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New York Agricultural Experiment Station.

GENEVA, N. Y.

FORTIETH ANNUAL REPORT

WITH THE DIRECTOR'S REPORT FOR 1921

R. W. THATCHER

PUBLISHED BY THE STATION

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Address all correspondence, not to individual members of the staff, but to the NEW YORK AGRICULTURAL EXPERIMENT STATION, GENEVA, N. Y.

The Bulletins published by the Station will be sent free to any farmer applying for them.

† Members of the faculty of the New York State College of Agriculture affiliated with this Station.

STATE OF NEW YORK:

DEPARTMENT OF FARMS AND MARKETS,

ALBANY, *January* 16, 1922.

To the Legislature of the State of New York:

As Commissioner of Farms and Markets, I have the honor to submit herewith the Fortieth Annual Report of the Director of the New York Agricultural Experiment Station, at Geneva, N. Y., in pursuance of the provisions of the Agricultural Law.

I am, respectfully yours,

BERNE A. PYRKE,

Commissioner of Farms and Markets.

NEW YORK AGRICULTURAL EXPERIMENT STATION.

R. W. THATCHER, *Director.*

GENEVA, N. Y., *December* 15, 1921.

HON. CHARLES R. MELLEN,
President of the Board of Control,
Geneva, N. Y.

Dear Sir: In compliance with Section 306 of Article 14 of the Agricultural Law of New York, I have the honor to transmit herewith the report of the Director of the New York Agricultural Experiment Station for the year 1921.

Yours respectfully,
R. W. THATCHER,
Director.

GENEVA, N. Y., *January* 3, 1922.

HON. BERNE A. PYRKE,
Commissioner of Farms and Markets,
Albany, N. Y.

Dear Sir: I have the honor to transmit herewith the Fortieth Annual Report of the Board of Control of the New York Agricultural Experiment Station, comprising the Treasurer's report for the fiscal year ended June 30, 1921, and the Director's report for the calendar year 1921.

Yours respectfully,
CHARLES R. MELLEN,
President of the Board of Control.

GENEVA, N. Y., *January* 3, 1922.

HIS EXCELLENCY, NATHAN L. MILLER,
Governor of New York,
Albany, N. Y.

Sir: In compliance with the requirement of the act of the United States Congress of 1887, known as the "Hatch Act," providing for the establishment of agricultural experiment stations in the several states, I have the honor to transmit herewith the Fortieth Annual Report of the New York Agricultural Experiment Station, for the year 1921.

Yours respectfully,
CHARLES R. MELLEN,
President of the Board of Control.

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FORTIETH ANNUAL REPORT

OF THE

Board of Control of the New York Agricultural Experiment Station

TREASURER'S REPORT

GENEVA, N. Y., *July* 1, 1921.

To the Board of Control of the New York Agricultural Experiment Station:

As Treasurer of the Board of Control, I respectfully submit the following report for the fiscal year ended June 30, 1921.

RECEIPTS

1920			
July 1.	To balance on hand		$5,040 74
	Salaries and labor (Albany)	$149,313 21	
	Repairs (Albany)	747 00	
	Adams fund	1,465 22	
	Hatch fund	1,499 49	
	Maintenance and operation (first adv.)	6,149 95	
	Fuel, light, and power	5,833 34	
	Printing	284 89	
	Equipment and supplies	13,333 34	
	Hired horses and vehicles	2,176 54	
	Traveling expenses	2,500 00	
	Communication	2,083 34	
	General plant service	833 33	
	Rent	492 01	
	Repairs	2,082 27	
	Produce	5,168 80	
		$193,962 73	193,962 73
			$199,003 47

EXPENDITURES

Salaries and labor (Albany)	$149,313 21	
Repairs (Albany)	747 00	
Adams fund	1,499 76	
Hatch fund	1,492 16	
Fuel, light, and power	7,304 41	
Printing	284 89	
Equipment and supplies	15,216 20	
Hired horses and vehicles	2,425 88	
Traveling expenses	2,982 43	
Communication	2,497 33	
General plant service	999 99	
Rent	650 00	
Repairs	1,495 27	
Produce, remitted to Treasurer State of New York	5,168 80	
	$192,077 33	$192,077 33
Balance on hand June 30, 1921		6,926 14
		$199,003 47
Balance Ring Memorial Fund		$1,293 52

All expenditures are supported by vouchers approved by the Auditing Committee of the Board of Control and have been forwarded to the Comptroller of the State of New York.

(Signed) W. O'HANLON,
Treasurer.

DIRECTOR'S REPORT FOR 1921

To the Honorable Board of Control of the New York Agricultural Experiment Station:

Gentlemen.— For the first time it becomes my pleasant duty to prepare a report of the year's operation of the experiment station which is under your charge. I assumed the duties of the directorship, on July 1 last, with a keen sense of the honor conferred upon me in being chosen to fill the position the duties of which had been so ably performed thru the preceding twenty-five years by former-Director Jordan, and with a profound feeling of responsibility for the continued maintenance of the high standards of research and careful investigation and the splendid reputation and standing which the New York Agricultural Experiment Station at Geneva enjoys, both at home and abroad. I have taken up these duties and responsibilities with a confident reliance in your wisdom and experience in guiding the affairs of the institution and with a keen appreciation of the helpful attitude of counsel and advice which you have already manifested toward me, and which I know to have been a constant source of strength and pleasure to Dr. Jordan.

It is both eminently fitting and a peculiar personal pleasure for me to present here a few extracts from a recent editorial in *Experiment Station Record,* published by the States Relations Service of the United States Department of Agriculture, commenting upon the occasion of Dr. Jordan's retirement:

> Dr. W. H. Jordan, who retired in June, was one of the few remaining pioneers among the state directors who aided in founding and building the American system of agricultural research. He was the last of the group who bind the original State stations with the present national system. * * *
>
> The period of his activity covers the greatest period of development in the American stations, not only in point of revenue but in the growth of agricultural research. He stood consistently through the formative period of the stations for the high ideals and purposes which these institutions were to express. His voice was heard in no uncertain terms in setting forth these ideals, in defining the nature and essentials of research, in criticism of tendencies he believed to be injurious, and in constructive suggestion.
>
> From the first, Dr. Jordan had a clear vision of the field and function of the experiment station as an institution for acquiring information through experiment and research. He contended that the Hatch Act established it "as a means of experimentation and research, and for no other purpose;" that to maintain otherwise was to distort the understanding of an experiment station and the idea fundamental to its organization as expresed in the word "experiment;" and that a station functioning chiefly as an instrument of popular instruction was an absurdity. * * *

Since knowledge is a limiting factor in all human endeavor, and it is the primary function of the station to acquire that knowledge essential to agriculture, he made many an ardent plea for opportunity to do its work, and for protection of the station from demands which were outside its proper field. On more than one occasion he called attention to the distortion of the stations' function, the extent to which they have been "coerced in efforts that do not belong to them," and declared that "the greatest and most permanent acquisitions that have come to agriculture as an art during the past fifty years are the outcome of profound scientific study." Again, he explained that "agricultural practice has no greater need today than an enlarged vision through more and safer knowledge, and that a new truth may have vastly greater value than many volumes of pleasing addresses." It was an apt illustration of his in referring to the application of scientific facts that "it is easier to cut a diamond to its setting than it is to find it."

Dr. Jordan helped us to understand what science is and what it is not, what the essentials are of scientific inquiry, and the distinction between research worthy of the name and other types of work. While admitting that purely practical and local experiments had brought farmers into sympathy with science as a means of progress, he drew the conclusion that "we should guard against centering an experiment around facts or conditions which are of mere local or temporary importance;" and he added that the literature was "already cluttered with so-called practical conclusions that in a brief time will be swept into the rubbish corner." He held it as fundamental to the largest success that experiments should "deal with matters of general and permanent utility;" and he reminded his hearers that the "contributions of note which have entered into the warp and woof of agricultural practice are those which have been proclaimed from the inner temple of science," and furthermore that "the discoveries of scientific truth which are today blessing the farmer in his daily toil are mostly those which have been reached through the severest and most searching investigations." * * *

Perhaps it was in the field of criticism that some of Dr. Jordan's most useful work was done. He preserved the attitude of scientific criticism toward his own work and that of his associates, for he sought sound truth and abhorred superficiality or hasty conclusions where the evidence was defective. His clear analysis of problems and the requirements for their solution was most helpful.

His frank exposure of what he conceived to be weaknesses in the stations, his vigorous comments on conditions and practices which ought to give way to higher standards, were made in no spirit of censoriousness, but with a directness that expressed the force of his convictions. They came with a full understanding of the difficulties under which many of the institutions labored, but with no disposition to condone. He looked for progress, and he urged constant pressure in that direction, reminding his co-workers that in this most ambitious and extensive scientific effort of the day their ideals, intelligence, integrity of thought and ability, in things scientific, would be judged by the outcome of their labors. * * *

The influence of such a vigorous, clear-visioned character in the councils of the experiment stations for a period of thirty-six years can hardly be overestimated. It is apparent only after a review of the things he contended for and the course which development has taken. He has been a leader in the march of progress. He will be greatly missed in the meetings of the Association and in his personal relations with those engaged in agricultural research. All who have known him will join in the feeling expressed in the resolutions of the faculty of the Cornell College of Agriculture, that "he has richly earned the relief which retirement from active service brings," and will "wish him many years in which to enjoy the privileges of the contemplative life."

The lack of health and physical strength prevented the realization of Dr. Jordan's hope, expressed in his last report to you, that he would, before relinquishing the directorship, be "able to prepare a resumé, in a somewhat popular form, of the results of Station work important to practical agriculture, which have been secured during the past twenty-five years." Such a resumé would be a fitting climax to the many contributions which he has made to the literature of American agriculture. I have earnestly urged him to undertake its preparation as soon as his strength will permit and it is greatly to be hoped that he may soon be able to undertake this important work. It is to be hoped also that when the resumé is ready for printing, this Station may have the honor of publishing it.

ADMINISTRATION

STATION STAFF

Reference has been made above to the retirement of Dr. Whitman H. Jordan on June 30, 1921, after 25 years of service as Director of this Station. On July 1, I took up the duties of this position to which you had chosen me at your meeting on March 14, 1921. In accordance with the custom with new appointments to the staff, I present the following brief summary of my academic training and professional experience. I was graduated from the University of Nebraska with the degree of B.Sc. in 1898, and received from the same institution the M.A. degree (1901), and the honorary degree of D.Agr. (1920). After teaching science in the Beatrice, Nebraska, High School for one year (1898–99), I was for two years assistant chemist of the Nebraska Agricultural Experiment Station. In June, 1901, I removed to the State College of Washington, at Pullman, Washington, where I held successively the following positions: Assistant chemist (1901–03), chemist (1903–10), and director (1907–13) of the Experiment Station; assistant professor (1905–07), associate professor (1907–10), and professor of agricultural chemistry (1910–13); superintendent of farmers' institutes (1907–10); and head of the Department of Agriculture (1910–13). On May 31, 1913, I removed to the University of Minnesota, where I filled the following positions: Professor of plant chemistry and plant chemist of the Experiment Station (1913–17); assistant director of the Experiment Station (1916–17); and dean of the Department of Agriculture and director of the Agricultural Experiment Station (1917–21).

George A. Smith retired October 30, 1921, after more than thirty-five years of service to agriculture in New York, the last twenty-four years of which were as dairy expert at this Station. His wealth of experience and wide familiarity with the dairymen

and dairy conditions in this State gave him a particular advantage in meeting the practical problems of the dairy industry which no one can possibly be found qualified to furnish. The dairy research of this Station in the future must, therefore, be organized and carried on in a somewhat different way than it has been during Mr. Smith's long period of service.

Theodore E. Gaty, B.S., Assistant in Research (Horticulture) resigned March 31, 1921, to accept a position as a farm manager in Columbia county.

Clarence R. Phipps B.S., resigned his position as Assistant in Research (Entomology) on December 31, 1921, in order to become Entomologist of the Missouri Fruit Station.

T. O. Sprague, B.S., resigned as Assistant in Research (Horticulture) on December 31, 1921, on account of ill-health.

Appointments during the year were as follows:

Leon R. Streeter, B.S., a graduate of Colgate University, was appointed Assistant Chemist, beginning February 1, 1921.

Archie H. Robertson, B.S., graduate of Cornell University, began work on February 1, 1921, as Assistant in Research (Bacteriology).

Fred R. Clark, M.S., a graduate and post-graduate student of the University of Michigan, was appointed Assistant in Research (Horticulture) November 1, 1921.

Arthur C. Dahlberg, M.S., a graduate from the course in dairy husbandry of the University of Minnesota with graduate work in the chemistry and bacteriology of milk and its products at the same institution, and with four years of subsequent experience in dairy teaching and extension work, followed by two years as manager of a large cooperative creamery at Fargo, North Dakota, was appointed as Associate in Research (Dairying), beginning November, 1921.

M. P. Sweeney, who had been on leave of absence for graduate study, returned to duty on June 27, 1921. James D. Harlan and Walter L. Kulp were given leaves of absence, beginning October 1, for graduate study at the State Agricultural College at Cornell University and at Yale University, respectively.

MAINTENANCE FUND

The expenditures of the Station during the fiscal year ended June 30, 1921, were as follows:

Personal service	$148,071 46
Maintenance and operation	52,647 97
Total	$200,719 43

The Legislature of 1921 made the following appropriations for the use of the Station during the fiscal year beginning July 1, 1921:

Personal Service:		
Salaries and wages	$146,250 00	
Salary of geneticist (special)	2,750 00	
		$149,000 00
Maintenance and operation:		
(Undistributed)		49,400 00
Insecticide and fungicide investigations		5,000 00
Total		$203,400 00

The budget proposal for 1922–23 carries the following sums for the various needs of the institution:

Personal Service		$172,240 00
Maintenance and operation:		
Fuel, light, power, and water	$7,500 00	
Printing and advertising	13,500 00	
Equipment, supplies, and materials	23,500 00	
Traveling expenses	3,500 00	
Communication	2,500 00	
Fixed charges and contributions	100 00	
Rent	575 00	
Repairs and alterations	6,000 00	
		* 57,175 00
Construction or permanent betterments		88,500 00
Total		$317,915 00

NEEDED INCREASES IN FINANCIAL SUPPORT

The appropriations made by the Legislature of 1921 made available for the support of this Station for the fiscal year beginning July 1, 1921, a sum which is $4,400 less than the total granted for the same purposes during the preceding year. This was in spite of the facts which were pointed out in last year's report that the salaries of the members of our staff are not yet on a par with those paid to men of similar ability in similar lines of work in the State, and that there is imperative need for a new range of forcing houses and a new cold storage plant in order to maintain adequately our present work. The need for economy in state and national expenditures is apparent to everyone. It is poor policy, however, for the State to curtail its expenditures for those enterprises which increase agricultural production and add to the taxable wealth of the State.

With this in mind, the budget proposals for the coming year have been made up on the basis of providing adequately for the

* If appropriated in a lump sum, $54,000.

needs of the Station on its present basis of operation. Moderate increases over existing allotments are asked for the purpose of bringing our salary scale to a par with that of the other State-supported agricultural agencies. Modest increases in the allotments for labor and for equipment are asked in order to permit the repairs to our fences, buildings, and equipment which have been suspended since the outbreak of the war and which must now be made if the State's property here is not to be allowed to deteriorate beyond the possibility of repair, thus requiring much more expense thru new construction in order to restore the property to workable condition. The request for the forcing houses and cold storage plant has been renewed as a need which is growing more and more urgent as the provision for them is longer delayed. To these has been added a request for small items to provide a coal shed to make possible needed economies in handling our fuel and an additional silo for preserving our feed crops in better form for economical use as well as to provide facilities for experimental work with new silage crops. These items have all been carefully scrutinized to see that they are reduced to the lowest possible minimum for efficient operation of our plant, with the result that the total requested is approximately $10,000 less than was asked for the same purposes last year.

Following out the suggestion made by Director Jordan last year, we have been at work upon a definite program for the future development of the Station. This program should include both an outline of the general policies which are to be followed in the development of the work of the Station and a plan for the future equipment of buildings, etc., which will be necessary to carry out the program. Significant progress has been made in the preparation of this program and it is hoped that a tentative plan of it may be ready for presentation to you for consideration in the near future.

MEETINGS OF THE STATION STAFF

Beginning with October, there have been held regular monthly meetings of the working staff of the Station, for the consideration of general problems concerning the organization and administration of Station work and the promotion of conditions favorable to the highest type of research in the agricultural sciences. Standing committees on Staff Business and on The Station Library have been appointed and are actively at work, promoting facilities in the fields represented by their titles. A special committee has made a study and presented a report concerning possible methods of promoting the research spirit, which report will probably lead to some definitely organized plan for fostering the research spirit and providing additional experience and training in research methods for all of the members of the staff.

PROGRESS OF STATION WORK DURING 1921

A marked departure from the plan of former years has been made in the preparation of the following report of the progress of our Station work during the past year. Formerly, this report consisted only of a review of the bulletins which had been issued during the period covered by the report. Obviously, such a review did not constitute a complete survey of the Station's activities during the year, since many investigations are in progress which do not come to the point of final publication in bulletin form during any given year. It seemed to me desirable that the Director's report for the year should give a fairly complete summary of the work of the Station which was in progress during that period. I have, therefore, asked the chiefs in research to prepare brief statements indicating the progress which has been made during the year on all of the projects which have been under way under their supervision. The following statements, therefore, present a fairly complete, altho necessarily very brief and concise, summary of the Station work during the year 1921.

DIVISION OF AGRONOMY

TOBACCO EXPERIMENTS

Two field plat experiments have been conducted for the past seven years in cooperation with the Bureau of Plant Industry of the United States Department of Agriculture. This work is located in the Baldwinsville section. One of the experiments was originally planned to determine if alfalfa could be grown in this region. Tobacco was included in the rotation because the majority of farmers in this section raise a small acreage of this crop every year.

The other experiment is concerned chiefly with the effects of fertilizers, without farm manure, on the quality of tobacco. It has been demonstrated that alfalfa can be successfully grown in this section where the proper methods are followed.

Fertilizers have had a considerable effect on the quality of cigar filler tobacco grown in this locality. Altho yields of tobacco have not been as large as where liberal applications of farm manure have been used, nevertheless under the best plat treatment both yield and quality have compared rather favorably in spite of the fact that tobacco occupies the land once in four years in the experiment instead of once in five years as is common in this section.

FERTILIZER EXPERIMENTS WITH FRUITS

This work is a continuation of that reported in Bulletin No. 477, June, 1920. The same orchards, namely, two Baldwin apple

orchards, one Spy apple orchard, one cherry orchard, one Kieffer pear orchard, and also one vineyard in Chautauqua county, are still under experiment.

The work this year has in no way conflicted with the conclusions drawn in the above-mentioned bulletin.

SOURCES OF LIMING MATERIALS

For some years past it has been the endeavor to keep in touch with all sources of agricultural liming materials in the State. Bulletin No. 478 gives the most recent list of these sources together with data for calculating the actual cost of material laid down on the farm. It is questionable whether this practice will be continued by the Station since the soils division of the Extension Service of the Cornell Agricultural College is looking after the matter of lime supplies for the farmers of New York.

SOIL FERTILITY EXPERIMENTS

In 1914 and 1915 a series of 104 one-tenth acre plats was laid out on the Station farm at Geneva and placed under systematic fertilizer treatment.

Up to date the work has demonstrated some of the many errors to which field plat work is subject. A critical study of the yields for the past seven years has shown that variations in soil type, composition, and topography among these plats have greatly affected crop yields. In fact, these factors seem to have been more important in affecting yields than have the fertilizer treatments.

If the field plat method is to retain the importance it has had in the past as a method of soil study, greater care will have to be given in laying out such work, so as to insure the greatest possible uniformity in plats and more adequate methods of control.

SOILS OF THE CHAUTAUQUA "GRAPE BELT"

During the years 1911 to 1916 this Station made extensive studies of the chemical composition of the soils of New York. Among the soils studied were 152 samples of soils from the so-called grape belt in Chautauqua county. As this group seemed to be a distinct unit in itself the analyses of these 152 samples has been published as Technical Bulletin No. 85.

The composition of these samples indicates that the majority of grape belt soils are well supplied with nitrogen, potassium, and magnesium, but are low in phosphorus and calcium and very deficient in carbonates.

For many crops, these soils would undoubtedly respond to additions of available phosphorus and to lime. Vineyard and cover crop experiments conducted by the Station on these soils

indicate that farm crop yields are much more likely to be affected by these soil deficiencies than are the yields of commercial vineyards on the same soils.

LYSIMETER INVESTIGATIONS

The Station now has the accumulated data of six to seven years on the twenty lysimeters installed in 1914–15. These lysimeters are furnishing a mass of valuable data on the question of the in-go and out-go of mineral constituents in connection with legume and non-legume crop rotation. The nitrogen problem has been emphasized. The first five years' results will soon be available. Analyses of the drainage water from these tanks have shown that during the first five years, a Volusia soil under a four-year rotation including two years of alfalfa has lost over seven times as much nitrate nitrogen as has the same soil under a rotation in which two years of timothy have replaced the alfalfa. In spite of this greater loss of nitrate from the soil under an alfalfa rotation, this soil has given in the barley crop succeeding alfalfa an increase of 4,370 pounds per acre over barley after timothy. This increase is also reflected in the wheat crop the following year.

Further data are also at hand bearing on the water relations of two soil types; on the potassium, calcium, magnesium, and sulphur relations; as well as other information throwing light on the nutrition of plants under these controlled conditions.

LIMING EXPERIMENTS

Some outdoor cylinder work has been carried on for several years on the response of certain high mineral requiring crops to varying amounts of calcium and magnesium limestone. This work has been on a Volusia soil of high lime requirement.

Up to date the indications are that both forms of limestone in amounts far below the lime requirement of the soil will produce normal yields, especially of alfalfa. In some cases the small applications have given more satisfactory returns than the large ones.

NITROGEN CHANGES IN MANURE

This work has now been in progress for over two years and is conducted in cooperation with the Division of Soil Bacteriology. Some work with preserving agents has been done. In this phase of the work, acid phosphate has been found to be the most efficient agent among those tried which included also peat, straw, soil, gypsum, and rock phosphate, and a combination of these with straw as a litter. Acid phosphate not only held more of the nitrogen which is readily lost, but appeared also to conserve the organic matter in the manure. Such a manure gave the best results in vegetation experiments. Peat also had considerable value as a preservative.

Some work has been done in connection with the nitrogen changes in manure caused by pure and mixed cultures of certain manure organisms.

One of the most interesting phases of the problem is that of the detrimental effect of fresh straw on plants. This is not a new observation, but in the present work some interesting new phases have presented themselves. This phase of the matter is under observation at the present time.

DIVISION OF ANIMAL INDUSTRY

FEEDING EXPERIMENTS WITH POULTRY

Work has been continued on a series of feeding experiments relating to the importance of the coarser vegetable foods and the utilization of waste foods. Feeding trials this year have been limited to those with different amounts of clover or alfalfa for hens. These trials involved the incubation of different lots of eggs.

BREEDING EXPERIMENTS WITH POULTRY

In a study of the effects of selection and inbreeding, a series of breeding experiments has been continued. Besides the keeping of records from mature stock, this work necessitated during the year the rearing of progeny from eighteen separate matings.

STUDY OF SOIL REQUIREMENTS

This study is based chiefly upon the use of soil plats that have been modified by annual applications of chemicals and the growing of various crops to secure a gradual change without disturbance of natural conditions. Chiefly considered in this work have been the relations of plant to soil in regard to the amounts of sulphur and calcium. The crop grown this year was oats. This had been preceded by flax. Because these plats have been under continued observation for many years they will supply data such as perhaps cannot now be obtained elsewhere in regard to certain questions besides those primarily considered.

DIVISION OF BACTERIOLOGY

Members of this division have had problems under investigation during the year touching upon the activities of bacteria in relation to soil fertility and the rotting of manure, and the bacterial flora of dairy utensils, market milk, cheese, and food.

GENERAL PROBLEMS

Technic.— Methods of studying problems in this field are always of importance so that each year sees the development of new

methods of work or improvements on old methods. Thus because of the rapid changes in business introduced by the war an extensive cooperative investigation of biological stains has been organized. On account of the minute size of the bacteria, the bacteriologist has to make use of certain anilin dyes to render them visible when examined under the microscope. The dyes thus used are known as stains. One of the most important uses of stains made in this laboratory is in preparing microscopic mounts for counting the number of bacteria in milk. All the stains formerly came from Germany and, during the war, this laboratory found difficulty in getting satisfactory stains. Others were found to be having similar difficulty, and the matter was brought to the attention of the Committee on Bacteriological Technic of the Society of American Bacteriologists. Cooperative work has been organized, and this institution, together with about thirty other laboratories at various institutions in the country, has been making tests during the past year of the stains most frequently used in bacteriological work. Recently this work has been taken over by the National Research Council in order to put it on a broader basis and to secure the cooperation of all interested biologists. One of the men in this laboratory has been given the responsibility of organizing the work. Altho the work has only just begun the indications are that American manufacturers can supply biologists with the stains they need as soon as biologists are in a position to state their requirements definitely.

Three modifications of bacteriological methods have been found to have sufficiently promising applications to cause them to be described briefly in a technical bulletin (No. 84). One of these has to do with the use of agar slants as a means of detecting the ability of cultures of bacteria to ferment various substances. Another deals with the use of rose bengal as a bacterial stain, while the third discusses the application of the Gram stain to the differentiation of the various types of bacteria found in milk and cheese.

SOIL AND MANURE PROBLEMS

A general study of the soil flora.— This general investigation is one in regard to which information is slowly accumulating from year to year. All the soil bacteriological work in progress is so planned as to contribute to it. The first object was to outline the main groups of soil microörganisms, classifying them in a general way, without trying to recognize individual species; the second object to select the groups apparently most important, as judged by their relative abundance, especially under conditions of particular bacterial activity; and the third object to make a more intensive study of one or two of the groups, both

as to classification and as to physiological activities, including their function in soil.

For the present two groups have been selected for intensive study — the Actinomycetes, and a certain group of non-spore-forming bacteria. In regard to the first of these groups a technical bulletin (No. 83) has just been published entitled, "The Use of Various Culture Media in Characterizing Actinomycetes." It shows the great variation in the appearance of these organisms on different culture media and the difficulty of characterizing them by their appearance unless they are studied on a long series of media of definitely controlled composition. For the present no further work is being done on their classification, but a study is being made as to their significance in cellulose decomposition in the soil and in certain other related phenomena.

The second group of soil organisms mentioned above (the non-spore-forming group) has recently been given special attention because a certain member of it has been found to be an active liberator of ammonia in manure, far surpassing the well-known spore-formers in this respect. The whole group has proved a difficult one to study because with the usual routine bacteriological methods no differences between the different types could be found. New methods have had to be developed, and with them progress is being made toward the classification of this group.

Difficulty has been experienced in studying the activities of fungi and Actinomycetes in soil because their active forms are filaments that are difficult to separate from the soil particles. It has recently been found possible to distinguish these filaments when present in soil by the use of the microscope, and the method promises to be of considerable value in solving certain problems facing the soil bacteriologists.

The decomposition and preservation of manure.— This is a problem being investigated in cooperation with the Division of Agronomy. A preliminary bulletin on the subject is now in course of preparation. The first step in this investigation was to find an organism producing a vigorous volatilization of ammonia from manure which was at last located in one of the non-spore-formers above mentioned. The second step was to use this organism in testing certain preservatives or reputed preservatives (peat, acid phosphate, gypsum, and rock phosphate) as to their ability to hold ammonia in manure. Peat and acid phosphate proved efficient, the other two of slight use or none. The third step was to prepare composts containing manure, with and without straw, and with the different preservatives, and to compare those composts with fresh manure as to their ability to supply nitrogen to crops grown in the greenhouse. Barley and rape have been the test crops used. The work so far completed indicates the

superiority of acid phosphate over any of the other preservatives except peat, and has shown that it is probably more practical than peat except in localities where peat can be dug and dried without transportation any distance. Acid phosphate not only fixes the ammonia chemically, but acts as a partial antiseptic, greatly lessening the rotting of the manure.

Another line opened up by this work, which is now developing into a separate problem, concerns the effect of straw in a manure applied to the field. Fresh straw has a very harmful effect upon crops in the absence of a large amount of nitrogen. This effect may be purely chemical, or bacteriological, or both. Experiments on this point have been carried out which have brought out many interesting indications, altho nothing has yet been definitely established besides what has already been brought out by other investigators.

The effect of one plant on another.— This is a problem under investigation in cooperation with the Division of Horticulture. Certain work of Pickering in England has shown that trees and other plants are harmfully affected by the growth of grass near their roots. Pickering's work pointed to one of two explanations: That the effect is due to a toxin formed by the grass roots, or that there is an influence on the bacterial flora. He favored the former theory without disproving the latter. The present work is planned to test the bacterial theory. At the present time many interesting indications in support of this theory have been obtained, altho it has not yet been shown to be the explanation of the phenomena investigated.

DAIRY PROBLEMS

Market milk problems.— Investigations on methods of sterilizing milking machines have been continued during the year. These have been planned to test the efficiency of certain newly urged chemical sterilizing agents (the chloramines), the effectiveness and limitations of hypochlorite sterilizing solutions, and the effect of heat and cold in keeping down the bacterial contamination of the teat-cups and tubes. A report on this work is in preparation. A bulletin (No. 488) has also been issued during the year that discusses leakage from the vacuum pipe line into the pail as a source of contamination of milk. It is found that where there is condensed moisture in the pipe line, there is danger that a few drops of this material may, during or at the close of each milking, leak back thru most of the check valves now used on milker pulsators. While this contamination does not appear to be large in amount, it may easily be sufficient to prevent the production of milk with an official plate count less than 10,000 per cc.

The cause and amount of the error present in counting bacteria in milk by officially approved methods has been still further studied

during the year and a bulletin issued (Technical Bulletin No. 86). If milk is to be graded upon the number of organisms present and dairymen paid on this basis, in the interest of all concerned it is necessary that the methods of analysis used be such as to give just and fair results. Few persons, other than those who have attempted actually to count the number of bacteria in milk, realize how difficult it is to determine whether the methods of estimating numbers of these very small objects give results that are reasonably correct. If it were a matter of counting objects as large as sheep where it was desired to determine whether the estimates of the number present in a large flock were reasonably correct, it would be possible to check the estimated numbers against an actual count and to determine the error. But in counting bacteria the best that can be done is to compare the estimates of numbers as made in one way with estimates made in a different way. In this way the probable accuracy or lack of accuracy of results can be estimated. Because several promising improvements in these methods of estimating numbers of bacteria in milk have recently been suggested, a member of this laboratory has been asked to act as referee in a more extensive series of tests for the Standing Committee on Standard Methods of the American Public Health Association. While this is a technical matter it is of fundamental importance to the increasing number of dairymen in the State who sell their milk on the basis of the bacterial count.

This division has continued to supervise the milk supply during the year for the City of Geneva, the city authorities having continued to pay the salary of a bacteriologist to do the work. This work has supplied much material of value from the investigational standpoint. Two graduate students from the Department of Dairy Industry at Ithaca have utilized the facilities offered by this work to study the bacterial flora of market milk, and studies are being started at the present time upon the types of bacteria found in milk from farms where milking machines are in use.

Cheese problems.— Because of a feeling that further bacteriological investigations in the field of cheese making might show methods of controlling the manufacture of this valuable dairy product that would aid in restoring the vitality of this industry in New York State, studies in this field were resumed by this division in 1919. There seems to be no adequate reason for the importation of one-fifth of the cheese consumed in the United States in 1920. Neither does there seem to be any real reason why this State cannot produce sufficient milk to supply both the market milk and the cheese and other dairy industries of the State. Studies have been completed during the year upon the types of bacteria found in miscellaneous samples of cheddar cheese of all grades as purchased on the public market. Comparing the results

obtained from these samples with those secured by previous investigators at this and other laboratories, it appears that certain types of bacteria are more or less characteristic of poor quality cheese.

In these floral studies methods of preparing thin slices of cheese for examination under the microscope have been so modified as to make it possible to estimate the number of bacteria present, thereby allowing the investigator to form an idea of their relative abundance in the substance of the cheese. This work has been discussed in Technical Bulletin No. 87, under the heading, "The Microscopic Study of Bacteria in Cheese."

One group of bacteria, the micrococci, found commonly in cheese has been selected for further study in their relation to this group of bacteria as a whole, and a large number of cultures from a great variety of sources have been obtained and are being studied in their relation to similar bacteria isolated from cheese.

During the year the work referred to in the 1920 report has appeared as a bulletin (No. 486) under the title, "The Relation of the Number of Bacteria in Milk to the Quality and Yield of Cheese."

FOOD CONTROL PROBLEMS

Tomato products investigations.— In 1920, a request was made that this division undertake an investigation of the accuracy of the results secured in the microscopic examination of manufactured tomato products. In the present control work maintained in the enforcement of the national pure food law quantitative determinations are made of the mold hyphæ, yeasts, spores, and bacteria present in catsup, tomato pulp, and like products. The methods used in making these examinations are similar to the microscopic methods for counting bacteria in milk, and the counts obtained are open to the same question regarding their accuracy as are those obtained from milk. Funds having been supplied for the work thru the National Reserch Council, a special investigation of this matter has been made during the seasons of 1920 and 1921. While the report on the work is not yet ready, enough has been done to show that whereas the quantitative determinations of the larger objects like mold hyphæ, yeasts, and spores can be made with reasonable accuracy, it does not appear possible to make determinations of the number of bacteria present that are more than very rough estimates. The cause of the errors in counts have also been determined with greater definiteness than has been done previously.

DIVISION OF BIOCHEMISTRY

The work in the Biochemical Laboratory during the past year has been devoted to the two principal projects mentioned below:

ANALYSIS AND COMPOSITION OF CORN POLLEN

A study of the composition of corn pollen was begun, but the results so far are only of a preliminary character. It was proposed to secure some information regarding (1) the approximate composition, (2) the inorganic constituents of the ash, and (3) the nature of the principal organic compounds contained in the pollen grain.

The approximate composition of the pollen of three varieties of corn was determined. The results indicate that different varieties of corn produce pollen which varies greatly in composition. The greatest variation was found in the starch and sucrose content, but there was less variation in the percentage of nitrogen.

A complete analysis of the ash of pollen from one variety of corn was made. It was very rich in phosphorus and potassium, and of the other elements magnesium was quantitatively the most important. Silica, sulfur, chlorine, calcium, sodium, iron, and aluminum were present in smaller amount.

One amorphous and one crystalline phosphatide were isolated. Considerable amounts of free inosite, choline, and l-proline were also isolated from alcoholic extracts of pollen.

METABOLISM AND RESPIRATORY EXCHANGE OF POULTRY DURING VITAMINE STARVATION

The greater part of the time during the past year was devoted to a study of the above-named problem. These studies included observations upon normal hens during the period of maximum egg production followed by a condition of vitamine starvation induced by feeding polished rice.

The first noticeable effect on the animals in vitamine starvation is a loss of appetite and the food consumption falls to a low level. There is a continuous loss in weight and the egg production ceases immediately. In from six to eight weeks active symptoms of polyneurites appear, resulting finally in more or less complete paralysis.

When normal birds are first placed on a diet of polished rice a large amount of it is consumed daily. The metabolism is very high and the respiratory quotient approaches unity but it may vary from 0.95 to 1.35. After a few days on the rice diet the metabolism begins to fall and gradually reaches a very low level.

The fall in the intensity of the metabolism is coincident with the decrease in food consumption. It is due, however, to some factors outside of mere consumption of food because if the animal is fed forcibly the utilization of such food is much delayed and the crop and gizzard may contain undigested rice for over a week. In vitamine starvation the animal is therefore unable to utilize

in the normal manner a diet consisting of carbohydrate. During this condition the respiratory quotient may approach unity during the digestion of rice but the heat production as determined by the consumption of oxygen has fallen in some cases to 40 per cent below that of the normal basal metabolism.

With the outset of polyneuritis there is a practical cessation of the processes of digestion and assimilation. Altho the crop may contain much undigested rice, the respiratory quotient seldom rises much above the value for fat. The heat production may fall more than 50 per cent below that in normal basal metabolism.

The lack of vitamine "B" in the diet causes a serious impairment of the digestive functions which, unless relieved by the administration of this vitamine, results in polyneuritis and death. The condition, if it has not progressed too far, may be quickly relieved by giving an extract from yeast. After an animal has been cured of polyneuritis by the administration of yeast extract the metabolism rapidly rises again, but the animal gains very slowly in weight and the appetite remains poor for a long time.

DIVISION OF BOTANY

POTATO EXPERIMENTS

Further studies on the effect of missing hills in potato fields and on the variation in the yield of potato plants from halves of the same seed tuber.— This is the title of Bulletin No. 489 which gives a full account of experiments made in 1919 in continuation of the work reported in Bulletin No. 459. The results obtained confirm those previously reported in showing that, for a spacing of 36 by 15 inches, approximately one-half of the loss due to a single-hill skip is made up by an increase in the yield of the two plants adjoining the vacant space.

In an attempt to determine the relative influence of single-hill and triple-hill skips in increasing the yield of adjoining plants, the results obtained indicate that the difference is very small.

Plants from similar halves of the same seed tuber often differ widely in yield without apparent cause. This shows that some important factors in potato culture are either unknown or not estimated at their proper value. It shows, too, that great caution should be exercised in drawing conclusions from the comparative yields of a small number of potato plants; also, that the improvement of potatoes by hill selection cannot be carried to a high degree of perfection.

The "probable error," usually considered a reliable test of the statistical significance of mathematical results in which chance is a factor, has proved misleading in one instance in which it was used in this work.

Potato seed experiments: Whole small tubers vs. pieces of large tubers of the same plant.— The object sought in these experiments was to determine the relative vigor and productivity of plants from large and small tubers of the same plant. Rows planted with whole small tubers alternated with rows planted with pieces of the same average weight cut from large tubers of the same plant. Our first experiment of this kind was conducted in 1906. Owing to a peculiar combination of circumstances a favorable opportunity for repeating the experiment did not occur until the season of 1920. It was then repeated very successfully. The results are interesting, but it is unnecessary to discuss them here because a bulletin containing a full account of the experiments is now in press.

The "running out" of potatoes on Long Island.— Long Island potato growers have found it necessary to change their seed frequently because of the rapid deterioration of potatoes grown continuously in that region. Large quantities of northern-grown seed are used. The investigation of spindling-sprout disease made by the Station in 1914 (see Bulletin No. 399) showed the desirability of having a clearer understanding of the relation of that disease to the "running out" of potatoes. Accordingly, it was planned to conduct some experiments which were designed to throw light upon this subject. The plan adopted required the making of cooperative field experiments on Long Island and in northern potato growing sections, and since much of the seed used on Long Island is grown in Maine, the cooperation of the Maine Station was sought and obtained. It was expected that the investigation, which was begun in 1915, would require several years for its completion; but, at the beginning, it was not realized that leafroll and mosaic might seriously interfere with carrying out the experiments successfully. At that time, the infectious nature of leafroll and mosaic were unknown. These two diseases have affected the experiments injuriously. While the objects sought have been only partially attained, it is now thought advisable to close the investigation and publish the results in a bulletin to be issued in the near future.

Control of leafroll and mosaic in the potato seed plat.— During the past two seasons a potato seed plat has been maintained on the Station farm for two purposes: (1) To secure healthy seed for use in potato experiments conducted by the Station, and (2) to determine whether leafroll and mosaic can be controlled by isolating the seed plat and roguing it thoroly.

In connection with this work an attempt has been made to secure small quantities of seed potatoes free from mosaic and leafroll by using the tuber-index method devised by Dr. F. M. Blodgett of the New York State College of Agriculture. Some important

results have been obtained, but they cannot be announced until further studies have been made.

The spread of potato leafroll to adjoining healthy plants.—An excellent opportunity having been presented for securing desired information on this subject, a field experiment was conducted on the Station grounds in the season of 1921. The results will be announced as soon as they can be prepared for publication.

Dusting vs. spraying of potatoes.— The Botanical Division is co-operating with the Entomological Division in conducting experiments which are designed to show the relative efficiency of dust and liquid sprays in the control of diseases and insects which attack potato foliage.

WINTER INJURY OF APPLE TREES

Six years ago a small orchard of Ben Davis apple trees was planted on the Station grounds for use in experiments designed to determine the conditions which induce winter injury. Among other things the effect of heavy applications of stable manure is being tested. While interesting results may be expected at any time now, it is likely to be several years before this study will be completed.

BLISTER CANKER OF APPLE

An investigation of apple canker carried on for several years past has been completed and the results published in Bulletin No. 485. The original object of this investigation was to determine whether the fungus *Nummularia discreta,* which is associated with the disease, is really the cause of it or merely a saprophyte. It was proved conclusively that the fungus is parasitic and the cause of the disease. Many other things were learned about the disease, including means by which its ravages may be lessened materially, but no thoroly satisfactory method of control was discovered. A coat of shellac followed by coal tar was found to be the most satisfactory dressing for pruning wounds.

BEAN STUDIES

An attempt is being made to determine the relation of the time of planting beans to the severity of attack by bacterial blight; also, to produce, by crossing, strains of beans resistant to bacterial blight. Another trouble under investigation is the hardness of beans. This is of two distinct types — hardening of the interior, to which the name sclerema is given, and hardening of the seed coat which we may call hardshell. The former results from enzymatic changes produced by storing the seed in a damp atmosphere and at a high temperature in the absence of ventilation. The latter is a physical condition produced by storing seed in an artificially heated room with a relatively low humidity. Beans ripened

in hot, dry weather also acquire this condition in the field. Both kinds of hardness injure the beans for planting and for cooking purposes. This investigation is incomplete, but a preliminary report on it has been published on page 60 of the Proceedings of the Twelfth and Thirteenth Annual Meetings of the Association of Official Seed Analysts of North America.

ASTER DISEASES

A destructive new leaf blight and some other diseases of China asters are being studied. The fungus causing leaf blight, being new to science, has been given the name *Septoria callistephi* Gloyer.[1] Experiments on the control of leaf blight by spraying and seed treatment are in progress.

SEED TESTING AND SEED STUDIES

During the year ended June 30, 1921, the seed analyst and his assistant tested 1,874 samples of seed. Of these, 1,469 samples were tested at the request of farmers and seed dealers, 392 for the State Department of Agriculture in connection with the enforcement of the seed law, and 13 for the Association of Official Seed Analysts in connection with referee work. Some of the samples were tested for purity, some for germination, and some for both purity and germination, the total number of tests made being 2,387.

A rather extensive study has been made, also, of the quality of lawn grass seed mixtures sold in the State. A bulletin on this subject is in preparation.

Much of this seed testing is routine work, but some research is carried on in connection with it. As time would permit, further study has been made of the parasitic fungi carried on seeds, of the methods of testing vegetable seeds, and of the comparative behavior of the "hard seeds" of legumes in the germination chamber and in the field.

During the past year the seed analyst has served as chairman of the Committee on Research and Methods of the Association of Official Seed Analysts of North America and, as such, has had general direction of certain research activities of the Association. Cooperative studies have been made on "hard seeds" of legumes, on detecting the origin of seed, on the number of seeds per unit weight, and on methods of seed testing in general. Our seed analyst has also had the task of preparing the Association's referee samples, consisting of 40 sets of 11 samples each, and, later, of tabulating the results of tests made on them by analysts in various laboratories thruout the United States and Canada.

In the seed work an attempt has been made to cooperate with all agencies whose aim it is to bring about the use of better grades

[1] *Phytopathology* 11, *50. 1921.*

of seed in New York State. It is believed that the seed laboratory renders a valuable public service.

DIVISION OF CHEMISTRY

PROPERTIES OF CASEIN

As casein is the constituent of milk which makes possible the manufacture of cheese, performing certain fundamental, important functions, both mechanical and chemical, it is necessary to learn all that is possible about the properties of casein before we can hope to understand fully its detailed relations to cheese-making and cheese-ripening. Our attention has thus far been directed to a study of the compounds formed by casein under those conditions prevailing in the manufacture and ripening of cheese. The work thus far has resulted in establishing some important fundamental facts but is still incomplete. It is expected that the work will be sufficiently advanced to justify the publication of results in the near future.

INSPECTION OF COMMERCIAL FERTILIZERS, 1921

The total number of samples of commercial fertilizers analyzed was 738, the largest since 1915. The number of samples in each class was as follows: 382 samples of complete fertilizers; 118 samples containing nitrogen and phosphoric acid; 54 samples containing phosphoric acid and potash; 68 samples of acid phosphate; 25 samples of nitrate of soda; 34 samples of bone; 11 samples of tankage; 3 samples of potash salts; 26 samples of dried animal manures; 13 samples of lime compounds; and 4 samples of miscellaneous materials.

INSPECTION OF FEEDING STUFFS, 1920

The total number of samples of feeding stuffs analyzed was 871, distributed as follows: 13 samples of alfalfa meals; 53 samples of animal products; 7 samples of buckwheat by-products; 21 samples of calf meal and pig meal; 5 samples of cocoanut meals; 201 samples of compounded feeds; 107 samples of compounded feeds containing molasses; 24 samples of corn gluten feeds and meals; 17 samples of corn meal and corn feed meal; 5 samples of corn, oats, and oat by-products; 42 samples of cottonseed feeds and meals; 5 samples of dried beet pulp; 30 samples of hominy feeds and meals; 24 samples of linseed meals; 20 samples of miscellaneous materials; 5 samples of oats and oat by-products; 114 samples of poultry feeds; 7 samples of rye products; 8 samples of wheat and rye products; 50 samples of wheat bran; 27 samples of wheat bran and middlings; 2 samples of wheat bran and low grade wheat flour; 9 samples of wheat bran, wheat middlings, and low grade flour; 64 samples of wheat middlings; and 9 samples

of wheat middlings and low-grade flour. The results of the analyses are discussed in Bulletin No. 482.

DIVISION OF DAIRYING

TESTING GLASSWARE

The total number of Babcock test bottles examined and marked under the law requiring such glassware to be tested was 39,977 from December 1, 1920, to December 1, 1921. The amount of each type of glassware with the total number of rejections is given below.

BABCOCK GLASSWARE TESTED FROM DECEMBER 1, 1920, TO DECEMBER 1, 1921

Milk bottles		
8 per cent	14,168	
10 per cent	9,671	
6 per cent	6	
		23,845
Cream bottles		
9-gram, 6-inch, 60 per cent	72	
9-gram, 6-inch, 50 per cent	3,493	
9-gram, 6-inch, 40 per cent	120	
9-gram, 6-inch, 30 per cent	305	
9-gram, 9-inch, 50 per cent	1,018	
9-gram, 9-inch, 30 per cent	74	
18-gram, 6-inch, 60 per cent	72	
18-gram, 6-inch, 50 per cent	1,220	
18-gram, 6-inch, 40 per cent	270	
18-gram, 6-inch, 30 per cent	631	
18-gram, 9-inch, 55 per cent	276	
18-gram, 9-inch, 50 per cent	482	
18-gram, 9-inch, 40 per cent	168	
18-gram, 9-inch, 30 per cent	803	
		9,004
Pipettes		
17.6 cc.	4,630	
18 cc.	261	
9 cc.	584	
8.8 cc.	60	
17.6 and 18 cc. combined	97	
Up-to-date 17.6 cc.	104	
Russian 17.6 cc.	21	
Miscellaneous	95	
		5,852
Skim milk bottles		383
Acid measures		575
		39,659
Rejected glassware		318
Total		39,977

The above table shows that a large variety of Babcock test bottles are in use in the State and suggests the advisability of limiting the types to those that are most desirable.

COOPERATION WITH OTHER DIVISIONS

The Dairy Division has continued its former policy of using the dairy herd for the needs of other divisions. The Division of Bacteriology has continued its study of the production of clean milk with the milking machine and has used some of the milk for the manufacture of cheese to be used for experimental bacteriological work. The Chemical Division has prepared pure casein from the milk for experimental work with casein.

DIVISION OF ENTOMOLOGY

CONTROL OF PEAR THRIPS

This insect is one of the most destructive pear pests in New York, but has been injurious mainly in the Hudson River Valley. The pest presents a difficult problem because of the nature and suddenness of its attacks. The period for effective treatment is restricted to a very brief interval when the buds are breaking and until they are opened at the tips. The physical features of the locations of the orchards, such as the direction and elevation of the slopes of land, proximity to the Hudson River, and character of the soil, have a marked influence on the development of the buds. The time for effective spraying, therefore, often varies with different plantings. Because of the difficulties encountered, many orchardists are taken unawares and fail to secure the degree of control proportionate to their expenditures for labor and materials.

In Bulletin No. 484 attention is directed to a number of experiments which have demonstrated that the pear thrips can be effectively controlled by spraying. The critical period for successful treatment begins with the emergence of the adults and continues until the buds open.

Several applications may be advantageously employed; *viz.*, one or two when the adults first appear, a third when the blossoms are in the cluster-bud stage, and a fourth against the larvæ when the petals are falling. Miscible oil or whale-oil soap in combination with nicotine sulfate have given the best results in recent years when applied with a spray outfit capable of maintaining a pressure of from 200 to 300 pounds.

CONTROL OF APPLE APHIDS WITH DELAYED DORMANT SPRAY

Bulletin No. 487 describes experiments and observations made in continuation of previous work of this Station on the life history and habits of rosy and green apple aphids, and on the improvement of control measures. The data corroborate the results of earlier experiments showing that the rosy aphis can be effectively controlled by a thoro application of the delayed dormant spray

made when the leaves have protruded from one-fourth to one-half inch.

In substantiation of previous efforts, the green aphis was only partially controlled by the delayed dormant spray, as the winged migrants reinfested the trees during the summer, altho this mid-summer infestation was not generally sufficient to cause appreciable staining of the fruit.

The mixture which has proved most efficient, safe, and economical is composed of 2½ gallons of lime-sulfur, ¾ pint nicotine sulfate, and water to make 100 gallons. If 11 gallons of lime-sulfur are used per 100 gallons of the mixture, the spray will also control San Jose scale, while both mixtures assist in checking apple scab.

Besides selecting a spray mixture that is toxic to the insect, it is noted that other important factors to be considered in the control of aphids are thoro pruning, proper time of application of the spray, and thoro spraying.

Thoroness of application can be accomplished by the nozzlemen operating from the ground and spraying each tree systematically, using a properly adjusted spray-gun attached to a 50-foot lead of hose which delivers the liquid under a pressure of not less than 200 pounds. Detailed directions are given for the system of spraying followed by the Station in its experimental work. The object of this system is to direct the spray toward each bud from several angles and at the same time to keep the operator and team as free as possible from the spraying mixture.

CONTROL OF APPLE RED BUGS BY DUSTING

Bulletin No. 490 deals with experiments with spraying mixtures and certain insecticidal materials in powdered form which had as their object the determination of the value of dusting in protecting apple orchards from injuries by red bugs. This study represents one of a number of projects under investigation by this Station which seek to obtain information relative to the susceptibility of common sucking insects such as aphids, scales, capsids, etc., to powdered substances; the influence of the chemical and physical properties of the materials used on the effectiveness of the substances as insecticides; and the effects of temperature and moisture on the toxicity of dusting mixtures. On account of their size, habits, and availability, red bugs lend themselves readily to an investigation of this sort, and this investigation was the first of the various projects under way to yield definite data.

In the experiments described, dusting and spraying mixtures containing nicotine sulfate were toxic to the apple red bugs, the nymphs and adults of both species proving very sensitive to treatment. Dusting mixtures containing 0.25, 0.50, 1.00, and 2.00 per cent nicotine displayed marked insecticidal properties.

In the treatment of 20-year-old trees, the dusting mixture applied at the rate of 5 pounds per tree was more effective than a 2-pound dosage per tree. As demonstrated with spraying mixtures, the results showed very conclusively that the amount of protection secured by the treatment depends to a large extent on the degree of thoroness of application.

Ordinary temperatures for the season, freedom of foliage from moisture, or wetting of leaves by dews or showers apparently exerted no appreciable influence on the effectiveness of dusting materials.

Effective dusting mixtures against red bugs require a larger nicotine content than spraying mixtures and, while there is great economy in time and labor by this method, the high dosage makes the expense of treatment per tree noticeably higher than that of spraying.

In view of the data available, it is concluded that apple red bugs may be effectively controlled by dusting, and concise directions are given to guide orchardists who desire to combat the insects by the new system of treatment. It is noted that dusting of apple orchards for sucking insects is in its first stage. Future efforts will doubtless reveal the desirability of modifications in present field practices as well as in the selection and compounding of materials.

STUDIES ON PEACH INSECTS

The chief object of this project is to ascertain the safeness and effectiveness of para-dichlorobenzene for the control of the peach borer. The deforming of young peach fruits by capsids as an investigational problem came to our attention during 1917 in connection with preliminary studies with the peach borer. Our studies have revealed the interesting fact that at least three species of plant bugs, breeding on hickory and oak, are the causal agents of serious deformities of peach fruits.

STUDIES ON CABBAGE INSECTS

In experiments with the cabbage maggot efforts are largely directed to the control of the pest by corrosive sublimate. The chemical is apparently destructive to the eggs and young larvæ of the species and, at standard dilutions, has proved quite safe to plants with a well established root system. The cabbage aphis and the imported cabbage worm are receiving attention with respect to their susceptibility to dusting mixtures.

STUDIES ON PEAR INSECTS

Life cycles of various species with reference to the period of occurrence of damage are under observation and characteristic injuries to fruits are being described and illustrated. Special attention is also being given to the psylla, thrips, and the sinuate

borer to develop economical and effective means of control. The investigation of the sinuate borer is practically concluded and the results of the investigation are being prepared for publication.

STUDIES ON POTATO INSECTS

In cooperation with the Division of Botany, these efforts seek primarily to determine the susceptibility of such species as leafhopper and aphis to dusting mixtures.

STUDIES ON GRAPE INSECTS

The object sought in these studies is to determine the comparative merits of dusting and spraying in controlling the grape root-worm and leafhopper. One experiment with para-dichlorobenzene is under way to ascertain its effect on grape vines and its usefulness against the grape root-worm.

STUDIES ON SAN JOSE SCALE

This investigation has been under way for several years. The number of broods proves to be smaller than determined for the latitude of Washington, D. C. There is a high rate of mortality among larvæ produced after the middle of September. The superiority of sulfur sprays for this area is due, in part, to a prolonged insecticidal action as compared with other materials.

SPIDER MITES ON FRUIT TREES

Injuries by mites are important, especially on bush and tree fruits in the Hudson River Valley. In this study effort is being made to determine species, distribution, and methods of control.

DIVISION OF HORTICULTURE

TESTS OF FRUIT VARIETIES

The Horticultural Division is continuing the work of testing all varieties of tree, bush, vine, and runner fruits that will grow in this climate. These tests have been carried on for more than 30 years, during which time about 10,000 varieties of fruit have been grown on the Station grounds. An attempt is made to test every variety of fruit offered by American nurserymen. Many varieties are imported from foreign countries. The results have been set forth in the fruit books published by the Station. Books on apples, grapes, plums, cherries, and peaches have been published. A volume on the pear is now in the press, and work for a monograph on small fruits is under way. Results have also been published in the series of bulletins called New and Noteworthy Fruits, five of which have appeared. Reports have also been made from year to year at various horticultural meetings.

BREEDING EXPERIMENTS

Under the assumption that there can be no great progress in horticulture without new varieties, the Horticultural Division is attempting to originate varieties of all the fruits that will grow in this climate. While the chief object is to produce desirable varieties, that of ascertaining how the characters of different fruits are inherited is almost if not quite as important an object in these experiments. This work has been going on since the beginning of the Station, during which time approximately 30,000 seedlings of the various fruits have been grown. Up to date about 40 new varieties of different fruits have been produced, several of which have become standard sorts in the horticulture of the State and Country. These new varieties are introduced thru the New York State Fruit Testing Cooperative Association, Inc., Geneva, N. Y., and cannot be obtained from the Station. Besides the work with fruits, breeding experiments are being carried on in the greenhouse with cucumbers, muskmelons, and roses.

FERTILIZER EXPERIMENTS WITH FRUITS

In 1896 an experiment was begun in an orchard of Rome Beauty apples to test fertilizers for apple orchards. Previous to this time a test of fertilizers for orchards had been carried on for 12 years with negative results. With the feeling that the first experiment had not been well planned, the new experiment was much more comprehensive. Two reports of this experiment with Rome Beauty apples have been published showing that the results of applications of nitrogen, phosphorus, and potash were practically negative in the Station orchards. The last report was published in 1919. Results in 1920 and 1921 but emphasize the findings set forth in the two reports previously published. Fertilizer experiments with apples and pears are being carried on in four localities in the State in cooperation with the Agronomy Division.

Experiments are also being carried on with fertilizers for grapes in vineyards leased by the Station at Fredonia and Urbana. Work with grapes at Fredonia began in 1909. Two reports have been published on the results obtained at the Fredonia Station, the first appearing in 1914 and the second in 1919. No report has yet been made of the experiments in the Urbana vineyards. The tests, however, in both vineyards show that nitrogen, phosphorus, and potash have had a beneficial effect on wood growth, yield, and quality of fruit. Of the three elements, nitrogen has been most helpful. The experiments in both vineyards suggest that applications of nitrogen is all that is needed in most vineyards.

PRUNING EXPERIMENTS

Pruning experiments are being carried on by this Division with all tree-fruits and with the grape. Orchards of tree-fruits were set in the spring of 1912 to test various methods of pruning.

Unfortunately, two severe winters ruined the peach plantation so that the experiments with this fruit have been discarded. Blight and unfavorable environment destroyed so many of the quince plants in the experiment that this fruit is no longer under test. Unfavorable environment and the cold winters vitiated the tests with the cherries, and it is now doubtful whether the results of this fruit will be worth consideration. The pruning tests with the apple, pear, and plum, however, are satisfactory in all respects, and progress is being made in the experiments with these fruits. Three distinct phases of pruning are under study: Testing the value of little and much pruning; determining the effectiveness of summer pruning as compared with winter pruning; and ascertaining the merits of high- and low-headed trees.

At Fredonia and Urbana pruning experiments are under way with the grape. Bulletin No. 464, published in 1919, gives the results of the work with grapes at Fredonia where seven methods of pruning were under test. It was found from these tests that the various Kniffen systems were best. This work is being continued.

PROPAGATION EXPERIMENTS

Three experiments are being carried on to test methods of propogating apples. One is a comparison of budded and grafted trees, the especial objects of which are to find out whether budded or grafted trees come in bearing first, and which makes the better tree eventually. The second is an experiment in top-working apples. Several standard varieties of apples have been top-worked on young Northern Spy trees. The purpose of the experiment is to find out whether such sorts as Tompkins King and Twenty Ounce, whose trunks are very susceptible to a trouble known as collar-rot, will not make better trees on Northern Spy stocks. Incidentally, it is desired to learn from this experiment whether the season of ripening and the color, quality, and markings of fruits vary when the varieties are top-worked on Northern Spy stock. These experiments were begun in 1912. A report as to the value of the Northern Spy stock with the several varieties will soon be forthcoming. A third propagation experiment has for its purposes the study of variation and the hereditability of variations in fruit trees. In this experiment buds have been taken from the most productive and from the least productive trees in a Rome Beauty orchard. The buds were worked on Northern Spy rooted cuttings set in the orchard in the spring of 1912. This experiment ought to throw light on the value of the so-called pedigreed apple trees.

A STUDY OF STRAINS OF BALDWIN APPLE

In the spring of 1911, 84 Baldwin apple trees were purchased from 40 different locations in the United States for the purpose of

ascertaining whether there are distinct strains of Baldwin, and if so, what the value of the several strains may be. These trees were set on a neighboring farm, and while they have not had the best of care, yet the experiment promises to serve eventually the purposes for which the test is being made.

STOCK EXPERIMENTS

Experiments with three tree-fruits are being carried on to determine the value of different stocks. Rather extensive experiments with the apple ran for ten years in three orchards in three different localities of the State, which showed that apples in commercial orchards are best grown in this State on standard rather than on any of the dwarfing stocks. In 1912, six stocks of plums were used for ten varieties of six trees each of the different plums most commonly grown in this State. The stocks used were St. Julien, Mariana, Myrobalan, peach, and *Prunus americana*. It now seems certain that the Myrobalan stock is the best for all varieties under test. The intention is to report on the experiment during the coming year.

A test of the value of Mazzard and Mahaleb stocks for sour cherries is also under way. The cherry plantation has suffered much from two cold winters and from unfavorable environment so that it may turn out that this experiment cannot be considered worth reporting, but there are many indications as to the behavior of the various varieties on the two stocks that will be valuable for certain varieties if not for all of those under test. In these stock experiments several criteria are used to judge the value of stock, as length of life of the trees, period and amount of fruiting, size and vigor of trees, and winter injury due to differences in time of maturity.

ASEXUAL INHERITANCE IN THE VIOLET

In 1914 an experiment was begun in the Station greenhouse to determine the effect of selection upon the length of blossom stem. Selections have been carried on each season in two directions — one for short stems and the other for long stems. Records are made of the blooms of each plant and at the end of the season cuttings are taken from the selected plants and propagated for the following crop. This experiment is expected to throw light on the heritable characters in other plants propagated vegetatively, as are all fruits. A report of this experiment was published in 1920 which shows that there are differences. Up until the time of publication, this experiment had only proved, however, that there existed differences which it seems may have existed before the experiment was begun. This experiment is to be continued indefinitely.

EFFECT OF ONE CROP UPON ANOTHER

This Division is cooperating with the Division of Bacteriology to determine the effect of one crop upon another. It has been dem-

onstrated by several experimenters that grass has a deleterious effect upon the apple tree. It is almost certain that all plants have favorable or unfavorable influences upon other plants when grown in close contact. It is the object in this experiment to ascertain whether the evidence favors the theory that these good or bad influences are due to toxins or to bacteria. It has been found that nitrogen helps to overcome the harmful effect of grass in an apple orchard. In this experiment, the reason for this influence of nitrogen is also sought. The experiment is but begun and results may not be obtained for several seasons.

GERMINATION OF SEED OF HARDY FRUITS

An experiment is being carried on in this Division to study normal and abnormal germination of the seeds of hardy fruits. Nurserymen and plant-breeders have great difficulty in obtaining a good stand of plants from seeds of some fruits. The purpose of this experiment is to ascertain if by stratification in various ways, or by other treatment, a better stand of plants cannot be obtained from seeds of the several fruits.

A STUDY OF SEX IN GRAPES

Dr. A. B. Stout, Director of the Laboratories of the New York Botanical Garden, is making a study in the vineyards of this Station of sex in the grape with reference to fruit development. These studies promise much from the standpoint of the botanist and scientist, and will throw light helpful to the grape-grower on the subject of sterility and fertility in cultivated varieties of grapes. The studies are also concerned with the quality and productiveness of seeded varieties, and the development of seedless or partially seedless varieties. From Dr. Stout's work it is certain that breeders of grapes must determine as fully as possible how the development of the desirable distribution of the sexes in the flowers may be regulated and controlled by breeding and by the selection of parentage. Results of work done in 1920 were published in Technical Bulletin No. 82 in January, 1921.

PUBLICATIONS ISSUED DURING 1921

The "Pears of New York," the publication of which was authorized by the Legislature of 1919, is now in the printer's hands and will be ready for distribution early in the coming year.

The mailing list, on the basis of which the Station publications for 1921 were issued, is as follows:

POPULAR BULLETINS

Residents of New York	35,551
Residents of other states	2,461
Newspapers	744

Experiment stations and their staffs	2,361
Miscellaneous	1,069
Total	42,186

COMPLETE BULLETINS

Experiment stations and their staffs	2,361
Libraries	333
Foreign list	480
Individuals	4,073
Miscellaneous	684
Total	7,931

A plan for classifying these mailing lists into subject-matter groups, which will insure that each person receives only those bulletins dealing with subjects in which he is interested, has been adopted, and the mailing lists will be completely revised on this basis early in the coming year.

The following bulletins were issued during the year 1921:

TECHNICAL BULLETINS

No. 81. January. An investigation of the seed of the silver maple (*Acer saccharinum*). I. Analysis and composition of maple seed. II. Occurrence of inosite hexaphosphoric acid in maple seed. III. Acerin, the principal globulin in maple seed. R. J. Anderson and W. L. Kulp. Pages 20. Distributed November 30, 1921.

No. 82. January. Types of flowers and intersexes in grapes with reference to fruit development. A. B. Stout. Pages 16, Pls. 7. Distributed June 1, 1921.

No. 83. April. The use of various culture media in characterizing Actinomycetes. H. J. Conn. Pages 26. Distributed November 30, 1921.

No. 84. July. The use of agar slants in detecting fermentation. H. J. Conn and G. J. Hucker. Rose Bengal as a general bacterial stain. H. J. Conn. A modification and new application of the Gram stain. G. J. Hucker. Pages 9. Distributed November 30, 1921.

No. 85. August. Composition of some soils from the Chautauqua County grape belt. R. C. Collison. Pages 15, Map 1. Distributed November 30, 1921.

No. 86. September. The relation between bacterial counts from milk as obtained by microscopic and plate methods. A. H. Robertson. Pages 21, Charts 9. Distributed June, 1922.

No. 87. October. The microscopic study of bacteria in cheese. G. J. Hucker. Pages 11, Pl. 1. Distributed November 30, 1921.

COMPLETE AND POPULAR BULLETINS

No. 484. January. The control of the pear thrips. C. R. Phipps. Pages 11, Pls. 5, Figs. 2. Distributed March 15, 1921.

No. 485. January. Blister canker of apple and its control. W. O. Gloyer. Pages 71, Pls. 15, Figs. 8. Distributed May 2, 1921.
Popular edition. Pages 12, Pls. 7.

No. 486. January. The relation of the number of bacteria in milk to the quality and yield of cheese. G. J. Hucker. Pages 19, Charts 8. Distributed June 1, 1921.

No. 487. April. Plant lice injurious to apple orchards: III. The delayed dormant spray for the control of rosy and green apple aphids. F. Z. Hartzell and L. F. Strickland. Pages 41, Pls. 4, Fig. 1. Distributed November 28, 1921.
Popular edition. Pages 8, Fig. 1.

No. 488. August. Milking machines: VI. Leakage from the vacuum pipe line into the pail as a source of contamination of milk. R. S. Breed and J. W. Bright. Pages 19, Figs. 9. Distributed June, 1922.
Popular edition. Pages 8, Figs. 8.

No. 489. October. Further studies on the effect of missing hills in potato fields and on the variation in the yield of potato plants from halves of the same seed tuber. F. C. Stewart. Pages 52, Charts 4. Distributed June, 1922.

No. 490. November. Control of apple red bugs by dusting. P. J. Parrott, Hugh Glasgow, and G. F. MacLeod. Pages 30, Pls. 5. Distributed January 12, 1922.
Popular edition. Pages 8, Pl. 1.

Fortieth Annual Report with Director's report for 1921. R. W. Thatcher. Pages 40. Distributed March, 1922.

In addition to the bulletins listed above, the following papers reporting results of investigations at this Station were approved for publication in various scientific journals during the year:

Methods of caring for milking machine tubes, by R. S. Breed. *Jour. Dairy Science.* (In preparation.)

The accuracy of bacterial counts from milk samples, by R. S. Breed and W. A. Stocking. *Jour. Dairy Science* **4**, *39–72, 1921.*

Bacteriological aspects of cheese ripening, by G. J. Hucker. *Abs. Bact.* **5**, *287–303. 1921.*

The use of domestic methylene blue in staining milk by the Breed method, by W. A. Wall and A. H. Robertson. *Jour. Bact.* (In preparation.)

Control of sucking insects with dust mixtures, by P. J. Parrott. *Jour. Econ. Ent.* **14**, *206–214, 1921.*

Potato insects, by C. R. Phipps. *Rpt. N. Y. Dept. Farms and Markets.*

Plum insects, by C. R. Phipps. *Rpt. N. Y. Dept. Farms and Markets.*

The season's experience with insects and insecticides, by P. J. Parrott. *Proc. 66th Ann. Meeting, N. Y. Hort. Soc., 17, 1921.*

The nature and cause of the water sprout encountered in germination testing, by M. T. Munn. *Proc. Assn. Official Seed Anal.* **1921**, *54.*

A study of the variations occurring in seed tests and its relation to the application of the tolerance formula, by Elizabeth F. Hopkins and M. T. Munn. *Proc. Assn. Official Seed Anal.* **1921**, *62–63.*

Further studies of the fungous associates of germination tests, by M. T. Munn. *Proc. Assn. Official Seed Anal.* **1921**, *57–59.*

Composition and analysis of corn pollen, by R. J. Anderson and W. L. Kulp. *Jour. Biol. Chem.* (In preparation.)

A study of the metabolism and respiratory exchange in poultry during vitimine starvation and polyneuritis, by R. J. Anderson and W. L. Kulp. *Jour. Biol. Chem.* (In preparation.)

Respectfully submitted,

R. W. THATCHER,
Director.

NEW YORK AGRICULTURAL EXPERIMENT STATION, GENEVA, N. Y., *December* 15, 1921.