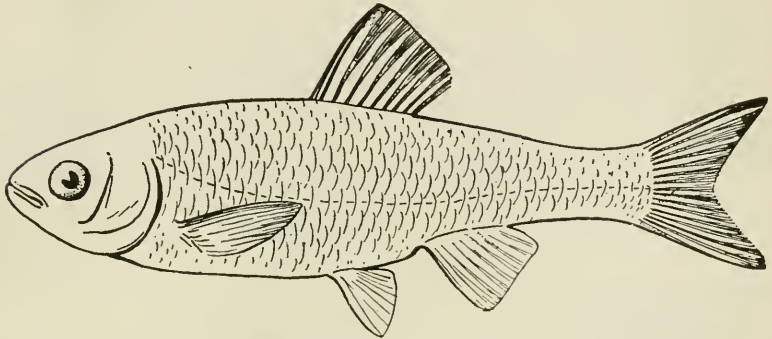
The black-nosed dace is found in shallow, swift water with a stony or gravelly bottom. It feeds largely on aquatic insects and may be recognized by a black lateral band which extends around the nose. In the spring the male has a salmon-colored band in place of the black one.



Johnny Darter.

In shallow, clear streams with a fairly swift current and a gravelly bottom may be found the little Johnny darters. You will find them under the stones or in the ripples darting from one stone to another. The darters have no air bladder; the food of the Johnny darters consist almost entirely of insect larvæ. The head is short; with eyes nearly on the top; there are brown w-shaped marks on the sides.

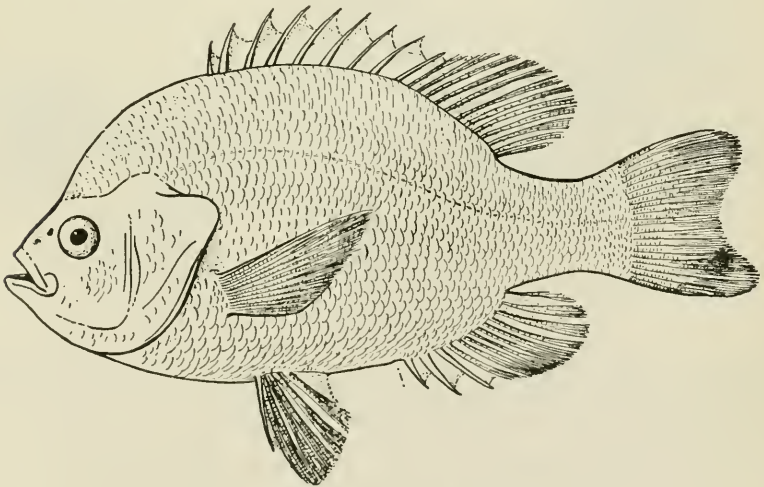
The common shiner or red fin may be found in a sandy bottomed stream having a rather slow current; it feeds on insects. The scales on the side of body are much deeper than wide, and beautiful, iridescent,



Red Fin or Common Shiner.

steel-blue outlined by a dusky margin; in the spring the lower parts of the body and the lower fins of the males are red.

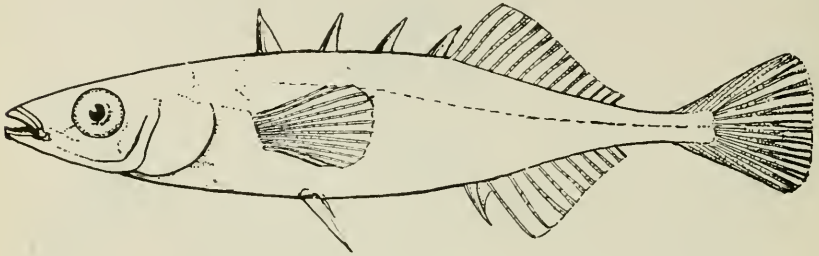
The sunfish is the most beautiful of our common little fishes. It can never be mistaken because of its thin, flat body and beautiful colors. Its back is olive green shaded with blue and is bright yellow beneath. It



Sunfish or Pumpkin Seed.

has orange-colored spots on the sides and bright scarlet "ear-flaps." Look for the sunfish in quiet pools; its food consists of worms, insects and little fishes.

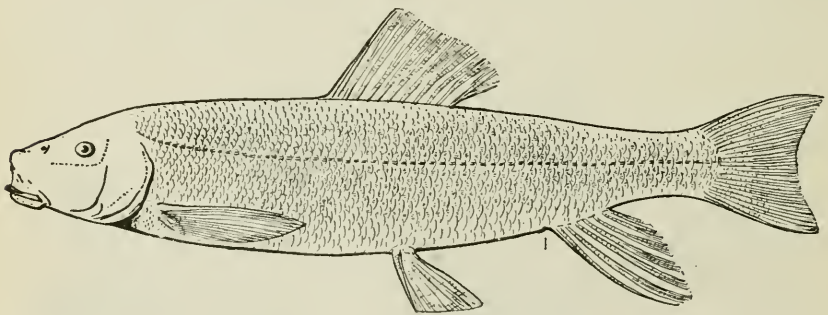
The sticklebacks are noted for their nest building; they may be found in stagnant water filled with decaying vegetable material; their food consists of the spawn and eggs of other fish and also young fish. A stickle-



Stickleback.

back is easily distinguished by its long, slender tail and the sharp, free spines before the dorsal fin.

The common or white sucker is a sluggish fish and does not like rapid currents, but may be found at almost any depth. It eats everything on the bottom and its mouth is on the lower side of the head and very



Common Sucker.

protractile. The scales are much crowded in front of the dorsal fin and in the spring the male has a rosy stripe on the side.

Name.....

Address.....

.Complete the pictures and return one copy of this leaflet to the Editor.

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INSECT STUDY

THE EGGS OF THE TENT CATERPILLAR

It is well to cultivate the eye to see these egg masses in the winter in our orchards for every egg mass left on the tree means devastation to its foliage next summer. I confess that I always do enjoy looking at a "good job" whatever it may be or whoever performed it. Thus it is that I never look at one of these egg masses carefully without paying admiring tribute to the moth which so cleverly constructed it. First of all, there is the color which is so nearly the color of the bark of the twig that the egg mass is protected from prying eyes; then I admire the way the eggs are laid so smoothly around the twig and covered with a fine coat of varnish that keeps out rain and dampness. And after removing the varnish and examining with a lens I admire more than all the white, thimble-shaped eggs, which are held in place by a network of cement. (Fig. 2.)



FIG. 1.—Egg masses of apple tree tent caterpillars.

QUESTIONS

Go into the orchard and look for these egg masses and gather as many as you can find. The wild cherry trees along the fences will usually give you plenty of specimens.

1. Study one carefully with a lens if possible and describe it.
2. Where on the tree do you find the egg masses?
3. What are the advantages to the insect of passing the winter in this way?
4. What are the enemies of these eggs?

5. When will the eggs hatch?

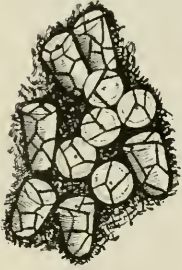


FIG. 2.—Eggs of tent caterpillar enlarged.

6. What are the best remedies for preventing the ravages of the tree caterpillar?

7. How and why does the work of the tent caterpillar injure the apple trees?

8. What do you think of the farmer who protects his apple trees from these caterpillars and allows them to breed in the cherry tree along the fence corners of his farm?

WASPS' NESTS

Now is an excellent time to study a wasp's nest because the owners will not be at home to give us a too warm welcome. Get a paper nest if you can find one, cut away the wall at one side and write a short account of it covering the following points:

- (a) Describe the situation in which you found the nest.
- (b) Describe shape of the nest and the entrance to it.
- (c) How many layers are there in the covering?
- (d) How are the nests enlarged inside and outside?
- (e) What sort of wasp do you think made the nest?
- (f) Describe the different stories or combs and what they are used for.
- (g) Describe shape of the cells and the direction of their opening; also the appearance of the cell openings.

Name.....

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Fill out the blanks and return one copy of this leaflet to the editor.

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No. 3



Pen drawing by W. C. Baker

White oak.

TREE STUDY

FORESTRY

When our ancestors found their way to America they found the shores bristling with inhospitable trees, and it was a part of their work to hew down these forests which obstructed the path of civilization. Year after year the fight went on between the axe and the wilderness; then after many years the axe continued its work for the sake of our material prosperity. At last the time has come when the axe is doing more damage

to human interests than it does to the trees which it levels. At the present time lumber and wood of all kinds in most parts of our country are so scarce and expensive, that it behooves every one who owns even a few acres of woodlot to study carefully the principles of forestry and to make the most of his possessions.

For the reasons just stated we shall ask the pupils of the Home Nature-Study Course to study the principles of forestry during this winter and answer the questions of this leaflet. There are several good and interesting books on forestry, any of which may be consulted in answering these questions. I base the work largely on "The Primer of Forestry," published by the Bureau of Forestry, U. S. Department of Agriculture. I would suggest as books of reference "The Primer of Forestry" by Gifford Pinchot; Bulletin 24, Division of Forestry, U. S. Department of Agriculture; "The First Book of Forestry" by Roth. Ginn & Co., \$1.00; "Practical Forestry" by John Gifford, D. Appleton & Co., \$1.20.

QUESTIONS

1. What is forestry?
2. Why is it practiced?
3. What relation has forestry to our water supply?
4. Name two advantages to our soils given by the forests?
5. What are the parts of the tree and their uses?

6. What is the food of the tree and where does it come from?
7. How does the tree breathe?
8. What is meant by transpiration?
9. Describe the process of forming the annual rings.
10. Describe how a wound heals over; describe how a knot is made.
11. What is the difference between heart wood and sap wood?
12. What are the various necessities for tree growth?
13. What are the tree's requirements for moisture? What are its requirements for light?
14. What do we mean by the terms tolerant and intolerant when applied to trees?
15. Describe the reproduction of trees by seed and by sprouts.

16. What do we mean by succession of forest trees?

17. What is meant by pure and mixed forestry?

18. Describe how a crop begins, the struggle for existence, the growth and the end of the struggle.

19. What is natural pruning?

20. Describe destructive lumbering.

21. What are the chief enemies of the forests in New York State?

22. How would you fight forest fires?

Name.....

Address.....

Fill out the blanks and return one copy of this leaflet to the editor.

Supplement to

Home Nature = Study Course

Published by the College of Agriculture of Cornell University,
in October, December, February and April and Entered October
1, 1904, at Ithaca, New York, as Second-class Matter, under
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ANNA BOTSFORD COMSTOCK, Editor

New Series, Vol. II. ITHACA, N. Y., FEBRUARY-MARCH, 1906

No. 3



Photographed by Verne Morton.

BIRD STUDY

WINTER NESTS

“Now comes the graybeard of the north;
The forests bare their rugged breasts
To every wind that wanders forth,
And in their arms, the lonely nests
That housed the birdlings months ago
Are egged with flakes of drifted snow.”

—Henry Abbey.

Much can be learned of the habits of birds by studying during the winter their abandoned nests. It is the time when the trees, bare of leaves, show us where the cunning architects hid their nests in the summer, and we may study them now without distressing the owners. I think that every one of us who carefully examines the way that a nest is made, must have a feeling of real respect for its clever little builder.

QUESTIONS.

Fill out the following blanks for each nest studied:

1. What kind of bird do you think made the nest?
2. Give the name of the tree or shrub if the nest was found in such location?
3. If on a tree was the nest situated on a branch, in a fork, or hung at the end of a branch?
4. How high from the ground was the nest placed? Give this approximately.
5. If the nest was found in a building or structure of any sort, how was it situated?
6. Did the nest have any protection from rain?
7. Give the size of the nest, the diameter of the inside and the outside; also the depth of the inside.
8. What is the form of the nest? Are its sides flaring or straight? Is the nest shaped like a cup, basket or pocket?
9. What materials compose the outside of the nest and how are they arranged?
10. Of what materials is the lining made, and how are they arranged? If hair or feathers are used, on what creature did they grow?
11. How are the materials of the nest held together,—that is, are they woven, plastered, or held in place by environment?
12. Had the nest anything peculiar about it in situation, construction or material that would tend to render it invisible to the casual glance?

Name.....

Address.....

Fill out the blanks and return one copy of this leaflet to the editor.

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ANNA BOTSFORD COMSTOCK, Editor

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No. 4

INSECT STUDY THE BUTTERFLIES.

Photographs of butterflies by Professor M. V. Slingerland.

A pleasure similar to that afforded by the sight of a beautiful flower is experienced when the eye rests upon a bright-hued butterfly. It may be balancing itself about its partner in beauty, the flower which gives it nectar, or it may be following the graceful curves of its path in the air, or if frightened it may zigzag by so swiftly that the



BLACK SWALLOWTAIL.

Expanse three and one-half to four inches. Color brownish-black, the front wings spotted with yellow, the hind wings bearing yellow and blue spots. There is a red eye-spot at the inner angle of the hind wing.

eye only catches a bit of moving color. Although almost every one is attracted by these beautiful creatures, yet aside from two or three of the most common species very few people know their names or their habits. Yet each one of the butterflies has a most interesting life-history, and some of them are of great economic importance.

In New York State there have been found all told, between seventy and eighty different species of butterflies. Probably any one locality would give thirty or forty species if the hunt for them was continued over a series of years; but in almost every locality twenty species are fairly common; and the object of this leaflet is to make the pupils of the Home Nature-Study Course acquainted with these more common butterflies, so that when they are seen on the wing they may be recognized, and afford the pleasure which mutual friendly recognition always gives.

The life-history of butterflies consists of four stages:

First.—The eggs which are laid upon the food plant by the mother

butterfly; these eggs are often exquisite in color and beautifully ribbed and pitted so that when seen through the microscope they look like gems.



Caterpillar of black swallowtail in two stages of growth. The larger one has the scent organs protruding.

Second.—The caterpillars which hatch from these eggs and which feed upon the food plant until fully developed. Before reaching their full growth, the caterpillars

shed their skeleton-skin four or five times; often this change of skin makes a change in the appearance and in the color of the caterpillar.

Third.—The pupa state or chrysalis. When the caterpillar is full grown it sheds its old skin and appears in a very different form, that of the chrysalis or pupa. The pupæ of the butterflies are *never protected by a cocoon* as are the pupæ of moths. This is one of the chief differences between moths and butterflies. The caterpillar, before it changes to a pupa, makes a button of silk and sometimes also a loop of silk by which the pupa is suspended. As the insect when in the pupa or chrysalis state is helpless and unable to move, it is, therefore, an easy prey to birds and other enemies; thus the chrysalis is usually inconspicuous and placed in some position where it is not easily detected by even the keenest eyes.

Fourth.—After a time the pupa skin is shed and from this comes the winged insect in all its beauty of color and form.

HOW TO STUDY THE BUTTERFLIES

There are three ways to study butterflies:

First.—The caterpillars may be found on their food plant and reared indoors. This requires a great deal of care in providing fresh food and in looking after the wants of the little prisoners. This is the best way to study the insects, as we thus become acquainted with the caterpillar and its habits and also the chrysalis; and when finally the winged insect emerges we may become familiar with its colors and

markings before we set it free to carry on its work of perpetuating the species and of carrying pollen for the flowers.

Second.—Catch a butterfly with a net without injuring it and let it loose in the room where we can study it at close range and get thoroughly acquainted with its size, form and colors. This is an excellent way.

Third.—The most common way of all, but perhaps not necessarily the best, is to make a collection of butterflies. This involves the catching of the insects in nets, and killing them in a cyanide bottle, and then spreading the wings carefully, letting them dry extended, and then placing the specimens in a box for safe keeping. Every beginner experiences great trouble in keeping such specimens free from the little pests which destroy them. The boxes of insects in any museum have to be looked over carefully every month and such as are infested treated with the deadly fumes of some gas. Undoubtedly the best and cheapest way for amateurs to mount their insects in permanent form is to use the Riker mounts, which consist of shallow cardboard boxes with glass covers and filled with cotton. The size of box large enough for most of our butterflies costs fifteen cents each, and they come in cases, a dozen in a case at \$1.90. The butterfly is spread and placed on the cotton, the cover put on and sealed with gum paper and the specimen is safe for all time. As there is a box for each, any specimen may be passed around and studied by itself.

Such a collection of butterflies is a great help to a teacher as she is thus able to bring a page from nature's book into the schoolroom for the pupil's enjoyment and enlightenment. However, we by no means advise that the pupils themselves make a collection of insects, or that they be encouraged to do so.

While we do not advise the children to make collections of insects our reasons for doing so are based quite as much upon other grounds as upon that of developing cruelty in the child. The taking of life of the lower animals is a matter that had best not be too much dwelt upon before children, for we cannot be consistent in our teaching and they soon discover it. For who shall say that the cat which catches and eats the robin is more culpable than the person who eats lamb chop for breakfast, thus sacrificing the life of an innocent and playful creature to satisfy his appetite? And in the wider view of the world and its creatures, the life of a butterfly is no more sacred than that of the housefly or a mosquito. It is far safer to let these questions alone in our teaching, and cultivate in the child an interest in the lives of the lower

animals, thus bringing him into kindly relations with his little neighbors of the field, so that he will naturally respect their rights. It is the boy who knows the birds and loves them, who will not shoot them; it is the child who knows the butterfly by name and something of its interesting habits, who will refrain from crushing the life out of its fragile body.

We cannot eradicate cruelty by punishment or repression; but we may crowd it out of the child's character, by putting in its place little by little the humane and tender sentiments which inevitably follow a knowledge of the life and habits of even the lowest creature.

THE BUTTERFLIES COMMON IN NEW YORK STATE

In the following descriptions the measurement of the butterfly is made across the spread wings from tip to tip; unfortunately, it was not practicable to have the pictures of all the butterflies natural size. It must be borne in mind that individual butterflies of the same species may vary in size somewhat. When the size of the caterpillar is given it means the fully grown larva just before it changes to a pupa.



TIGER SWALLOWTAIL.

Expanse, three and one-half to four inches. Colors pale straw-yellow marked with black. On the hind wing near the inner angle are blue and red spots.

disagreeable to smell and probably to taste.

THE SWALLOW TAILS

These are large handsome butterflies and get their name because of the prolongation of the hind wing in a manner suggesting the tail-feathers of a swallow. The caterpillars have a pair of scent organs just back of the head, which they can thrust out at will. These are supposed to protect them from the attacks of birds by rendering them

The Tiger Swallowtail.—This magnificent creature flies about leisurely and is fond of strong odors whether they be fragrant or otherwise. It is especially fond of tobacco smoke and will often be seen following in the wake of a smoker. The caterpillar has large eye-spots on the thorax, and it has a pretty habit of making a silken, spring mattress to rest upon when it is not eating; it makes this by weaving the web of silk across the leaf, pulling the edges of the leaf slightly together. Food plants, ash, birch, and poplar.

The Black Swallowtail.—This graceful insect is often found about our houses visiting the flower gardens. It is one of the most important pollen carriers among the butterflies. The male is smaller than the female, and has two complete rows of yellow spots on both wings. The caterpillar is mostly black and spiny when young but later it is adorned with green and black cross-wise stripes, the black stripes enclosing six yellow spots. Food plants, caraway, parsley, celery, and wild carrot.



Caterpillar of the Tiger swallow-tail resting on its silken mattress.

THE PIERIDS

THE WHITES

The Cabbage Butterfly.—This is the white butterfly common near every garden in which grows cabbage or its near relatives. We had native species of cabbage butterflies which did comparatively little damage to gardens, although they were found quite commonly prior to 1870; but this emigrant *Pieris rapæ* came to us from Europe, getting its foothold in New York State in 1868. Now it has driven out all of our native species; they have literally taken to the woods and are found only occasionally flitting about the wild cruciferous plants. The velvety-green caterpillar of the cabbage butterfly is very destructive and is well known. It feeds on other cruciferous garden-plants but prefers cabbage.



THE CABBAGE BUTTERFLY

*Expanse, an inch and three-quarters.
Color, white with black spots.*



THE ROADSIDE BUTTERFLY

Expanse, one and three-fourths to two inches. Color, bright, sulphur-yellow. Wings bordered with blackish. Spot on the fore-wing black and on the hind wing orange yellow.

THE YELLOWS

The Roadside Butterfly.—This is the best representative that we have of the yellows, and it may be seen in the summer in great numbers flitting about the flowers of our roadsides, or settled for a social drink about some mud puddle in the road. Its caterpillar is small, green in color, and feeds on clover, vetch, lupine, etc. It is so well concealed by color that it is rarely found.



SILVER BORDERED FRITILLARY, above; MEADOW FRITILLARY, below.

Expanse, one and three-quarters inches. Color, orange-yellow spotted with black. The under side of wings shows the "meadow" at the right.

THE NYMPHS

THE FRITILLARIES

These are reddish-brown butterflies with many black spots on the upper sides of the wings and with many silver spots on the lower sides of the wings. When we were children we used to call these round, silver spots "butterfly money," and it was one of our pastimes to gently seize one of these butterflies when we found it sucking nectar from some thistle blossom and count its

money before we let it go. There are four species of the fritillaries common in our State.

The Silver Bordered Fritillary and the Meadow Fritillary.—These are two little fritillaries which resemble each other very much, but may be easily separated by the fact that the silver bordered has the silver spots on the lower side of the hind wings, while the meadow has not a butterfly dollar on its wings anywhere. The caterpillars of these species are small, mottled green and spiny. They feed upon violets.

The Great Spangled Fritillary and the Silver Spot Fritillary.—These two are of the same size and marked very similarly. The only way to distinguish the two species is to study the lower side of the hind wings; in the great, banded



THE GREAT SPANGLED FRITILLARY

Expanse, about three inches. Color, orange (which fades to a dull brown late in the season) marked with black, the wings shading to brown next to the body. Under sides of the wings of the Great Spangled at the left, of the Silver Spot at the right.

species there is a broad, buff band inside the silver spots that border the wings; it is one-fourth as broad as the wing itself. This band is very much narrower in the silver spot. The caterpillars of these species are velvety black and spiny, and feed on the leaves of violets.



PEARL CRESCENT

Expanse, one and one-half inches. Color, orange-yellow with black markings.

THE CRESCENT SPOTS

The Silver Crescent and the Pearl Crescent.—These are two little butterflies which



SILVER CRESCENT

Expanse, one and one-half inches. Color, orange-yellow with black markings.

may be distinguished from other orange-yellow, small butterflies because there is so much of brown or black upon the wings that it is hard to tell whether that or the orange is the ground color. The lower sides of the wings are much paler than above and are marked with various shades of yellow in a most complicated pattern. The caterpillars of these species are black marked with yellow or orange, spiny, and feed on sunflowers, asters,

and other composite plants.

The Baltimore.—This is another crescent spot, but is very striking in appearance. It is found near swampy places. Its caterpillar is black and orange banded and striped and spiny. The caterpillars of one brood live together like a happy family, weaving leaves around themselves for protection; a queer thing about them is that during late summer the whole brood suddenly stops eating voluntarily and waits for winter, although surrounded by plenty of food. The food is snake-head.



THE BALTIMORE

Expanse, two inches. Color, black with outer marginal row of reddish-orange spots and two parallel rows of very pale yellow spots.

THE ANGLE WINGS

These butterflies are so called because the edges of their wings look as if they were cut in sharp notches and scalloped with a pair of scissors; they are among our most interesting and beautiful butterflies.

THE THISTLE BUTTERFLIES

Three of the angle wings are called the thistle butterflies because they are particularly fond of the nectar of thistle blossoms, and each one

bears on the lower side of the wings a band of rich rose-color, which well matches the color of the thistle flowers.

The Red Admiral.—This is one of our most striking and beautiful butterflies. The wings beneath are beautifully mottled and the front wings bear a diagonal band of rich rose-red. Its caterpillar is dull yellow, mottled with black, with a yellow stripe along the side; it has many spines. It feeds upon nettles and hops.

The Painted Beauty and Cosmopolite.—These two species resemble each other very much; each has the hind half of the front wing colored rose-pink on the lower side; on the hind wing of the painted beauty are two eyespots while on the cosmopolite there are five or six smaller ones in a row.



THE RED ADMIRAL, upper and under sides

Expanse, a little less than two and one-half inches. Color, purplish black with white spots near the tips of the front wings. Orange-red band across front wings and bordering middle part of hind wings.



THE PAINTED BEAUTY, showing under side of wings

Expanse of wings, about two and one-half inches. Color, orange-red, marked with black, tips of front wings spotted with white.



The caterpillar of the painted beauty is velvety black with cross lines of yellow and with a row of white spots on each side back of the middle. It has bristly spines; it feeds upon everlasting and allied plants. The cosmopolite caterpillar is mottled, greenish-yellow with black and yellow



THE COSMOPOLITE, showing under side of wings

Expanse of wings, about two and one-half inches. Color, orange-red marked with black; tips of front wings spotted with white.

The American Tortoise Shell.—This striking butterfly sometimes passes the winter as an adult and sometimes as a chrysalis. Its caterpillar is black with greenish sides and sprinkled with white raised spots; it is spiny. The caterpillars of the same brood live together, feeding on the lower sides of the leaves which they fasten together making a protective abode. The food plant is nettle.

Over the fields where the brown quails
whistle,

Over the ferns where the rabbits lie,
Floats the tremulous down of a thistle.

Is it the soul of a butterfly?

— *T. W. Higginson*



THE AMERICAN TORTOISE SHELL

Expanse, two inches. Wings, blackish, crossed by a broad band of reddish brown which shades to yellow on the inner side.

stripes along the side. It has bristling yellow spines; its food plants are thistle, willow, and everlasting. The cosmopolite has the widest distribution of any of our butterfly species. It is found in every part of the world except South America and the Arctic regions.

The Mourning Cloak.—This butterfly which is well known in Europe is very common here. It winters as a butterfly and is the earliest of all our butterflies to appear in the spring. Its caterpillar is velvety black covered with white raised dots, and a row of red spots along the middle of the back. It has rows of black spines. It feeds on elm, willow, poplar and other trees.



THE MOURNING CLOAK

Expanse, two and one-half to three and one-half inches. Color, purplish-brown, appearing black when flying. The wings have a broad yellow border sprinkled with brown and just inside the border a row of blue spots.



THE COMPTON TORTOISE

Expanse, two and one-half inches, mottled with dark red and ochre yellow like the colors of a tortoise shell. A white spot on the front of each wing near the tip. The hind wings on the lower side each bear a small L-shaped silvery or white mark.

It has black, bristly spines, and the caterpillars of the same brood feed in a flock. The food plants are birch and willow.

The Compton Tortoise.—This butterfly resembles very much the polygonias, even having the "embroidered" initial on the lower side of the hind wings. However, it differs in one particular. The hind margin of the front wings is straight and not incurved. Its caterpillar is greenish in color, more or less speckled with lighter color. It

THE POLYGONS

These are distinguished from the other butterflies not only by the sharp notches and angles of the edges of the wings, but also by having the hind margin of the front wing cut out in a graceful curve. Each species has on the lower side of the hind wing near the center an initial or punctuation mark wrought in silver, this mark varying with the species. The flight of the polygons is very erratic; they dash about, making quick angles, so that the eye cannot follow them. While the upper sides of the wings are bright orange red and quite striking, the lower sides of the

wings are mottled in dull colors so that they resemble dead leaves or grass. All one of these butterflies has to do to become invisible when resting on the ground is to close its wings above its back, and it is then almost impossible for the eye to detect it.

The Violet Tip.—This is the largest of the polygons and the most graceful in form of all butterflies. It winters as an adult. The caterpillar is yellowish-brown with irregular spots and marks of lighter color. It has many branching spines, one pair being on the top of the head. It feeds on elm, hop, nettle, linden, and hackberry.



THE VIOLET TIP

Expanse, two and one-half to three inches. Color, rich orange red spotted with black. The margins of the wings and the tails tinted with violet color. The hind wings bearing a large silver semicolon on the lower side.

butterfly and is one of the earliest that we see in the woods in the spring. Its caterpillar is about an inch long, dark brown or greenish, with blotches and lines and adorned with thorny spines, one pair of which is on the head. It feeds on hops, nettle and elm. The chrysalis is a beautiful object ornamented with knobs that shine like the precious metals. There is a superstition that if these knobs are golden the price of hops will be high; if they are silver, the price will be low.

The Hop Merchant.—This looks on the upper side like a dwarf violet tip, for the margins of the wings are tinged with violet. It hibernates as a but-



THE HOP MERCHANT

Expanse, two inches. Color, bright orange-red with black spots. The borders of the wings dark brown, shading off to violet at the margin. The "initial" on the lower side of the hind wings is like a badly made G.

The Green Comma.—This always hibernates as a butterfly. It may be distinguished from the gray comma, which it very much resembles, by the green tinge quite noticeable in the darker markings of the upper side of wing, and by the amount of olive green and the very different pattern on the lower side of the wings, and a quite different initial. Its cater-

pillar is a little more than an inch long, reddish or yellowish in color, with a large patch of white on its back. Its branching spines are light colored. It eats the leaves of black birch, willow, alder, currant and gooseberry.

The Gray Comma.—This butterfly always hibernates as an adult and appears early in the spring. It especially frequents orchards. Its caterpillar attains the length of an inch and has a body yellowish-brown marked with greenish-black. It has many branched spines, one pair being on the head. It feeds on currant, gooseberry and elm.



THE GRAY COMMA

Expanse, about two inches. Color, orange-red with black spots, brownish borders to the wings. The under sides of the wings are "pepper and salt" arranged in wavy lines. The "initial" a delicate wide-angled L.

THE SOVEREIGNS

These butterflies are noted for the very interesting habits of the caterpillar which are omitted here. The caterpillars when fully grown are so covered with humps that they look most grotesque. On the front end of the body is borne a pair of tiny tubercles that look like pompons. The chrysalis has a projection which resembles a Roman nose.



THE RED SPOTTED PURPLE

Expanse, about three inches. Upper surface of wings velvety indigo-black tinged with blue or green iridescence. The border rows of spots on the hind wings a light iridescent blue. The wings on the under sides show many red spots.

The Red Spotted Purple.

—This is not so common in New York State as the banded purple. There is a form which is hybrid between the two, showing the trace of the white band across the front wings, while the hind wings are usually like those of this species. Its caterpillar feeds upon plum, thorn-apple and others.

The Viceroy.—This butterfly has forsaken the dark uniform of its family and has put on the dress

of the monarch. This disguise affords it protection from the birds be-

cause the monarch is very distasteful to them, and they have learned to avoid all butterflies which look like it. The black band across the hind wings of the viceroy distinguishes it readily from the monarch. It is also a smaller butterfly. (See figure on page 789.) Its caterpillar feeds upon willow and poplar.

The Banded Purple.—This beautiful and striking butterfly is quite local in its habits and spends its whole life near the same spot. It frequents shady roads. Its caterpillar feeds upon birch, poplar and shadbush.



THE BANDED PURPLE

Expanse, about three inches. Color, velvety chocolate-black; the broad white band across the wings distinguishes it from other species.

THE MEADOW BROWNS

These are brown butterflies which do not attract much attention from the uninitiated, but are very much loved by any real student of butterflies.



THE BLUE-EYED GRAYLING

Expanse, two to two and one-half inches. Color, dull brown with broad yellow bands crossing the front wings outside the middle. In this band are two black eye-spots, with little blue centers; small dark eye-spots on each hind wing.

The Blue-eyed Grayling and the Dull-eyed Grayling.—These two species blend into each other, the blue-eyed being the southern form and the dull-eyed the northern form. The only difference between the two species is that the dull-eyed grayling lacks the broad yellow band on the front wings, but almost every grade between the two species may be found. The caterpillar attains the length of over one and one-third inches. It is green in color with yellowish stripes along each side. The body is covered with down, otherwise smooth. The rear end is forked. It feeds on grass.

The Eyed-brown.—This delicate fawn-colored butterfly repays well a little closer attention. The velvety brown spots which ornament the

upper surface of the wings have a white center like a bull's eye on the lower surface. The caterpillar attains the length of one and one-fourth inches, is greenish in color and striped lengthwise. It is not only forked at the rear end, but has a pair of red horns at each end of the body; it hibernates when about half grown. It feeds on the coarser grasses and sedges.



THE EYED-BROWN

Expanse, about two inches. Color, pale mouse-brown, with a row of four velvety-brown spots along the border of the front wing and five or six smaller spots on the hind wing.



A MONARCH CATERPILLAR



THE MONARCH below

Expanse, about four inches. Color, orange-red, with veins outlined in black, and the wings bordered with black, enclosing a double row of white spots.

THE VICEROY is shown above THE MONARCH, which it imitates in color.

THE MILKWEED BUTTERFLIES

The Monarch.—This magnificent butterfly is a monarch indeed. The birds will not touch it, and so it is afraid of nothing. Its flight is leisurely and extends over long distances. It does not winter with us, but comes to us each year from the South. In the fall it may be seen migrating back in flocks. Its caterpillar is banded crosswise with narrow black and yellow stripes. At either end of the body is a pair of whip-lash-like organs; it attains the length of two inches. It feeds on milkweed; the chrysalis is plump and comparatively smooth, of an exquisite green color ornamented with dots of shining gold.

THE GOSSAMER WINGS

These are our smallest butterflies, few of them measuring more than an inch across the expanded wings. They include the hair streaks, coppers and blues.

THE HAIR STREAKS

These little butterflies are distinguished from others by the long tail-like prolongations of the hind wings.

The Gray Hair Streak.—This frisky little brown butterfly has a bright orange-spot on the hind wings and one or two white tipped tails; it also has orange on the tip of its antennæ and its head. Its caterpillar is less than a half an inch long and slug-shaped. It is naked reddish-brown. It feeds upon the fruit and seeds of hop, hawthorne, hound's tongue and St. John's wort.



THE BANDED HAIR-STREAK

Expanse, one and one-fifth inches. Color, dark brown or blackish; lower side of the wings grayish with rows of black spots margined with white. Blue spot with orange spot on each side of it on the hind angle of the lower wing.

The Banded Hair Streak.—This is our commonest hair streak. It frequents openings in the woods, especially scrub oak clearings; though dull in color it has on the inside at the tip of the hind wings a blue patch with an orange patch on each side of it. Its caterpillar is slug-shaped, half an inch long, grass-green in color and feeds on oak, hickory and butternut, eating holes in the leaves; it winters as a newly-hatched caterpillar.

THE COPPERS

These are distinguished from the other gossamer wings by their orange-red and brown colors.

The Wanderer.—This lovely little butterfly is usually found near alders. Its caterpillar is rather wide in the middle and pointed at each end, about one-half inch in length; its color is brown, marked with brownish stripes. It differs from the caterpillars of other butterflies in that it is not vegetarian, but lives instead, upon the woolly plant-lice which infest the alder and thus is a very good friend to this tree.



THE WANDERER

Expanse, a little over an inch. Color, dark brown with large, irregular, orange-yellow patch in the central part of the fore wing and a similar patch on the outer half of the hind wing.



THE AMERICAN COPPER

Expanse, about an inch. Color of front wings, red with black spots, and borders of hind wings, coppery-brown with broad orange-red band on the outer margins.

The American Copper.—These jolly midgets flit about over lawns almost always playing with each other and sometimes even daring to play

with us as we cross their path. The caterpillar is slug-shaped, a half an inch long, dull rosy-red in color; it feeds on sorrel.

THE BLUES

The Spring Azure.— This bit of a blue butterfly comes to us early in the spring and seems like a promise of blue skies and sunshine. Its caterpillar is two-fifths of an inch in length, slug-shaped, whitish with dark brown head. It lives on the flowers of dogwood, sunac, spiræa and others. A remarkable thing about its caterpillar is that it bears an organ on the back which exudes honeydew; ants feed upon this and protect the caterpillar.



THE SPRING AZURE
*Expanse, about an inch.
 Color, blue with purplish tinge; wings bordered more or less with black.*

THE SKIPPERS

There is a family of insects usually included with the butterflies called skippers. These are usually small dark brown or dull yellow, and may be distinguished from the butterflies by the fact that the antennæ are either hooked at the tips or bent at an angle. The character which distinguishes butterflies from moths most readily is that the butterflies always have antennæ which are enlarged at or toward the tips. Knobbed antennæ they are called; while the antennæ of moths may be straight and simple or feather-like. The antennæ of the skippers are enlarged like those of the butterflies toward the tip, but the knob is very bent or hooked. The skippers have heavy bodies and are very agile in flight. The caterpillars of the skippers are absurd looking creatures, the neck being very small and the head very large. They usually live concealed in a folded leaf or in a nest made of a few leaves fastened together.

The pupils in the Home Nature-Study class will please make full notes on any butterflies which they have studied and send the same to the editor.

BOOKS FOR THE STUDY OF BUTTERFLIES

- Everyday Butterflies*, Scudder, Houghton, Mifflin Co., \$2.00.
The Butterfly Book, Holland, Doubleday, Page & Co., \$4.00.
How to Know the Butterflies, Comstock, Appleton, \$2.25.
Moths and Butterflies, Mary Dickerson, Ginn Co., \$2.50.

SWALLOWTAILS,	{ Tiger Black	
	{ Whites,	{ Cabbage.
PIERIDS,	{ Yellows,	{ Roadside.
	FRITILLARIES,	{ Great Spangled. Silver Spot. Meadow. Silver Bordered.
	CRESCENT SPOTS,	{ Pearl. Silver. The Baltimore.
NYPHS,	THISTLE BUTTERFLIES	{ Red Admiral, Painted Beauty, Cosmopolite.
	ANGLE WINGS,	{ Mourning Cloak. American Tortoise Shell. Compton Tortoise.
	SOVEREIGNS,	{ Polygons, Banded Purple. Red Spotted Purple. Hybrid Purple. Viceroy.
MEADOW BROWNS,	{ Blue-eyed Grayling. Dull-eyed Grayling. The Eyed Brown.	
THE MILKWEED,	{ The Monarch.	
THE GOSSAMER WINGS,	{ HAIR STREAKS, COPPERS, BLUES,	{ Gray Hair Streak. Banded Hair Streak. The Wanderer. American Copper. Spring Azure.

CHECK LIST AND TABLE OF THIRTY-FOUR COMMON BUTTERFLIES.

The pupils of the Home Nature-Study Course will find it helpful if they will cross off this list the name of each butterfly as soon as they are sure they know the species.

Home Nature = Study Course

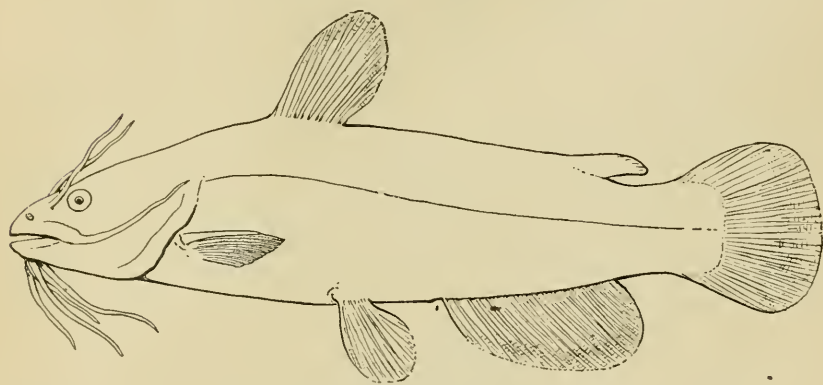
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No. 4

FISH STUDY

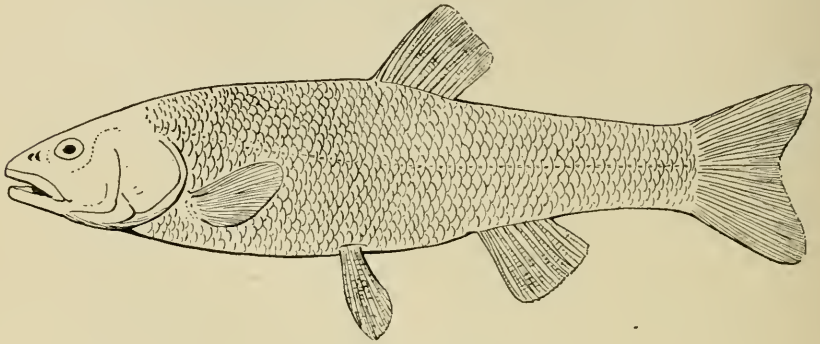


Bullhead or Horned Pout.

The common bullhead or horned pout is a sluggish fish living in muddy water where it moves about slowly waving its eight whip-like barbels; the barbels are about the mouth and serve as feelers while searching the bottom for food. The bullhead is not particular about what it eats; any animal food, either living or dead, suits it. In the early spring it builds a rude nest and spawns; the young, after hatching, swim away with the mother and are cared for by her for a short time. Handle the horned pout carefully for the dorsal and pectoral fins are preceded by very sharp spines. There is a second dorsal fin called the adipose fin, which is soft and fleshy.

The horned dace is so called because it has tubercles on the head in the spring. It haunts small streams and clear ponds and is one of the most common species caught by the small boy's hook. It reaches a length of a foot or more and feeds upon mollusks, crustacea, mud and some

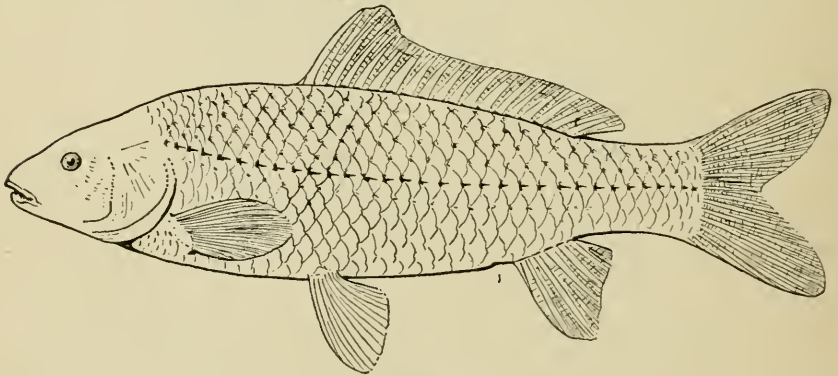
vegetation. The horned dace has a black lateral band, which does not extend around the nose; there is always a black spot on the front of the



Horned Dace.

base of the dorsal fin. In the spring the belly of the breeding males is rosetinted, and the dorsal spot is bordered with red.

The German carp is a European form which has been introduced into our streams where it is abundantly found in sluggish water having a rather deep bottom. Its food consists principally of vegetable matter, preferably seeds of water plants; in captivity it will eat lettuce, cabbage,

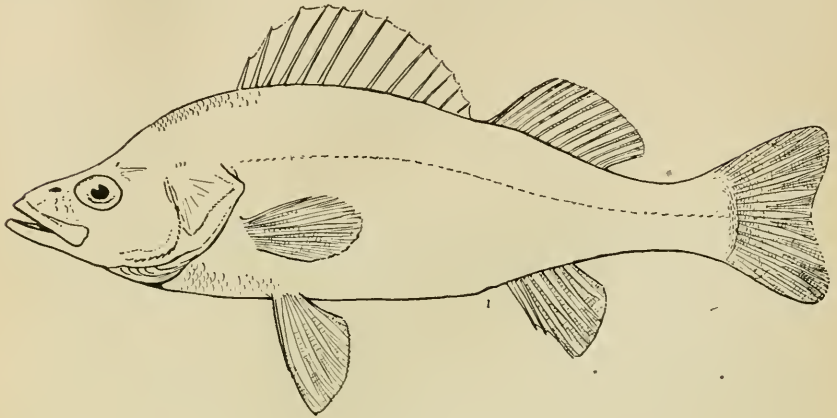


The German Carp.

grain or meats of various kinds. The carp has much the same shape as a gold-fish and often grows to an enormous size; there is a barbel at the angle of the mouth and the dorsal and anal fins are preceded by serrated spines.

The yellow perch can be caught with a hook and line at almost any time of the year; it is found in open ponds, rivers and lakes and will

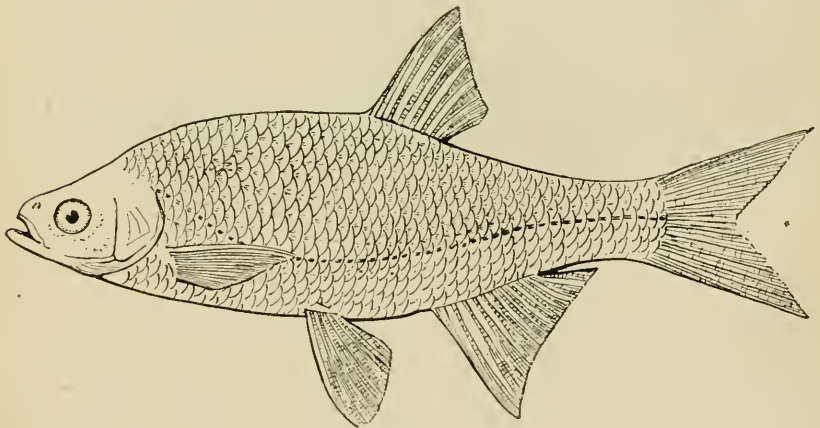
often come to the surface when a hole is cut in the ice in winter. It feeds upon small fishes, crustaceans and other animal matter. The yellow



Yellow Perch.

perch may be distinguished from the other perches by six or eight dark bands on its yellow sides. The lower fins are orange and rosy.

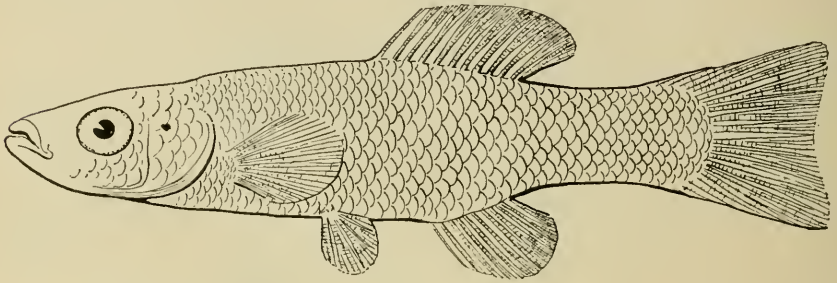
The golden shiner is one of the commonest fishes of the eastern states. It is found in sluggish waters and weedy ponds; it lives upon animal food. The golden shiner is characterized by a deeply decurved



The Golden Shiner.

lateral line; it is greenish above with silvery sides having golden reflections. The fins are usually yellowish but the lower fins of the males are scarlet in the spring.

The barred killifish is essentially a salt water fish but it ascends streams to their sources and hence is often abundant in clear springs, ponds and streams as far inland as Michigan. The killifishes are small, usually not more than four inches long; they have a very small protractile



The Barred Killifish.

mouth and because of their extremely small gullet they live upon microscopic organisms found near the surface of the water. The females are greenish and have from fifteen to twenty-five narrow, dark cross-bands. In the breeding season the cross-bands of the males are pearly white.

The pupils in the Home Nature-Study class will please make full notes as to how, when and where they have found any of the fish described in this leaflet and send them to the editor. Special care should be taken in studying the colors and markings of the fish and also the situation in which they are found.

BOOKS FOR THE STUDY OF FISH

American Food and Game Fishes, Jordan and Evermann, Doubleday, Page & Co., price \$4.00.

Guide to the Study of Fishes, Jordan, 2 volumes, Henry Holt Co.

Familiar Fish, McCarthy, Appleton, \$1.50.

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No. 4



The purple trillium.

PLANT STUDY

SPRING FLOWERS OF THE WOODS

While those people who live in warmer climates may have pleasures of their own, yet I doubt if they ever experience a keener delight than we who live in the northern and colder climates experience when we first get out into the woods after, or even before the snow has entirely melted away. Although many blossoms may be more intrinsically beautiful, yet I doubt if there are any flowers in the world, which give so great pleasure as do these little blossoms of the woodland, which appear in our country during the months of April and May.

Although they are little, wild flowers, they are by no means lacking in individuality; each species has its own way of living, of blossoming, of scattering its seeds, of sending forth leaves, and of meeting the problems which confront plant life.

There are certain questions about these plants which we can answer if we use our eyes, and we will get as many different answers to a given question as there are species studied. This lesson consists of such questions, and I hope that the pupils of the Home Nature-Study Course will answer these questions about some or all of the following named plants, or any other they choose and report the answers to me:

Hepatica, Arbutus, Anemone, Spring beauty, Adder's tongue, Trilliums, Dutchman's breeches, Jack-in-the-pulpit.

1. Where and when did you find the blossom?
2. Were there any new leaves on the plant at the time it blossomed?
3. Describe the blossom, telling:
 - (a) Colors.
 - (b) Number and shape of petals.
 - (c) Color and shape of sepals, if present.
 - (d) Number of stamens and how placed.
 - (e) Pistils and how placed.
 - (f) Has the blossom any nectar that you can discover?
4. Do you find any insects visiting the blossom?
5. How long does the plant remain in bloom?
6. Describe the seed or seed pods of the plant.
7. What sort of roots has the plant?

Fill out the blanks for each flower studied and return to editor.

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Address.....

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No. 4

TREE STUDY

TREE BLOSSOMS

For half our May's so awfully like May n't,
 'Twould rile a Shaker or an evrige saint;
 Though I own up I like our back'ard springs
 Thet kind o'haggle with their greens an' things,
 An' when you 'mos' give up, 'ithout more words
 Toss the fields full o'blossoms, leaves an' birds;
 Thet's Northun natur' slow an' apt to doubt,
 But when it does got stirred, ther' 's no gin-out!

'Fore long the trees begin to show belief,—
 The maple crimsons to a coral-reef,
 The saffern swarms swing off from all the willers
 So plump they look like yeller caterpillars,
 Then gray hossches' nuts lectle hands unfold
 Softer'n baby's be at three days old;
 Thet's robin-redbreast's almanick; he knows
 Thet arter this ther's only blossom-snows.

—James Russell Lowell.

The strange belief is held by certain people who see only what they stumble over, that forest trees do not blossom. Of course, they know that basswood, locust, fruit trees and some others bloom every year, but they do not believe that this is true of the beech, elm, birch and hemlock, though they admit that these latter trees bear fruit. They do not seem to realize that if there are any seeds or nuts on a tree, it is sure evidence that there were blossoms on it earlier in the season; for naturally the whole object of a blossom is to produce fruit.

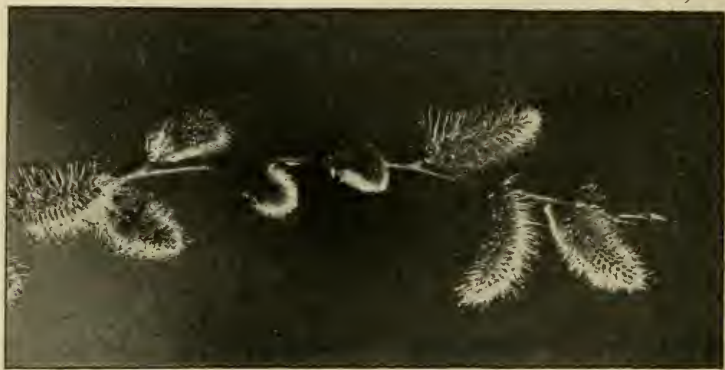
An instance of the ignorance which prevails about the blossoms of trees is shown by what is taught in hundreds of schools about the pussy



Seed-bearing catkins of the willow.

The photographs of the willow blossoms were made by Verne L. Morton. All the others were made by Ralph W. Curtis.

willow. The " pussies " on their twigs are placed in water in the school-room windows and the children are taught that these are the blossoms of the willow, but they are never told why these blossoms never produce



The pollen-bearing catkins of the willow.

seeds. In fact very few people know what sort of seeds the willow has. The facts about the blossom of the willow are as follows: There are two kinds of flowers growing on separate trees. One tree produces the soft,



Trembling aspen. Pollen bearing flowers at the left. Seed-bearing flowers at the right.

furry catkins which finally develop into the pollen-bearing flowers; while some other tree in the neighborhood produces catkins of quite a different sort, not nearly so soft and furry nor so attractive, and these are the seed-bearing flowers of the willow. The pollen is carried from tree to tree by insects, largely bees. The willow blossoms are a mine of wealth for the bees, as they appear early in the season before other flowers give them food. When the pollen of the pussy willow is fully developed, the tree is filled with the hum of the happy bees working upon it. It may be asked why the insects pass from this tree to the other one

which bears the pistillate flowers where there is no pollen; but this is part of the life scheme of the willows, for the seed-bearing flowers yield nectar while the pollen-bearing flowers yield only pollen. As pollen and nectar both form the food of bees, these little carriers pass back and forth and fertilize the flowers. I have seen many lessons given to the children in our schools on the pussy willow, and I never saw but two which were given properly, revealing the whole story. One of these was in a primary room where the little children came to me with their treasures and told me the pretty story of the pollen and the bees; and together we studied the seeds which developed on the twigs in the schoolroom window and discovered for ourselves how they were scattered. As a matter of fact, it is because the "pussies" of the pussy willows are so noticeable that most people have discovered the willow blossoms at all, although the other species have blossoms quite as interesting, if not so showy.

This spring the Home Nature-Study Class will study the blossoms of trees and find as many of these as possible. Please send to me pressed specimens of the blossoms labeled with the name of the



Flowers of red maple.



*Flowers of clem. American clem at the left.
Slippery clem at the right.*



Blossoms of sugar maple.

tree if you know it. Answer the following questions about the blossoms of as many of the following named trees as possible:

(a) Describe the chape and color of blossom, noting especially if the seeds and pollen are produced in the same flower, or in separate flowers.

(b) Date of blossoming.

(c) Is the pollen carried by bees, or by the wind? You can determine this by noticing whether insects are working on the flowers or not.

Shad bush.—

(a)

(b)

(c)

Sugar Maple.—

(a)

(b)

(c)

Soft Maple.—

(a)

(b)

(c)



Blossoms of mountain maple.



Blossoms of silver maple.

Oak.— (Any species)

(a)

(b)

(c)

Hickory.—

(a)

(b)

(c)

Elm.—

(a)

(b)

(c)

Ash.—

(a)

(b)

(c)

Pine.—

(a)

(b)

(c)

Hemlock.—

(a)

(b)

(c)



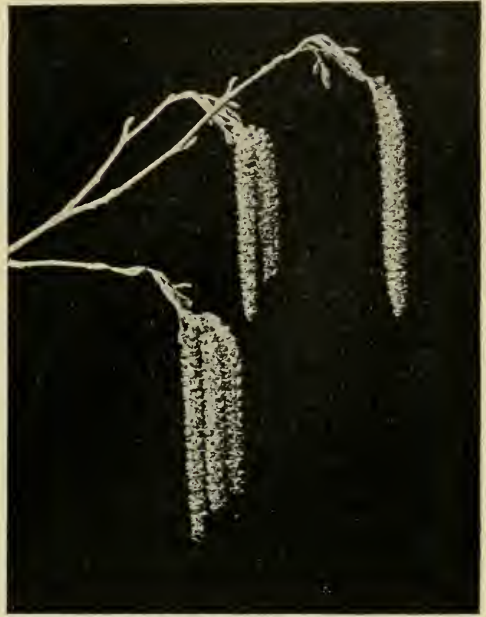
Young and mature cones of the white pine.

Spruce.—

(a)

(b)

(c)



Alder blossoms.



Horsechestnut.—

(a)

(b)

(c)

Blossoms of chestnut oak.

Willow.—

(a)

(b)

(c)

Poplar.—

(a)

(b)

(c)

Birch.—

(a)

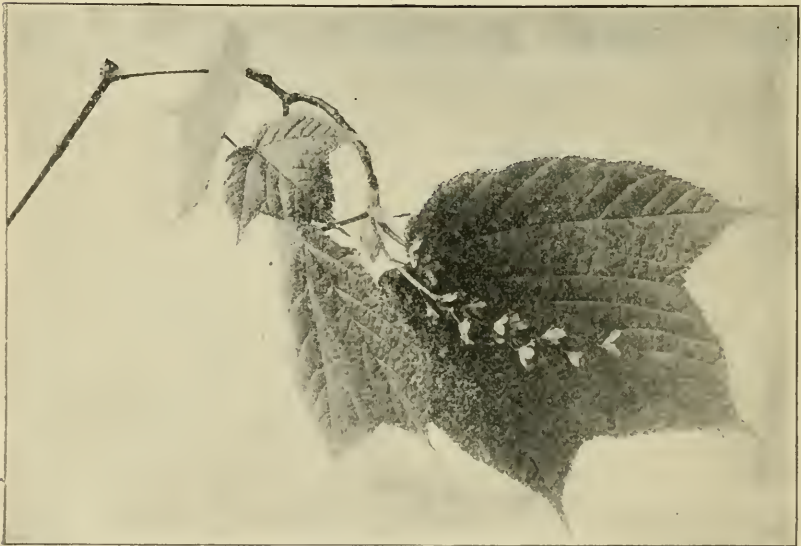
(b)

(c)

Fill out the blanks and return one copy of this leaflet to editor.

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Blossom of striped maple.

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No. 4



Photographed by George W. Fiske.

American Redstart.

BIRD STUDY

Winged lute that we call a bluebird, you blend in a silver strain
The sound of the laughing waters, the patter of spring's sweet rain,
The voice of the winds, the sunshine, the fragrance of blossoming things,
Ah! you are an April poem, that God has dowered with wings!

—*Eben Eugene Rexford.*

Those of us who have spent winters in the warmer countries where our common birds spend the cold weather, realize how much more interesting these birds are when they come back to us after their winter journey, than they are at their winter resorts. I think this is because the birds themselves are more interested in life when they return to us. They have something very important to do and their zeal and enthusiasm for their work is made manifest in their songs and in their actions, and even, in some cases, in the brightness of their plumage.



Photographed by O. L. Foster.

Wood Thrush.

While in a general way we, most of us, know something of the habits of the birds which build their nests around our grounds and houses, yet when it comes to exact knowledge, I think very few of us know very much about them. The work of the Home Nature-Study Class will be devoted largely this spring to an accurate and careful study of the nesting habits of some of our more neighborly birds. I wish that each pupil would keep a diary of the robin, the blue-bird, the chippy, the English sparrow, or any other bird that is building near at hand this spring, and thus gain some exact information about the home life of our bird neighbors, and answer the following questions:

1. On what date did you first see the bird?

2. Did the male bird appear first or the female?

3. What is their food and where do they get it?

4. When was the nest begun?

5. Where is the nest placed?

6. What is the material used?

7. How is the work of construction carried on?
8. How is the nest lined?
9. Do both parents work at the construction of the nest?
10. Do both the parents sing?
11. When does the first egg appear?
12. How many eggs in the nest and the length of time between the laying of the first and the last egg?
13. Describe the eggs in a general way, the color, the markings and size.
14. How long after the incubation begins before the first bird is hatched?



Photographed by Geo. W. Fiske.

Young of the Yellow Warbler.

15. Do both parents take turns at sitting on the nest?
16. Does one bird feed the other on the nest?
17. When the eggs are hatched do both birds help feed the young?
18. Describe the young when hatched.
19. How long after hatching before the eyes of the young birds are open?
20. How long before wing feathers appear?
21. How long before the young birds are able to leave the nest?

22. Describe the actions of the old birds in teaching the young to take care of themselves after they leave the nest.
23. How is the nest kept clean after the young birds hatch?
24. After the young birds are fully feathered, how do they differ in appearance from the old birds?
25. Do the parents raise a second brood? If so, do they use the same nest?



Photographed by Geo. W. Fiske.

Nest of Red-Shouldered Hawk;

Fill out the blanks and return one copy of this leaflet to editor.

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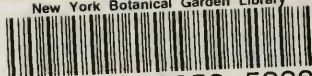
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