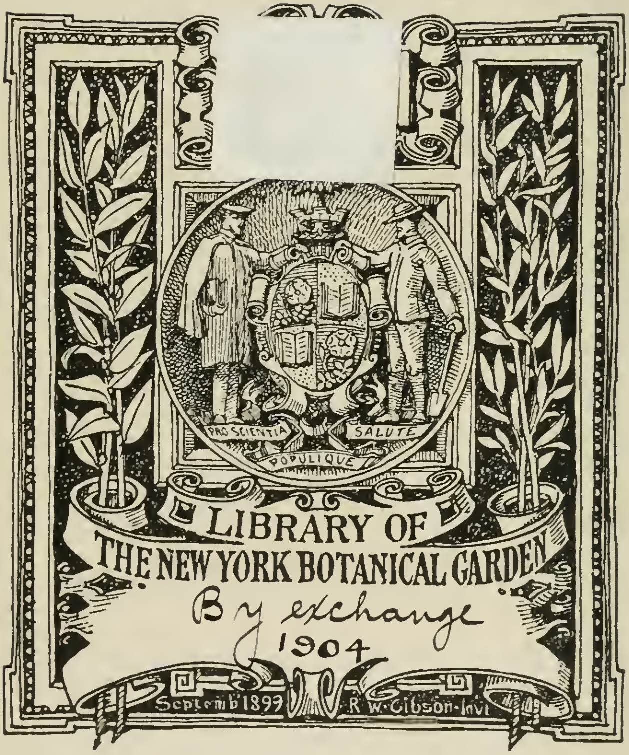
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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 58.

B. T. GALLOWAY, *Chief of Bureau.*

THE

VITALITY AND GERMINATION OF SEEDS.

BY

J. W. T. DUVEL,

ASSISTANT IN THE SEED LABORATORY.

BOTANICAL INVESTIGATIONS AND EXPERIMENTS.

ISSUED MAY 28, 1904.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1904.

BULLETINS OF THE BUREAU OF PLANT INDUSTRY.

The Bureau of Plant Industry, which was organized July 1, 1901, includes Vegetable Pathological and Physiological Investigations, Botanical Investigations and Experiments, Grass and Forage Plant Investigations, Pomological Investigations, and Experimental Gardens and Grounds, all of which were formerly separate Divisions, and also Seed and Plant Introduction and Distribution, the Arlington Experimental Farm, Tea Culture Investigations, and Domestic Sugar Investigations.

Beginning with the date of organization of the Bureau, the several series of bulletins of the various Divisions were discontinued, and all are now published as one series of the Bureau. A list of the bulletins issued in the present series follows.

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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 58.

B. T. GALLOWAY, *Chief of Bureau.*

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BUREAU OF PLANT INDUSTRY.

Beverly T. Galloway, *Chief.*
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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., March 26, 1904.

Sir: I have the honor to transmit herewith and to recommend for publication as Bulletin No. 58 of the series of this Bureau the accompanying technical paper entitled "The Vitality and Germination of Seeds."

This paper was prepared by J. W. T. Duvel, Assistant in the Seed Laboratory, and has been submitted by the Botanist with a view to publication.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

PREFACE.

Because of variation in the amount and quality of each year's crop it is frequently necessary for seedsmen to carry over large quantities of seeds from one year to another. Such seeds often lose their ability to germinate, and either are a loss to the seedsman or, if they are marketed, cause still more serious losses to those who plant them. Since 1899 Mr. Duvel has been engaged in a general investigation of the causes affecting the vitality of seeds, with special reference to the conditions under which they are stored commercially. This investigation was begun in 1899 under the Dexter M. Ferry Botanical Fellowship at the University of Michigan, and since September 1, 1902, it has been continued by the United States Department of Agriculture. An account of the whole study is presented herewith.

The general method pursued has been to store seeds experimentally under all sorts of conditions, and afterward to ascertain the exact percentage of germination. It is now possible to speak with precision of the extent of damage caused by careless methods of storage, to express in actual figures the greater liability of seeds to loss of vitality under the warm humid conditions existing in the South Atlantic and Gulf States than under colder and drier conditions, and to demonstrate the utility of storing seeds, when they must be kept in a humid climate, in moisture-proof packages. A further investigation, i. e., of the extent to which vitality may be preserved by means of commercial cold storage, is now in progress.

FREDERICK V. COVILLE,
Botanist.

OFFICE OF BOTANICAL INVESTIGATIONS AND EXPERIMENTS,
Washington, D. C., December 5, 1903.

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THE VITALITY AND GERMINATION OF SEEDS.

INTRODUCTION.

It has long been known that the conditions under which plants are grown and the degree of maturity at the time of harvesting are factors which play an important part in the life of seeds. But, granting that seeds are of strong vitality at the time of harvesting, there remain to be considered the methods of gathering and curing, the water content of the seed at the time of storing, the methods of storage, the humidity and temperature of the surrounding atmosphere, the composition of the seed, the nature of the seed coats, activities within the cells, and numerous other factors which play important parts in the life of the seed.

The conditions necessary for the successful germination of a seed of good vitality and the chemical transformations accompanying these early stages of development have received considerable attention from numerous investigators. These changes and conditions are fairly well understood for many of our common seeds. However, several important facts still remain unexplained, and our knowledge will not be complete until each and every species has been carefully studied.

On the other hand, the conditions influencing the vitality of seeds as commercially handled are but little understood and have been almost wholly neglected in research work. Likewise, but little attention has been given to the complex chemical and physical changes which take place in mature seed during the slow process of devitalization. It was in order to determine some of these factors that the work described in these pages was begun, and the results are thus of considerable practical value as well as of scientific importance. The present paper treats chiefly of the conditions influencing the vitality and germination of seeds when subjected to such methods of treatment as are generally met with in the ordinary handling of seed. Particular attention has been given to the effect of climate, moisture, and temperature on vitality, supplemented with a discussion of the changes taking place in mature seeds, especially the respiratory activities and the part played by enzymes.

The results of the above experiments have suggested improved methods of storing and shipping seeds so as to prolong their vitality and also to secure the production of more vigorous seedlings.

The work for the present paper was begun in 1899 at the University of Michigan and was continued for three consecutive years while the writer held the Dexter M. Ferry Botanical Fellowship in that institution. During this time the investigation was under the direction of Prof. V. M. Spalding, Ph.D., and Dr. F. C. Newcombe, who showed great interest in it and gave valuable suggestions as the work progressed, at the same time placing the facilities of the laboratory and of the library at the disposal of the writer. Since September 1, 1902, the work has been continued in the Seed Laboratory of the U. S. Department of Agriculture. Valuable assistance in storing seeds was rendered by Prof. C. W. Burkett, at Durham, N. H.; Mr. E. E. Smith, Wagoner, Ind. T.; Prof. W. R. Dodson, Baton Rouge, La.; Prof. F. S. Earle, Auburn, Ala.; Zimmer Brothers, Mobile, Ala.; Prof. H. H. Hume, Lake City, Fla., and Prof. Charles B. Scott, San Juan, Porto Rico.

MATERIALS AND METHODS.

SEEDS.

For these experiments thirteen different samples of seeds were used, being so selected as to include representatives of ten different families and twelve genera and species, as follows:

Poaceæ—Zea mays, sweet corn (two samples).

Liliaceæ—Allium cepa L., onion.

Brassicaceæ—Brassica oleracea L., cabbage; *Raphanus sativus* L., radish.

Apiaceæ—Daucus carota L., carrot.

Fabaceæ—Pisum sativum L., pea; *Phaseolus vulgaris* L., bean.

Violaceæ—Viola tricolor L., pansy.

Polemoniaceæ—Phlox drummondii Hook, phlox.

Solanaceæ—Lycopersicon lycopersicum (L.) Karst., tomato.

Cucurbitaceæ—Citrullus citrullus (L.) Karst., watermelon.

Asteraceæ—Lactuca sativa L., lettuce.

It will thus be seen that the seeds used cover a wide range as to family characteristics, as well as size, structure, and composition of seed. Likewise they are all from plants of the garden or field that have undergone a high degree of cultivation, thus enabling the seeds to withstand more or less variation as to conditions of vitality and growth.

All seeds used throughout these experiments were provided by D. M. Ferry & Co., of Detroit, Mich., and the seed furnished was of strong vitality and of known age and origin. The corn "A" (Minnesota Sweet), onion (Yellow Danvers), pea (D. M. Ferry Extra Early), bean (Yellow Kidney, Six Weeks), tomato (Dwarf Champion), and the watermelon (Sweet Mountain) were grown in Michigan. The corn "B" (Minnesota Sweet), was grown in Nebraska, the cabbage (Winningstedt), in Washington, and the lettuce (Black-Seeded Simpson), in California, while the radish (Early Scarlet Turnip-Rooted), carrot (Chantenay), pansy (mixed), and *Phlox drummondii* (mixed) were grown in France. The seed was all of the harvest of 1899 and was received at the botanical laboratory of the University of Michigan on January 27, 1900.

On January 30, 1900, germination tests were made, showing the vitality of the seeds to be as follows:

Vitality of seeds tested January 30, 1900.

Kind of seed.	Percentage of germination.	Kind of seed.	Percentage of germination.
Bean	100	Pansy	69.5
Cabbage	93	Pea	97
Carrot	83.5	Phlox	78
Corn, sweet, "A"	94	Radish	81
Corn, sweet, "B"	88	Tomato	98
Lettuce	87.5	Watermelon	99
Onion	98		

GERMINATION TESTS AND APPARATUS.

In the preliminary work several methods of testing were tried, but as none proved as serviceable as the "Geneva tester," this apparatus was adopted for all subsequent tests as recorded in the following pages. The detailed construction of this tester need not be described, for it is simple and quite familiar to all. However, some modifications were made in the preparation of the apparatus, and some precautions taken in the manipulation, which have proved to be of much value. The brass wires originally and ordinarily used to support the folds of cloth were replaced by glass rods of 6 to 7 mm. diameter. Rods of this size are much heavier than is necessary to support the folds of cloth, but the chief advantage in having rods of large diameter is that in case of the germination of large seeds the folds can be drawn near together at the top and still have sufficient space within the fold for the seeds. On the other hand, in the germination of small seeds that require considerable quantities of air, the folds can be closed at the top by bringing the rods together, thus insuring more uniform conditions throughout the fold and at the same time leaving sufficient space above the seeds for an abundant supply of air. The chief advantage in substituting glass rods for brass wires is in removing the possible source of injury resulting from the poisonous action of the dissolved copper.

Another error frequently, if not always, made in using such a tester is in allowing the ends of the cloths, or sometimes the bottoms of the folds, to dip into water in the pan. This should never be permitted, for in that way seeds are kept too moist, especially near the ends of the folds. Likewise such methods give an opportunity for the transmission of dissolved copper and a resulting injury to the seeds. For this same reason the strips of cloth should be made sufficiently narrow not to come into contact with the sides of the pan.

Much better results are obtained if the seeds, before being placed in the germinator, are soaked in water for several hours, the length of time depending on the power of absorption of the seeds. In these experiments the seeds were always soaked in distilled water for twelve or fifteen hours before transferring them to the germinator. This preliminary soaking gives a more speedy germination, which is always advantageous, especially in making comparative germination tests. In order to supply the requisite amount of moisture for subsequent growth, the cloths were first uniformly and completely wet with distilled water; moreover much care was taken to see that there was only a very small quantity of water in the bottom of the pan. In case of seeds that germinate readily, such as cabbage, lettuce, and onion, it is necessary that all surface water be removed from the bottom of the germinator if good results are desired. The pan then being covered with a glass plate, it is seldom necessary to increase the amount of moisture, for seeds when once soaked need only to be kept slightly moist and not wet, as must necessarily be true if the ends of the cloths or bottoms of the folds dip into the water. After soaking, the water in the seeds and cloths is ample for the completion of most germination tests. However, in an occasional test the seeds may become slightly dry, which happens when the cover is kept off the pan for a considerable time while counting germinated seeds. In such cases the remedy is to pour a small quantity of water in the bottom of the pan, or in extreme cases to moisten the folds with a fine spray.

If the above modifications be adopted and the necessary precautions taken, many of the objections frequently made to the Geneva tester will be removed and the difficulties will be overcome; at least it is a most excellent method of testing seeds where comparative results are especially desired. It must also be borne in mind that the Canton flannel (which is generally used in making the pockets) should always be of the best grade and should never be used a second time without being thoroughly cleaned and sterilized.

In selecting samples for germination the impurities and the immature seeds were first removed. The samples for test were then made up of the remaining large and small seed. For the most part 200 seeds were taken for a test, but with the larger seeds—corn, pea, bean, and watermelon—100 seeds were usually used. In all cases where any irregularity was apparent, tests were repeated. The controls are based on the results of several duplicate tests.

All germination tests were made in a dark room where the temperature could be comparatively well regulated and was maintained nearly constant throughout most tests. Germinated seeds were removed daily during early stages of the tests and a complete record of the number germinating each day was kept. This is of value in seed testing, because the germinative energy of a seed tells much as to its vitality. If seeds have a high vitality, the germinative energy will be very strong, i. e., germination will take place rapidly, giving rise to strong and vigorous seedlings; but if the seeds are of very low vitality, there will be a corresponding retardation in germination, giving rise to weak seedlings, i. e., showing a low germinative energy. In most cases throughout this work only the final percentages of germination are tabulated.

EFFECT OF CLIMATIC CONDITIONS ON THE VITALITY OF SEEDS.

It has long since been known that seeds under ordinary conditions lose their power of germination after the lapse of a few years, or in some cases within a few weeks or months. Many investigators have also learned that the rapidity with which seeds lose their vitality, when stored under ordinary conditions, varies greatly with the section of the country in which such seeds are kept. This loss in vitality is especially marked in the case of seeds stored in places of relatively high humidity. The rapid deterioration of seeds in localities having a humid atmosphere has become a source of much embarrassment to seedsmen, for they have experienced many difficulties in shipping seed to such places. This is especially marked in the case of seeds sent to growers or dealers in the vicinity of the Gulf of Mexico. Gardeners and planters in that part of the United States are continually complaining about the nonviable seeds sent out by seedsmen. Some growers have learned how to guard against this difficulty to a certain extent. Zimmer Brothers, of Mobile, Ala., wrote, on February 28, 1900, concerning this matter, as follows:

> During thirty years' experience in market gardening, we have learned that seeds of many hardy plants will not keep in our climate, and when ordering we so time our order that we can plant the seeds as soon as received. If such be impossible, we are very careful to keep the original package unopened until conditions are favorable for planting. If we find it necessary to keep seeds of hardy plants for some months, we put them up on arrival in dry bottles, put on top a bit of cotton saturated with chloroform and cork tightly. We have kept, in that way, cauliflower seed satisfactorily for twelve months. At the shore seeds keep very badly; one-half mile back they do much better. As a rule seeds of tender plants give but little trouble.

As far as has been ascertained, no definite experiments have been made with these points in view, and especially with the idea of determining the cause or causes of this deterioration of vital energy. In order to obtain reliable data on these points, a series of experiments was undertaken in February, 1900, to determine how seeds are affected when distributed to different parts of the United States and submitted to the free influence of various climates. Likewise at the various points where tests were made the seeds were subjected to different treatments.

The places selected for these tests were San Juan, P. R., Lake City, Fla., Mobile, Ala., Auburn, Ala.. Baton Rouge, La., Wagoner, Ind. T., Durham, N. H., and Ann Arbor, Mich.

A sample of each species of seed was put up separately in double manila coin envelopes and in closely corked bottles. Duplicate sets of each series were then subjected at each of the above-named places to the following conditions:

Trade conditions.—Conditions similar to those in which seeds are kept when offered for sale by retail dealers, the seed being more or less exposed to meteorological changes and subjected to natural variations in temperature and humidity. For the most part the seeds were in rooms that were never heated.

Dry rooms.—Rooms in the interior of buildings which were artificially heated during cold weather, and where the quantity of moisture was relatively small and the temperature comparatively constant.

Basements.—Rooms where the temperature was comparatively low and uniform, and the relative humidity of the surrounding air was much higher than in "trade conditions" and "dry rooms."

These conditions varied in the different places at which tests were made, and a more detailed description will be given when the results of the germination tests are discussed.

For the first part of this paper, treating of the influence of climate on vitality, none of the seeds need to be considered save those prepared in paper packages and kept under trade conditions, these coming more nearly under the direct action of the surrounding atmosphere. A sample of each kind of seed was put up in a manila (No. 2) coin envelope, and each of these packages was then inserted in a second (No. 3) coin envelope. Duplicate samples of every kind of seed were sent to the various testing places, where they were subjected to trade conditions. At San Juan the packages of seeds were kept in an open room, being subjected to the full action of the atmosphere but protected from the direct rays of the sun and from rain. At Lake City the packages were kept in a one-story frame building which was not artificially heated and the doors of which were open the greater portion of the time. At Mobile the packages of seeds were stored in a comparatively open attic of a private dwelling. At Auburn the seeds were stored in a greenhouse office, with the doors frequently standing open. At Baton Rouge the packages were kept on a shelf in a grocery store, the doors of which were closed only during the night. At Wagoner the conditions were very similar to those of Baton Rouge, save that the packages of seeds were kept in a drug store. At Durham the seeds were kept over a door at the entrance of one of the college buildings. This door opens into a hall which communicates with the offices, chemical laboratory, and the basement. At Ann Arbor the seeds were stored in the botanical laboratory, with slightly varying conditions, they being near a window which was frequently open during the summer, and at irregular intervals during the early part of the summer the packages were placed in the window so as to receive the direct rays of the sun. The seeds stored at Ann Arbor served partially as controls for those sent to the various other places, and, in addition to the last-named series, seeds from the original packages, as received from D. M. Ferry & Co., were kept in a dry and comparatively cool closet on the fourth floor of the botanical laboratory. These seeds served as checks for the complete set of experiments, and are designated throughout this paper as "Control."

The samples were sent out to the above-named places in February, 1900. The first complete set was returned in June, or early July, of that year. The second complete set was allowed to remain throughout the entire summer, and was returned in October and early November of the same year. The average time of treatment for the two series of experiments was 128 and 251 days respectively. When the seeds were returned, germination tests were made as soon as possible. The length of time that the seeds were in the various places and the vitality as shown by the germination tests are given in Tables I and II. In both tables the columns from left to right, beginning with Mobile, Ala., are in the order of the degree to which the seeds were injured.

TABLE I.—*Effect of climate on vitality, as shown by percentage of germination—first test.*

Kind of seed.	Control.	Mobile, Ala., Feb. 17 to July 7. 140 days.	San Juan, P. R., Feb. 9 to June 20. 129 days.	Baton Rouge, La., Feb. 17 to June 18. 121 days.	Wagoner, Ind. T., Feb. 17 to June 23. 126 days.	Lake City, Fla., Feb. 9 to June 18. 129 days.	Durham, N. H., Feb. 17 to July 14. 147 days.	Auburn, Ala., Feb. 17 to May 30. 102 days.	Ann Arbor, Mich.
Corn, sweet, "A"	95.9	80.0	96.0	96.0	96.0	94.0	100.0	96.0	100.0
Corn, sweet, "B"	89.3	48.0	72.0	80.0	70.0	86.0	89.3	88.0	92.0
Onion	95.8	7.0	84.5	90.0	93.5	95.0	96.5	96.0	95.0
Cabbage	92.7	64.5	82.0	88.5	83.5	89.5	93.0	91.0	96.0
Radish	83.6	58.5	64.0	77.5	77.5	79.0	80.6	75.5	82.5
Carrot	83.3	59.0	71.5	74.3	81.5	76.5	78.0	84.5	76.0
Pea	95.3	69.2	94.0	94.0	98.0	96.0	98.0	93.3	90.0
Bean	98.7	58.0	100.0	96.0	96.0	98.0	100.0	98.0	98.0
Pansy	63.0	3.0	20.0	28.5	48.5	44.5	55.5	57.5	53.5
Phlox drummondii	69.0	0.5	23.5	47.5	50.5	41.5	67.0	61.5	67.0
Tomato	95.5	90.0	94.0	91.5	96.5	94.0	94.5	95.0	89.0
Watermelon	98.3	98.0	96.0	100.0	98.0	98.0	98.0	94.0	100.0
Lettuce	81.6	63.0	79.0	82.5	78.0	87.0	82.0	86.5	82.0
Average of all seeds	87.79	53.59	75.12	80.48	82.12	83.00	85.57	85.70	86.23

From Table I it will be seen that the loss of vitality in the case of seeds stored at Mobile was much greater than in those stored at any of the other places. The greatest loss in the samples tested was in the phlox, where the germination was only 0.5 per cent, or a loss in vitality of 99.3 per cent as compared with the control. These results were closely followed by a loss in vitality of 95.9 and 92.7 per cent for the pansy and onion seed, respectively. The percentages of germination in the other cases, except the "B" sweet corn, pea, and bean, were sufficient to have produced a fair stand, i. e., if we consider that far too many seeds are usually sown. But a decrease in the percentage of germination means seeds of a low germinative energy. Even though the final percentage of germination be up to standard, the retardation may be of vital importance. A very good example of the retardation in germination is shown in the tests of the watermelon seeds. In the control sample 94 per cent of the seed germinated in 47½ hours, while the seed returned from Mobile showed, during the same time, a germination of only 12 per cent; yet the difference in the final germination was only 0.3 per cent in favor of the control. Likewise the seed returned from San Juan germinated only 20 per cent in 47½ hours, the final germination being 96 per cent or only 2.3 per cent lower than the control.

Many similar cases might be mentioned in which the final percentages of germination, as shown by the first set of tests given in Table I, represent a loss such as might be justly considered well within the limits of normal variation. However, that all of the samples of seed were injured as a result of the unfavorable climatic conditions is shown in the second set of tests set forth in Table II. In the latter case the seeds remained in the various places nearly twice as long as those used for the first test.

TABLE II.—*Effect of climate on vitality as shown by percentage of germination—second test.*

Kind of seed.	Control.	Mobile, Ala., Feb. 17 to Nov. 6. 262 days.	Baton Rouge, La., Feb. 17 to Oct. 22. 247 days.	Durham, N. H., Feb. 17 to Oct. 26. 251 days.	Auburn, Ala., Feb. 17 to Nov. 19. 275 days.	Lake City, Fla., Feb. 9 to Oct. 1. 234 days.	Wagoner, Ind. T., Feb. 17 to Oct. 13. 238 days.	San Juan, P. R., Feb. 9 to June 20. 129 days.	Ann Arbor, Mich.
Corn, sweet, "A"	91.5	20.0	88.0	96.0	88.0	92.0	90.0	92.0	98.0
Corn, sweet, "B"	88.5	12.0	54.2	82.0	62.0	77.0	78.0	78.0	80.0
Onion	97.0	0.0	0.5	0.0	12.0	16.5	24.5	50.0	97.5
Cabbage	92.4	17.0	25.5	12.0	61.5	63.5	70.5	76.2	91.0
Radish	78.8	51.0	55.5	59.5	63.0	58.5	60.5	62.0	77.5
Carrot	82.0	8.5	25.0	2.0	36.0	43.5	49.0	48.5	86.0
Pea	95.7	44.0	80.0	91.0	97.9	86.5	80.0	98.0	98.0
Bean	98.7	0.0	60.0	78.0	56.0	84.0	82.0	96.0	100.0
Pansy	53.0	0.0	0.0	0.0	2.0	1.5	7.5	6.5	46.5
Phlox drummondii	53.9	0.0	0.0	0.5	1.0	2.5	5.5	11.5	40.0
Tomato	97.5	79.5	96.0	87.0	94.0	94.0	94.0	96.5	98.0
Watermelon	99.0	64.0	92.0	82.0	86.0	92.0	94.0	88.0	96.0
Lettuce	92.3	20.0	84.5	88.5	86.0	85.0	82.0	83.5	92.5
Average of all seeds	86.77	24.31	50.86	52.42	57.34	61.27	62.11	68.21	84.58

Even though the columns in both Tables I and II are arranged in the order of the loss in vitality as shown by the averages of the various places, it will at once be seen that the relative degree of injury did not remain the same throughout the experiment. This is probably best explained by a variation in the climatic influences. It is evident that in some of the places where seeds were stored the effects were more deleterious during the time between the first and second tests than they were during the first period of storage of 128 days. The results given in Table II are of the greater value in showing the relative merits of the different localities as places for storing seeds, extending as they do over a longer period of time.

As a result of the second series of tests it was found that the average percentage of germination of all of the samples of seed that were stored in trade conditions at Mobile for 262 days was only 24.31 per cent. This is equivalent to a loss in vitality of 71.98 per cent as compared with the average percentage of germination of the control samples, the average germination of the controls being 86.77 per cent. The pansy, phlox, onion, and beans stored at Mobile wholly lost their power of germination. The tomato seed, which proved to be the most resistant to unfavorable conditions, gave a germination of 79.5 per cent, or a loss in vitality of 18.46 per cent, as compared with the control sample, which germinated 97.5 per cent. The degree of deterioration in the seeds stored at the other places was much less marked than for those stored at Mobile. The loss in vitality was only 41.39 per cent in the seeds returned from Baton Rouge. The results from the seeds which were stored at Durham, Auburn, Lake City, Wagoner, and San Juan differed but little from those from Baton Rouge. The relative losses in vitality are in the order given. The seeds kept in the packages which were stored under trade conditions in the laboratory at the University of Michigan showed a loss in vitality of only 2.52 per cent as compared with the control, the seeds of which were stored in a cool, dry closet on the fourth floor of the botanical laboratory. Ordinarily a loss of 2.52 per cent would be considered as a normal variation due to sampling and testing, and such was probably true in these two sets, with the exception of the greater deterioration of the phlox, pansy, and "B" sweet corn, which were undoubtedly injured by the unfavorable trade conditions, as repeated tests have shown.

From Table II it will also be seen that the "A" sweet corn, peas, tomato, and watermelon, with the exception of those returned from Mobile, show a fair percentage of germination. In some cases the final percentages of germination were even higher than the controls; but, as previously stated, the final germination is not always a good criterion for the determination of vitality, it being necessary to consider the germinative energy as a basis for comparison. In order to show this more fully some of the detailed results are herewith given in Table III. These results show to a good advantage the degree to which germination has been retarded.

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TABLE III.—*Retardation in germination due to injury caused by unfavorable climatic conditions.*

Place where seeds were kept.	Corn "A."		Peas.		Watermelon.		Tomato.		
	Germination at end of 64 hours.	Final germination.	Germination at end of 40 hours.	Final germination.	Germination at end of 84 hours.	Final germination.	Germination at end of 83 hours.	Germination at end of 107 hours.	Final germination.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Control	81.3	94.5	79.6	95.7	98.0	99.0	78.0	92.7	97.5
Mobile, Ala	4.0	20.0	[a] 24.0	44.0	0.0	64.0	1.5	12.5	79.5
San Juan, P. R	64.0	92.0	60.0	98.0	12.0	88.0	38.5	78.0	96.5
Baton Rouge, La	50.0	88.0	36.0	80.0	0.0	92.0	9.0	56.0	96.0
Wagoner, Ind. T	64.0	90.0	36.0	80.0	2.0	94.0	40.0	81.5	94.0
Lake City, Fla	68.0	92.0	50.0	86.0	0.0	92.0	16.5	65.0	94.0
Durham, N. H	86.0	96.0	54.0	94.0	0.0	82.0	0.5	5.5	87.0
Auburn, Ala	80.0	88.0	[a] 93.7	97.9	22.0	86.0	59.0	75.5	94.0
Ann Arbor, Mich	82.0	98.0	82.0	98.0	94.0	96.0	75.5	91.0	98.5

[a] After 62 hours.

In order that the results of Tables I and II may be more readily and fully comprehended, it has been deemed advisable to summarize them in another table. For this purpose the average percentages of germination of all of the different samples of seed have been determined for each of the different places. From these average percentages of germination the deterioration in vitality, as shown by both the first and second tests as given in Tables I and II, have been calculated, the germination of the controls serving as a basis for comparison. These results furnish more trustworthy data as to the relative merits of the different localities as places for storing seeds. Likewise the percentages of deterioration between the time of the first and the second tests are shown in Table IV.

TABLE IV.—*Average percentages of germination of all seeds kept at the various places, their deviations from the controls, and the increased percentages of loss in the second series of tests.*

Place of storage.	Average germination of all seeds used in experiments.		Deterioration in vitality as compared with controls.		Deterioration in vitality between first and second tests.
	First test.	Second test.	First test.	Second test.	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Control	87.79	86.77			1.16
Mobile, Ala	53.59	24.31	38.95	71.98	54.64
San Juan, P. R	75.12	68.21	14.31	21.39	9.20
		[a] 45.18		[a] 47.93	[a] 39.86
Baton Rouge, La	80.48	50.86	8.32	41.39	36.81
Durham, N. H	85.57	52.42	2.52	39.58	38.74
Auburn, Ala	85.70	57.34	2.38	33.91	33.10
Lake City, Fla	83.00	61.27	5.45	29.38	26.18
Wagoner, Ind. T	82.12	62.11	6.45	28.41	24.37
Ann Arbor, Mich	86.23	84.58	1.77	2.52	1.91

[a] Calculated results.

In Table IV the results are arranged in the order of the loss in vitality as shown by the second tests. However, a few words of explanation will be necessary, especially concerning the loss at San Juan. In the first place, the seeds were kept at San Juan only 131 days[a] during the early part of the summer, while during the most critical period, June 20 to November 6, they were in the botanical laboratory of the University of Michigan. Those marked Mobile, Ala., were, during the entire time, 262 days, under the influence of the warm, moist climate of the Gulf of Mexico. The seeds kept at other places can well be compared with those from Mobile, the time being approximately the same. The average loss as shown by the second tests was 3.35 times greater than the loss in the first test, which by calculation would bring San Juan next below Mobile, with a loss of vital energy in the seeds equal to 47.93 per cent. But more data are necessary before such a gradation of injurious climatic influences can be established.

Table IV, however, brings out another interesting point, as shown by comparing the results of the first and second tests at San Juan and Mobile. In the first test the loss in vitality of the seeds from Mobile was 38.95 per cent, while the seeds returned from San Juan showed a loss of only 14.31 per cent as compared with 71.98 and 21.39 per cent, respectively, as shown in Table II. The degree to which the seeds were injured while they were stored in San Juan was such that they continued to deteriorate much more rapidly than the control sample. This deterioration was most marked in the case of the pansy seed, the germination of the first test being 20 per cent and that of the second test only 6.5 per cent, showing a loss in vitality of 68.2 per cent and 87.7 per cent, respectively. Thus when seeds are once placed in conditions unfavorable for the preservation of their vitality for a sufficient length of time to cause some injury, this injury will always be manifest and cause a premature death of the seeds even though they afterwards be removed to more favorable conditions.

Seeds of strong vitality can withstand greater changes in conditions than seeds of low vitality without any marked deterioration. Throughout these experiments a wide difference has been observed between the "A" sweet corn and the "B" sweet corn. The original tests made January 30, 1900, at the time the seeds were received, showed a germination of 94 per cent for the "A" sample and 88 per cent for the "B" sample of corn. The control tests, made in November, 1900, showed a germination 0.5 per cent higher in each case; but the average loss in vitality of the two samples of seed kept at the various places was 12.17 per cent for the "A" sample and 26.10 per cent for the "B" sample. As with the pansy and the phlox these samples showed that

[a] The number of days here given for San Juan is not absolutely correct. The time was reckoned from the date the seeds were sent from the laboratory until they were received in return.

the stronger the vitality of the original sample of seed the more harsh treatment can be undergone without being injured. Strong vitality implies long life as well as vigorous seedlings.

Another very important factor to be considered in the handling of seeds is the relative resistance of seeds of various species to adverse conditions. Certain seeds under one set of conditions may retain their vitality exceedingly well, while seeds of other species of plants under identical conditions may be killed in a comparatively short time. For this reason no general rule can be laid down for the preservation of seeds. Table V shows the varying degrees of deterioration of the different species of seeds used in the experiments.

TABLE V.—*Different degrees of deterioration of various kinds of seeds.*

Kind of seed.	First test.			Second test.		
	Germination of control.	Average germination from the various places.	Deterioration in vitality as compared with the control samples.	Germination of control.	Average germination from the various places.	Deterioration in vitality as compared with the control samples.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Tomato	95.5	93.06	2.55	97.5	92.43	5.20
Pea	95.3	91.56	3.92	95.7	84.80	11.39
Corn, sweet, "A"	95.9	94.75	1.20	94.5	83.00	12.17
Watermelon	98.3	97.75	.57	99.0	86.62	12.51
Lettuce	81.6	80.00	1.96	92.3	77.75	15.77
Radish	83.6	74.38	11.02	78.8	60.93	22.67
Corn, sweet, "B"	89.3	78.16	12.47	88.5	65.40	26.10
Bean	98.7	93.00	5.76	98.7	69.50	29.58
Cabbage	92.7	86.00	7.22	92.4	52.15	43.56
Carrot	83.3	75.16	9.77	82.0	37.81	53.89
Onion	95.8	82.18	15.26	97.0	25.12	74.10
Pansy	63.0	38.87	38.33	53.0	8.00	84.90
Phlox drummondii	69.0	44.87	34.97	53.9	7.62	85.85

In the above table the list of seeds is arranged in the order of their power to withstand the action of diverse climatic conditions, as shown by the results of the second test, given in Table II. Tomato seeds were found to be the most resistant, the control sample germinating 97.5 per cent. The average germination of the samples of tomato seed kept at the various places was 92.43 per cent, or a loss in vitality of only 5.20 per cent. The seed showing the next least injury was the peas, with a deterioration of 11.39 per cent. The phlox, which was the most affected by the unfavorable conditions, germinated only 7.62 per cent, thus showing a loss in vitality of 85.85 per cent.

It is also interesting to note that the order, as shown by the second series of tests, is quite different from that of the first. This lack of uniformity increases the difficulties that must be overcome before the causes of the loss of vitality in seeds can be fully comprehended. Were all seeds affected in the same way when subjected to identical conditions, the order should have remained the same throughout, but the wide variation in atmospheric changes affects different seeds so very differently that no uniformity of results can be secured. For example, the conditions prevailing from February until June were much more disastrous to the vitality of the tomato and pea than to the "A" sweet corn, watermelon, and lettuce, while the conditions existing from June to November were more injurious to the "A" sweet corn, watermelon, and lettuce. An examination of the table will show other results of a similar nature. During the earlier stages of devitalization seeds undergo a gradual deterioration in vitality, but after reaching a certain stage in their decline there is a comparatively sudden falling off, and seeds, except perhaps a few of the most persistent, soon cease to show any power of germination. Such factors as these must be taken into account in determining the relative length of time that different kinds of seed will retain their vitality. But as yet sufficient information is lacking in order to make any trustworthy attempt to classify seeds in respect to their viable periods when subjected to different conditions. Numerous experiments are now under way, with the hope of furnishing a basis for such a classification.

In order to obtain more data as to the influence of climate upon vitality additional samples of seed were sent to Mobile and Baton Rouge, where they were stored under the same trade conditions as for the former experiment. For these tests only cabbage, lettuce, and onion seeds, put up in envelopes, as for the previous tests, were used. The different packages of seed, placed in paper boxes from which they were not removed, were sent from the laboratory on May 20, 1901, and were returned November 26, 1901, the total time of storage being 190 days. The results of these tests are shown in Table VI, and are even more striking than those of the former tests shown in Tables I and II.

TABLE VI.—*Relative merits of Mobile, Ala., Baton Rouge, La., and Ann Arbor, Mich., as places for storing seeds.*

[Period, 190 days.]

Seeds subjected to "Trade conditions."	Cabbage.			Lettuce.			Onion.			
	Percentage of seeds germinated at the end of—			Percentage of seeds germinated at the end of—			Percentage of seeds germinated at the end of—			
	36 hours.	60 hours.	14 days.	36 hours.	60 hours.	11 days.	60 hours.	84 hours.	108 hours.	14 days.
Mobile, Ala	0.0	0.0	8.5	0.0	14.0	64.0	0.0	0.0	0.0	0.0
Baton Rouge, La	0.0	0.0	22.5	2.5	35.5	74.0	0.0	0.0	0.0	0.0
Ann Arbor, Mich	10.0	64.5	86.5	67.0	82.5	96.5	3.0	10.0	43.0	93.0

Table VI shows quite clearly the deleterious action of the warm, moist climate of the Gulf of Mexico on the life of seeds. The onion seed which was stored at Mobile and Baton Rouge did not germinate, while seed from the same lot stored at Ann Arbor germinated 93 per cent. The cabbage seed was injured nearly as much as the onion, the sample from Mobile germinating only 8.5 per cent. The conditions at Baton Rouge were slightly more favorable to the preservation of vitality. The cabbage seed stored at the latter place germinated 22.5 per cent, while a like sample of seed stored at Ann Arbor germinated 86.5 per cent. The lettuce was much more resistant than either the cabbage or the onion seed, but here, too, the injury was quite marked, especially as shown by the retardation in germination. The conditions at Mobile were also the most disastrous for the lettuce seed. During the first 36 hours that the tests were in the germinating chamber none of the lettuce seed from Mobile germinated, while the seed from the corresponding sample from Ann Arbor germinated 67 per cent. The final percentages of germination were 64 and 96.5 per cent, respectively, for the seed from Mobile and Ann Arbor, showing a loss in vitality of 33.68 per cent in the seed stored at Mobile. Here it will be seen, as in Table V, that the onion seed was most sensitive and the lettuce seed most resistant to the unfavorable conditions. In the first tests shown in Table V the average loss in vitality of the lettuce, cabbage, and onion was 15.77, 43.56, and 74.10 per cent, respectively, while for the last tests, as shown in the foregoing table, the losses in vitality of similar samples of seed kept at Mobile were 33.68, 91.29, and 100 per cent, respectively. The ratio is practically the same in both cases, the loss in the cabbage seed being 2.7 times greater than that of the lettuce.

The foregoing data are sufficient to indicate that climatic influences play a very important part in the life of seeds, and that the degree of injury varies greatly in different places and likewise in different seeds. Some seeds were practically worthless after an exposure of four or five months in such places as Mobile, Baton Rouge, or San Juan, as shown in Table I. After longer exposures, six or nine months, similar results were obtained from all of the places to which seeds were sent. Many of the seeds were killed, as shown in Table II. The conditions at Mobile were fatal to all of the seeds; that is, the seeds were worthless so far as the gardener is concerned.

CAUSES OF THE LOSSES IN VITALITY IN DIFFERENT CLIMATES.

Having shown that seeds lose their vitality much sooner in some localities than in others, the question naturally arises, "Why this loss in vitality?" Unfortunately only two of the places where seeds were stored, Mobile and San Juan, have Weather Bureau stations which are equipped for making complete observations of the meteorological conditions. It has been observed, however, that there is a very close relationship between the precipitation and the loss in vitality in seeds; that is to say, in a measure the loss in vitality is directly proportional to the amount of rainfall. This deterioration is more apparent as the temperature increases, but the injury due to the increase in temperature is dependent on the amount of moisture present.

The following table has been compiled in order to show the ratio between the loss in vitality and the precipitation and temperature. The loss in vitality, as given in the second column of Table VII, represents the average losses in percentages, calculated from the results of the germination tests of the 13 different samples of seeds, as shown in Table II.[a]

The third column shows the annual precipitation in inches. The annual precipitation has been taken, because in some instances heavy rainfalls occurred just previous to the time that the seeds were put into storage. Then, too, the annual precipitation furnishes more accurate data for a basis of comparison. The mean temperatures, as given in column 4, are not the mean annual temperatures, but the averages covering the time during which the seeds were stored. The mean annual temperatures were not taken, chiefly for the reason that the critical period, in so far as temperature is concerned, is during the summer months.

TABLE VII.—*Ratio between vitality, precipitation, and temperature.* [b]

Place where seeds were stored.	Average loss in vitality of the 13 different samples of seeds.	Annual precipitation.	Temperature.	
			Mean Fahr.	Maximum Fahr.
	Per cent.	*Inches.*	*Degrees.*	*Degrees.*
Mobile, Ala	71.98	91.18	71.4	96.0
Baton Rouge, La	41.39	66.37	72.2	98.0
Durham, N. H	39.58	48.20	52.3	98.0
Auburn, Ala	33.91	62.61	64.4	98.0
Lake City, Fla	29.38	49.76	73.3	103.0
Wagoner, Ind. T	28.41	42.40	67.1	107.0
Ann Arbor, Mich	2.52	28.58	49.12	98.0

[a] These seeds were sent out in February, 1900, and were returned to the botanical laboratory and tested in October and November, 1900. The average time that the seeds were kept at the various places was 252 days.

[b] The results of the San Juan tests have been omitted from this table because, as has been previously stated, all of the seeds were returned from San Juan on June 20, 1900, when the first tests were made. The second series of tests was made in October, 1900. During the time intervening between the first and second tests the San Juan samples were kept in the botanical laboratory at the University of Michigan.

According to the table the seeds kept at Mobile suffered the greatest loss in vitality. However, it is quite probable that the greatest loss would have been from the seeds stored at San Juan had the time of storage been the same for the two places, so that the results of the San Juan tests could have been included in the table. This conclusion is based on the following facts: Normally, the number of rainy days at San Juan far exceeds those at Mobile. In 1900 there were 211 days on which rain fell in San Juan, while the records for Mobile show only 146. Likewise the average temperature of the dew-point for San Juan was 71° F. and only 59° F. for Mobile, which, when expressed in terms of absolute moisture, gives 8.240 and 5.555 grains of water per cubic foot at the time of saturation. On the other hand, the relative humidity of San Juan was 78.5 per cent, or slightly lower than that of Mobile, the latter having a relative humidity of 80.5 per cent. However, the mean annual temperatures were 77.6° and 71.4° F., respectively, hence a mean absolute humidity of 7.099 grains of aqueous vapor for San Juan and only 6.718 grains per cubic foot for Mobile.

From the foregoing table it will be seen that precipitation is a factor of much greater importance than temperature. In order to show the real value which the amount of precipitation furnishes as a basis for judging the length of time that seeds will retain their vitality when stored in localities having a marked difference in the amount of rainfall, the results set forth in the above table are represented diagrammatically as follows:

Effect of precipitation on vitality.

Place.	Percentage of loss in vitality.	Inches of precipitation.
Mobile	71.98	91.18
Baton Rouge	41.39	66.37
Durham	39.58	48.20
Auburn	33.91	62.61
Lake City	29.38	49.76
Wagoner	28.41	42.40
Ann Arbor	2.52	28.58

A discrepancy is very marked for Durham, N. H., which may be partially explained by considering again the conditions under which the seeds were stored. It will be remembered that these samples of seeds were stored in a hall which opened directly into a chemical laboratory. It is quite probable that the low percentages of germination were due to the injurious action of gases emanating from the laboratory. Of these gases, ammonia probably played a very important part, as it is well known that seeds are very readily injured when subjected to the action of ammonia.

It is to be understood that the above comparisons are somewhat indefinite. If the amount of rainfall were equally distributed throughout the year a definite ratio could, in all probability, be established; but in the majority of places there are alternating wet and dry seasons, which make such a comparison very difficult and unsatisfactory. Yet for ordinary considerations it is sufficient to say that seeds will retain their vitality much better in places having a small amount of rainfall. For more exact comparison other factors must be taken into account, especially the relative humidity, mean temperature, and temperature of the dew-point, which ultimately resolves itself into the absolute amount of moisture present in the atmosphere.

EFFECT OF MOISTURE AND TEMPERATURE UPON VITALITY.

From the foregoing experiments it is quite evident that moisture plays an important part in bringing about the premature death of seeds and that the detrimental action of moisture is more marked as the temperature increases. Formerly the general consensus of opinion has been to make this statement in the reverse order—that is, that temperature exerts a very harmful action on seeds if much moisture be present. For comparatively high temperatures the latter statement would probably suffice—at least it is not misleading, and in a certain measure it is true; but at the lowest known temperatures, as well as at ordinary temperatures, moisture is the controlling factor, and in order to be consistent it should likewise be so considered for higher temperatures—that is, within reasonable limits.

That temperature is only of secondary importance is brought out in the results obtained by a number of investigators. It has been well established by Sachs,[a] Haberlandt,[b] Just,[c] Krasau,[d] Isidore-Pierre,[e] Jodin,[f], Dixon,[g] and others that most seeds, if dry, are capable of germination after being subjected to relatively high temperatures for periods of short duration. The maximum for most seeds is a temperature of 100° C. for one hour; but if the seeds contain comparatively large quantities of moisture they are killed at much lower temperatures. It has been reported that lettuce seed will lose its vitality in two weeks in some of the tropical climates where moisture is abundant. Dixon has shown that if lettuce seed be dry it will not all be killed until the temperature has been raised to 114° C.

In case of low temperatures the factor of moisture is of less importance, yet even under such conditions the moisture must not be excessive or the injury will be quite apparent. But if seeds are well dried it can safely be said that they will not be killed as a result of short exposures to the lowest temperatures which have thus far been produced. Our knowledge of the resistance of seeds to extremely low temperatures is based on the experiments of Edwards and Colin,[h] Wartmann,[i] C. De Candolle and Pictet,[j] Dewar and McKendrick,[k] Pictet,[l] C. De Candolle,[m] Brown and Escombe,[n] Selby,[o] and Thiselton-

[a] Handbuch d. Exp. Phys. d. Pflanzen, Leipzig, 1865, p. 66.

[b] Pflanzenbau I, 1875, pp. 109–117; Abs. in Bot. Jahresbr., 1875, p. 777.

[c] Bot. Zeit., 33, Jahrg. 1875, p. 52; Cohn's Beiträge zur Biol. der Pflanzen, 1877, **2**: 311–348.

[d] Sitzungsbr. d. Wiener Akad. d. Wiss., 1873, **48**: 195–208. I. Abth.

[e] Ann. Agron., 1876, **2**: 177–181; Abs. in Bot. Jahresbr., 1876, II. Abth., **4**: 880.

[f] Compt. Rend., 1899, **129**: 893–894.

[g] Nature, 1901, **64**: 256–257; notes from the Botanical School of Trinity College, Dublin, August, 1902, pp. 176–186.

[h] Ann. sci. nat. bot., ser. 2, 1834, **1**: 257–270.

[i] Arch. d. sci. phys. et nat., Genève, 1860, **8**: 277–279; ibid., ser. 3, 1881, **5**: 340–344.

[j] Ibid., ser. 3, 1879, **2**: 629–632; ibid., ser. 3, 1884, **11**: 325–327.

[k] Proc. Roy. Inst., 1892, **12**: 699.

[l] Arch. d. sci. phys. et nat., Genève, ser. 4, 1893, **30**: 293–314.

[m] Ibid., ser. 4, 1895, **33**: 497–512.

[n] Proc. Roy. Soc., 1897–8, **62**: 160–165.

[o] Bul. Torr. Bot. Club., 1901, **28**: 675–679.

Dyer.[a] In the experiments of the last-named investigator seeds were subjected to the temperature of liquid hydrogen (-250° to -252° C.) for six hours, and when tested for vitality the germination was perfect and complete.[b]

Much more might be said on the effect of high and low temperatures on vitality. But for the commercial handling of seeds the extremes of temperature are of secondary importance and need not be further discussed at this time. In the present work the purpose has been to show the effect of moisture on the vitality of seeds when subjected to such temperatures as are usually met with in the storing of seeds.

SEEDS PACKED IN ICE.

On February 6, 1900, samples of each of thirteen kinds of seed were put up in duplicate, both in manila coin envelopes and in small bottles. The bottles were closed with carefully selected cork stoppers. These two sets of duplicate samples were then divided into two lots. Each lot contained one of each of the packages and one of each of the bottles of seeds. The samples thus prepared were carefully packed with excelsior in wooden boxes, the boxes being then wrapped with heavy manila paper. In one of the boxes was also placed a Sixes' self-registering thermometer, so that the minimum temperature could be ascertained.

These boxes were stored in a large ice house near Ann Arbor, being securely packed in with the ice at the time the house was being filled. The first box was taken out with the ice on June 12, 1900, after a lapse of 126 days. The thermometer in this box registered a minimum of -3.6° C. It is safe to assume that this temperature was uniform, at least up to within a few days of the time when the seeds were taken out. Unfortunately, absence from the university at this particular time delayed an examination of the seeds until June 20. During the eight intervening days the box of seeds was kept in the laboratory and there many of the seeds in the packages molded, so that they were unfit for germination tests. In fact, the results of the tests from the packages are of little value within themselves; but in comparison with the vitality tests of the seeds kept in the bottles some important facts are brought out, and it has been deemed advisable to tabulate these results with those of the second series.

The second box of seeds was packed approximately in the center of a large ice house (100 by 60 by 20 feet) and was taken out with the ice on July 21, 1900, after having been 167 days in cold storage. The

[a] Proc. Roy. Soc., 1899, **65**: 361–368.

[b] *Brassica alba* (oily), *Pisum sativum* (nitrogenous), *Cucurbita pepo* (oily), *Triticum sativum* (farinaceous), and *Hordeum vulgare* (farinaceous).

box was brought directly to the laboratory and the seeds were examined at once. Those contained in the paper packages had absorbed a considerable quantity of moisture and were much softened. In all of the packages except those containing the onion and watermelon seeds some mold had developed; but in the seeds used for the germination tests care was taken to avoid using those that showed any trace of a mycelium, thereby reducing the injury due to fungous growth to a minimum, even though subsequent experiments have shown that such injury is practically negligible.

An interesting point concerning the germination of some of the seeds at this low temperature may be stated in this connection. Eight of the peas, or 4 per cent, had already germinated, the radicles varying in length from 1 to 2.5 cm., thus corroborating Uloth's results in germinating peas at or slightly below the temperature of melting ice.[a]

TABLE VIII.—*The vitality of seeds kept in an ice house in envelopes and bottles, and likewise the vitality of the controls.*

Kind of seed.	First test, after 126 days.					Second test, after 167 days.				
	Germination.			Difference between envelope and control samples.	Difference between envelope and bottled samples.	Germination.			Difference between envelope and control samples.	Difference between envelope and bottled samples.
	Control.	Envelope.	Bottle.			Control.	Envelope.	Bottle.		
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Corn "A"	96.0	36.0	94.0	60.0	58.0	92.0	86.0	96.0	6.0	10.0
Corn "B"	90.0	60.0	96.0	30.0	36.0	92.0	74.0	94.0	18.0	20.0
Onion	95.0	92.5	96.5	2.5	4.0	95.0	94.5	95.0	0.5	0.5
Cabbage	93.5	89.0	94.0	4.5	5.0	92.0	90.0	94.0	2.0	4.0
Radish	88.5	....	81.5	....	....	80.5	74.0	89.0	6.5	15.0
Carrot	79.5	....	80.0	....	....	73.5	52.0	75.5	21.5	23.5
Pea	92.0	....	88.0	....	....	94.7	90.0	96.0	4.7	6.0
Bean	100.0	....	100.0	....	....	100.0	0.0	98.0	100.0	98.0
Pansy	52.5	5.0	65.5	47.5	60.5	52.0	2.5	65.5	49.5	63.0
Phlox	74.0	....	[a]16.5	....	....	54.0	11.0	68.5	43.0	57.5
Tomato	95.5	73.0	93.5	22.5	20.5	96.5	51.5	96.0	45.0	44.5
Watermelon	98.0	90.0	100.0	8.0	10.0	100.0	96.0	100.0	4.0	4.0
Lettuce	80.0	....	66.0	....	....	81.5	66.0	71.0	15.5	5.0
Average	87.3	63.6	87.9	25.0	27.7	84.9	62.1	87.6	24.3	27.0

[a] In making up the averages the result of the germination of the phlox was omitted because a subsequent examination showed that the bottle containing this sample of seed was broken at the bottom, thus admitting sufficient moisture to destroy vitality, as is borne out by the second test.

The above table shows, as previously stated, that the results of the first tests are incomplete and not very satisfactory, owing to the fact that the germination tests were unavoidably delayed for eight days after the seeds were taken from the ice house; but with the second set

[a] Flora, 1875, pp. 266–268.

of samples the counts for the vitality tests were begun within an hour from the time the seeds were removed from the ice house. Thus, the conclusions for these experiments must be drawn chiefly from the second series of tests. However, comparisons will be made with the first where such seem justifiable.

It will at once be seen that the seeds which were in paper packages gave a much lower percentage of germination than either the control samples or those kept in bottles. The average germination of the controls was 84.9 per cent, and the average germination of the seeds kept in bottles was 87.6 per cent, while only 62.1 per cent of the seeds kept in paper packages germinated. This is equivalent to a loss in vitality of 24.3 and 27 per cent, respectively, as compared with the vitality of the control samples and the samples from the bottles. The results of the first tests are practically the same, save that the differences between the control and the bottle samples are less marked. In the second case the average vitality of the seeds kept in envelopes was much reduced by the complete failure to germinate in the case of the beans, which are most susceptible to the deleterious action of moisture at the given low temperature.

One of the most important points brought out by these experiments is the result obtained with onion, cabbage, and watermelon seeds. In both the first and the second tests the germination varied but little throughout. However, in all cases the seeds in the paper packages were slightly injured by the action of the moisture. This factor is of much importance, especially in the case of the onion seed, which, when kept in a moist atmosphere at normal temperatures, soon loses its vitality, but when maintained at temperatures slightly below freezing it becomes very resistant to the action of moisture. The beans, on the other hand, were all killed, although they are ordinarily much more hardy than onion seed. It is quite probable, however, that the death of the beans may be attributed to the reduction in temperature. Containing as they do large quantities of starch, they absorb more water than less starchy or more oily seeds. This factor, together with the large embryo, renders them much more susceptible to the injurious action of freezing temperatures.

Another important feature brought out by these experiments was the better germination of the seeds which had been stored in bottles in the ice house. The average germination of these samples was 2.7 per cent higher than that of the control. In a measure this may be included within the limits of variation; but when it is considered that all of the bottle samples except the beans, tomato, and lettuce showed a vitality equal to or greater than the control, it can hardly be considered as a normal variation, especially since only the lettuce gave any marked variation in favor of the control. Likewise, the average percentages of the first series of tests show a slight increase in favor of the seeds kept in the bottles, though the increase is not so well marked and is less uniform than in those of the second series.

Aside from the final germination there is still another factor that must be taken into consideration as bearing evidence of the advantage of keeping seeds at low temperatures, provided that they are kept dry. All of the samples that were stored in the ice house in bottles showed a marked acceleration in germination. It is quite evident that the respiratory activities and accompanying chemical transformations were much reduced by the reduction in temperature, and the vital energy was thus conserved; but when the conditions were favorable for germination the greater amount of reserve energy in these seeds gave rise to a more vigorous activity within the cells and a corresponding acceleration in germination.

Numerous other experiments showing the effect of moisture on the vitality of seeds were made. In contrast to those just given, the injurious action of moisture at higher temperatures, yet temperatures well within the limits of those ordinarily met with in the handling of seeds, will be next considered.

EFFECT OF MOISTURE ON VITALITY AT HIGHER TEMPERATURES.

This set of experiments was undertaken particularly to furnish conditions somewhat similar to those existing in the States bordering on the Gulf of Mexico, or, in fact, all places having a relatively high degree of humidity and a temperature ranging from 30° to 37° C. (86° to 98.6° F.) during the summer months. In order to secure the desired degrees of temperature two incubators were utilized, one being maintained at a temperature varying from 30° to 32° C., the other from 36° to 37° C. The thermo-regulators were so adjusted as to admit of a possible variation of nearly two degrees in each case.

Beans, cabbage, carrot, lettuce, and onion were used for these tests. In each of the incubators the seeds were subjected to four different methods of treatment: 1. In a moist atmosphere, in free communication with the outside air. 2. In a moist atmosphere, but not in contact with fresh air, the seeds being in sealed bottles of 250 cc. capacity. 3. In a dry atmosphere, in free communication with the outside air. 4. Air-dried seeds in sealed bottles.

In order to obtain the conditions requisite for the first method of treatment, an apparatus was used as shown in figure 1. The seeds were put up in small packages and then placed in a 250 cc. bottle. The bottle containing the packages of seeds was placed within a specimen jar which was partially filled with water. This jar was then closed with a large cork stopper which carried two glass tubes, each of 1 cm. bore. These tubes extended 25 cm. above the top of the jar and out through the opening in the top of the incubator. The primary object of the tubes was to prevent any water vapor from escaping within the incubator and thereby doing damage to the seeds that were to be kept dry in the same incubator. For the same reason the cork in the jar was well coated with paraffin. Approximately the same volume of water was maintained in the jar throughout the experiment, more water being added through tube *a*, as occasion demanded, to replace the loss by evaporation. The chief advantage in having two tubes was the comparative ease with which the air within could be displaced by a fresh supply by forcing a current of fresh air through one or the other of the tubes.

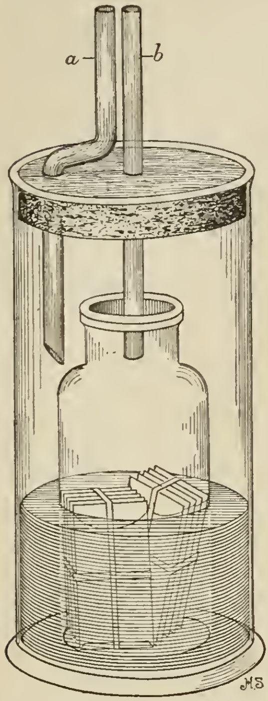

FIG. 1.—Apparatus used to determine the effect of moisture and temperature on the vitality of seeds in communication with free air.

Two such preparations were made, one being left in the oven maintained at a temperature varying from 30° to 32° C., the other in the oven maintained at a temperature varying from 36° to 37° C. In both cases the bottles contained five packages of each of the five samples of seed, thus making provisions for testing at different intervals.

In order to supply the conditions for the second method of treatment, similar packages from the same samples of seeds were put into 8-ounce bottles, which were then kept for five days in a moist chamber. The increase in weight due to the absorption of water within the five days was as follows: Beans, 3.03 per cent; cabbage, 8.09 per cent; carrot, 8.26 per cent; lettuce, 7.45 per cent, and onion 8.43 per cent. This increase, with the water already present in the air-dried seeds, gave a water content of 13.23 per cent for the beans, 13.99 per cent for the cabbage, 13.60 per cent for the carrot, 12.45 per cent for the lettuce, and 14.84 per cent for the onion.

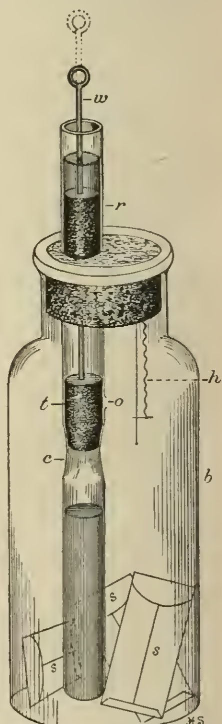

FIG. 2.—Apparatus used to determine the effect of moisture and temperature on the vitality of seeds not in communication with free air.

The bottles were then corked and sealed with paraffin, but were so constructed that the relative humidity of the inclosed air could be increased without the admission of more free air. The detailed construction of this apparatus is shown in fig. 2.[a]

The seeds continued to absorb moisture to a limited extent. In order that the inclosed air might be maintained at approximately the same degree of saturation, a crude hygroscope was attached on the inside of each bottle. These hygroscopes were made from awns of *Stipa capillata* L., the tip of the awns being removed and a short piece of fine copper wire used as an indicator. These hygroscopes were suspended from the under side of the cork, as shown at *h*, and by the side of each was suspended a fine fiber of silk, which, being carried around by the indicator, recorded the number of turns made by the awn.

Five such preparations were made for each of the two sets, so as to furnish seeds for a series of tests. One set was kept at a temperature of 30° to 32° C., the other at 36° to 37° C. The seed from one of the bottles, at each of the temperatures, was weighed after eighty-one days, at the time the germination tests were made. These weighings showed that at the lower temperatures the average increase in weight for all the seeds was 8.6 per cent, and at the higher temperatures, 6.3 per cent. The increase in the case of the beans was quite marked at this time, being 13.3 per cent for those maintained at a temperature ranging from 30° to 32° C., and 9.8 per cent for those maintained at 36° to 37° C.

The third set of conditions consisted simply of packages of the air-dried seeds kept in open boxes in each of the incubators. This series of tests was made especially for the purpose of determining the effect of dry heat on the vitality of seeds when maintained at the temperatures above given for some considerable time.

For the fourth series small packages of the seeds were put into 2-ounce bottles, which were then corked and sealed with paraffin. Five of these bottles were kept in each of the ovens and germination tests were made at irregular intervals. The results of these tests furnish a

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[a] The wide-mouth bottle (*b*) contains the packages of seed (*s*). Through an opening in the cork is inserted a short piece of soft glass tubing, being first fused at the lower end and having a slight constriction drawn at *c*. At a distance of 1 cm. above the constriction is blown a small opening, as shown at *o*. A short piece of heavy rubber tubing (*t*), cemented on a piece of heavy brass wire (*w*), serves as a stopper. This stopper, which must fit closely within the glass tube, is operated by means of the heavy wire. When drawn up, the water in the tube may give off aqueous vapor, which can escape through the small opening (*o*) into the bottle. When sufficient moisture is present the supply is shut off by pushing the stopper down firmly against the constriction. The stopper must be well coated with vaseline to prevent its sticking to the sides of the glass tube. To make the apparatus more secure against the entrance of fresh air, a second piece of rubber tubing (*r*) is placed in the upper part of the glass tube, the top of which is then filled with oil.

basis for comparing the relative merits of keeping seeds in open vessels and in sealed bottles.

Table IX will show the effect of the various methods of treatment on the vitality of the seeds.

TABLE IX.—*Vitality of seeds when subjected to the action of a dry and a moist atmosphere, both when exposed to free air and when confined in glass bottles, at relatively high temperatures.* [a]

Kind of seed.	Beginning of experiment.	End of experiment and date of germination tests.	Duration of experiment.	Vitality of seeds when kept in a moist atmosphere.				Vitality of seeds when kept in a dry atmosphere.				Germination of control samples.
				In open bottles, at temperatures varying from—		In sealed bottles, at temperatures varying from—		In open boxes, at temperatures varying from—		In sealed bottles, at temperatures varying from—		
				30° to 32°.	36° to 37°.	30° to 32°.	36° to 37°.	30° to 32°.	36° to 37°.	30° to 32°.	36° to 37°.	
			Days.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Bean	Mar. 4	Apr. 4	31	100.0	100.0	78.0	44.0	86.0	84.0	98.0	98.0	94.0
Do	...do....	May 12	69	97.5	0.0	75.0	0.0	100.0	90.0	92.5	95.0	98.7
Do	...do....	May 21	81	94.0	......	0.0	0.0	98.0	90.0	98.0	100.0	98.0
Do	...do....	July 22	140	2.3	......	0.0	0.0	100.0	94.0	98.0	96.0	99.4
Cabbage	...do....	Apr. 4	31	87.8	90.5	73.0	72.5	86.5	84.0	83.5	86.9	91.0
Do	...do....	May 12	69	71.6	0.0	30.0	0.0	67.5	87.9	79.0	78.5	83.0
Do	...do....	May 21	81	80.0	......	1.0	0.0	89.0	92.0	92.5	92.0	92.5
Do	...do....	July 22	140	0.0	......	0.0	0.0	84.0	83.0	88.5	86.7	93.1
Carrot	...do....	Apr. 4	31	83.5	77.5	54.5	29.5	84.5	88.0	89.5	89.0	92.5
Do	...do....	May 12	69	69.5	0.0	22.5	0.5	82.0	85.0	83.5	82.5	78.0
Do	...do....	May 21	81	48.0	......	2.5	0.0	44.5	50.0	50.0	48.0	64.5
Do	...do....	July 22	140	0.5	......	0.5	0.0	81.0	81.2	78.5	83.1	83.1
Lettuce	...do....	Apr. 4	31	92.5	90.5	78.0	58.0	91.0	86.5	91.5	90.0	90.0
Do	...do....	May 12	69	38.0	0.0	44.5	2.0	42.0	38.5	38.5	51.5	31.5
Do	...do....	May 21	81	55.5	......	1.0	0.0	65.0	58.5	62.5	67.0	53.5
Do	...do....	July 22	140	0.0	......	1.5	0.0	82.0	87.0	81.5	88.0	79.9
Onion	...do....	Apr. 4	31	95.5	89.0	64.5	45.0	95.5	93.0	96.0	97.5	96.0
Do	...do....	May 12	69	68.0	0.0	2.5	0.0	97.0	95.0	97.5	93.0	98.5
Do	...do....	May 24	81	59.5	......	0.0	0.0	95.5	94.0	99.0	95.0	96.5
Do	...do....	July 22	140	0.0	......	0.0	0.0	90.0	92.0	97.5	94.7	95.4

[a] A study of the table will show that the lettuce and carrot seed germinated very poorly at the end of 69 and 81 days. This, however, was not due to any inherent quality of the seed, but to an excessive temperature at the time the tests were made. Both of these seeds require a comparatively low temperature for their successful germination, lettuce germinating best at 20° C., and carrot at an alternating temperature of from 20° to 30° C.

The amount of moisture absorbed or expelled under the different methods of treatment has an important bearing on the duration of vitality and will be considered briefly at this time. Only the general results will be discussed in this connection, inasmuch as later experiments, carried out in a similar manner, show the detailed results to much better advantage. Nevertheless, it requires only a glance at the above table to show the marked difference in the germinative power of seeds which have been stored in moist and in dry conditions. The seeds which were exposed in a moist atmosphere to the higher temperatures (36° to 37° C.) were killed much earlier than those subjected to the moist atmosphere at the lower temperatures—30° to 32° C.—in both the open and the closed bottles.

A weighing at the end of 31 days showed that the average increase in weight of the seeds kept in the open, moist chamber, due to the absorption of moisture, was 6 per cent at a temperature of 30° to 32° C., and 5 per cent at a temperature of 36° to 37° C. For the seeds kept in the oven, maintained at the temperature of 30° to 32° C., another weighing was made at the end of 134 days, at which time the average increase in the water content had risen to 8.67 per cent. Unfortunately the seeds from the second oven, maintained at the higher temperature, had become badly molded in 69 days, so that only the one weighing was made.

Vitality tests made at this time, 69 days, showed that all of the seeds from the open, moist chamber, at the higher temperatures, had been previously killed as a result of the drastic treatment; consequently no future germination tests were made. Those maintained at the lower temperatures were almost entirely free from mold at the expiration of the experiment, only an occasional seed showing any trace of fungous growth. Nevertheless, germination tests showed that the vitality had been destroyed in the cabbage, lettuce, and onion. Beans and carrot were most resistant, the former having germinated 2.3 per cent and the latter 0.5 per cent. All of the seeds had become very much softened. The beans and the lettuce had changed very materially in color, the beans (Early Kidney Wax Six Weeks) having become much darker and the lettuce (Black-Seeded Simpson) almost a lemon color.

With the seeds constituting the second series, i. e., *in a moist atmosphere but in sealed bottles*, the injury was much more severe. Here, as with the open chambers, the seeds subjected to the higher temperatures were killed first, even though the amount of moisture actually absorbed was less, as was also true with the other series. A weighing made at the end of 81 days gave an increase of 8.6 per cent for those from the oven maintained at a temperature of 30° to 32° C., and 6.3 per cent at the higher temperature. Likewise, in this series, the seeds had become very much softened and a very disagreeable odor had developed as a result of the putrefaction of their nitrogenous constituents. A close examination made at the end of 81 days revealed slight traces of fungous growth, but there is no reason to believe that these played any part in the destruction of vitality. However, in making counts for germination tests all molded seeds were carefully discarded.

The results of the germination tests showed that the vitality of the seeds kept at the lower temperatures had been practically destroyed at this time. The beans and onions failed to germinate, while the cabbage, carrot, and lettuce germinated only 1, 2.5, and 1 per cent, respectively.

During the succeeding 60 days much mold had developed, and at the expiration of the experiment, 140 days, only the carrot and the lettuce gave any indications of vitality. It is especially interesting to note with what rapidity the deterioration took place between the sixty-ninth and the eighty-first days, showing that when vitality reaches a certain point in its decline there follows a comparatively sudden death. This same fact is also shown in the case of those seeds in this same series kept at the higher temperature. After 31 days' treatment they all failed to germinate, except 0.5 per cent in carrot and 2 per cent in lettuce seeds.

In the two series of experiments just considered there was an increase in water content as a result of the humidity of the air in which the seeds were kept. But the third series, *open and dry*, presents quite another factor. A weighing made at the end of 30 days showed that there had been an average loss of 2.5 per cent for the lower temperatures and 3.5 per cent for higher temperatures. After this time the weight remained nearly constant. Subsequent experiments, which will be considered later, also show that the water capable of being expelled at any given atmospheric temperature is driven off in a comparatively short time. In case of seeds this condition is practically completed in eight or ten days when maintained at temperatures as above given. This extra drying of the seed causes a greater contraction of the seed coats, and in a number of cases a corresponding retardation in the rapidity with which germination takes place. The retardation in the germinative activity is dependent on the increased difficulty with which the seeds absorb water, and in many cases has an important bearing on the vitality tests.

The fourth and last series, in which the air-dried seeds were sealed in bottles and subjected to the temperatures at which the two ovens were maintained, gave still another very different set of conditions. Here there was also an increase in weight, due probably to some process of oxidation, but the increase was very slight. The average increase from those kept at either of the temperatures was less than one-half of one per cent.

Seeds, if well matured and thoroughly air-dried, are not injured when kept at temperatures below 37° C., whether they be kept in free communication with fresh air, or in sealed bottles, or tubes. In the experiments under discussion the average percentage of germination was slightly higher in the case of the seeds which had been stored in the sealed bottles. The mean percentage of germination for the seeds which had been exposed to the open air at a temperature of 30° to 32° C. was 83.05 per cent. Those from the sealed bottles kept at the same temperature germinated 84.82 per cent. At the higher temperatures—36° to 37° C.—the mean germination of the seeds from the open and the closed bottles was 82.68 and 85.62 per cent, respectively. The control sample germinated 85.45 per cent. That 37° C. is about the maximum temperature at which air-dried seeds can be stored without injury is shown by the following experiments.

Preparations similar to those above mentioned were used, and after being subjected to a temperature of 37° C. for 219 days, there was no appreciable loss in vitality, except the deterioration of 4 per cent in the case of the cabbage seed that was kept in an open bottle, and 6.3 per cent in the seed from a closed bottle.[a] But by increasing the temperature, during an additional period of 68 days, from 37° C. to a maximum of 44° C., the injury was much more marked, especially in the closed bottles. In the open bottles the vitality of the cabbage was lowered from 91.3 per cent to 77 per cent, representing a loss in vitality of 15.66 per cent. The onion seed fell from 95.7 per cent to 87 per cent when kept in an open bottle, and to 61 per cent when kept in a closed bottle. The beans showed no apparent injury in either case, except that they became very dry; consequently there was a retardation in germination as a result of the slow absorption of water.

The greater loss in vitality of the seeds kept in the bottles was the direct result of the higher humidity of the air immediately surrounding the seed, and not because there was a deficiency in the supply of fresh air, as might be readily assumed. In the open receptacles the additional amount of free water expelled, as a result of the increase in temperature, was allowed to escape, while in the sealed bottles it only gave rise to a relatively moist atmosphere, and consequently to a premature death of some of the seeds. If seeds are to be so confined, they should be previously dried at a temperature at which they are to be stored.

All of these seeds had become very dry and brittle. The odor of the air confined within the sealed bottles had become very unpleasant; likewise there was a marked change in the color of the seed coats of the inclosed seeds.

SUMMARY.

Most seeds if kept dry are not injured by prolonged exposures to temperatures below 37° C. (98.6° F.), it being immaterial whether they are in open or in sealed bottles.

If the temperature be increased above 37° C., vitality is seriously reduced.

If seeds are kept in a moist atmosphere, a temperature even as high as 30° C. (86° F.) works much injury in a comparatively short period. The degree of injury rapidly increases as the temperature rises.

Provided the degree of saturation is the same, the deleterious effect of moisture is fully as great in open as in closed bottles.

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[a] Only cabbage, onion, and beans were used for this experiment, the carrot and the lettuce seed being omitted.

THE EFFECT OF DEFINITE QUANTITIES OF MOISTURE ON THE VITALITY OF SEEDS WHEN THEY ARE KEPT WITHIN CERTAIN KNOWN LIMITS OF TEMPERATURE.

The results of the experiments just discussed furnish a fair criterion by which to judge the vitality of seeds when influenced by temperature and moisture. It was still necessary to determine the effect of definite quantities of moisture on the vitality of seeds when they are submitted to temperatures well within the limits of that which may be encountered in commercial transactions.

On December 19, 1900, preparations were made to determine these factors. Seeds of cabbage, lettuce, onion, tomato, and peas were used for these experiments, which continued for 70 or 72 days. All of this seed was of the harvest of 1899 and had been in the laboratory during the eleven months immediately preceding the setting up of the experiments, being thus thoroughly air-dried. The amount of moisture present in the seeds at this time, as indicated by drying at 100° C., was as follows: Cabbage, 5.90 per cent; lettuce, 5 per cent; onion, 6.41 per cent; tomato, 4.71 per cent, and peas, 8.44 per cent.

The preparations were made as follows:

(*a*) Air-dried seeds were placed in bottles of 125 cc. capacity. The bottles were closed with cotton plugs in order to protect the seeds from dust while permitting a free circulation of air. This set served largely as a check.

(*b*) Air-dried seeds were carefully weighed and then put into 125 cc. bottles, closed with firm corks, and sealed with paraffin.

(*c*, *d*, *e*, and *f*) These samples were also carefully weighed and sealed in bottles as *b*, but in the different series of bottles there was first introduced 0.5, 1, 2, and 3 cc. of water which had been previously absorbed by small strips of filter paper.

(*g*) The seeds constituting this series were first dried for 30 days at a temperature of from 30° to 32° C. and then put up in bottles which were sealed with paraffin. The loss in weight as a result of the drying was as follows: Cabbage, 2.41 per cent; lettuce, 2.59 per cent; tomato, 2.71 per cent, and onion, 3.47 per cent, leaving a water content of only 3.49 per cent, 2.41 per cent, 2 per cent, and 2.94 per cent, respectively. (Peas were not included in this series.)

One of each of the above preparations was then subjected to different degrees of temperature as follows:

(1) Outdoor conditions, protected from rain and snow, but freely subject to all changes in temperature and humidity. The temperature during the time of the experiment, December 19, 1900, to February 28, 1901, varied from a minimum of −21.6° C. to a maximum of 8.9° C.

(2) In a fruit cellar having a comparatively low and uniform temperature ranging from 10° to 13° C.

(3) In the "dark room" of the botanical laboratory, which was quite dry and maintained at a temperature of 20° to 22° C.

(4) In the herbarium room on the fourth floor of the botanical laboratory. The air here was very dry and the mean temperature about the same as for No. 3, but with a much wider variation, reaching at times a maximum of 30° and a minumum of 10° C.

(5) In an incubator maintained at 30° to 32° C.

(6) In an incubator maintained at 37° to 40° C.

It will be observed that all of the preparations, except Nos. 1 and 4, were kept at temperatures which were quite uniform. The increase or decrease in the weight was determined at the expiration of 70 or 72 days by again carefully weighing the seed, after which germination tests were made. The results of the germination tests and the gain or loss in weight are given in Table X.

TABLE X.—*Relation of moisture and temperature to vitality.*

Laboratory numbers.	Place where seeds were stored.	Extremes of temperature to which seeds were subjected.	Amount of water put into each bottle.	Cabbage.			Lettuce.			Onion.				Tomato.			Peas.		
				Percentage of increase in weight while seeds were inclosed in bottles.	Percentage of germination.		Percentage of increase in weight while seeds were inclosed in bottles.	Percentage of germination.		Percentage of increase in weight while seeds were inclosed in bottles.	Percentage of germination.			Percentage of increase or decrease in weight while seeds were inclosed in bottles.	Percentage of germination.		Percentage of increase or decrease in weight while seeds were inclosed in bottles.	Percentage of germination.	
					At the end of 36 hours.	Final.		At the end of 36 hours.	Final.		At the end of 77 hours.	At the end of 120 hours.	Final.		At the end of 72 hours.	Final.		At the end of 60 hours.	Final.
		Degrees C.	*cc.*																
Control..	Botanical laboratory....	....	....	....	57.3	92.8	....	80.7	92.0	....	29.5	89.5	91.8	....	73.0	97.7	....	90.0	92.0
1534......	Outdoors...............	−21.6− 8.9	(*a*)	....	56.0	91.5	....	79.5	92.0	....	26.0	90.0	97.0	....	72.5	97.0	....	90.0	98.0
1535......	Fruit cellar.............	10 −13	(*a*)	....	56.5	89.5	....	81.5	94.0	....	18.5	83.0	94.5	....	77.5	96.5	....	96.0	98.0
1536......	Dark room..............	20 −22	(*a*)	....	58.0	89.5	....	82.5	92.5	....	23.0	89.0	96.0	....	70.5	97.0	....	78.0	92.0
1537......	Herbarium room.........	10 −30	(*a*)	....	63.0	94.0	....	83.5	93.0	....	24.5	88.5	98.0	....	71.5	94.0	....	87.2	89.1
1538......	Incubator...............	30 −32	(*a*)	....	55.0	93.5	....	82.0	90.5	....	23.0	85.5	97.5	....	72.0	97.0	....	76.0	86.0
1539......	Incubator...............	37 −40	(*a*)	....	54.0	89.0	....	83.0	92.5	....	16.5	77.5	95.5	....	67.5	92.5	....	64.0	72.0
1528......	Outdoors...............	−21.6− 8.9	(*b*)	0.06	57.5	89.0	None.	76.5	91.5	0.13	35.0	92.5	98.5	0.12	71.0	95.5	0.16	90.0	96.0
1529......	Fruit cellar.............	10 −13	(*b*)	0.08	61.0	90.0	0.18	80.0	93.5	0.54	26.5	87.5	95.0	0.22	74.0	94.5	−0.20	86.0	94.0
1530......	Dark room..............	20 −22	(*b*)	0.11	52.0	91.0	0.26	79.5	94.0	0.35	27.0	87.5	99.0	0.03	68.5	93.5	−0.28	86.0	90.0
1531......	Herbarium room.........	10 −30	(*b*)	0.16	58.0	90.5	0.16	81.5	90.5	0.35	27.0	84.0	95.5	0.27	74.5	96.5	−0.25	98.0	100.0
1532......	Incubator...............	30 −32	(*b*)	0.17	50.0	91.5	0.13	79.0	91.5	0.45	18.5	77.0	93.5	0.14	60.5	92.5	−0.74	88.0	92.0
1533......	Incubator...............	37 −40	(*b*)	0.05	25.0	88.0	0.11	68.5	91.0	0.24	2.5	59.5	96.0	None.	47.0	93.0	−0.32	94.0	100.0
1522......	Outdoors...............	−21.6− 8.9	0.5	1.47	66.0	90.0	1.89	77.0	92.0	3.13	33.0	86.5	97.5	2.14	82.5	96.0	1.31	90.0	94.0
1523......	Fruit cellar.............	10 −13	0.5	1.54	62.0	92.5	1.44	79.0	91.0	2.81	23.5	84.0	96.0	1.60	63.5	98.5	1.31	88.0	92.0
1524......	Dark room..............	20 −22	0.5	1.38	59.0	90.5	1.41	83.5	93.0	3.02	27.0	86.0	98.0	1.96	80.5	95.0	1.48	96.0	96.0
1525......	Herbarium room.........	10 −30	0.5	1.02	54.5	94.5	1.01	83.0	93.0	2.47	19.5	87.5	99.5	1.40	76.5	94.0	1.38	94.0	98.0
1526......	Incubator...............	30 −32	0.5	1.43	26.5	86.5	1.44	72.5	87.5	2.96	3.5	62.5	93.0	1.86	65.0	91.0	1.68	88.0	96.0
1527......	Incubator...............	37 −40	0.5	1.26	0.0	82.5	1.20	27.0	85.0	2.65	0.0	10.5	51.0	1.38	32.0	89.0	1.43	66.0	88.0
1504......	Outdoors...............	−21.6− 8.9	1.0	3.01	70.0	95.0	3.34	81.0	94.5	5.49	24.0	85.0	96.5	3.16	83.0	92.5	2.96	94.0	94.0
1505......	Fruit cellar.............	10 −13	1.0	2.79	53.5	88.5	3.03	78.0	93.5	5.22	24.5	88.5	96.0	3.40	84.0	96.0	3.24	94.0	96.0
1506......	Dark room..............	20 −22	1.0	2.82	51.5	91.5	2.75	78.0	90.5	4.57	19.5	84.5	97.0	3.23	81.0	95.0	3.49	98.0	98.0
1507......	Herbarium room.........	10 −30	1.0	2.41	60.0	92.0	2.39	77.5	89.5	4.12	11.5	81.0	94.0	2.75	76.5	95.5	3.35	100.0	100.0
1508......	Incubator...............	30 −32	1.0	2.66	5.5	81.5	2.24	53.0	86.5	3.72	0.0	19.5	53.0	2.48	59.0	92.0	3.01	80.0	90.0
1509......	Incubator...............	37 −40	1.0	2.35	0.0	11.0	2.33	0.0	55.0	3.91	0.0	0.0	0.0	2.70	1.0	67.5	3.29	38.0	80.0
1510......	Outdoors...............	−21.6− 8.9	2.0	5.08	60.0	93.0	5.34	83.5	96.5	7.89	24.0	88.5	97.5	5.36	83.0	93.0	6.74	92.0	98.0
1511......	Fruit cellar.............	10 −13	2.0	5.08	62.5	92.0	5.22	83.0	90.0	7.47	25.0	87.0	97.0	5.47	84.5	93.5	7.02	96.0	96.0
1512......	Dark room..............	20 −22	2.0	5.19	27.5	90.5	4.71	74.5	90.0	6.73	4.5	47.0	76.0	4.60	75.5	93.5	4.57	90.0	96.0

1513	Herbarium room	10 -30	2.0	5.36	26.5	86.0	4.85	72.5	91.0	7.14	8.5	64.0	85.5	5.12	84.5	98.5	7.17	98.0	100.0
1514	Incubator	30 -32	2.0	5.71	0.0	3.5	5.19	0.0	34.0	9.31	0.0	0.0	0.0	5.00	18.5	77.5	7.50	30.0	54.0
1515	Incubator	37 -40	2.0	4.62	0.0	0.0	4.81	0.0	0.0	6.59	0.0	0.0	0.0	4.60	0.0	2.0	6.92	0.0	0.0
1516	Outdoors	-21.6- 8.9	3.0	7.50	52.0	92.0	7.02	79.5	95.0	10.38	13.0	80.0	94.0	6.50	70.5	92.0	11.22	96.0	96.0
1517	Fruit cellar	10 -13	3.0	7.50	52.5	89.0	6.80	84.5	94.0	9.54	18.0	82.5	94.5	6.77	80.5	95.0	9.73	100.0	100.0
1518	Dark room	20 -22	3.0	6.67	22.0	83.5	6.73	54.0	80.5	9.78	4.5	22.0	37.5	6.70	71.5	91.0	10.86	88.0	88.0
1519	Herbarium room	10 -30	3.0	7.59	16.0	77.5	6.96	59.5	78.0	8.90	0.5	8.5	17.5	6.26	67.5	93.5	11.18	88.0	88.0
1520	Incubator	30 -32	3.0	7.51	0.0	0.0	7.20	0.0	0.0	9.37	0.0	0.0	0.0	6.18	5.0	64.5	10.79	0.0	4.0
1521	Incubator	37 -40	3.0	6.89	0.0	0.0	6.43	0.0	0.0	9.25	0.0	0.0	0.0	5.18	0.0	0.0	10.72	0.0	0.0
1540	Outdoors	-21.6- 8.9	(c)	0.33	57.5	88.5	0.28	79.0	93.5	0.22	28.0	91.5	99.5	0.23	73.5	92.5	......	......	......
1541	Fruit cellar	10 -13	(c)	0.10	52.5	92.0	None.	78.0	89.5	None.	32.0	91.5	99.5	0.20	75.0	99.0	......	......	......
1542	Dark room	20 -22	(c)	0.18	63.5	92.0	0.27	81.5	90.0	0.06	29.5	90.0	96.5	0.03	74.5	96.0	......	......	......
1543	Herbarium room	10 -30	(c)	0.02	50.0	90.5	0.02	84.5	95.5	0.04	25.0	88.5	97.0	0.08	68.0	97.5	......	......	......
1544	Incubator	30 -32	(c)	None.	60.0	89.0	0.02	79.5	92.0	None.	29.0	83.5	95.5	-0.24	69.5	95.5	......	......	......
1545	Incubator	37 -40	(c)	None.	50.0	91.0	None.	74.5	89.5	0.11	21.5	86.0	97.0	-0.02	67.5	95.5	......	......	......
1546	Herbarium room	10 -30	(c)	0.60	58.5	93.0	0.58	84.0	92.5	0.89	25.0	83.0	97.0	1.56	78.0	94.5	......	......	......

[a] These bottles were simply closed with a cotton plug. [b] Air-dried seeds. [c] Dried 30 days at 30° to 32° C. and then kept in open bottles until tests were made 40 days later.

The foregoing table, showing the conditions under which the seeds were kept, has been made quite complete. Aside from the final percentages of germination, the percentages of germination after a definite number of hours have likewise been given, the latter being better expressed as germinative energy. The germinative energy, as has been previously stated, is an important factor in determining the potential energy of a seed. This is quite clearly shown in many of the germination tests recorded in the above table. The preliminary results show a marked contrast as a result of the different kinds of treatment, while the final results reveal nothing more than the regular degree of variation usually met with in testing seeds. Of the five species of seeds, the onion has yielded the most striking variations in the earlier stages of germination. Take, for example, No. 1535, the sample that was kept in an open bottle in the fruit cellar. The moisture absorbed was sufficient to cause a chemical transformation, which injured the vitality of the seed and consequently caused a retardation in germination. No. 1539, the onion seed from the incubator maintained at a temperature of 37° to 40° C., germinated only 16.5 per cent in 77 hours, while the final percentage of germination was 95.5 per cent. Onion seeds Nos. 1532 and 1533 germinated in 77 hours 18.5 and 2.5 per cent respectively, while the final germination of the former was 93.5 per cent and of the latter 96 per cent. All of these tests gave final percentages of germination somewhat higher than the mean of the control samples. But the germination was considerably retarded, the control samples having germinated 29.5 per cent during the first 77 hours. These retardations in germination must be due to a lowering of vitality, as a more careful study of the table will show, and not to any excessive drying that may have taken place during the time of treatment. Numerous other examples are to be found in the table, some even more striking than those mentioned, but it is not deemed necessary that they all be pointed out and discussed here.

The table also shows the results of the various weighings made of all of the different samples which were kept in closed bottles. With but very few exceptions there was an increase in weight, which increase was quite marked in all cases where free water was introduced. The air-dried seeds that were sealed in bottles without the introduction of free water all increased slightly in weight, with the exception of the peas, which showed a slight decrease in weight. It has been observed that the absolute loss in the weight of the peas was slightly greater than the total gain in the four other samples of seed. This, however, is not of sufficient uniformity throughout to fully justify the conclusion that cabbage, lettuce, onion, and tomato seed have a greater affinity for water than peas, and that the former robbed the latter of a portion of their water content. Yet a portion of the increased weight of the cabbage, lettuce, onion, and tomato seed is probably best accounted for in that way. On the other hand, it is quite probable that a portion of the increase in weight was due to the results of intramolecular transformations and to the coexistent respiratory activities of the seed. The means of making these determinations are far from easy. Van Tieghem and G. Bonnier have shown[a] that seeds kept in sealed tubes in atmospheric air increased in weight during two years, but the increase was very small. In their experiments the peas which were in sealed tubes increased $\frac{1}{790}$ of their original weight. A corresponding sample kept in the open air increased $\frac{1}{72}$ of its original weight.

Nos. 1540 to 1545 in Table X show an increased weight in seeds when sealed in bottles for 70 days. These seeds were previously dried for 30 days at a temperature of 30° to 32° C. Disregarding the increase in weights as above given and the factors to which such increase may be attributed, it is quite evident that in all cases where water was added the increase in weight was due chiefly to the absorption of the water. The absolute increase was approximately the same as the weight of the water added.

The amount of water absorbed by different seeds varies greatly under identical conditions, depending largely upon the nature of the seed coats and the composition of the seed. The average increase in weight of the seeds used in these experiments was as follows: Onion, 6.27 per cent; pea, 5.51 per cent; cabbage, 4.12 per cent; lettuce, 3.99 per cent; tomato, 3.99 per cent. The loss in vitality of the corresponding samples was 28, 12, 23.7, 18.5, and 14.7 per cent, respectively. The relationship here is quite close, the amount of water absorbed being roughly proportional to the loss in vitality. The peas, however, afford an exception to this general statement. But it must be remembered that peas require a much larger percentage of moisture to start germination and are likewise capable of undergoing much wider variations than the other seeds in question. However, before a definite ratio can be established between the absorption of water and the loss in vitality, many other factors must be taken into consideration, such as the composition, water content, and duration of vitality of the seed under natural conditions.

Another interesting factor is shown in No. 1546 of Table X. These seeds were dried for 30 days at a temperature of 30° to 32° C., after which they were kept in an open bottle in the laboratory for 40 days. During the 30 days' drying the cabbage lost 2.41 per cent, lettuce 2.59 per cent, tomato 2.71 per cent, and the onion 3.47 per cent of moisture. These same seeds when exposed to the free air of the laboratory for 40 days never regained their original weight, the increase being as follows: Cabbage, 0.6 per cent; lettuce, 0.58 per cent; tomato, 1.56 per cent; onion, 0.89 per cent. The average quantity of water expelled was 2.79

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[a] Bul. Soc. bot. France, **29**: 25–29, 149–153, 1882.

per cent in 30 days, while the average increase in weight during the 40 days was only 0.91 per cent. These results show that if seeds are once carefully and thoroughly dried, they will remain so; that is, if kept in a comparatively dry room. This is an important factor in the preservation of vitality, as is borne out in the results of the germination tests. Later experiments were made with very similar results, and an analogous method of treatment promises to be of much value as a preliminary handling of seeds. It is not definitely known to what this stronger vitality is due, whether it be simply to the effect of the drying or to some process of chemical transformation which makes the seeds more viable. These results are now under consideration and will be reported at some future time.

The table also shows in a very striking degree the decrease in the number of germinable seeds with an increase in the moisture and temperature. The amount of moisture absorbed by the seeds, with a limited amount present in the bottles, was inversely proportional to the temperature. At the higher temperatures the inclosed air held a larger portion as water vapor; however, there was a greater deterioration in vitality. Where the seeds were kept outdoors at the low temperatures (−21.6° to 8.9° C.) of the winter months, no injury was apparent except where 3 cc. of water was added, and then only the onion seed was affected. This sample of seed had absorbed a quantity of water equal to 10.38 per cent of the original weight, which together with the original water content (6.41 per cent of the original sample) made 17.88 per cent of moisture in the seed. Practically the same results were obtained with the seeds kept in a fruit cellar at a temperature of 10° to 13° C. The samples of this series, in the open bottles, were also injured, as has been pointed out. With the samples that were stored in the dark room and in the herbarium room, the injury was more marked as a result of the higher temperature; but even here the seeds in the bottles which contained 0.5 cc. of free water deteriorated very little. The injury was confined to the onion seed, which showed a slight retardation in germination. Where 1 cc., 2 cc., and 3 cc. of water were added, vitality in some instances was likewise remarkably well preserved. The lettuce, tomato, and peas gave no indications of any deterioration save in the bottles containing 3 cc. of water. Here the lettuce and peas were permanently injured, while the tomato seeds suffered only sufficiently to cause a delay in the rapidity with which they germinated. The cabbage seed was retarded with 2 cc. and a lowering of the final percentage of germination with 3 cc. of water. The onion seed, being very sensitive to these unfavorable conditions, deteriorated very greatly, being practically worthless where 3 cc. of water were added. A brief study of the table will readily show that many seeds were killed at the still higher temperatures of 30° to 32° C. and 37° to 40° C. The onion seed was slightly injured even where no water was added. However, a temperature of 40° C. is sufficient to injure many seeds, even though the liberated water be permitted to escape, as is shown in the tests of the onion, No. 1539 of the table. The greatest injury when air-dried seeds are sealed in bottles and then subjected to a higher temperature is due to the increased humidity of the confined air, as a result of the water liberated from the seeds.

At first glance some of the conditions given in the above table may seem to be extreme and far beyond any normal conditions that would be encountered in the ordinary handling of seeds. This may seem to be especially true with the seeds kept in the bottles with 3 cc. of water where the additional amount of moisture absorbed gave rise, in some of the seeds, to a water content of approximately 20 per cent. Yet this need not be thought of as an exception, for such extreme cases are often encountered in the commercial handling of seeds. During the process of curing even more drastic treatment is not infrequently met with. Pieters and Brown[a] have shown that the common methods employed in the harvesting and curing of *Poa pratensis* L. were such that the interior of the ricks reached a temperature of 130° to 140° F. (54.4° to 60° C.) in less than sixteen hours, at which temperature the vitality of the seed is greatly damaged and frequently entirely destroyed. The interior of one rick reached a temperature of 148° F. (64.4° C.) in twenty hours, and the vitality had decreased from 91 per cent to 3 per cent, as shown by the germination of samples taken simultaneously from the top and from the inside of the same rick.

On the other hand, the extreme cases need not be considered. Take, for example, the onion seed that was sealed in a bottle with 1 cc. of water and maintained at a temperature of 37° to 40° C. The increase in weight due to the water absorbed was 3.91 per cent, thus giving a moisture content of 11.2 per cent and a complete destruction of vitality. The cabbage seed, kept in the same bottle, had absorbed a quantity of water equivalent to 2.35 per cent of its original weight, which, with the 5.90 per cent contained in the original sample, gave 8.25 per cent of water. This sample of seed germinated only 11 per cent, having thus no economic value. In neither of these samples was the amount of water present in the seeds greater than that ordinarily found in commercial samples. Moreover, the temperature was much below that frequently met with in places where seeds are offered for sale and likewise well within the limits of the maximum temperature of our summer months, especially in the Southern States. Take, by way of comparison, the maximum temperatures of some of the places at which seeds were stored to determine the effect of climate on vitality, as shown in another part of this paper. During

[a] Bulletin 19, Bureau of Plant Industry, U. S. Department of Agriculture, 1902.

the summer of 1900 the maximum temperature at Wagoner, Ind. T., was 107° F. (41.1° C.), while that of Lake City, Fla., was 103° F. (39.5° C.). If these points are kept in mind, it is not at all surprising to find that seeds lose their vitality within a few weeks or months in warm, moist climates.

In order to make the above facts more clear the preceding table has been summarized and is presented in the following condensed form, showing the relation of the water content of the seed to vitality:

TABLE XI.—*Marked deterioration in vitality with an increase in the quantity of the water content of seeds.*

How preparations were made.	Amount of water introduced into the bottles.	Average increase in weight as a result of the greater water content.	Average moisture in seeds at the time germination tests were made.	Average germination.
	cc.	*Per cent.*	*Per cent.*	*Per cent.*
Control sample			6.07	93.3
Closed bottles, sealed with paraffin	Water expelled.	0.06	[a] 2.77	[a] 93.9
Do	None.	.08	6.55	94.0
Do	0.5	1.75	8.31	91.7
Do	1.0	3.24	9.91	83.3
Do	2.0	5.91	12.75	67.5
Do	3.0	8.13	15.10	58.6

[a] Peas not included in this set.

Numerous other results of a similar character might be cited, but it hardly seems necessary at this time, since there can be no doubt that moisture is the prime factor in causing the premature destruction of vitality in seeds in the usual conditions of storage. Why they lose their vitality as a result of the unfavorable conditions is quite a different question, and has to do with the very complex composition of the seed.

A COMPARISON OF METHODS OF STORING AND SHIPPING SEEDS IN ORDER TO PROTECT THEM FROM MOISTURE AND CONSEQUENTLY TO INSURE A BETTER PRESERVATION OF VITALITY.

SUGGESTIONS OF EARLIER INVESTIGATORS.

As early as 1832, Aug. Pyr. De Candolle[a] wrote a chapter on the conservation of seeds, in which he said that if seeds be protected from moisture, heat, and oxygen, which are necessary for germination, their vitality will be much prolonged; moreover, that if seeds are buried sufficiently deep in the soil, so that they are protected at all times from the very great influence of oxygen and moisture, their vitality will be preserved for a much longer period.

[a] Physiologie Végétale, Paris, 1832, Tome II, p. 618.

Giglioli[a] goes so far as to say:

There is no reason for denying the possibility of the retention of vitality in seeds preserved during many centuries, such as the Mummy wheat and seeds from Pompeii and Herculaneum, provided that these seeds have been preserved from the beginning in conditions unfavorable to chemical change. * * * The original dryness of the seeds and their preservation from moisture or moist air must be the very first conditions for a latent secular vitality.

Some of the earliest suggestions for storing seeds in quantity were made by Clément and Fazy-Pasteur, and were reported by Aug. Pyr. De Candolle in his Physiologie Végétale. Clément suggested the use of large cast-iron receptacles, made impervious to air and water, the well-dried seeds to be poured in through an opening at the top, after which the opening should be hermetically sealed and the seeds withdrawn through an iron pipe and stopcock at the bottom of the tank. The scheme of Fazy-Pasteur was to store seeds in wooden boxes well covered with tar. This method was especially applicable to small quantities of seeds, and was used to a limited extent at that time, but, so far as has been ascertained, it has long since been discarded. The keeping of seeds in large iron tanks, as suggested by Clément, has never been practiced to any extent. It seems quite possible, however, that the present "tank" grain elevator, now so universally used, might readily be modified in such a way as to make the method suggested by Clément quite practicable.

THE NECESSITY FOR THOROUGHLY CURING AND DRYING SEEDS.

In addition to being well matured and carefully harvested, seeds should be thoroughly cured and dried before being put into the storage bins. Much better results would be obtained if such seeds were artificially dried for several days in a current of dry air at a temperature not to exceed 35° C. With this method of drying, from 2 to 4 per cent of the moisture usually present in air-dried seeds is expelled. The accompanying contraction of the seed coats makes them more impervious to the action of moisture, and consequently the seeds are better prepared for storing and shipping. Experiments made with cabbage, lettuce, onion, and tomato seeds gave results as follows: The average loss in weight of the air-dried seeds, after an additional drying of 30 days at a temperature of 30° to 32° C. was 2.79 per cent. Yet these same seeds, when kept for 40 days in the laboratory, reabsorbed only an average of 0.91 per cent of moisture. Like quantities from the original sample gave only the slight variations ordinarily met with, due to the humidity of the atmosphere. Thus seeds, when once carefully and thoroughly dried, will not regain their original weight, provided they be kept in a dry room.

[a] Nature, 1895, **52**: 544–545.

CHARACTER OF THE SEED WAREHOUSE OR STORAGE ROOM.

Another important factor in the storing of seeds is the character of the seed warehouse or storage room. The first point to be considered is dryness. Such houses should be kept as dry as possible, which can be accomplished either by means of artificial heat or by the use of strong drying agents, or better still, by both. True, if the seed warehouse be located in a section having a dry climate, this difficulty is at once largely overcome. But in many cases such a location is impracticable or even impossible, and other means must be resorted to. As a matter of fact, most large seed warehouses are not heated and a great loss in vitality inevitably follows; but each seedsman must determine for himself whether or not this loss is sufficiently great to justify the expense of heating such a storage room.

Experiments carried on during the progress of this work have shown some very marked differences in favor of seeds stored in rooms artificially heated. The averages of the thirteen samples of seeds from the eight places at which they were stored show a difference in the loss of vitality of 9.87 per cent. Those kept in rooms that were artificially heated during a greater portion of the time deteriorated 25.91 per cent, while those stored in rooms not so heated deteriorated 35.78 per cent. The loss here given for seeds stored in dry rooms is greater than such conditions warrant, owing to the very unfavorable conditions at Mobile, Ala., and Baton Rouge, La. At Lake City, Fla., the relative percentages of deterioration were 29.42 and 16.27 for the unheated and heated rooms, respectively; at Auburn, Ala., 33.90 and 10.34 per cent, and at Durham, N. H., 39.58 and 3.57 per cent, respectively. Unfortunately these experiments were not made with this definite point in view, and the results are not entirely satisfactory, as no records were made of the temperatures and humidities.

THE VALUE OF GOOD SEED TO THE MARKET GARDENER.

This work was undertaken chiefly for the purpose of finding some improved methods of shipping and storing seeds in small packages, wherein their vitality might be better preserved. The rapid deterioration in vitality causes great losses to gardeners living in districts where the climatic conditions bring about the premature destruction of vitality in seeds. In many cases the seeds are practically worthless or altogether fail to germinate after a few weeks' exposure. The loss in such cases is not in the greater quantity of seed required, but the retardation or complete failure of the germination often means delay, making the difference between success and failure in the desired crop. Seed of low vitality is even worse than dead seed. With the latter the difficulty is soon discovered, while with the former, although the seed will germinate, the seedlings are not sufficiently vigorous to develop into strong and healthy plants. True, most enterprising gardeners usually have vitality tests made immediately preparatory to planting, but this is not always convenient, and they rely on the results of tests made at some earlier date. In such cases it quite frequently happens that they accept the results of tests made several weeks earlier. With many seeds this will suffice, yet there are many others that will deteriorate very materially within a few weeks or even within a few days in such unfavorable climates as exist, for example, near the Gulf of Mexico. In a letter dated January 15, 1903, Mr. J. Steckler, of New Orleans, La., wrote as follows concerning the vitality of seeds:

> Some seeds are not worth being planted after being here three months. This is especially true of cauliflower seed. We have made repeated tests and this seed after remaining here 90 days was worthless and had to be thrown away.

SHIPPING SEEDS IN CHARCOAL, MOSS, ETC.

Bornemann[a] made some experiments with seeds of *Victoria regia* and *Euryale ferox*, in which he found that when packed in powdered charcoal they soon lost their vitality, but when packed in powdered chalk slightly better results were obtained. On the other hand, Dammer[b] recommends powdered charcoal as a method of packing for seeds that lose their vitality during shipment, especially the seeds of palms and a number of the conifers.

Charcoal is undoubtedly much better than moist earth or moss, which are frequently used, the latter affording abundant opportunities for the development of molds and bacteria during transit. Some such method as moist charcoal is necessary in case of seeds which lose their vitality on becoming dry. Numerous other reports have been published from time to time concerning the shipping of seeds of aquatic plants, as well as those of low vitality, but they need not be discussed further at this time.

NATURE OF THE EXPERIMENTS.

Aside from some popular accounts and miscellaneous suggestions, but little has been done toward finding improved methods of shipping and storing seeds of our common plants of the garden and field. Accordingly, in February, 1900, a series of experiments was undertaken to determine some of these factors, in which three questions were considered: (1) How may small quantities of seeds be put up so as to retain a maximum germinative energy for the greatest length of time? (2) What immediate external conditions are best suited for the longevity of seeds? (3) What part do climatic conditions play in affecting the life of seeds?

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[a] Gartenflora, 35. Jahrg., 1886, pp. 532–534.
[b] Ztschr. trop. Landw., Bd. I, 1897, No. 2.

In order to answer the first question, duplicate samples of the various kinds of seeds were put up in double manila coin envelopes, as described on page 14. Likewise, duplicate samples were put up in small bottles, the bottles being closed with good cork stoppers. Some of the bottles were filled with seed, while others were only partly full. In some cases there was a surplus air space five times as great as the volume of the inclosed seeds. This space, however, had no bearing on the vitality of the seeds as far as could be determined.

In order to determine what immediate external conditions play an important part in the destruction of vitality, samples of seed, prepared as above described, were stored in different places.[a] At each place they were subjected to three different conditions of storage, which, for convenience, have been designated as "trade conditions," "dry room," and "basement," as described on page 14. In addition to these three methods of storage, numerous other conditions were tried in and near the laboratory; such as in incubators at increased temperatures and with varying degrees of moisture, in cold storage, in greenhouses, and in various gases, in vacuo, in liquids, etc.

The third question, "What part do climatic conditions play in affecting the life of seeds?" has been answered for the most part in a discussion on the effect of climate on vitality, page 13. In fact, the seeds in the envelopes kept under trade conditions were the same in both cases, being used here simply as a means for comparing the vitality of seeds when stored in paper packages and in bottles, as well as to show the relative merits of trade conditions, dry rooms, and basements as storage places for seeds.

DISPOSITION OF THE SAMPLES.[b]

A more definite description of the treatment given the seeds in the various places may be summed up as follows:

San Juan, P. R.—The seeds were sent to San Juan on February 9, 1900, and were returned on June 20, 1900, after a lapse of 131 days.[c] At San Juan the seeds were stored under trade conditions only, and the various packages were not removed from the original box in which they were sent. While in San Juan the box containing the seeds was kept in a room well exposed to climatic influences, being protected only from the direct rays of the sun and from rain.

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[a] San Juan, P. R.; Lake City, Fla.; Mobile, Ala.; Auburn, Ala.; Baton Rouge, La.; Wagoner, Ind. T.; Durham, N. H., and Ann Arbor, Mich.

[b] The places of storage represented by trade conditions have already been described for each of the localities, but it seems advisable to rewrite the descriptions here so that they may be more readily compared with the dry room and basement conditions.

[c] The exact time that the seeds remained at San Juan was much less than 131 days, the time of transportation being included, as has been done for the other places.

Lake City, Fla.—The seeds were sent to Lake City on February 9, 1900. The first complete set was returned on June 18, after 129 days. The second complete set was returned October 1, after 234 days. The "trade conditions" at Lake City were supplied by keeping the seeds in a small, one-story frame building, the doors of which were open the greater part of the time. This building was not heated, and the seeds were stored approximately 5 feet from the ground. "Dry room" conditions were those of a storage room on the fourth floor of the main building of the Florida Agricultural College. The third set was kept in a small bulletin room in the basement of the same building.

Mobile, Ala.—The seeds were sent to Mobile on February 17, 1900. One set was received in return on July 7, after 180 days. The other set was received on November 6, after 262 days. The "trade conditions" in this case consisted of a comparatively open attic in a one-story frame dwelling. The set in a "dry room" was kept in a kitchen on a shelf 5 feet from the floor, and not more than 6 feet distant from the stove. Here they were subjected to the action of artificial heat throughout the entire period.[a] The seeds under "basement" conditions were kept in a small cellar, which during the season of 1900 was very moist.

Auburn, Ala.—The seeds were sent to Auburn on February 17, 1900. The first complete set was received in return on May 30, the second on November 19 of the same year, or after 102 and 275 days, respectively. "Trade conditions" consisted of an office room connected with a greenhouse, with the doors frequently standing open; "dry room" conditions were obtained in the culture room of the biological laboratory on the third floor of the main building of the Alabama Polytechnic Institute, "basement" conditions being found in the basement of the same building, a comparatively cool situation, yet with a relatively high degree of humidity.

Baton Rouge, La.—The seeds were sent to Baton Rouge on February 17, 1900. On June 18 the first complete set was received in return. The second set remained until October 22, making the time of absence 121 days for the first and 247 for the second set. "Trade conditions" at Baton Rouge were furnished by keeping the seeds throughout the entire time of the experiment on shelves in a grocery store, the doors of which were not closed except at night. These conditions were thus identical with those to which seeds are subjected when placed on sale in small stores. The "dry room" was a class room on the second floor in one of the college buildings. A storeroom in the basement of a private residence, having two sides walled with brick, furnished "basement" conditions.

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[a] Presumably these were in a dry place, but further evidence showed that the presumption was erroneous. The vapors arising while cooking was being done on the stove gave rise to conditions very detrimental to a prolonged life of the seeds.

Wagoner, Ind. T.—The seeds were sent to Wagoner on February 17, 1900. The first series was received in return on June 23, after 126 days; the second set was returned after 238 days, on October 13, 1900. The sets for "trade conditions" were kept in a drug store, on a counter near an open door. The "dry room" was a sleeping room on the first floor of the same building, while "basement" conditions were supplied by keeping the seeds in a large depository vault in a bank.

Durham, N. H.—The two sets of seeds were sent to Durham on February 17, 1900, and were returned on July 14 and October 20, after 117 and 231 days, respectively. The seeds under "trade conditions" were kept over a door at the entrance of one of the college buildings. The door opened into a hall, which led into office rooms, the chemical laboratory, and the basement. An office room on the first floor of the same building supplied "dry room" conditions. The seeds were located well toward the top of the room, which was heated with steam and remained quite dry at all times. The "basement" conditions were found in a storage room in one corner of the basement of the same building.

Ann Arbor, Mich.—The set of samples placed under "trade conditions" was kept in the botanical laboratory, being moved about from time to time in order to supply the necessary variations to an herbarium room, to an open window, and to an attic. From February 18, 1900, until May 12, 1900, the set of seeds under "dry room" conditions was stored in a furnace room. The seeds were only a few feet from the furnace and were always quite dry and warm: The maximum temperature recorded was 43° C., with a mean of 38° during cold weather, and of 30° C. during milder weather. On May 12 this set of seeds was transferred to the herbarium room on the fourth floor of the botanical laboratory, where they remained until vitality tests were made. "Basement" conditions were found in a fruit cellar, having two outside walls and a temperature fluctuating between 10° and 13° C.

These packages and bottles were all securely packed in new cedar boxes from which they were not removed until after their return to the laboratory.

RESULTS OF THE GERMINATION TESTS.

After receipt of the seeds, germination tests were made as rapidly as possible, the results of which are given in the tabulations which follow. Likewise, in each case is shown the vitality of the control sample. Furthermore, a summary of each table is given, showing the average percentages of germination of the seed from the various places for the first and second tests, respectively. From these results the average percentage of loss in vitality has been calculated, reckoning the germination of the control sample as a standard. It is thus a very simple matter to compare the relative merits of the different methods of storing and the rôle they play in promoting the longevity of seeds.

TABLE XII.—*Percentage of germination of beans subjected to various conditions of storage in different localities.*

[Germination of control sample: First test, 98.7 per cent; second test, 98.7 per cent.]

Place of storage.	Order of tests.	Number of days in storage.	Percentage of germination.					
			Trade conditions.		Dry rooms.		Basements.	
			Envelopes.	Bottles.	Envelopes.	Bottles.	Envelopes.	Bottles.
Lake City, Fla	First	129	98	98	98	98	86	98
Do	Second	234	84	98	96	98	0	100
Auburn, Ala	First	102	98	97.5	100	100	97.9	97.5
Do	Second	275	56	98	91	98	66	100
Mobile, Ala	First	110	58	96	82	100	0	100
Do	Second	262	0	90	0	98	....	98
Baton Rouge, La	First	121	96	100	92	100	54	98
Do	Second	217	60	96	28	100	0	98
San Juan, P. R	First	131	100	100	....	....	....	....
Do	Second	....	96	98	....	....	....	....
Wagoner, Ind. T	First	126	96	96	98	100	100	98
Do	Second	238	82	100	....	100	84	98
Durham, N. H	First	117	100	100	100	98	100	100
Do	Second	251	78	96	98	96	92	98
Ann Arbor, Mich	First	....	98	84	98	84	98	92
Do	Second	....	100	100	100	91.5	92	100
Average percentage of germination.	First	128	93	96.44	95.43	97.14	66.99	97.61
	Second	251	69.50	97	69.33	97.36	55.66	98.86
Average percentage of gain or loss in vitality.	First	128	5.78	2.29	3.31	1.58	32.13	1.06
	Second	251	29.59	1.72	29.76	1.36	43.61	+0.10

The beans at Mobile were seriously affected under all conditions except when put up in bottles and thus protected from the moist atmosphere. Those kept in bottles under "trade conditions" deteriorated to 90 per cent, but the result of the first test of the same series indicates that some moisture passed through the cork and that the seeds were injured in that way.

At Baton Rouge the beans retained their vitality somewhat better; but even here all those from the envelopes were practically worthless after 247 days, for beans that germinate only 60 per cent are of no value for planting.

The "trade conditions" at Auburn, Ala., and Durham, N. H., were also very unfavorable to the prolonged vitality of the beans. At Wagoner, Ind. T., San Juan, P. R., and Lake City, Fla., there was a marked deterioration, yet not sufficiently great during the time given to render them worthless for planting. However, it is quite evident that beans subjected to such conditions of storage would not be fit for planting the second season.

A summary of the table shows that the vitality of the beans when kept in bottles and subjected to either of the three conditions was not interfered with. The averages show a variation of less than 2 per cent. With those kept in paper packages the results were quite different, the advantage being slightly in favor of the "trade conditions." The loss in vitality was 29.59, 29.76, and 43.61 per cent, respectively, for "trade conditions," "dry rooms," and "basements."

TABLE XIII.—*Percentage of germination of peas subjected to various conditions of storage in different localities.*

[Germination of control sample: First test, 95.3 per cent; second test, 95.7 per cent.]

Place of storage.	Order of tests.	Number of days in storage.	Percentage of germination. Trade conditions. Envelopes.	Trade conditions. Bottles.	Dry rooms. Envelopes.	Dry rooms. Bottles.	Basements. Envelopes.	Basements. Bottles.
Lake City, Fla	First	129	96	97.9	94	94	96	98
Do	Second	234	86	98	92	92	6	98
Auburn, Ala	First	102	93.3	94	87.8	97.8	93.9	94
Do	Second	275	97.9	94	90	96	86	98
Mobile, Ala	First	140	69.2	92	88	96	10.2	98
Do	Second	262	44	100	42	96	....	98
Baton Rouge, La	First	121	94	92	94	90	90	98
Do	Second	247	80	88	70	98	0	98
San Juan, P. R	First	131	94	100	....	....	....	....
Do	Second	....	98	98	....	....	....	....
Wagoner, Ind. T	First	126	98	90	96	92	90	88
Do	Second	238	80	92	....	96	88	92
Durham, N. H	First	147	98	94	100	98	94	98
Do	Second	251	94	98	94.7	96	98	90
Ann Arbor, Mich	First	....	90	94	94	72	96	94
Do	Second	....	98	94	94	92	86	100
Average percentage of germination.	First	128	91.56	94.24	93.4	91.41	81.44	95.43
	Second	251	84.74	95.25	80.45	95.14	60.66	96.28
Average percentage of gain or loss in vitality.	First	128	3.92	1.12	1.99	4.08	14.55	+0.14
	Second	251	11.45	0.47	15.94	0.58	36.62	+0.60

The peas retained their vitality much better than the beans. However, the greatest loss in both peas and beans was in the envelopes at Mobile and Baton Rouge. Some of the samples from the envelopes germinated fully as well or even better than the control, but the general averages of the second tests for all of the localities show a loss of 11.45 per cent in "trade conditions," 15.94 per cent in "dry rooms," and 36.63 per cent in "basements." The beans under identical conditions lost 29.59, 29.76, and 43.61 per cent, respectively.

The seeds kept in bottles deviated but very little from the standard of the control.

TABLE XIV.—*Percentage of germination of cabbage subjected to various conditions of storage in different localities.*

[Germination of control sample: First test, 92.7 per cent; second test, 92.4 per cent.]

Place of storage.	Order of tests.	Number of days in storage.	Percentage of germination.					
			Trade conditions.		Dry rooms.		Basements.	
			Envelopes.	Bottles.	Envelopes.	Bottles.	Envelopes.	Bottles.
Lake City, Fla	First	129	89.5	92.5	89.5	94	86.5	90.5
Do	Second	234	63.5	89.5	81.5	89.5	11.5	94.5
Auburn, Ala	First	102	91	90.5	89.5	81	92	91
Do	Second	275	61.5	90	90	89	60	85.5
Mobile, Ala	First	140	64.5	93.5	58.5	96	58.5	92.5
Do	Second	262	17	87.5	5	95	....	94
Baton Rouge, La	First	121	88.5	93	90.5	91	79.5	94
Do	Second	247	25.5	90.5	11.5	86	0.5	90.5
San Juan, P. R	First	131	82	95.5	....	....	....	....
Do	Second	....	76.2	89	....	....	....	....
Wagoner, Ind. T	First	126	83.5	93	94	95.5	88.5	97.5
Do	Second	238	70.5	91.5	....	92.5	76.5	89
Durham, N. H	First	147	93	97.5	89	96	95.5	94.5
Do	Second	251	12	92.5	93	95.5	92.5	96.5
Ann Arbor, Mich	First	....	96	92	94	90.5	89.5	94.5
Do	Second	....	91	94	88	82	76	95.5
Average percentage of germination.	First	128	86	93.47	86.43	92	84.29	93.5
	Second	251	52.15	90.56	61.5	89.93	53.33	92.21
Average percentage of gain or loss in vitality.	First	128	7.23	+0.83	6.77	0.86	9.07	+0.86
	Second	251	43.56	1.94	33.44	2.67	42.29	0.22

Table XIV shows that the cabbage, like the peas, was injured to a less degree at Mobile and Baton Rouge than the beans, but even the cabbage seed kept in the paper packages in these cities were all but killed. The average degree of injury, however, was greater in the cabbage than in the beans. In a majority of cases there was more or less deterioration in the case of this seed kept in the envelopes. Aside from those already mentioned, the trade conditions at Durham, N. H., and the basement at Lake City, Fla., should be expressly noted.

The seeds kept in the bottles deviated but little from the control, while those kept in paper packages germinated only 52.15, 61.50, and 53.33 per cent for the trade conditions, dry room, and basement—equivalent to a loss in vitality of 43.56, 33.44, and 42.29 per cent, respectively.

TABLE XV.—*Percentage of germination of radish subjected to various conditions of storage in different localities.*

[Germination of control sample: First test, 83.6 per cent; second test, 78.8 per cent.]

Place of storage.	Order of tests.	Number of days in storage.	Percentage of germination.					
			Trade conditions.		Dry rooms.		Basements.	
			Envelopes.	Bottles.	Envelopes.	Bottles.	Envelopes.	Bottles.
Lake City, Fla	First	129	79	78.5	84.5	75	66	83
Do	Second	234	58.5	64	67.5	71.5	48.5	67
Auburn, Ala	First	102	75.5	85	85.5	80.5	86.5	85.5
Do	Second	275	63	72.5	66	73.5	60.5	76.5
Mobile, Ala	First	140	58.5	81	56.5	81	75	76
Do	Second	262	51	71.5	49	70	....	72
Baton Rouge, La	First	121	77.5	85.5	73.5	78.5	61.5	78.5
Do	Second	247	55.5	69.5	49.5	74.5	51.5	75
San Juan, P. R	First	131	64	81.5	....	....	....	....
Do	Second	....	62	73.5	....	....	....	....
Wagoner, Ind. T	First	126	77.5	80.5	79	84	80.5	86.5
Do	Second	238	60.5	75.5	....	77	63	70.5
Durham, N. H	First	147	80.6	75.5	76.5	85	81	74
Do	Second	251	59.5	81.5	74.5	85	68	79
Ann Arbor, Mich	First	....	82.5	85	82.5	79.5	78	82.9
Do	Second	....	77.5	80.5	79.5	57.5	62.5	78.5
Average percentage of germination.	First	128	74.39	81.56	76.86	80.5	75.5	80.91
	Second	251	60.94	73.56	64.33	72.71	59	74.07
Average percentage of loss in vitality.	First	128	11.02	2.44	8.07	3.71	9.67	3.22
	Second	251	22.67	6.65	18.37	7.73	25.13	6

The results of the tests of the radish seed are very similar to those of the cabbage; the latter, however, showed a greater loss in vitality. As shown by the second tests, the average percentages of deterioration of the cabbage seed which was kept in the envelopes were as follows: Trade conditions, 43.56 per cent; dry room, 33.44 per cent; basement, 42.29 per cent, while the loss in vitality of the radish was only 22.67, 18.37, and 25.13 per cent, respectively.

TABLE XVI.—*Percentage of germination of carrot subjected to various conditions of storage in different localities.*

[Germination of control sample: First test, 83.3 per cent; second test, 82 per cent.]

Place of storage.	Order of tests.	Number of days in storage.	Percentage of germination.					
			Trade conditions.		Dry rooms.		Basements.	
			Envelopes.	Bottles.	Envelopes.	Bottles.	Envelopes.	Bottles.
Lake City, Fla	First	129	76.5	83	78	78.5	73	77.5
Do	Second	234	43.5	80.5	67.5	78.5	3	84.5
Auburn, Ala	First	102	84.5	82	83	86	86.5	86.5
Do	Second	275	36	76.5	72.5	76.5	47.5	82.5
Mobile, Ala	First	140	59	87.5	51.5	83.5	20.5	87
Do	Second	262	8.5	86	.5	69	....	78
Baton Rouge, La	First	121	74.3	82.3	75.1	86.8	57.3	82.3
Do	Second	247	25	72.5	16.5	52.5	0	39
San Juan, P. R	First	131	71.5	82.5	....	....	....	....
Do	Second	....	48.5	86.5	....	....	....	....
Wagoner, Ind. T	First	126	81.5	82	77.5	81	77.5	87.5
Do	Second	238	49	81.5	....	81	45.5	84
Durham, N. H	First	147	78	82.5	84	85.5	83.5	82.5
Do	Second	251	2	85.5	87.5	85.5	72	87.5
Ann Arbor, Mich	First	....	76	79	83	75.5	78	83.5
Do	Second	....	86	78	78.5	80	58.5	71
Average percentage of germination.	First	128	75.16	82.6	76.01	82.4	68.04	83.83
	Second	251	37.31	80.87	53.83	74.71	37.75	75.21
Average percentage of gain or loss in vitality.	First	128	9.72	0.84	8.75	1.08	18.32	+0.63
	Second	251	54.5	1.38	34.35	8.89	53.96	9.5

Table XVI shows results very similar to those of Table XV, except that the carrot was affected slightly more than the cabbage. There was also a greater falling off in the case of the seeds kept in the bottles in dry rooms and basements. The reason for this is not very clear. Apparently it was due to some local conditions, inasmuch as it was confined chiefly to the bottles kept at Mobile and Baton Rouge. The average results of the germination tests of the seeds kept in packages are quite low for the carrots. Seed from trade conditions germinated 37.31 per cent, from basements 37.67 per cent, and from dry rooms 53.83 per cent, with a loss in vitality of 54.5, 54.06, and 34.36 per cent, respectively. Under similar conditions the cabbage lost in vitality 43.56, 42.28, and 33.45 per cent, respectively.

TABLE XVII.—*Percentage of germination of "A" sweet corn subjected to various conditions of storage in different localities.*

[Germination of control sample: First test, 92.7 per cent; second test, 92.4 per cent.]

Place of storage.	Order of tests.	Number of days in storage.	Percentage of germination.					
			Trade conditions.		Dry rooms.		Basements.	
			Envelopes.	Bottles.	Envelopes.	Bottles.	Envelopes.	Bottles.
Lake City, Fla	First	129	94	96	94	92	88	98
Do	Second	234	92	100	96	90	54.5	100
Auburn, Ala	First	102	96	98	94	98	100	92
Do	Second	275	88	98	94	90	80	100
Mobile, Ala	First	140	80	100	80	96	94.1	96
Do	Second	262	20	96	26	100	....	96
Baton Rouge, La	First	121	96	94	96	88	86	100
Do	Second	247	88	96	88	96	14	100
San Juan, P. R	First	131	96	94	....	....	....	....
Do	Second	....	92	94	....	....	....	....
Wagoner, Ind. T	First	126	96	98	94	96	96	96
Do	Second	238	90	96	....	96	92	94
Durham, N. H	First	147	100	92	95.9	90	100	96
Do	Second	251	96	96	96	96	100	98
Ann Arbor, Mich	First	....	100	86	94	89	100	96
Do	Second	....	98	98	100	96	92	98
Average percentage of germination.	First	128	94.75	94.75	92.56	94.14	94.87	96.29
	Second	251	83	96.75	83.33	94.86	72.08	98
Average percentage of gain or loss in vitality.	First	128	+2.21	+2.21	0.15	+0.01	+2.34	+3.87
	Second	251	10.11	+4.71	9.81	+2.66	22	+6.06

TABLE XVIII.—*Percentage of germination of "B" sweet corn subjected to various conditions of storage in different localities.*

[Germination of control sample: First test, 89.3 per cent; second test, 88.5 per cent.]

Place of storage.	Order of tests.	Number of days in storage.	Percentage of germination.					
			Trade conditions.		Dry rooms.		Basements.	
			Envelopes.	Bottles.	Envelopes.	Bottles.	Envelopes.	Bottles.
Lake City, Fla	First	129	86	60	90	38	76	46
Do	Second	234	77.1	2	64	0	30	0
Auburn, Ala	First	102	88	92	86	86	86	84
Do	Second	275	62	56	82	38	82	89.6
Mobile, Ala	First	140	48	81.2	60	87.5	75	86
Do	Second	262	12	52	16	54	....	76
Baton Rouge, La	First	121	80	82	84	94	64	88
Do	Second	247	54.2	36	66	46	4.5	61.2
San Juan, P. R	First	131	72	72	....	....	....	....
Do	Second	....	78	71.7	....	....	....	....
Wagoner, Ind. T	First	126	70	82	90	88	84	84
Do	Second	238	78	76	....	88	88	76
Durham, N. H	First	147	89.3	69.5	84.2	83.6	80	80
Do	Second	251	82	91.8	84	88	76	88
Ann Arbor, Mich	First	....	92	88	88	48	88	96
Do	Second	....	80	92	86	22	82	88
Average percentage of germination.	First	128	78.16	78.31	83.17	75.01	79	80.55
	Second	251	65.41	59.70	66.33	48	60.41	68.40
Average percentage of loss in vitality.	First	128	12.47	12.31	6.87	16	11.54	9.80
	Second	251	26.09	32.55	25.06	45.76	31.74	22.71

Tables XVII and XVIII have been considered together, since both have to do with the same variety of sweet corn. The difference in the quality of these two samples was quite marked when the seed was received. Germination tests were made January 30, 1900, and showed 94 per cent for the "A" and 88 per cent for the "B" corn. In November, 1900, samples of seed from the same original packages were tested, giving a germination of 92.4 per cent and 88.5 per cent for the "A" and "B" samples, respectively, as shown in the controls of the above tables. Thus, when two grades of corn are subjected to favorable conditions of storage, both are well preserved; but when subjected to unfavorable conditions, the one of poorer quality is much more susceptible to injury. The "A" sample which was stored in envelopes in trade conditions lost 10.11 per cent, as compared with 26.9 per cent for the "B" sample. The "A" sample which was stored in dry rooms lost only 9.81 per cent, while the "B" sample lost 25.06 per cent. In basements, the "A" sample lost 23 per cent and the "B" sample 31.74 per cent. In both samples the corn in the packages stored in the basement at Mobile was so badly molded at the time the second tests were made that they have been omitted from the table.

The most interesting feature in comparing the results of these two samples is found in the seed which was stored in the bottles. The average results of the "A" samples show a much higher percentage of germination for those from the bottles than the control, while the averages for the "B" sample were much lower than the corresponding controls. The average germination of the "B" sample from the bottles was 59.7 per cent for the trade conditions, 48 per cent for dry rooms, and 68.4 per cent for basements, or a loss in vitality of 32.55, 45.76, and 22.71 per cent, respectively. This difference was due to two causes, first, a difference in the quality of the seed at the beginning of the experiment, and, secondly, the larger amount of water in the second sample, "B." The greater quantity of water present in the seed gave rise to a more humid atmosphere after the seeds were put into the bottles, especially when subjected to higher temperatures than those in which the seeds had been previously stored. This is an important factor always to be borne in mind when seeds are put up in closed receptacles; they must be well dried if vitality is to be preserved.

TABLE XIX.—*Percentage of germination of lettuce subjected to various conditions of storage in different localities.*

[Germination of control sample: First test, 81.6 per cent; second test, 92.3 per cent.]

Place of storage.	Order of tests.	Number of days in storage.	Percentage of germination.					
			Trade conditions.		Dry rooms.		Basements.	
			Envelopes.	Bottles.	Envelopes.	Bottles.	Envelopes.	Bottles.
Lake City, Fla	First	129	87	84	81	76.5	68	77
Do	Second	234	85	92	92.5	90	43.5	95.5
Auburn, Ala	First	102	86.5	85.5	88.5	84.5	84.5	88.5
Do	Second	275	86	90.5	90.5	91	83.5	90
Mobile, Ala	First	140	63	78	58	87.5	1.5	83
Do	Second	262	20	88.5	31	90.5	....	91.5
Baton-Rouge, La	First	121	82.5	81.5	79	78.5	70.5	76
Do	Second	247	84.5	93.5	74.5	87.5	.5	92.5
San Juan, P. R	First	131	79	87.5	....	....	....	....
Do	Second	....	83.5	89	....	....	....	....
Wagoner, Ind. T	First	126	78	76	80	82	81	76.5
Do	Second	238	82	92.5	....	91	87.5	89
Durham, N. H	First	147	82.5	80.25	83.25	77.5	80	75.2
Do	Second	251	88.5	93	92	93	90.5	90.5
Ann Arbor, Mich	First	....	82	68.5	84.5	81.5	78.5	72
Do	Second	....	92.5	90	89.5	90.5	88	91.5
Average percentage of germination.	First	128	80.06	80.15	79.18	81.14	66.28	78.31
	Second	251	77.75	91.12	78.33	90.93	65.58	90.78
Average percentage of loss in vitality.	First	128	1.89	1.77	2.97	.56	18.78	4.03
	Second	251	15.76	1.29	15.14	1.49	28.95	1.65

The lettuce has shown no very marked deviation from the controls, save the seeds from the packages kept at Mobile, and those which were stored in basements in envelopes at Baton Rouge and Lake City. The average results of the second series of tests show a similar loss in vitality of all of the seeds from the envelopes. The samples of seed from the bottles germinated practically as well as the controls. The results of the first series of tests are not entirely satisfactory, none of the tests having gone to standard. The low germination of the lettuce in this series was due to inability to properly control the temperature in the germinating pans. The proper temperature for the successful germination of lettuce seed is 20° C., while in this first series the germination tests were unavoidably made at 26° to 27.5° C. Nevertheless, this seeming objection is of little consequence, since all of the results are directly comparable with the control.

TABLE XX.—*Percentage of germination of onion subjected to various conditions of storage in different localities.*

[Germination of control sample: First test, 95.8 per cent; second test, 97 per cent.]

Place of storage.	Order of tests.	Number of days in storage.	Percentage of germination.					
			Trade conditions.		Dry rooms.		Basements.	
			Envelopes.	Bottles.	Envelopes.	Bottles.	Envelopes.	Bottles.
Lake City, Fla	First	129	95	95	95.5	95	80	97.5
Do	Second	234	16.5	95.5	79	96	0	97.0
Auburn, Ala	First	102	96	96.5	96	98.5	97	97.5
Do	Second	275	12	96	96	98	23.5	99
Mobile, Ala	First	140	7	94.5	11.5	96.5	75.5	99
Do	Second	262	0	94.5	0	96.5	[a]0	97.5
Baton Rouge, La	First	121	90	93	94	93.5	35	96.5
Do	Second	247	0.5	97.5	0	65	0	48.5
San Juan, P. R	First	131	81.5	98	....	....	....	....
Do	Second	....	50	96.5	....	....	....	....
Wagoner, Ind. T	First	126	93.5	97.5	95.5	97	96	94.5
Do	Second	238	24.5	95	....	97.5	34	97.5
Durham, N. H	First	147	96.5	96	94.5	96	93	94.5
Do	Second	251	0	97.5	96	97	94	98
Ann Arbor, Mich	First	....	95	96	99.5	97	93	97
Do	Second	....	97.5	97.5	95	96.5	47	98
Average percentage of germination.	First	128	82.19	95.81	83.79	96.21	81.36	96.64
	Second	251	25.12	96.25	61	92.36	33.08	90.86
Average percentage of gain or loss in vitality.	First	128	14.20	+0.01	12.53	+ 0.43	15.07	+0.87
	Second	251	74.11	1.20	37.12	4.80	65.90	6.33

[a] This test has not been included in making up the averages inasmuch as the seeds were badly molded when put in test.

The onion seeds which were stored in the envelopes were very seriously affected in many of the places. Those from the basement at Lake City, from all of the conditions at Mobile, and from the dry room and basement at Baton Rouge were entirely killed. The seed from trade conditions at Baton Rouge germinated only 0.5 per cent. In many other cases the samples from the envelopes had become practically worthless. In only two instances was there any loss in vitality where the seeds were stored in bottles, viz, the second tests from the dry rooms and basement at Baton Rouge. These two tests have lowered the average results quite materially. If they were not included the averages would be raised to 96.91 and 97.90 per cent, respectively, instead of 92.36 and 90.86 per cent, as given in the table. The average percentages of germination of the seeds from the envelopes were very low in the second test, and were as follows: Trade conditions, 25.12 per cent; dry rooms, 61 per cent, and basements, 33.8 per cent. This represents a loss in vitality of 74.11, 37.12, and 65.9 per cent, respectively.

Onion seed is relatively short lived, and very easily affected by unfavorable external conditions. For this reason onion seed should be handled with the greatest care if vitality is to be preserved for a maximum period. This may be done successfully by keeping the *dry* seed in well-corked bottles, or in any good moisture-proof package.

TABLE XXI.—*Percentage of germination of pansy subjected to various conditions of storage in different localities.*

[Germination of control sample: First test, 63 per cent; second test, 53 per cent.]

Place of storage.	Order of tests.	Number of days in storage.	Percentage of germination.					
			Trade conditions.		Dry rooms.		Basements.	
			Envelopes.	Bottles.	Envelopes.	Bottles.	Envelopes.	Bottles.
Lake City, Fla	First	129	44.5	63	45	58.5	10.5	62.5
Do	Second	234	1.5	54	22.5	47	0	57.5
Auburn, Ala	First	102	57.5	68	66.5	62	60	59.5
Do	Second	275	2	20.5	28	27.5	0	33.5
Mobile, Ala	First	140	3	57.5	2	61	1	59
Do	Second	262	0	20.5	0	25.5	....	2.5
Baton Rouge, La	First	121	28.5	53	38	44	4.5	54
Do	Second	247	0	34	0	17	0	2.5
San Juan, P. R	First	131	20	60.5	....	....	....	....
Do	Second	....	6.5	58.5	....	....	....	....
Wagoner, Ind. T	First	126	48.5	61.5	50.5	62.5	46	59
Do	Second	238	7.5	65	....	59.5	8.5	52.5
Durham, N. H	First	147	55.5	66.5	49.5	63.5	49	63.5
Do	Second	251	0	60.5	44	60.5	36.5	60
Ann Arbor, Mich	First	....	53.5	51	59.5	40	50	53
Do	Second	....	16.5	45	52	48.5	3.5	60.5
Average percentage of germination.	First	128	38.87	60.12	44.43	55.93	31.57	58.64
	Second	251	8	44.75	24.41	40.80	8.08	38.43
Average percentage of loss in vitality.	First	128	38.3	4.57	29.48	11.23	49.89	6.92
	Second	251	84.91	15.60	53.97	23.02	84.76	27.49

TABLE XXII.—*Percentage of germination of phlox drummondii subjected to various conditions of storage in different localities.*

[Germination of control sample: First test, 69 per cent; second test, 53.9 per cent.]

Place of storage.	Order of tests.	Number of days in storage.	Percentage of germination.					
			Trade conditions.		Dry rooms.		Basements.	
			Envelopes.	Bottles.	Envelopes.	Bottles.	Envelopes.	Bottles.
Lake City, Fla	First	129	41.5	78	62	62	20.5	77.5
Do	Second	234	2.5	57	6	25.5	0	63
Auburn, Ala	First	102	61.5	72.5	62	63	65.5	67.5
Do	Second	275	1	56.5	13.5	59	1	65
Mobile, Ala	First	140	0.5	55	0.5	74.5	0.5	58.5
Do	Second	262	0	51.5	0	58.5	....	48.5
Baton Rouge, La	First	121	47.5	62.5	43.5	58.5	2	70.5
Do	Second	247	0	58	0	58.5	0	61.5
San Juan, P. R	First	131	23.5	65	....	....	....	....
Do	Second	....	11.5	61.5	....	....	....	....
Wagoner, Ind. T	First	126	50.5	73.5	61	70	65	75
Do	Second	238	5.5	66	....	57	9.5	47.5
Durham, N. H	First	147	67	74	62.5	45.5	69.5	71.5
Do	Second	251	0.5	62.5	33	30.5	45.5	70
Ann Arbor, Mich	First	....	67	66	75.5	69.5	64.5	72
Do	Second	....	40	54	55	58.5	10.5	61
Average percentage of germination.	First	128	44.87	68.31	52.76	63.28	41.07	70.35
	Second	251	7.62	58.37	17.91	49.64	11.08	59.5
Average percentage of gain or loss in vitality.	First	128	34.97	1	23.51	8.29	40.49	+ 2.01
	Second	251	85.86	+8.27	66.78	7.91	79.45	+10.39

Pansy and phlox have been considered together, since their behavior was almost the same. Both of the controls deteriorated to a considerable degree during the 123 days which elapsed between the time of the first and the second test, pansy losing 15.87 per cent and phlox 21.88 per cent. In both cases the mean loss in vitality of the seeds in the envelopes was very great. The results of the second tests show a loss of 84.91 per cent for pansy, and 85.86 per cent for phlox where stored under trade conditions. In dry rooms there was a mean loss of 53.57 per cent for pansy and 66.78 per cent for phlox, and in basements a loss of 84.76 per cent for the pansy and 79.45 per cent for the phlox. These results are obtained by considering the second test of the control as a standard, the depreciation of the control being disregarded. Some samples were dead and many more were of no economic value. It is especially interesting to note how quickly the seeds died at Mobile, Ala., there being only a few germinable seeds at the end of 140 days.

The behavior of the seeds in the bottles was more or less variable. Some of the pansy seeds showed a higher vitality than the control, but the averages were somewhat lower, the mean loss ranging from 15.60 per cent under trade conditions to 27.49 per cent in basements, while with the phlox the means for trade conditions and for basements were higher than the control by 8.27 and 10.39 per cent, respectively.

TABLE XXIII.—*Percentages of germination of tomato subjected to various conditions of storage in different localities.*

[Germination of control sample: First test, 95.5 per cent; second test, 97.5 per cent.]

Place of storage.	Order of tests.	Number of days in storage.	Percentage of germination.					
			Trade conditions.		Dry rooms.		Basements.	
			Envelopes.	Bottles.	Envelopes.	Bottles.	Envelopes.	Bottles.
Lake City, Fla	First	129	94	94	94	95.5	88.5	94
Do	Second	234	94	98	94	97.5	77	97.5
Auburn, Ala	First	102	95	94.5	93.5	97.5	96	94.5
Do	Second	275	94	98.5	97	94.5	98	96.5
Mobile, Ala	First	140	90	94.5	91.5	96.5	64.5	93.5
Do	Second	262	79.5	97.5	87	95.5	19.5	98
Baton Rouge, La	First	121	91.5	95	91	95	83.5	95
Do	Second	247	96	96.5	93	98	39.5	96
San Juan, P. R	First	131	94	94.5	....	....	....	....
Do	Second	....	96.5	94 5	....	....	....	....
Wagoner, Ind. T	First	126	96.5	97	98	96.5	98.5	96
Do	Second	147	94	98	....	97.5	98.5	93.5
Durham, N. H	First	147	94.5	95	97	94	97.5	96.5
Do	Second	251	87	98	97	99	97.5	97
Ann Arbor, Mich	First	....	89	94	93	91.5	89	92.5
Do	Second	....	98.5	98	98	97.5	95	98
Average percentage of germination.	First	128	93.06	94.81	84	95.21	88.21	94.57
	Second	251	92.44	97.31	94.33	97.07	84.25	97.21
Average percentage of loss in vitality.	First	128	2.56	0.72	1.57	0.30	7.64	0.98
	Second	251	5.20	0.20	3.29	0.41	13.63	0.30

The tomato seed, as shown in Tables V and XXV, was the most resistant to the unfavorable conditions of storage. The seed in the bottles was not injured at any of the places. The lowest germination was 91.5 per cent from the seed kept in a dry room at Ann Arbor, Mich. The seed in the envelopes gave a much wider variation, falling quite low in some of the samples which were stored in the basements. The average losses in vitality for the entire series of the second set of seeds which were kept in envelopes were as follows: Trade conditions, 5.20 per cent; dry rooms, 3.29 per cent; basements, 13.63 per cent. The average percentage of germination of the seed which was kept in the bottles differed from the control less than one-half of 1 per cent.

TABLE XXIV.—*Percentage of germination of watermelon subjected to various conditions of storage in different localities.*

[Germination of control sample: First test, 95.5 per cent; second test, 99 per cent.]

Place of storage.	Order of tests.	Number of days in storage.	Percentage of germination.					
			Trade conditions.		Dry rooms.		Basements.	
			Envelopes.	Bottles.	Envelopes.	Bottles.	Envelopes.	Bottles.
Lake City, Fla	First	129	98	98	96	98	98	100
Do	Second	234	92	96.2	86	98	70	94
Auburn, Ala	First	102	94	94	96	98	99	100
Do	Second	275	86	100	98	98	94	96
Mobile Ala	First	140	98	98	98	100	80	100
Do	Second	262	64	96	68	96	0	100
Baton Rouge, La	First	121	100	98	96	100	98	98
Do	Second	247	92	98	86	100	20	100
San Juan, P. R	First	131	96	100	....	....	....	....
Do	Second	....	88	100	....	....	....	....
Wagoner, Ind. T	First	126	98	98	98	100	96	98
Do	Second	238	94	98	....	96	88	98
Durham, N. H	First	147	98	98	100	98	98	96
Do	Second	251	82	96	98	92	94.1	98
Ann Arbor, Mich	First	....	100	100	94	94	98	96
Do	Second	....	96	100	96	92	100	96
Average percentage of germination.	First	128	97.75	98	96.86	98.29	95.29	98.29
	Second	251	86.75	98.02	88.67	96	77.70	97.43
Average pecentage of loss in vitality.	First	128	0.56	0.31	1.47	0.01	3.06	0.01
	Second	251	12.37	0.99	10.44	3.03	21.52	1.59

What has been said of the tomato seed is practically true for the watermelon, save that there was a greater loss in vitality in the latter, when seeds were kept in envelopes. The average percentage of germination of the second tests was 86.75 per cent for trade conditions; 88.67 per cent for dry rooms; and 77.7 per cent for basements, or a loss in vitality of 12.37, 10.44 and 21.52 per cent, respectively, as compared with the vitality of the control sample, which germinated 99 per cent.

An examination of the foregoing set of tables will show that in most cases the deterioration was comparatively slight during the first 128 days. Yet even during this short period the losses in vitality were very marked in some of the more critical localities, particularly at Mobile. However, the greatest loss, as shown by the germination tests, was during the 123 days immediately following.

While seeds, like other living things, are capable of withstanding quite unfavorable conditions for a considerable time without showing any appreciable deterioration in vitality, still the forces destroying vitality are at work. When the turning point is once reached and can be detected by germination tests, the decline is more noticeable and death soon follows.

The preceding tables show that the loss in vitality was very different in the different places. The conditions at Mobile, Ala., proved to be the most injurious, while those at Ann Arbor, Mich., were the most conducive to longevity. These results, however, are given in another part of this paper dealing with the effect of climate on the vitality of seeds. The results are tabulated on pages 18 and 23 and represented diagrammatically on page 24, so that any further discussion at this time is unnecessary.

Likewise each table has been summarized, giving the average percentages of germination and the average percentages of the loss in vitality of each sample of seed for both the first and second tests. These averages include those of the three conditions of storage—trade conditions, dry rooms, and basements—in both envelopes and bottles.

Naturally, the results of the second tests are of the greater importance, and, in order that the results may be readily compared and more critically examined, they have been collected and tabulated herewith:

Table XXV.—*Average percentage of germination and average percentages of loss in vitality of the different kinds of seeds when kept under different conditions.*

Kind of seed.	Germination of control sample.	Trade conditions.				Dry rooms.				Basements.			
		Envelopes.		Bottles.		Envelopes.		Bottles.		Envelopes.		Bottles.	
		Germination.	Loss in vitality.	Germination.	Loss in vitality.	Germination.	Loss in vitality.	Germination.	Loss in vitality.	Germination.	Loss in vitality.	Germination.	Loss in vitality.
Tomato	97.5	92.44	5.20	97.31	0.20	94.33	3.29	97.07	0.44	84.25	13.63	97.21	0.30
Sweet corn, "A"	92.4	83	10.11	96.75	+4.71	83.33	9.81	94.86	+2.66	73.08	22	98	+ 6.06
Peas	95.7	84.74	11.45	95.25	.47	80.45	15.94	95.14	.58	60.66	36.62	96.28	+ .60
Watermelon	99	86.75	12.37	98.02	.99	88.67	10.44	96	3.03	77.70	21.52	97.43	1.59
Lettuce	92.3	77.75	15.76	91.12	1.29	78.33	15.14	90.93	1.49	65.58	28.95	90.78	1.65
Radish	78.8	60.94	22.67	73.56	6.65	64.33	18.37	72.71	7.73	59	25.13	74.07	6
Sweet corn, "B"	88.5	65.41	26.09	59.70	32.55	66.33	25.06	48	45.76	60.41	31.74	68.40	22.71
Bean	98.7	69.50	29.59	97	1.72	69.33	29.76	97.36	1.36	55.66	43.61	98.86	+.10
Cabbage	92.4	52.15	43.56	90.56	1.94	61.50	33.44	89.93	2.67	53.33	42.29	92.21	.22
Carrot	82	37.31	54.50	80.87	1.38	53.83	34.35	74.71	8.89	37.75	53.96	75.21	9.50
Onion	97	25.12	74.11	96.25	1.20	61	37.12	92.36	4.80	38.08	65.90	90.86	6.33
Pansy	53	8	84.91	44.75	15.60	24.41	53.97	40.80	23.02	8.08	84.76	38.43	27.49
Phlox	53.9	7.62	85.86	58.37	+8.27	17.91	66.78	49.64	7.91	11.08	79.45	59.50	+10.39
Average loss in vitality	......	......	36.63	......	3.92	......	21.19	......	8.08	......	42.28	......	4.51

In comparing the average results shown in Table XXV, it will be seen that different seeds behave very differently under practically identical conditions. The list of seeds has been arranged according to their loss of vitality as represented by those kept in envelopes under trade conditions, as shown in the fourth column. The tomato seed gave a loss in vitality of 5.20 per cent, being the most resistant to the unfavorable climatic conditions. Phlox, on the other hand, germinated only 7.62 per cent, representing a loss in vitality of 85.86 per cent.

Likewise the same seeds behave very differently under slightly different conditions, as will be seen by comparing the percentages of deterioration in the case of seeds kept in envelopes under trade conditions, in dry rooms, and in basements. In dry rooms the order, except the peas, is the same as for trade conditions. The loss of vitality in the seeds stored in the dry rooms was uniformly less than for those stored under trade conditions, excepting for the peas and beans; but in the series from the basements there was great irregularity. The loss in vitality for the most part was uniformly greater than under trade conditions or in dry rooms save in the last five—cabbage, carrot, onion, pansy, and phlox—where the loss was less in the case of those kept in the basements. This indicates that these five species of seed are less susceptible to the evil effects of a moist atmosphere when the temperature is relatively low.

The relative value of these three conditions for storing seeds in paper packets is best obtained by a comparison of the general averages. The average losses in vitaliy for the thirteen different samples of seed which were kept at the eight different stations were as follows: Trade conditions, 36.63 per cent; dry rooms, 21.19 per cent; basements, 42.28 per cent. From these results it is quite clear that seeds put up in paper packages will retain their vitality much better if kept in dry, artificially heated rooms than if they are subjected to trade conditions or stored in basements.

But another comparison needs yet to be made, and is the most important of the series, i. e., the vitality of seeds when kept in closely corked bottles. In the majority of cases there was but little deviation from the control samples, and many of the samples germinated even better where the seeds were kept in bottles. The "A" sweet corn offers the best illustration of the increased germination. At the same time the "B" sample of sweet corn was very much injured. Here are two samples of the same variety of corn behaving very differently when kept in bottles. This difference in vitality is directly attributed to the greater quantity of water in sample "B," showing the necessity of thoroughly drying seeds if they are to be put up in closed vessels. A comparison of the general averages of the bottle samples and of those kept in envelopes indicates that the former is far superior to the latter as a method for preserving the vitality of seeds. Under trade conditions the loss in vitality was 36.63 per cent in envelopes and

3.93 per cent in bottles; in dry rooms, 21.19 per cent in envelopes and 8.08 per cent in bottles; in basements, 42.28 per cent in envelopes and 4.51 per cent in bottles.

The necessary precautions to be taken, if seeds are to be stored in bottles, are (1) a well-dried sample, preferably artificially dried seed, and (2) a cool place for storing, at least a place in which the temperature will not be higher than the temperature at which the seeds were originally dried.

If the above precautions are taken at least two beneficial results will follow: First, protection against moisture, which is of considerable importance, as many seeds are soon destroyed in that way when kept in paper packages. Secondly, vitality will be preserved for a longer period and consequently there will be a more vigorous germination, a better growth of seedlings, and a greater uniformity in the resulting crop.

Having thus shown that seeds retain their vitality in warm, moist climates much better when kept in bottles than when kept in paper packages, the necessity of finding a more suitable method for sending small quantities of seed to such places at once presents itself.

EXPERIMENTS IN KEEPING AND SHIPPING SEEDS IN SPECIAL PACKAGES.

At present the greatest disadvantages in sending out seeds in bottles are the inconvenience and expense involved by this method of putting up seeds. The increased cost of bottles, as compared with the paper packets now so universally employed, the additional labor and expense necessary to put up the seeds, the greater cost in handling and packing the bottles to insure against losses by breakage, and the increased cost of transportation, are all matters of vital importance. Seedsmen claim that the existing conditions of the trade will not admit of their raising the price of seeds sufficiently high to justify the increased expense of glass containers. Although to the seedsmen the preservation or the prolongation of vitality is an important factor, yet the demand is for an inexpensive and at the same time a neat and serviceable package.

Accordingly, duplicate samples of the following-named seeds were put up in special packages, one set being sent to Mobile, Ala., and the other kept at Ann Arbor, Mich. The seeds used for these experiments were beans, peas, cabbage, lettuce, onion, pansy, and phlox.[a]

[a]The lettuce, onion, pansy, and phlox were from the same bulk samples of seeds as those used in the earlier experiments; but the beans, peas, and cabbage used for these tests were from samples received at the laboratory on February 4, 1901. However, the latter three were from the same general stock of seed, differing from those used in experiments already given only in that they were stored during the interval in the warehouse of D. M. Ferry & Co., Detroit, Mich., instead of in the botanical laboratory at the university.

All of these samples were first dried for ten days in an incubator maintained at a temperature of from 30° to 32° C. The amount of moisture in the samples before and after drying, as well as the moisture expelled during the drying process, was as follows:

Moisture test of seeds in special packages.

Kind of seed.	Moisture in air-dried samples.	Moisture remaining.	Moisture liberated.
	Per cent.	*Per cent.*	*Per cent.*
Beans	10.32	4.90	5.42
Peas	9.70	6.00	3.70
Cabbage	4.89	3.47	1.42
Lettuce	5.33	3.80	1.53
Onion	6.48	4.47	2.01
Pansy	4.82	3.13	1.69
Phlox	5.82	4.30	1.52

These well-dried seeds were then put up in seven different kinds of packages:

(1) Double coin envelopes, of much the same quality as those in which seeds are commonly sold.

(2) Bottles of 120 cc. capacity, closed with firm cork stoppers.

(3) Bottles of 120 cc. capacity, corked and sealed with paraffin.

(4) Tin cans having closely fitting lids, the whole being then carefully dipped in paraffin.

(5) Double coin envelopes, as for No. 1, the packets being then dipped in melted paraffin.

(6) Double coin envelopes, the inner one paraffined, the outer envelope being used simply to protect the paraffin and to facilitate ease of handling.

(7) Double coin envelopes, with both the inner and the outer coated with paraffin.

On February 15, 1901, one of each of the above preparations was sent to Mobile, Ala., and stored in a cellar approximately 400 feet back from the bay. After the lapse of 108 days, i. e., on June 3, these samples were received in return, at which time germination tests were made.

The other complete set, retained in the botanical laboratory at Ann Arbor, was subjected to a very moist atmosphere. The samples were kept in a damp chamber made by taking two battery jars of different sizes, the smaller containing the seeds being placed within the larger, which was lined with filter paper and then partially filled with water. The whole was covered with a glass plate, and the atmosphere within was always on the verge of saturation.

A third and an extreme set of conditions was established by keeping some of the paraffined packages immersed in water for twenty-seven days. At the end of that time (March 14) the seeds were tested for germination, as were also those from the unprotected envelopes in the moist chamber. The seeds that were kept under water in the paraffined packages germinated readily and normally, showing no deterioration in vitality; but the seeds from the packages not paraffined, which were kept in the moist chamber, had been injured to an appreciable extent, there being a marked retardation in the germination of all of the species of seed. The cabbage at the end of thirty-six hours had germinated only 11 per cent, as compared with 57.5 per cent for seed from the immersed paraffined package. The relative merits of the two conditions as affecting onion seed may be expressed by a germination of 13.5 per cent and 39 per cent, respectively, after sixty-one and one-half hours. Not only was there a marked retardation, but likewise a reduction in the final percentage of germination, with the single exception of the cabbage. These results can be more carefully studied in Table XXVI.

Germination tests were made of all of the other samples on June 3, 1901, the date when the seeds were returned from Mobile. At this time the seeds in the unprotected envelopes in the moist chamber were so badly molded that no germination tests were made. The samples from Mobile, which were directly comparable with the above, except that they had been stored in a basement, were greatly injured. The beans had deteriorated to 88 per cent, the onion to 27 per cent, the pansy to 8 per cent, while the phlox was dead. However, seed of the other species—cabbage, lettuce, and peas—gave final percentages of germination varying but little from the control, but the slowing down in the rapidity of germination was sufficiently marked to show a corresponding loss in vitality.

With the samples which were put up in bottles, tin cans, and paraffined packages the results were quite different from those given above. In no case was there any marked deviation beyond that which might be justly attributed to ordinary variation, except in the phlox from a tin can which had been stored in the moist chamber in the laboratory. This sample of phlox germinated only 3.5 per cent. Unfortunately, both the pansy and the phlox seeds used for these experiments were not very satisfactory. These samples were at this time nearly two years old and consequently of a low vitality. The tabulated results of the foregoing experiment follow.

TABLE XXVI.—*Vitality of seeds preserved in different kinds of packages.*

Treatment of samples.	Duration of experiment.	Percentage of germination.							
		Beans.	Cabbage.	Lettuce.	Onions.	Peas.	Pansy.	Phlox.	Averages.
	Days.								
Control	....	94.0	90.2	89.5	97.5	90.0	37.7	42.5	77.34
Ann Arbor, Mich., moist chamber:									
Envelopes	27	80.0	91.0	76.5	90.0	88.0	25.0	0.0	64.35
Bottle, corked	108	98.0	91.5	91.0	93.5	94.0	36.0	31.0	76.43
Bottle, paraffined	108	97.5	93.5	90.5	95.5	90.0	39.5	39.0	77.93
Tin can, paraffined	108	96.0	87.0	90.0	93.0	90.0	35.0	3.5	70.63
Two envelopes, outer paraffined	108	98.0	91.5	91.5	97.0	92.0	33.5	27.5	75.85
Two envelopes, inner paraffined	108	98.0	94.0	89.0	93.0	88.0	24.0	47.0	76.14
Two envelopes, both paraffined	108	96.0	90.5	86.5	95.5	92.0	23.0	38.5	74.57
Two envelopes, both paraffined and immersed in water	27	100.0	88.5	88.5	94.5	90.0	34.5	30.5	75.21
Mobile, Ala., basement:									
Envelopes	108	88.0	86.0	88.0	27.0	96.0	8.0	0.0	56.14
Bottle, corked	108	98.0	91.0	90.5	95.5	84.0	34.5	32.5	75.14
Bottle, paraffined	108	98.0	90.5	92.5	95.5	92.0	34.5	44.5	78.21
Tin can, paraffined	108	96.0	88.0	95.0	96.0	88.0	26.0	23.0	73.14
Two envelopes, outer paraffined	108	94.0	90.5	89.0	95.5	92.0	29.5	34.0	74.73
Two envelopes, inner paraffined	108	96.0	92.0	88.0	90.0	98.0	33.0	38.0	76.43
Two envelopes, both paraffined	108	100.0	92.0	89.5	88.5	90.0	25.5	33.5	74.14

Subsequent experiments were made, using envelopes of different qualities, as well as varying the treatment of the packages. Samples of cabbage, lettuce, and onion seed were put up as follows:

(*a*) The regular seedsmen's envelope, made of a heavy grade of manila paper.

(*b*) Envelopes made of a medium quality of waterproof paper.

(*c*) Envelopes made of a thin parchment paper.

(*d*) Envelopes made of the same quality of parchment paper as for the preceding series, but paraffined previous to being filled with seed. The packages were then sealed by redipping the open ends.

(*e*) Envelopes of parchment paper, as for the two preceding series, except that the envelopes were first filled with seed, sealed, and then the entire package was dipped in paraffin at a temperature of from 55° to 60° C.

Samples of all of these packages were then stored under trade conditions and in dry rooms in Ann Arbor, Baton Rouge, and Mobile. The exact conditions of storage in the different places were the same as described on pages 49 and 50.

The samples were put up on May 20, 1901. The period of storage ended on November 26, having continued 190 days. Unfortunately, no special precautions were taken to dry the seeds. They were simply air-dried samples; hence they contained a quantity of moisture sufficiently large to give rise to an increased relative humidity of the confined air in the paraffined packages. This increased humidity was accompanied by a greater activity within the cells, and consequently by a greater deterioration of vital force. For this reason the results are not as definite as the conditions warrant. Nevertheless, some important facts were brought out by the experiments which justify their being discussed and tabulated (in part) at this time.

TABLE XXVII.—*Vitality of seed preserved in paraffined packages.*

Kind of seed.	Trade conditions, seeds put up in—			Dry room, seeds put up in—		
	Paraffined envelopes.	Parchment envelopes, then dipped in paraffin, at 50° to 60° C.	Seedsmen's packages.	Paraffined envelopes.	Parchment envelopes, then dipped in paraffin, at 50° to 60° C.	Seedsmen's packages.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Cabbage:						
Ann Arbor, Mich	91	90	86.5	90.5	85.5	86.5
Mobile, Ala	30.5	57.5	8.5	38	50.5	5
Baton Rouge, La	70	63	22.5	73.5	79.5	35.5
Lettuce:						
Ann Arbor, Mich	89.5	89.5	96.5	91.5	90	93
Mobile, Ala	80	75	64	78	78.5	61.5
Baton Rouge, La	81.5	77.5	74	82	73.5	72.5
Onion:						
Ann Arbor, Mich	91	90	93	91.5	89	89
Mobile, Ala	0	4	0	0	4.5	0
Baton Rouge, La	1	20	0	5	40	0
Average	59.39	62.94	49.44	61.11	65.66	49.22

In the first place, the injury resulting from the effect of the climatic influences is quite well marked in the above table. The conditions at Mobile and Baton Rouge were much more detrimental to the life of the seeds than were the conditions at Ann Arbor. Secondly, the differences in the preservation of vitality of those seeds stored under trade conditions and of those kept in dry rooms were much less marked than they were in earlier experiments. This is probably accounted for by the marked difference in the two seasons. The summer of 1900 was extremely wet in the South, especially at Mobile, while the summer of 1901 was exceptionally dry. Concerning the conditions Zimmer Brothers wrote on November 26, 1901, as follows:

> We do not think you will find much difference in the two packages. The season this year has been very dry, with no rain since the big August storm; in fact, we do not remember such a dry season in thirty years.

Although the season was exceptionally dry at Baton Rouge and Mobile, the loss in vitality was very great in comparison with the loss at Ann Arbor, demonstrating very clearly that climatic influences play a very important part in the storage of seeds.

This table shows the relative resisting powers of lettuce, cabbage, and onion seed, the lettuce being most resistant and the onion least resistant, as shown in a preceding table. However, the chief purpose of this series of experiments was to demonstrate the relative value of different packages as a means of putting up seeds.

In Table XXVII it will be observed that the results obtained from the waterproof and parchment paper envelopes have been omitted. These omissions have been made because the results were practically identical with those of the ordinary seedsmen's packets; but the comparisons to be made between the ordinary paper packets and the paraffined packages are worthy of consideration. The envelopes that were paraffined after being filled with seed gave the best results. This difference, however, was due not to the special treatment but to the higher melting point of the paraffin. The average percentages of germination of the three samples of seed kept under trade conditions in the three localities were 59.39 per cent for the envelopes previously paraffined, 62.94 per cent for the envelopes dipped in paraffin after being filled with seed, and 49.44 per cent for the seedsmen's envelopes. In dry rooms the results were 61.11, 65.66, and 49.22 per cent, respectively. These averages were somewhat higher than the true conditions of Baton Rouge and Mobile warrant, as the results of the germination tests from all of the packages retained at Ann Arbor showed but little variation. Taking the three samples of seed which were stored under trade conditions in Mobile, the average percentage of germination was 24.2 for the seed from the nonparaffined package and 45.5 per cent for the seed from the paraffined package, showing a loss in vitality of 77.3 and 49.5 per cent, respectively, considering the germination of the Ann Arbor sample as a standard. At Baton Rouge the results were slightly better; the average percentages of germination were 32.2 for the seeds from the nonparaffined and 53.5 per cent for the seeds from the paraffined packages, representing a loss in vitality of 65 and 40.5 per cent, respectively. While in either case the loss was very great, still the advantages of the paraffined packages are worthy of consideration for the reason that a prolongation of life for only a few weeks is frequently of the greatest importance, particularly in districts where much fall planting is done.

In this connection may be given the results of some other tests, which really were a part of this same experiment, but included only onion seed. This seed was put up in seedsmen's envelopes and in paraffined envelopes like those previously described. In addition, seed was also put up in small bottles, which were corked. These packages were kept in a small box within a suit case carried on two trips across the Atlantic and on a tour through Central Europe, thus subjecting them to very variable conditions. Germination tests gave the following results: Seed from the ordinary packages, 77 per cent; paraffined envelopes, 90 per cent; bottles, 91 per cent.

To test more thoroughly the keeping qualities of seeds in paraffined packages and in bottles, another series of experiments was begun on December 20, 1901. For these tests only cabbage and onion seeds were used, but each with three different degrees of moisture: (1) Seed from the original packages, i. e., air-dried samples, the cabbage having a water content of 5.80 per cent, and the onion 6.48 per cent. (2) Air-dried samples were exposed in a moist atmosphere under a bell jar for two days, during which time the cabbage absorbed 1.83 per cent of water and the onion 2.41 per cent, thus raising the water content to 7.63 and 8.89 per cent, respectively. (3) Air-dried seeds which were dried in an incubator for eight days at a temperature varying from 27° C. to 39° C. During this interval 2.05 per cent of water was expelled from the cabbage and 3.11 per cent from the onion-seed, leaving a water content of only 3.75 per cent in the former and 3.37 per cent in the latter.

Each of the samples, treated as just described, was put up in three different kinds of packages: (1) Seedsmen's regular seed envelopes. (2) Similar envelopes which were paraffined, after being filled with seed, at a temperature of from 70° to 75° C. The melting point of the paraffin was 53° C. (3) In bottles which were closed with firm cork stoppers.

One of each of the above packages was then stored at Mobile under trade conditions and in a basement; likewise at Ann Arbor in the herbarium room of the botanical laboratory, in a greenhouse, and in an incubator maintained at 40° C. The duration of this experiment was 131 days, from December 20, 1901, to April 30, 1902. The results of the germination tests are given in Table XXVIII. Two percentages have been given for the control sample, one for Ann Arbor and the other for Mobile. This was necessary since the two series were tested at different times and comparisons can not be made interchangeably between the two.

TABLE XXVIII.—*Vitality of cabbage and onion seed as preserved in various kinds of packages and subjected to different conditions of storage.*

[Germination of control samples—Ann Arbor: Cabbage, 81.7 per cent; onion, 74 per cent. Mobile: Cabbage, 88 per cent; onion, 84.5 per cent.]

Kind of seed and package.	Special treatment of package.	Percentage of water content of seed.	Percentage of germination.					
			Ann Arbor, Mich.				Mobile, Ala.	
			Botanical laboratory.	Trade conditions.	Greenhouse.	Incubator at 40° C.	Trade conditions.	Basement.
Cabbage:								
Envelope	None	5.80	81.0	81.0	68.0	72.5	60.0	10.0
Do	Paraffin	5.80	80.0	79.0	85.5	62.0	87.5	52.5
Bottle	Corked	5.80	79.5	85.0	85.0	68.5	84.0	84.0
Envelope	None	7.63	85.5	80.5	65.5	74.5	64.5	15.5
Do	Paraffin	7.63	80.5	82.0	83.5	69.5	86.5	46.5
Bottle	Corked	7.63	80.5	85.0	86.5	48.0	82.0	91.5
Envelope	None	3.75	76.0	85.5	67.0	73.0	64.0	9.0
Do	Paraffin	3.75	86.0	84.0	76.0	71.0	82.5	78.0
Bottle	Corked	3.75	83.0	84.0	74.0	64.5	82.5	85.0

TABLE XXVIII.—*Vitality of cabbage and onion seed as preserved in various kinds of packages and subjected to different kinds of storage*—Continued.

Kind of seed and package.	Special treatment of package.	Percentage of water content of seed.	Percentage of germinatien.					
			Ann Arbor, Mich.				Mobile, Ala.	
			Botanical laboratory.	Trade conditions.	Greenhouse.	Incubator at 40° C.	Trade conditions.	Basement.
Onion:								
Envelope	None	6.48	78.5	69.5	3.5	47.0	19.5	10.0
Do	Paraffin	6.48	76.5	66.5	67.0	4.5	83.0	27.0
Bottle	Corked	6.48	73.5	71.5	60.0	64.0	86.0	82.5
Envelope	None	8.89	74.5	60.0	11.5	28.0	21.0	2.5
Do	Paraffin	8.89	74.5	66.0	56.0	9.0	74.5	21.0
Bottle	Corked	8.89	78.0	68.0	67.5	3.0	77.5	78.5
Envelope	None	3.37	61.5	63.5	8.5	? 6.0	17.0	6.0
Do	Paraffin	3.37	75.5	72.5	58.0	? 9.0	77.0	60.5
Bottle	Corked	3.37	76.5	71.0	77.0	59.5	84.5	81.5

Many of the points brought out by this table are very similar to those of the preceding one, yet the differences are sufficiently marked to justify its being given in this connection. The seeds stored in the botanical laboratory and those subjected to trade conditions at Ann Arbor have germinated practically the same, the cabbage slightly favoring trade conditions and the onion being better preserved in the laboratory. But a comparison of the trade conditions at Ann Arbor and Mobile in the unprotected packages shows the same wide variation that has been already pointed out.

The advantage of drying is not very clearly brought out in this table; in many cases there seems to have been a slight injury as a result of the high temperature at which the drying was done. Unavoidably the temperature at that time reached 39° C., which, as has already been stated, is slightly above the maximum to which seeds can be subjected for any considerable time without injury. The injury due to heat is very evident in the samples stored in the incubator maintained at 40° C., this injury being more apparent with the increased moisture, especially in the paraffined package and in the bottle. However, on the whole the percentages of germination are higher for the dried seed than for the seed which had absorbed an additional quantity of moisture; and, indeed, the comparison should properly be made with these two, for seeds as they are usually stored contain even higher percentages of moisture than either the cabbage or lettuce after they had absorbed the additional amount of water.

But the chief purpose of the present experiments was to determine the relative advantages of envelopes, paraffined packages, and bottles as methods of putting up seed in order that vitality might be preserved for a longer time. This comparison is best made by considering the vitality of the seed stored in the greenhouse at Ann Arbor and under trade conditions at Mobile. It will be readily seen that the vitality of the seed from the unprotected packages was greatly reduced, while those from the paraffined envelopes and from the bottles germinated nearly as well as the controls. These differences are better represented diagrammatically, as follows:

Diagram representing the percentages of germination of cabbage seed when treated as described.

Kind of package.	Special treatment of package.	Percentage of water content of seeds.	Ann Arbor, Mich., greenhouse.	Mobile, Ala., trade conditions.
Envelope	....	5.80	73.3	60
Do	Paraffined	5.80	92.1	87.5
Bottle	Corked	5.80	91.5	84
Envelope	....	7.63	70.5	64.5
Do	Paraffined	7.63	89.9	86.5
Bottle	Corked	7.63	93.1	82
Envelope	....	3.75	72.1	64
Do	Paraffined	3.75	81.8	82 5
Bottle	Corked	3.75	79.7	82.5
Control sample	Original package.	5.80	88	88

Diagram representing the percentages of germination of onion seed when treated as described.

Kind of package.	Special treatment of package.	Percentage of water content of seeds.	Ann Arbor, Mich., greenhouse.	Mobile, Ala., trade conditions.
Envelope	....	6.48	4	19.5
Do	Paraffined	6.48	76.6	83
Bottle	Corked	6.48	68.6	86
Envelope	....	8.89	13.2	21
Do	Paraffined	8.89	64	74.5
Bottle	Corked	8.89	77.3	77.5
Envelope	....	3.37	9.7	17
Do	Paraffined	3.37	66.3	77
Bottle	Corked	3.37	88	84.5
Control sample	Original package.	6.48	84.5	84.5

The percentages for Ann Arbor shown in the graphic representations are not the same as those given in the foregoing table. In the diagram they are directly comparable with the results from the Mobile series, all being based on the vitality of the controls, as shown by the tests made at that time, the standard being 88 per cent for the cabbage and 84.5 per cent for the onion.

A discussion here hardly seems necessary, as there can be no doubt that seeds retain their vitality much better in moist climates if protected from the action of the atmosphere. This may be accomplished by dipping the packages in paraffin or by putting the seed in bottles. Disregarding the expense, bottles surpass paraffined envelopes as a means for the preservation of vitality, and also in the ease with which the seed can be put up. The results are more certain if care is exercised in selecting good corks.

RESPIRATION OF SEEDS.

From a practical point of view it has been conclusively shown that moisture is the controlling factor in seed life. Seeds stored in a humid atmosphere soon lose their vitality, but if carefully dried and protected from moisture life is greatly prolonged.

The question at once presents itself: In what way does the presence of increased quantities of moisture cause a premature death of the seed, or why is vitality prolonged if the water content of the seed be reduced?

In a measure, the answer to this question is *respiration*. Seeds as we commonly know them absorb oxygen and give off carbon dioxid; that is, respire.[a] During their respiratory activities the energy stored within the seed is readily evolved, the vital processes are destroyed, and life becomes extinct. The intensity with which respiration takes place is largely dependent upon the humidity of the surrounding atmosphere, which ultimately resolves itself into the amount of water in the seed. The respiratory activity is directly proportional to the quantity of moisture absorbed by the seed up to a certain point, attaining its maximum during the process of germination. It has been found that a decrease in the water content results in a corresponding diminution in the intensity of respiration and consequently in a prolongation of the life of the seed as such.

Bonnier and Mangin[b] were the first to show that respiration in living plants increases with an increase in the humidity in the surrounding air. As this is true for growing plants, it is even more marked in stored seeds. Maquenne[c] suggested that a reduction in moisture is accompanied by a reduction in respiration, but at that time no experiments had been made to show that such was actually the case.

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[a] Kolkwitz (Ber. d. deutsch. Bot. Ges., **19**: 285–287, 1901) reports respiration in recently ground seeds.

[b] Ann. sc. nat. bot., ser. 7, **2**: 365–380, 1885.

[c] Ann. Agron., **26**: 321–332, 1900.

In 1832, Aug. Pyr. De Candolle wrote in the second volume of his Physiologie Végétale that the vitality of seeds would be prolonged if they were buried sufficiently deep in the soil to protect them from oxygen (or air) and moisture. Unfortunately, De Candolle did not discover the true cause of this prolonged life, for nowhere did he make any reference to respiration. Nevertheless his general conclusions were properly drawn. De Candolle also stated that light accelerates evaporation in seeds and thus causes a premature death. Here, however, his results were wrongfully interpreted. These conclusions are applicable only in case of seeds that die if allowed to become dry. The real effect of light is to cause a slightly accelerated respiration and consequently a greater deterioration in vitality. Jodin[a] states that light accelerates respiration to a marked degree. His experiments were with peas which contained 10 to 12 per cent of moisture. Two samples of peas were placed, each under a bell jar, over mercury. One sample was kept in the light and the other in the dark. At the end of 4 years 6 months and 14 days an analysis of the confined air from the sample kept in the light gave the following results:

Peas, 3.452 grams, in air, in light:	Per cent.
Oxygen	19.1
Nitrogen	78.6
Carbon dioxid	1.2

At the end of 4 years 7 months and 14 days an analysis of a sample of air taken from the other chamber was as follows:

Peas, 3.580 grams, in air, in dark:	Per cent.
Oxygen	20.8
Nitrogen	79.1
Carbon dioxid	.1

The 3.452 grams of peas that were subjected to the influence of the action of light had absorbed, in the given time, 2.4 cc. of oxygen and produced 1.8 cc. of carbon dioxid. The seed kept in the dark showed but little signs of respiratory activity. Germination tests of the former showed the peas to be dead, while five peas from the sample kept in the dark germinated perfectly.

While there is no question that light exerts some influence on respiration, still the above results do not furnish sufficient data to establish the fact that respiration practically ceases in the absence of light. In fact, experiments have shown that respiration is also quite marked in case of seeds stored in the dark, and the difference is very slight if the same temperature be maintained.

Van Tieghem and Bonnier, in their "Recherches sur la vie latente des graines,"[b] demonstrated that 7.976 grams of peas, sealed, in air,

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[a] Ann. Agron., **23**: 433–471, 1897.

[b] Bul. Soc. bot. France, **29**: 25–29, 1882.

in a tube, respired quite freely. After the lapse of two years an analysis of the confined air gave the following results:

	Per cent.
Oxygen	14.44
Nitrogen	81.74
Carbon dioxid	3.82

These same seeds germinated 45 per cent and had increased $\frac{1}{790}$ of their original weight.

In the experiments of the writer it was found that 40.1150 grams of air-dried beans liberated 7.7 cc. of carbon dioxid in 370 days. The concentration of the carbon dioxid in the flask at the time the gas was drawn for analysis was 1.54 per cent. This sample of seed germinated 97 per cent, and there was only a very slight retardation in germination, which indicated that the vitality had not been materially reduced. During this time there was a slight decrease in the weight of the seed—0.19 per cent. At the same time two check bottles were set up, one containing 40.1184 grams of beans known to be dead, and the other bottle containing nothing except air. Analyses of the air from these two bottles gave the same results as samples of air drawn from the laboratory. These preparations were kept in subdued light throughout the experiment.

That respiration may take place in the dark, that it is very intense if much moisture be present, and that intensive respiration is accompanied by a rapid loss in vitality is shown by the following experiments. On April 3, 1900, samples of beans, cabbage, carrot, lettuce, and onion were sealed, each in bottles of 250 cc. capacity, and were stored in a dark room which was maintained at a temperature of from 20° to 25° C. These samples were first carefully weighed and then placed in a damp chamber for 175 hours, so that an additional quantity of moisture could be absorbed.

Control samples of air-dried seeds were also kept in sealed bottles and subjected to the same subsequent treatment. After the lapse of one year analyses of the confined gases and germination tests of the seeds were made, the results of which are given with the general details.

Beans.—Of beans, 24.9994 grams absorbed 4.70 per cent of water while in the damp chamber. The respiration during the year was equivalent to 2.5 cc. of carbon dioxid. The loss in weight was only 0.05 per cent, but the vitality had fallen from 100 to 86 per cent, as shown by the control.

Cabbage.—Of cabbage seed, 10 grams, with an additional 9.79 per cent of water, were used for this test. During the year this sample of cabbage seed had given off 24 cc. of carbon dioxid, an equivalent of 2.4 cc. of carbon dioxid per gram of seed per year. The control sample germinated 89 per cent, but this seed was dead.

Carrot.—Of carrot seed, 10 grams were allowed to absorb during 175 hours an additional 10.25 per cent of water. In one year 27 cc. of carbon dioxid were produced, giving a concentration of carbon dioxid of nearly 12 per cent. The deterioration in vitality was from 84 to 0 per cent, as compared with the control.

Lettuce.—Of air-dried lettuce seed, 10 grams were allowed to absorb an additional 8.87 per cent of water. During the experiment 19.5 cc. of carbon dioxid were formed, an equivalent of approximately 10 per cent of the original volume of the inclosed air. These seeds were all killed. The control sample germinated 94 per cent.

Onion.—Of air-dried onion seed, 10 grams were allowed to absorb an additional 10.11 per cent of water. The seed gave off 26.5 cc. of carbon dioxid during the experiment and deteriorated in vitality from 97 to 0 per cent.

A bottle containing 4 cc. of water was also sealed at the same time and served as a check for the other analyses. A sample of air taken from this bottle gave the same results as the original air sample.

It is a matter of much regret that no analyses could be made of the air from the bottles which contained the check samples. These bottles contained the same weight of air-dried seeds as was used for the experiments. Unfortunately the seals on these bottles had become dry and admitted of an exchange of gases, so that the results were not reliable.

Another series of experiments consisted in keeping onion seeds in sealed bottles for 1 year and 13 days, with the following results:

(*a*) Fifty grams of air-dried seed were sealed, in air, in a bottle of 500 cc. capacity. There was an increase in the weight of the seeds of 0.1091 gram—slightly more than 0.2 per cent. An analysis of the inclosed gas gave:

	Per cent.
Oxygen	12.27
Nitrogen	85.87
Carbon dioxid	1.86

(*b*) Fifty grams of air-dried seed were sealed, in air, in a 500 cc. bottle, with 4 cc. of water in a small test tube at the bottom of the bottle. Nearly all of the water was absorbed by the seeds, there being an increase in weight of 3.6475 grams, or 7.3 per cent. The composition of the inclosed air was:

	Per cent.
Oxygen	None
Nitrogen	86.65
Carbon dioxid	13.35

The oxygen had all been consumed and the seeds were all dead.

(*c*) Fifty grams of onion seed were sealed in a 500 cc. bottle, in a mixture of illuminating gas and air. The increase in weight was only 0.04 per cent. An analysis of the inclosed gas was as follows:

	Per cent.
Oxygen	3.23
Carbon dioxid	1.21
Methane and nitrogen	95.96

(*d*) Another 50-gram sample of onion seed, belonging to a different series, was sealed in a bottle of 300 cc. capacity, and showed the following composition of the inclosed air:

	Per cent.
Oxygen	8.02
Nitrogen	85.17
Carbon dioxid	6.81

In only one case was there any deterioration in vitality, namely, where the large quantity of moisture was present. The other samples germinated normally. The seed kept in the illuminating gas germinated even better than the control.

In all of the bottles there was a marked decrease in pressure, showing that the volume of oxygen absorbed was much greater than the volume of the carbon dioxid given off.

During respiration certain chemical changes must be taking place which exert a marked influence on the vitality of seeds. What these changes are is a question yet to be solved. The protoplasts of the individual cells gradually but surely become disorganized. C. De Candolle[a] takes the view, in discussing the experiments of Van Tieghem and Bonnier, that during respiration life is simply subdued. But the period of subdued activity, he says, is comparatively short, for respiration soon ceases and life becomes wholly latent. As a result of his own experiments in storing seeds at low temperatures he concludes that seeds cease to respire and become completely inert; in which case they can suffer any degree of reduction in temperature without being killed. The killing of the seeds experimented with (lobelia) he attributes to the fact that the protoplasm had not become inert, but simply subdued, and the seeds were thus affected by the low temperature.

As a result of later experiments C. De Candolle,[b] in keeping some seeds under mercury to exclude air, concludes that "seeds can continue to subsist in a condition of complete vital inertia, from which they recover whenever the conditions of the surrounding medium permits their 'energids,' or living masses of their cells, to respire and assimilate." He compares the protoplasm in latent life to an explosive mixture, having the faculty of reviving whenever the conditions are favorable. This comparison seems rather an unfortunate one; yet, within a certain measure it is probably true.

[a] Revue Scientifique, ser. 4, **4**: 321–326, 1895.
[b] Pop. Sci. Monthly, **51**: 106–111, 1897.

It is now quite generally accepted that respiration is not absolutely necessary for the maintenance of seed life, notwithstanding the fact that Gray contended that seeds would die of suffocation if air were excluded.[a] The experiments of Giglioli[b] in keeping seeds of *Medicago sativa* immersed in various liquids for approximately sixteen years, after which many responded to germination tests, has done much toward demonstrating the fact that seeds can live for a considerable time in conditions prohibiting respiration.

Kochs[c] succeeded in keeping seeds for many months in the vacuum of a Geissler tube without being able to detect the presence of any carbon dioxid, and consequently he concluded that there was no gas given off by intramolecular respiration.

Romanes[d] kept various seeds in vacuum in glass tubes for 15 months and the seeds were not killed. However, his vitality tests can not be considered as entirely satisfactory. In the first place, the number of seeds used (ten) was too small; secondly, the variations in the results, even in the controls, indicate that the samples were not of very good quality.

In the experiments of the writer cabbage and onion seed were kept in a vacuum over sulphuric acid for 182 days. During this time all of the free water had been extracted from the seed. When again connected with a vacuum gauge the dial showed that there was not the slightest change in pressure, and that consequently no evolution of gases had taken place. The cabbage germinated 75 per cent and the onion 73 per cent as compared with 81 and 74 per cent, respectively, for the controls.

The results of the various experiments above given demonstrate quite fully that the vitality of seeds, as we commonly know them, is not interfered with if they are kept in conditions prohibiting respiration. Brown and Escombe[e] hold that all chemical action ceases at temperatures of liquid air. They accordingly conclude that "any considerable internal chemical changes in the protoplasts are rendered impossible at temperatures of $-180°$ to $-190°$ C., and that we must consequently regard the protoplasm in resting seeds as existing in an absolutely inert state, devoid of any trace of metabolic activity and yet conserving the potentiality of life * * * And since at such low temperatures metabolic activity is inconceivable an immortality of the individual protoplasts is conceivable providing that the low temperatures be maintained."

[a] Amer. Jour. of Sci., 3d series, **24**: 297, 1882.
[b] Nature, **52**: 544, 1895.
[c] Biol. Centrbl., **10**: 673–686, 1890.
[d] Proc. Roy. Soc., **54**: 335–337, 1893.
[e] Ibid., **62**: 160–165, 1897–98.

Giglioli [a] arrived at practically the same conclusions when he said:

It is a common notion that life, or capacity for life, is always connected with continuous chemical and physical change * * * The very existence of living matter is supposed to imply change. There is now reason for believing that living matter may exist, in a completely passive state, without any chemical change whatever, and may therefore maintain its special properties for an indefinite time, as is the case with mineral and all lifeless matter. Chemical change in living matter means active life, the wear and tear of which necessarily leads to death. Latent life, when completely passive in a chemical sense, ought to be life without death.

But even though ordinary respiratory exchanges are not necessary for the maintenance of vitality, and granting that intramolecular respiration does not occur in the resting protoplasts, there is no experimental evidence pointing to the fact that all chemical action ceases, although some writers, as has already been shown, maintain the view that living matter may exist in a completely passive state. If "completely passive" meant devoid of respiratory activities none would dare dissent; but that seeds are entirely quiescent under any known conditions has not been proved. To conceive of all activity ceasing within the seed under certain conditions, and that with such cessation of activity an immortality of the seed is possible, i. e., if such conditions continue to exist, is, from our present knowledge of the chemistry and behavior of the living cell, impossible. In Giglioli's experiments respiration was undoubtedly prevented, and, according to his own conclusions, vitality should have been preserved, for he says "in the absence of any chemical change the special properties may be maintained indefinitely." But, in his own experiments, the special properties were not maintained, for all of the seeds with which he experimented deteriorated very much, and many died. Granting that those which suffered the greatest loss in vitality were injured by the presence of the particular gas or liquid used there remain no means of accounting for the deterioration in those giving the highest percentages of germination. His experiments were made for the most part with *Medicago sativa*, which, under ordinary conditions of storage, is especially long lived. Samek [b] has shown that seed of *Medicago sativa* 11 years old was capable of germinating 54 per cent. Giglioli succeeded in getting a germination of only 56.56 per cent after a little more than 16 years in hydrogen, and 84.20 per cent when they had been kept in carbon monoxid. Jodin [c] kept peas immersed in mercury for 4½ years and they germinated 80 per cent. After 10 years the vitality had fallen to 44 per cent. Nobbe obtained a germination of 33 per cent in peas 10 years old which had been stored under normal conditions. Likewise the experiments of Brown and Escombe do not justify the

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[a] Nature, **52**: 544–545, 1895.

[b] Tirol. landw. Blätter, **13**: 161–162, 1894.

[c] Ann. Agron., **23**: 433–471, 1897.

conclusions which they have drawn. It is now definitely known that all chemical actions do not cease at the temperature of liquid air. Thus it can not be granted that the protoplasm becomes inert as a result of the reduction in temperature. Maquenne[a] more nearly expressed the true conditions applicable to low temperatures when he wrote that with dessication, at low temperatures, seeds are transformed from a condition of diminished activity into a state of suspended life. But there are still other factors to be considered. The vegetative functions may cease, metabolic processes may be at a standstill, intramolecular respiration need not exist, yet vitality is not, nor ever has been, preserved; sooner or later life becomes extinct. What does this signify? The gradual process of devitalization means chemical change, and chemical change means activity within the cells. We must not forget the great complexity of the composition of the protoplasmic bodies which go to make up a seed. The chemistry of the living cell is still surrounded by many difficulties and is likewise filled with many surprises, and before the question of the vitality of seeds can be understood a more comprehensive knowledge of both the functions and composition of the cell contents is necessary.

It is well known that all organic compounds are made up of a very few elementary substances, but the numerous and obscure ways in which they are put together furnish questions of the greatest perplexity. Substances having the same elements may differ widely as to their properties. Moreover, isomeric substances—i. e., those having the same elements in the same proportions, giving an equivalent molecular weight—are usually very different in their chemical reactions and physiological functions. As yet this intramolecular atomic rearrangement is but vaguely understood, and the writer ventures to suggest that with a more comprehensive knowledge of the chemistry of the living cell some such chemical activity will be discovered. With these discoveries will come, perhaps, an understanding of the devitalization of seeds, and with it the theory of the immortality of seeds will vanish.

SUMMARY.

(1) Seeds, like other living organisms, respire when subjected to normal conditions of storage.

(2) Respiration means a transformation of energy, and consequently a premature death of the seed.

(3) Within certain limits respiration is directly proportional to the amount of water present in the seeds and to the temperature at which they are stored.

(4) By decreasing the water content of seeds respiration is reduced and vitality greatly prolonged.

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[a] Compt. Rend., **134**: 1243-1246, 1902.

(5) In most seeds the quantity of oxygen absorbed greatly exceeds the quantity of carbon dioxid evolved.

(6) Respiration is nearly as active in the dark as in the light.

(7) Respiration apparently is not necessary for the maintenance of seed life.

(8) A cessation of respiration does not mean a cessation of chemical activities.

ENZYMES IN SEEDS AND THE PART THEY PLAY IN THE PRESERVATION OF VITALITY.

During the past decade the so-called unorganized ferments have taken an important place among the subjects of biological research. Our knowledge of their wide distribution has increased many fold. The part they play in both anabolism and catabolism has furnished us many surprises, but with all of the work that has been done our knowledge of these most complex compounds is very limited.

The part that enzymes play in the processes of germination is of the utmost importance. It is now quite well understood that they are developed as germination progresses. They act on the most complex reserve food products, converting them into simpler substances that can be more readily utilized by the growing seedling.

However, even in this connection there is a great diversity of opinion, especially as to their distribution and enzymic action within the endosperm itself. Puriewitsch,[a] Grüss,[b] and Hansteen[c] are cited by Brown and Escombe[d] as holding the view that the amyliferous cells of the endosperm of the grasses can digest their reserve materials independently of any action of the embryo—i. e., the starch-bearing cells are living cells and secrete enzymes in the grasses as well as in the cotyledonous cells of *Lupinus*, *Phaseolus*, and *Ricinus*. In 1890, Brown and Morris[e] did not find such to be the case; but the results of Puriewitsch, Grüss, and Hansteen led to a duplication of the experiments by Brown and Escombe in 1898. At this time they demonstrated that the amyliferous cells play no part in the chemical changes which take place during the process of germination, but on the contrary that the enzymic action in the endosperm of the grasses is confined to the aleuron layer.

But the purpose of the present paper is not to consider the localization of the particular enzyme, and much less the action of enzymes during germination. At this time quite another question is to be

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[a] Pringsheims Jahrb., **31**: 1, 1897.

[b] Landw. Jahrbücher, 1896, p. 385.

[c] Flora, **79**: 419, 1894.

[d] Proc. Roy. Soc., **63**: 3–25, 1898.

[e] Jour. Chem. Soc., London, **57**: 458–528, 1890.

considered, viz, In what way do enzymes function in the preservation of vitality?

Maquenne[a] points to the view that the vitality of seeds is dependent on the stability of the particular ferment present. He attributes the prolongation of vitality in seeds that are kept dry to the better preservation of the enzymes. This view has been largely strengthened as a result of the investigations made by Thompson,[b] Waugh,[c] Sharpe,[d] and others, in which they have shown that the artificial use of enzymes may greatly increase the percentage of germination in some old seeds. By the use of diastase the percentage of germination of 12-year-old tomato seed has been increased more than 600 per cent.

If the suggestions made by Maquenne were true in every sense, then dead seeds should be awakened into activity by artificially supplying the necessary enzymes; but this can not be, or never has been, accomplished. True, many experiments have been recorded in which a greater percentage of seed has been induced to germinate by the judicious use of commercial enzymes than by the ordinary methods of germination; but this treatment is applicable only where the vital energy is simply at a low ebb and does not in any way affect dead seeds. The experiments of the writer with naked radicles from the embryos of living and dead beans have shown the presence of enzymes in both. The carefully excised radicles were ground and macerated in water for one hour. The filtrate was then added to dilute solutions of starch paste. The solutions from the living embryos gave rise to an energetic hydrolytic action. In all cases hydrolysis was sufficiently advanced to give a clear reaction with Fehling's solution. The solutions extracted from the radicles from the dead beans also gave reactions sufficiently clear to indicate that there was still some ferment present.[e]

However, the hydrolysis was scarcely more than begun, giving only a brown color with iodin, but not reacting with Fehling's solution. Results of a similar character were obtained from portions of the seed

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[a] Ann. Agron. **26**: 321–332, 1900; Compt. Rend., **134**: 1243–1246, 1902.

[b] Gartenflora, **45**: 344, 1896.

[c] Ann. Report, Vt. Agr. Exp. Sta., 1896–97, and Science, N. S., **6**: 950–952, 1897.

[d] Thirteenth Annual Report, Mass. Hatch Exp. Sta., Jan., 1901, pp. 74–83.

[e] This was a sample of "Valentine" beans grown in 1897. The same year they tested 97.3 per cent. In March, 1898, the same sample tested 87 per cent. At this time they were sent to Orlando, Fla., where they remained until May 8, 1899, approximately fourteen months. The beans were then returned and numerous germination tests were made at irregular intervals, but in no case was there any indication of vitality. Several samples were also treated with "Taka" diastase (solutions varying in strength from 2 to 10 per cent), but none was stimulated into germination. The radicles were tested for enzymes in the spring of 1902, nearly three years after the beans first failed to germinate, at which time they were nearly 6 years old.

taken from the point of union of the axis and the cotyledons. These possessed stronger hydrolytic powers, the preparations from the living and dead beans each giving clear reactions with Fehling's solution. A third series of tests was made by stopping the germination of beans when the radicles were from 1 to 1.5 cm. long. These were then kept quite dry for nearly seven months, after which the dessicated radicles were broken off and macerated like the above. This solution was then allowed to act on starch paste, and the transformations were almost as rapid and complete as when a 1 per cent solution of commercial "Taka" diastase was used.

These results lead one to believe that the loss of vitality in seeds is not due to the disorganization of the enzymes present. There is something more fundamental and probably more complex to which we must look for this life-giving principle. True, as Maquenne has suggested, there is a close relationship between the loss of vitality in seeds and the decomposition of enzymes.

In order to determine what such a relationship might signify, the following series of experiments were made:

Beans, peas, cabbage, lettuce, onion, phlox, and pansy seed, with definite quantities of good commercial "Taka" diastase, were put up in bottles of 120 cc. capacity, as follows:

(1) In bottle closed with cork stopper.

(2) In bottle closed with cork stopper and paraffined.

(3) 0.5 cc. of water in the bottle with the seeds and the diastase, the bottle sealed with paraffin.

(4) 1 cc. of water in the bottle with the seeds and the diastase, the bottle sealed with paraffin.

(5) 2 cc. of water in the bottle with the seeds and the diastase, the bottle sealed with paraffin.

(6) 3 cc. of water in the bottle with the seeds and the diastase, the bottle sealed with paraffin.

(7) 4 cc. of water in the bottle with the seeds and the diastase, the bottle sealed with paraffin.

The water in each case was carefully added on small strips of filter paper and never were the seeds or the diastase wet, only becoming gradually moist as the water was absorbed.

These different preparations, each containing one of each of the samples of seeds and a definite quantity of the dry powdered diastase, were then maintained at the temperature of the laboratory for a period of 85 days. At the end of that time the vitality of the seeds was determined and simultaneously the hydrolytic power of the diastase was ascertained. The results of the germination tests are given in Table XXIX. The effect of the increased quantity of moisture on the diastase is given in the discussion following the table.

TABLE XXIX.—*Loss in vitality of seeds with varying degrees of moisture when kept at ordinary room temperature.*

[Duration of experiment, 85 days.]

Laboratory number.	Preparation of sample.	Amount of water added.	Percentage of germination.						
			Beans.	Peas.	Cabbage.	Onion.	Phlox.	Pansy.	Average of all samples.
		cc.							
	Control[a] ...	None ...	96.0	90.0	91.5	95.0	41.25	46.0	76.6
1547	Corked	None ...	98.0	96.0	91.0	92.5	52.0	32.0	76.9
1548	Paraffined ..	None ...	96.0	92.0	91.5	93.0	39.5	31.0	73.8
1549	.....do......	0.5	96.0	92.0	89.0	88.8	28.5	25.5	69.9
1550	.....do......	1.0	96.0	88.0	89.0	64.0	12.5	18.0	61.2
1551	.....do......	2.0	96.0	86.0	78.0	13.0	.5	2.5	46.0
1552	.....do......	3.0	94.0	94.0	65.0	2.5	.5	.5	46.1
1553	.....do......	4.0	90.0	81.6	54.5	.0	.0	.0	37.6

[a] The samples prepared, excepting the control, were in bottles of 120 cc. capacity.

The above table shows that there was a gradual deterioration in vitality as the quantity of water was increased. All stages of injury were manifested, but it is not necessary to enter into a discussion of the table at this time, inasmuch as similar tabulations, showing the injurious effects of varying quantities of moisure on the seeds, have already been given on page 38. This table is inserted here in order that a comparison can be made with the decomposition of the commercial diastase used and the loss in vitality of the seeds.

For a determination of the diastasic activity various quantities of 1 per cent "Taka" diastase solutions were allowed to act on definite quantities of a 1 per cent solution of starch paste, the whole being maintained at a temperature of from 45° to 48° C. Ten cubic centimeters of the starch solution were taken for each determination, and the amount of the diastase solution varied from one-half to 1, 2, 3, and 5 cc. In the control sample, consisting of diastase from the original bottle as it was kept in the laboratory, 2 cc. of the 1 per cent solution were sufficient to cause a complete hydrolysis of the 10 cc. of 1 per cent starch solution. In Nos. 1547, 1548, and 1549 the samples from the control bottle, the paraffined bottle, and the paraffined bottle containing 0.5 cc. of water, respectively, 3 cc. of the diastase solution were necessary for a complete hydrolysis. In Nos. 1550, 1551, and 1552—that is, the samples from the bottles which contained 1, 2, and 3 cc. of water, respectively—the diastase was very much injured as a result of the increased quantity of water in the bottle and 5 cc. of the diastase solution were required to hydrolyze the 10 cc. of the 1 per cent starch paste. No. 1553—the sample from the bottle which contained the 4 cc. of water—showed that the diastase had been almost completely disorganized, inasmuch as the greatest quantity used (5 cc. of the 1 per cent diastase solution) was only sufficient to cause a slight hydrolytic action. When tested with iodine there was still a deep, purplish-blue color. In this last case the average percentage of germination had decreased to 37.6 per cent, as compared with 76.6 per cent for the control samples. Moreover, in the latter case, the onion, phlox, and pansy seeds were killed.

These results show that there is a remarkable uniformity between the loss in vitality of seeds and the loss in the enzymic action of the "Taka" diastase under similar conditions, but it does not furnish conclusive evidence that the loss in vitality of the seeds is in any way governed by the particular enzymes present. In fact, the evidence at hand better substantiates the opposite view. In the first place dead seeds may still contain active ferments. Secondly, the prolonged subjection of seeds to the action of ether and chloroform is generally accompanied by a premature death, and if the seeds are moist the loss in vitality is much more marked. On the other hand, it is generally accepted that either of these gases exerts no injurious effect on the hydrolytic action of the various ferments. Townsend[a] has shown that the action of diastase on starch paste is even more energetic in the presence than in the absence of ether, but in germination ether usually has a retarding influence. In some cases, however, growth is stimulated by the use of ether.

In the third place enzymes can not be the chief factors controlling the vitality of a seed, because the more sensitive growing point of the radicle suffers injury much in advance of the other portions of the seed. Not infrequently in making germination tests do we find that the growing tip of the embryo is dead, while other portions of the seed may still be living and capable of carrying on all normal metabolic processes. The bean is one of the best examples for demonstrating this fact. Here the radicle may be entirely dead, yet the cotyledons may still be able to make some growth; but in all seeds where the growing tip is dead the remaining portion of the radicle may be living, in which case adventitious roots may be formed and growth may continue for a considerable time, though very rarely will a healthy seedling be developed. It thus seems quite clear that the real vital elements are closely associated with the growing point, and when this portion of the embryo is once dead the vital energy in the other parts of the seed is not of such a nature as to enable growth to continue for any length of time. Even though the reserve food products are digested they can not be assimilated by the growing radicle, which should be the case were enzymes the chief elements to which the preservation of vitality is attributed.

Enzymes play an important part in the vitality of seeds, and are undoubtedly necessary for the normal development of a seedling, but the points above given show that the life of a seed is not entirely

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[a] Bot. Gaz., 1899, **27**: 458–466.

dependent on the stability of the particular ferment or ferments present. There is something more remote, possibly of a simpler but probably of a more complex composition, to which we must attribute the awakening of the metabolic processes. Reference is not made here to the zymogenic substances which develop into the particular ferment, for what has been said of the latter applies equally well to the former. If the zymogens were perfectly preserved the resulting ferments would be developed normally and germination would continue in the usual manner.

In conclusion, it may well be emphasized that no single element or compound can be isolated as the sole source of vitality in seeds. There must be a combination of factors, each of which plays an important rôle in the preservation of vitality. The destruction of any one of these factors may upset the principles governing the life of a seed, and consequently cause a premature death.

It is quite probable that the nucleus is one of the most important organs governing vitality, for unless it continues to function no other growth can take place. Other parts of the cell, however, may be of equal importance. At all events all hope of future gain must come from more critical studies of the cell contents to know their chemical composition and possible reactions. A correct solution of these perplexing questions is nothing less than a determination of the fundamental principles of life. What will be the ultimate results no one is prepared to say.

SUMMARY.

(1) A seed is a living organism, and must be dealt with as such if good results are expected when put under favorable conditions for germination.

(2) The first factors determining the vitality of a seed are maturity, weather conditions at the time of harvesting, and methods of harvesting and curing.

(3) Immature seeds sown soon after gathering usually germinate readily, but if stored they soon lose their vitality. On the other hand, well-matured seeds, harvested under favorable conditions, are comparatively long lived when properly handled.

(4) Seed harvested in damp, rainy weather is much weaker in vitality than seed harvested under more favorable conditions. Likewise, seed once injured will never regain its full vigor.

(5) The curing of the various seeds is of the utmost importance, and great care should be taken to prevent excessive heating, otherwise the vitality will be greatly lowered.

(6) The life period of any species of seed, granting that it has been thoroughly matured and properly harvested and cured, is largely dependent on environment.

(7) The average life of seeds, as of plants, varies greatly with different families, genera, or species, but there is no relation between the longevity of plants and the viable period of the seeds they bear. The seeds of some plants lose their vitality in a few weeks or months, while others remain viable for a number of years.

(8) With special precautions and treatment there is no question that the life of seeds may be greatly prolonged beyond that which we know at present, though never for centuries, as is frequently stated. Cases so reported can not be taken as evidence of the longevity of seeds.

(9) It is known that seeds retain their vitality much better in some sections of the country than in others. The part which climatic influences play in the vitality of seeds is of much more importance than is generally supposed.

(10) Experiments have shown that *moisture* is the chief factor in determining the longevity of seeds as they are commercially handled. Seeds stored in dry climates retain their vitality much better than when stored in places having a humid atmosphere.

(11) The deleterious action of moisture is greatly augmented if the temperature be increased. Not infrequently is vitality destroyed within a few weeks or months when the seeds are stored in warm, moist climates. If stored in a dry climate, the question of temperature within the normal range is of little moment.

(12) The storage room for seeds as they are ordinarily handled should always be *dry*. If seeds could be kept dry and at the same time cool, the conditions would be almost ideal for the preservation of vitality; but the difficulties to be overcome in order to secure a dry and cool storage room render this method impracticable.

(13) The most feasible method for keeping seeds dry and thus insuring strong vitality is to store them in well ventilated rooms kept dry by artificial heat. This method of treatment requires that the seeds be well cured and well dried before storing.

(14) If seeds are not well dried vitality is best preserved at temperatures just above freezing, provided that the temperature is maintained uniformly.

(15) In no case must the temperature of the storage house be increased unless the seed is amply ventilated so that the moisture liberated from the seed can be carried off readily by the currents of warm air. If this precaution is not taken the increased humidity of the air confined between the seeds will cause a marked injury. For this same reason seeds kept at low temperatures during the winter will deteriorate in the warm weather of spring, especially if they contain much moisture.

(16) Most seeds, if first carefully dried, can withstand long exposures to a temperature of 37° C. (98.6° F.) without injury, but long exposures to a temperature of from 39° to 40° C. (102.2° to 104° F.)

will cause premature death. If the seeds are kept in a moist atmosphere a temperature of even 30° C. (86° F.) will soon cause a marked injury.

(17) Seeds can endure any degree of drying without injury; that is, by drying in a vacuum over sulphuric acid. It is believed that such a reduction in the water content is necessary if vitality is to be preserved for a long period of years. However, with such treatment the seed coats become very firm, and there usually follows a retardation in germination as a result of the inability of the seeds to absorb water rapidly enough to bring about the necessary physical and chemical transformations for the earlier stages of germination.

(18) Seeds that are to be sent to countries having moist climates should be put up in air-tight packages. Experiments have shown that by the judicious use of bottles and paraffined packages seeds can be preserved practically as well in one climate as in another.

(19) It is of the utmost importance that the seeds be dry before being sealed in bottles or paraffined packages. A drying of ten days at a temperature of from 30° to 35° C. (86° to 95° F.) will usually be sufficient. However, a better method to follow is to dry until no more moisture is given off at a temperature equivalent to the maximum of the region in which the seeds are to be distributed. If this is not done, the subsequent increase in temperature will liberate an additional quantity of moisture, which being confined in the package will leave the seeds in a humid atmosphere and a rapid deterioration in vitality will follow.

(20) Experiments in storing seeds in open and sealed bottles and in packages with definite quantities of moisture and at various known temperatures have shown a very close relationship between the loss in vitality and the increase in water content, the deterioration likewise increasing with the temperature.

(21) Of a series of experiments the average loss in vitality of seeds kept in envelopes in a "dry room" was 21.19 per cent, "trade conditions" 36.63 per cent, "basement" 42.28 per cent, while the loss in the case of seeds stored in bottles was only 8.08, 3.92, and 4.51 per cent, respectively. (See Table XXV.)

(22) Seeds under ordinary conditions of storage respire quite freely, and respiration is much more rapid if much moisture is present. Within certain limits respiration is directly proportional to the amount of moisture present in the seed and inversely proportional to the duration of vitality.

(23) Respiration is not necessary to the life of seeds, as they can be kept in conditions unfavorable for respiratory activity and still retain their vitality even better than under normal conditions of storage. Even though respiration be entirely prevented seeds will continue to deteriorate, and sooner or later lose their vitality.

(24) The continued deterioration in the vitality of a seed after respiration has ceased indicates a chemical activity within the cells, giving rise to a transformation of energy which sooner or later leads to the death of the seed.

(25) Respiration is almost as active in the dark as in the light, provided that the temperature and humidity remain the same.

(26) Ferments and seeds lose all power of activity under similar conditions of moisture, and the former are undoubtedly of the utmost importance in metabolic activity, but the evidence at hand goes to show that the life of a seed is not dependent on the preservation of the particular ferment involved or on the zymogenic substances giving rise to the enzyme.

(27) The life of a seed is undoubtedly dependent on many factors, but the one important factor governing the longevity of good seed is *dryness.*

LITERATURE CITED.

Bonnier, G., et Mangin, Louis. La fonction respiratoire chez les végétaux. Ann. sc. nat. bot., sér. 7, **2**: 365–380, 1885.

Bornemann, G. Versuche über Erhaltung der Keimfähigkeit bei importirten Samen von Wasserpflanzen während des Transportes. Gartenflora, **35**: 532–534, 1886. Also abstract in Bot. Jahresber., Jahrg. XIV, Abt. I, p. 132, 1886.

Brown, Horace T., and Escombe, F. Note on the influence of very low temperatures on the germinative power of seeds. Proc. Roy. Soc. London, **62**: 160–165, 1897–98.

——— On the depletion of the endosperm of *Hordeum vulgare* during germination. Proc. Roy. Soc. London, **63**: 3–25, 1898.

——— and Morris, M. Germination of some of the *Gramineæ*. Jour. Chem. Soc. London, **57**: 458–528, 1890.

Dammer, U. Verpackung und Versandt von Samen, welche ihre Keimkraft schnell verlieren. Zeitschr. f. trop. Landw., Bd. 1, No. 2, 1897. Abstract in Bot. Centralbl., **70**: 196–197, 1897.

De Candolle, Aug. Pyr. Physiologie végétale (Conservation des graines), v. 2, p. 618, Paris, 1832.

De Candolle, C. Sur la vie latente des graines. Arch. des sci. phys. et nat., sér. 4, **33**: 497–512, 1895. Abstract in Amer. Gard., **18**: 339, 1897.

——— La vie latente des graines. Revue scientifique, sér. 4, **4**: 321–326, 1895.

——— The latent vitality of seeds. Pop. Sci. Monthly, **51**: 106–111, 1897.

——— et Pictet, R. Recherches concernant l'action des basses températures sur la faculté germinative des graines. Arch. des sci. phys. et nat., sér. 3, **2**: 629–632, 1879. Abstract in Just's Botan. Jahresber., Jahrg. VII, Abt. 1, p. 253, 1879.

——— Action d'un grand froid prolongé sur des graines. Arch. des sci. phys. et nat., sér. 3, **11**: 325–327, 1884. Abstract in Just's Bot. Jahresber., Jahrg. XII, Abt. 1, p. 26, 1884.

Detmer, W. Vergleichende Physiologie des Keimungsprocesses der Samen, Jena, 1880.

Dewar and McKendrick. On liquid air. Proc. Roy. Inst., **12**: 699, 1892.

Dixon, H. H. Vitality of seeds. Nature, **64**: 256–257, 1901.

Dixon, H. H. On the germination of seeds after exposure to high temperatures. Notes from the Botanical School of Trinity College, Dublin, pp. 176–186, August, 1902.

Edwards et Colin. De l'influence de la température sur la germination. Ann. des sci. nat. bot., sér. 2, **1**: 257–270, 1834.

Giglioli, Italio. Sulla resistenza di alcuni semi all' azione prolungata di agenti chimici gassosi e liquid. Annuario della R. Scuola Superiore d'Agricoltura in Portici, v. 2, 1880, Napoli, 1881, 51 p. Abstract in Nature, **25**: 328, 1882.

——— Latent vitality in seeds. Nature, **52**: 544–545, 1895.

Gray, A. Latent vitality of seeds. Amer. Jour. Sci., 3d ser., **24**: 297, 1882.

Grüss, J. Beiträge zur Physiologie der Keimung. Landw. Jahrbücher, p. 385, 1896.

Haberlandt, F. Ueber die untere Grenze der Keimungstemperature der Samen unserer Getreidepflanzen. Pflanzenbau I, pp. 109–117, 1875. Abstract in Bot. Jahresber., p. 777, 1875.

Hansteen, B. Ueber die Ursachen der Entleerung der Reservestoffe aus Samen. Flora, **79**: 419, 1894.

Isidore-Pierre, J. Ueber den Einfluss der Wärme und des Beizens mit Kalk und Kupfervitriol auf die Keimfähigkeit des Weizens. Ann. Agron., **2**: 177–181, 1876. Abstract in Bot. Jahresber., **4**, Abt. 2, p. 880, 1876.

Jodin, Victor. Recherches sur la germination. Ann. Agron., **23**: 433–471, 1897.

——— Sur le résistance des graines aux températures élevées. Compt. Rend., **129**: 893–894, 1899.

——— et Gantier, A. La vie latente des graines. Compt. Rend., **122**: 1349–1352, 1896.

Just, L. Ueber die Wirkung höherer Temperaturen auf die Keimfähigkeit der Samen von *Trifolium pratense*. Bot. Zeit., **33** Jahrg., p. 52, 1875.

——— Ueber die Einwirkung höherer Temperaturen auf die Erhaltung der Keimfähigkeit der Samen. Cohn's Beiträge zur Biol. der Pflanzen, **2**: 311–348, 1877.

Kochs, W. Kann die Kontinuität der Lebensvorgänge zeitweilig völlig unterbrochen werden? Biol. Centralbl., **10**: 673–686, 1890.

Kolkwitz, R. Ueber die Athmung ruhenden Samen. Ber.d.deut.bot. Ges., **19**: 285–287, 1901.

Krasau, F. Welche Wärmegrade kann der Weizensame ertragen, ohne die Keimfähigkeit zu verlieren? Sitzungsber. d. Wiener Akad. d. Wiss., Abt. I., **48**: 195–208, 1873.

Maquenne, L. Sur l'hygrométricité des graines. Compt. Rend., **129**: 773–775, 1899.

——— Recherches sur la germination. Ann. agron., **26**: 321–332, 1900.

——— Contributions à l'étude de la vie ralentie chez les graines. Compt. Rend., **134**: 1243–1246, 1902.

Pictet, R. De l'emploi méthodique des basses températures en biologie. Arch. sci phys. et nat., Genève, **30**: 293–314, 1893.

Pieters, A. J., and Brown, E. Kentucky Bluegrass seed—harvesting, curing, and cleaning. Bul. 19, Bureau of Plant Industry, U. S. Dept. of Agriculture, 1902.

Romanes, C. J. Experiments in germination. Proc. Roy. Soc., **54**: 335–337, 1893.

Sachs, Julius. Beschädigung und Tödtung durch zu hohe Temperatur. Handbuch d. exp. Phys. d. Pflanzen, Leipzig, 1865, p. 63.

Samek, J. Duration of the vitality of some agricultural seeds. Tirol. landw. Blätter, **13**: 161–162, 1894. Abstract in Exp. Sta. Rec., **6**: 429, 1894–95.

Schmid, B. Ueber die Einwirkung von Chloroformdämpfen auf ruhende Samen. Ber. d. deut. bot. Ges., **19**: 71–76, 1901.

Selby, A. D. Germination of the seeds of some common cultivated plants after prolonged immersion in liquid air. Bul. Torr. Bot. Club, **28**: 675–679, 1901.

Sharpe, E. H. Influence of chemical solutions upon the germination of seeds. Thirteenth Annual Report, Mass. Hatch Agr. Exp. Sta., pp. 74–83, 1901.

Thiselton-Dyer, Wm. T. Influence of the temperature of liquid hydrogen on the germinative power of seeds. Proc. Roy. Soc., **65**: 361–368, 1899.

Thompson, A. Zum Verhalten alter Samen gegen Fermentlösungen. Gartenflora, Jahrg. 45, p. 344, 1896.

Townsend, C. O. The effect of ether upon the germination of seeds and spores. Bot. Gaz., **27**: 458–466, 1899.

Treviranus, Ludolph C. Physiologie der Gewächse. Vol. II, p. 578, section 637, 1838. [Vitality of seeds as affected by age, heat, and moisture.]

Uloth, W. Ueber die Keimung von Pflanzensamen in Eis. Flora, n. s., Jahrg. 33, pp. 266–268, 1875.

Van Tieghem et Bonnier, G. Recherches sur la vie latente des graines. Bul. Soc. Bot. France, **29**: 25–29, 149–153, 1882.

Wartmann, E. L'influence de froids excessifs sur les graines. Arch. des sci. phys. et nat., Genève, **8**: 277–279, 1860.

——— Recherches sur la végétation (section 3—Rôle de froids excessifs). Arch. des sci. phys. et nat., Genève, sér. 3, **5**: 340–344, 1881.

Waugh, Frank A. The enzymic ferments in plant physiology. Science, n. s., **6**: 950–952, 1897. Also Tenth Annual Report Vermont Agr. Exp. Sta., 1896–97.

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O

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN No. 59.

B. T. GALLOWAY, *Chief of Bureau.*

PASTURE, MEADOW, AND FORAGE CROPS IN NEBRASKA.

BY

T. L. LYON,
AGRICULTURIST, NEBRASKA EXPERIMENT STATION,

AND

A. S. HITCHCOCK,
ASSISTANT AGROSTOLOGIST, IN CHARGE OF COOPERATIVE EXPERIMENTS,
U. S. DEPARTMENT OF AGRICULTURE.

GRASS AND FORAGE PLANT INVESTIGATIONS.

ISSUED APRIL 29, 1904.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1904.

BULLETINS OF THE BUREAU OF PLANT INDUSTRY.

The Bureau of Plant Industry, which was organized July 1, 1901, includes Vegetable Pathological and Physiological Investigations, Botanical Investigations and Experiments, Grass and Forage Plant Investigations, Pomological Investigations, and Experimental Gardens and Grounds, all of which were formerly separate Divisions, and also Seed and Plant Introduction and Distribution, the Arlington Experimental Farm, Tea Culture Investigations, and Domestic Sugar Investigations.

Beginning with the date of organization of the Bureau, the several series of bulletins of the various Divisions were discontinued, and all are now published as one series of the Bureau. A list of the bulletins issued in the present series follows.

Attention is directed to the fact that "the serial, scientific, and technical publications of the United States Department of Agriculture are not for general distribution. All copies not required for official use are by law turned over to the Superintendent of Documents, who is empowered to sell them at cost." All applications for such publications should, therefore, be made to the Superintendent of Documents, Government Printing Office, Washington, D. C.

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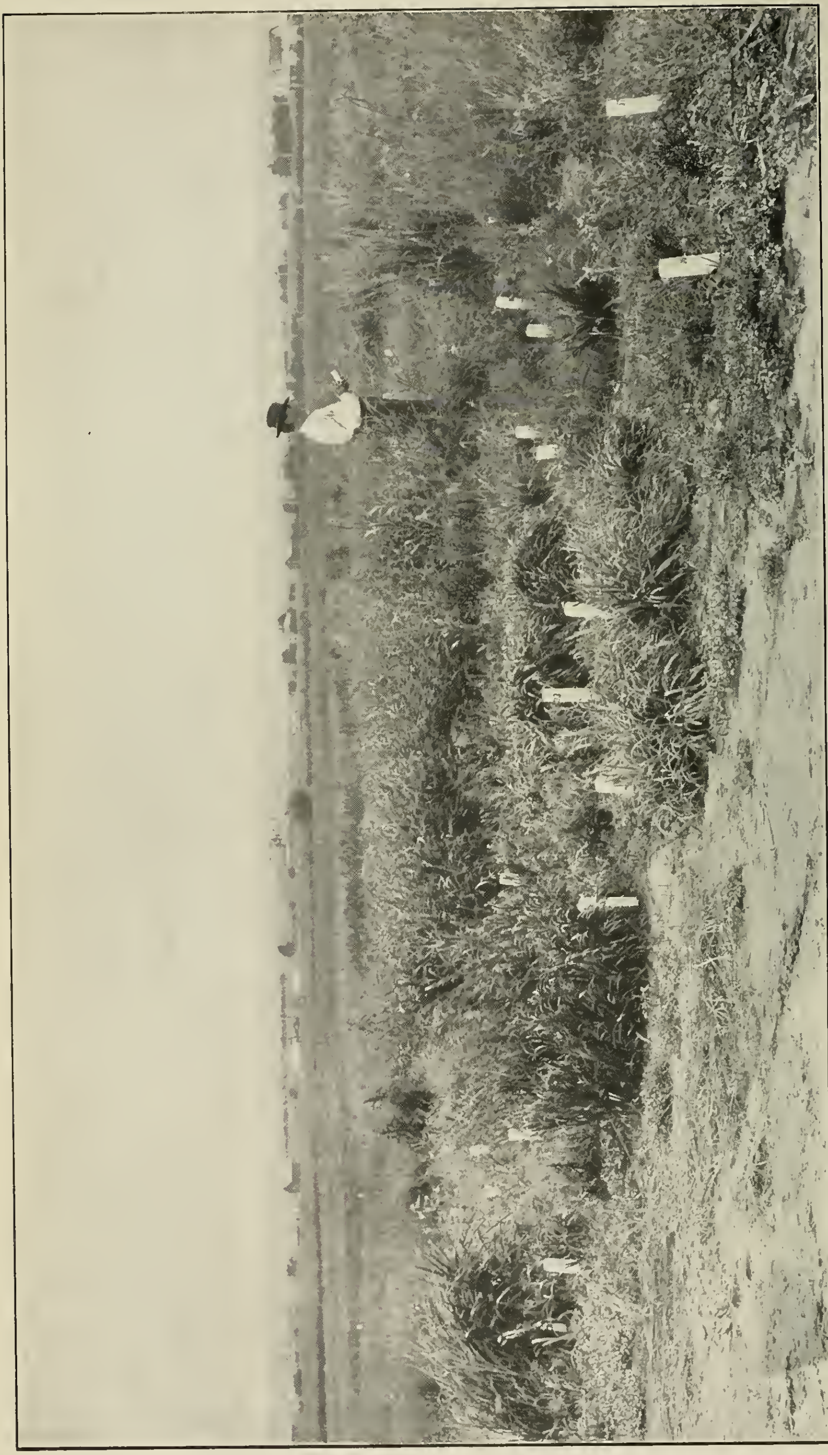
[Continued on page 3 of cover.]



GRASS GARDEN, NEBRASKA EXPERIMENT STATION.

U. S. DEPARTMENT OF AGRICULTURE.

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B. T. GALLOWAY, *Chief of Bureau.*

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BEVERLY T. GALLOWAY, *Chief.*

J. E. ROCKWELL, *Editor.*

GRASS AND FORAGE PLANT INVESTIGATIONS.

SCIENTIFIC STAFF.

W. J. SPILLMAN, *Agrostologist.*

A. S. HITCHCOCK, *Assistant Agrostologist, in Charge of Cooperative Experiments.*
C. V. PIPER, *Systematic Agrostologist, in Charge of Herbarium.*
C. R. BALL, *Assistant Agrostologist, in Charge of Work on Arlington Farm.*
DAVID GRIFFITHS, *Assistant Agrostologist, in Charge of Range Investigations.*
S. M. TRACY, *Special Agent, in Charge of Gulf Coast Investigations.*
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R. A. OAKLEY, *Assistant in Agrostology.*
C. W. WARBURTON, *Assistant in Farm Management.*
AGNES CHASE, *Agrostological Artist.*

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., March 4, 1904.

Sir: I have the honor to transmit herewith a paper entitled "Pasture, Meadow, and Forage Crops in Nebraska," and respectfully recommend that it be published as Bulletin No. 59 of the series of this Bureau.

This paper was prepared by Mr. T. L. Lyon, Agriculturist of the Nebraska Experiment Station, and Mr. A. S. Hitchcock, Assistant Agrostologist, in Charge of Cooperative Experiments, Grass and Forage Plant Investigations, and has been submitted by the Agrostologist with a view to publication.

The illustrations, consisting of six half-tone plates and eight text figures, are necessary to a full understanding of the text.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

PREFACE.

During the past few years a large number of tests of grasses and forage plants have been made by the Nebraska Agricultural Experiment Station in cooperation with the United States Department of Agriculture. The Department has furnished a part of the seeds for these tests, and has from time to time, at the request of the director of the station, made suggestions regarding the nature and plans of the work to be done. At the request of Prof. T. L. Lyon, Associate Director of the Station, Prof. A. S. Hitchcock, of this Office, visited the station during the past winter and prepared the following bulletin from notes made by the officers of the station. It is a matter of gratification that these notes were in such form as to render the task comparatively easy.

The present paper contains the results of the cooperative experiments and also some general information upon the forage conditions of Nebraska, in the preparation of which Professor Hitchcock has been in constant consultation with Professor Lyon.

The results of these experiments are of interest to many of the surrounding States having similar climatic conditions and in which many of the same forage plants are grown.

W. J. Spillman,
Agrostologist.

Office of the Agrostologist,
Washington, D. C., February 27, 1904.

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PASTURE, MEADOW, AND FORAGE CROPS IN NEBRASKA.

INTRODUCTION.

The value of the hay and forage crop of the United States may best be presented by reciting a few facts taken from the agricultural statis-

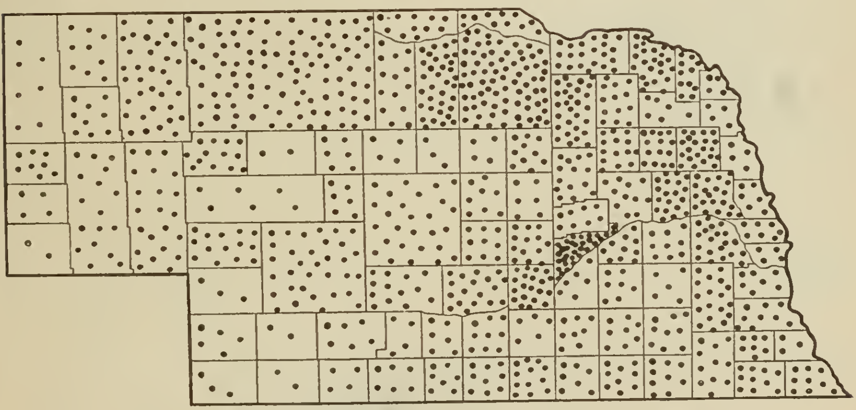

FIG. 1.—Localities in Nebraska where prairie hay is grown. Each dot represents 2,000 acres.

tics given in the Report of the Twelfth Census, where it is shown that in 1899, out of a total valuation for all crops of $2,910,138,663, the value of the hay and forage crop was $484,256,846, or 16.6 per cent.

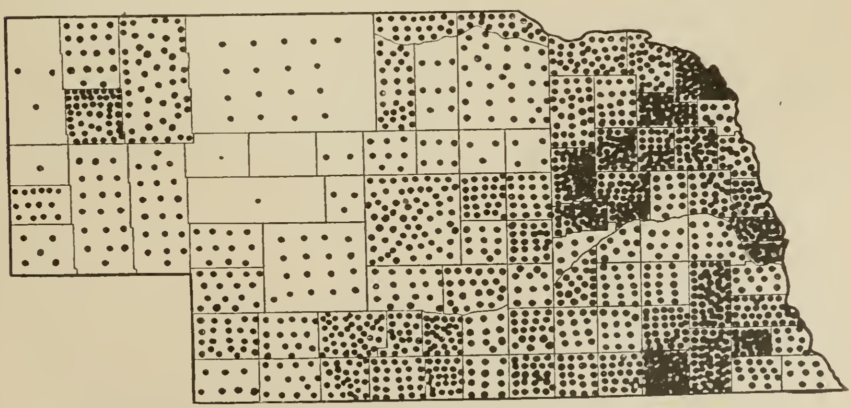

FIG. 2.—Localities in Nebraska where millet is grown. Each dot represents 100 acres.

The value of this crop is greater than that of any other, with the single exception of corn, which had a valuation that year of $828,258,326.

From the same source it is learned that out of a total valuation of $92,056,580 for all crops grown in Nebraska in 1899, the forage crop was worth $11,230,901, or 12.2 per cent.

TABLE I.—*Statistics for Nebraska of hay and forage crops for 1899, taken from the Report of the Twelfth Census.*

Total acreage devoted to hay and forage crops	2,823,652
Total acreage devoted to all crops	15,153,956
Total acreage of improved land	18,432,595
Per cent of acreage of forage crops to that of all crops	18.6
Per cent of acreage of forage crops to that of improved land	15.3
Value of all crops	$92.056,580
Value of forage crops	$11,230,901
Per cent of value of forage crops to that of all crops	12.2
Average value per acre of all crops	$6.07
Average value per acre of forage crops	$3.98
Tons of forage crops (excluding cornstalks)	3,502,380
Average value per ton	$3.19

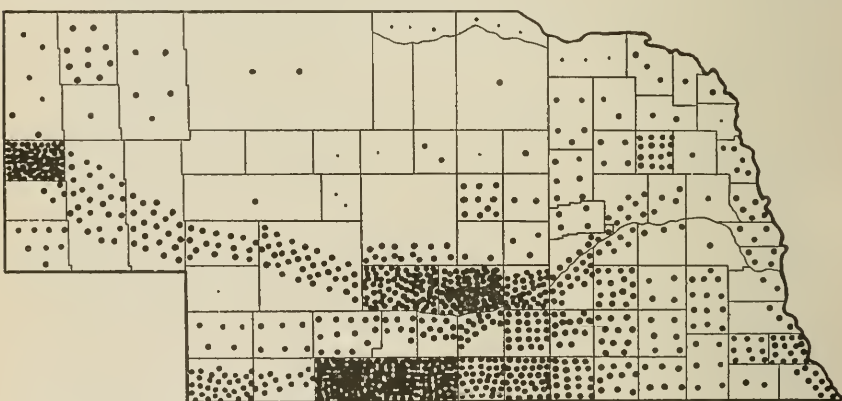

FIG. 3.—Localities in Nebraska where alfalfa is grown. Each dot represents 100 acres.

During the year mentioned Nebraska produced 2.3 per cent of the total valuation of the forage crop of the United States, ranking thirteenth in this respect. New York was first, with 11.4 per cent. The records show that during the last three decades the average yield per acre in Nebraska has decreased, while that of the entire United States has increased:

Year.	Nebraska.	United States.
	Tons.	*Tons.*
1899	1.2	1.4
1889	1.3	1.3
1879	1.5	1.1

In 1880 Nebraska was eighteenth among the States in the per cent of the total acreage that was devoted to forage crops, the percentage being 1.7. In 1890 and 1900 it stood ninth, with a percentage of 4.6.

In tonnage the figures are much the same, Nebraska ranking in 1860 as the thirty-second State in the Union, with only 0.1 per cent of the total; in 1870, twenty-third, with 0.6 per cent; 1880, fifteenth, with 2.2 per cent; 1890, ninth, with 4.7 per cent; 1900, ninth, with 4.4 per cent.

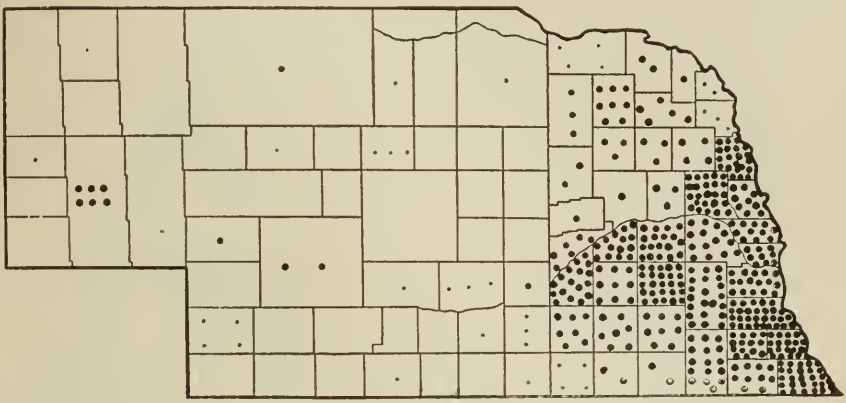

FIG. 4.—Localities in Nebraska where clover is grown. Each dot represents 100 acres.

Equally interesting are the figures showing the acreage, tonnage, and yield of the various forage crops in 1899, as classified in the census report, as follows:

Crop.	Rank of State.	Acreage.	Tonnage.	Average yield per acre.
				Tons.
Prairie hay	1	2,248,927	2,416,468	1.1
Millet	2	191,347	357,356	1.9
Alfalfa	6	115,142	275,334	2.4
Clover	15	42,447	72,747	1.7
Other tame grasses	27	92,895	143,109	1.5
Coarse forage	9	90,828	183,097	2.0

For comparison the following table is given of the acreage of the leading States for the above crops:

Crop.	State.	Acreage.
Millet	Kansas	349,906
Alfalfa	Colorado	455,237
Clover	Indiana	776,810
Other tame grasses	New York	4,758,523
Coarse forage	Kansas	1,041,447

In this classification the term "other tame grasses" includes in Nebraska chiefly timothy (also timothy and clover mixed) and bromegrass, and some bluegrass. Forage refers to sorghum, Kafir corn, and corn that was cut green for forage. It does not, however, include corn that was cut and allowed to ripen in the shock, or what is usually known as corn fodder.

It appears that Nebraska also produced 8,156 bushels of clover seed, valued at $37,332, and 41,816 bushels of other grass seed, valued at $32,450.

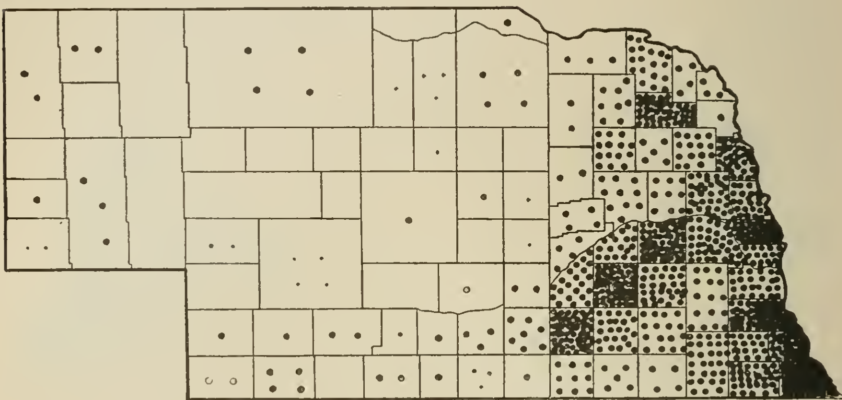

FIG. 5.—Localities in Nebraska where tame grasses are grown. Each dot represents 100 acres.

The accompanying maps (figs. 1–6) show graphically the distribution of the chief forage crops of Nebraska by counties. The distribution is based upon the tables given above. Each large dot represents 100 acres, except in the map illustrating the acreage of prairie hay, where each

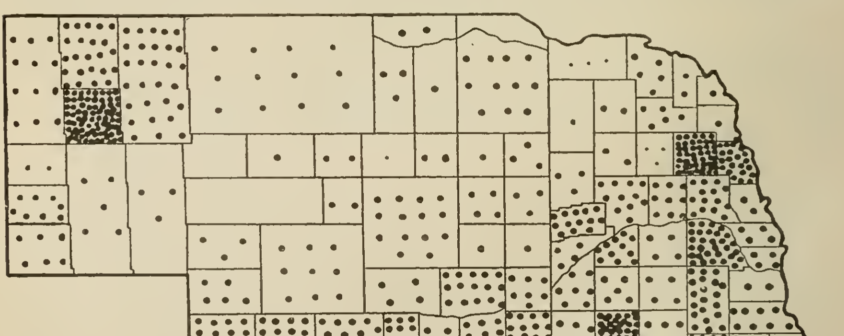

FIG. 6.—Localities in Nebraska where coarse forage is grown. Each dot represents 100 acres.

dot represents 2,000 acres. From 50 to 149 acres would be represented by one dot; 150 to 249 acres by two dots. Each small dot represents 10 acres and is used for acreages from 5 to 49. On the alfalfa map the dots in certain western counties are congregated in the vicinity of the Platte and Republican rivers, although the figures given in the tables do not indicate the distribution within the counties.

CLIMATIC AND SOIL CONDITIONS OF NEBRASKA.

RAINFALL.

For details concerning the rainfall the reader is referred to Bulletin No. 45 of the Nebraska Station, "The Rainfall of Nebraska," by G. D. Swezey and George A. Loveland. Since the amount and distribution of the rainfall is one of the most important factors in determining the agricultural possibilities of a country, it is well to summarize here the chief points as indicated in that bulletin.

The annual rainfall decreases from 34 inches in the extreme southeast to 13 inches in the extreme southwest. However, the average rainfall does not tell the whole story. Much depends upon the distribution of rain through the year, and especially during the growing

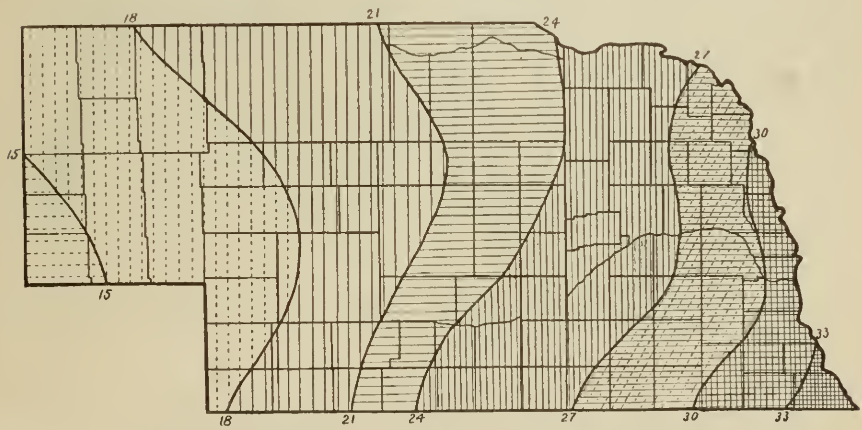

FIG. 7.—Normal annual rainfall for Nebraska, in inches.

season. The average rainfall for the entire State is 23.33 inches, of which 16.08 inches, or 69 per cent, falls in the five months from April to August, inclusive.

TABLE II.—*Average monthly precipitation for Nebraska.*

Month.	Precipitation.	Month.	Precipitation.	Month.	Precipitation.
	Inches.		*Inches.*		*Inches.*
January	0.68	May	3.62	September	1.84
February	.71	June	3.93	October	1.49
March	1.16	July	3.51	November	.68
April	2.40	August	2.62	December	.69

An examination of the table and of the accompanying charts (figs. 7 and 8) shows that it is only in the eastern tier of counties, lying approximately within the region receiving as much as 30 inches average rainfall, that the common eastern meadow and pasture grasses, such as timothy, red clover, redtop, and Kentucky bluegrass, will thrive with a fair degree of certainty. The next region, included between 27 and 30 inches, is one in which these grasses may do well in favorable localities, but are more or less uncertain, and are quite sure to fail in dry seasons. On account of the lower summer temperature, these grasses may extend farther west in the northern part of the State than in the southern portion. For this belt, orchard grass and meadow fescue are more likely to be successful than timothy and clover, while brome-grass

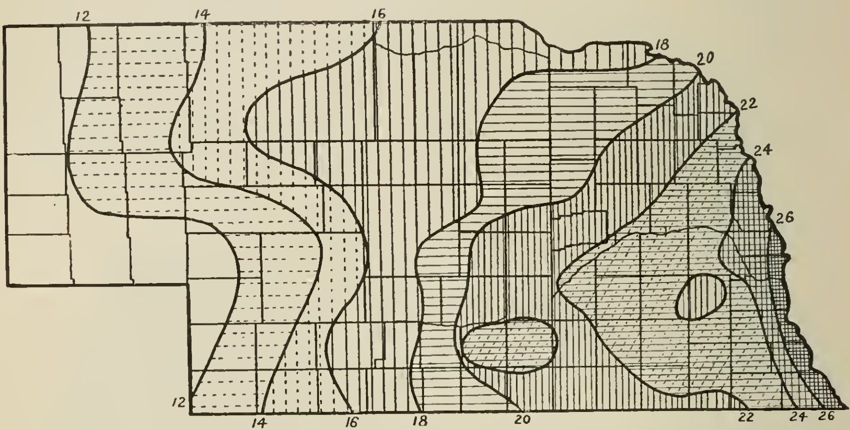

FIG. 8.—Normal rainfall in Nebraska during the growing season, April to September, in inches.

is the only satisfactory cultivated pasture grass west of this. Even brome-grass fails in the extreme west.

TEMPERATURE.

Prof. George A. Loveland, director of the Nebraska section of the Weather Bureau, has furnished the normal monthly temperature for several stations distributed over the State, which data are incorporated in the following charts. Besides these are given the normal annual temperature for the same stations, the average yearly minimum and the lowest recorded temperature for each station.

TABLE III.—*Normal monthly temperature, normal annual temperature, average minimum and absolute minimum for several stations in Nebraska.*

Town.	County.	Normal monthly temperature. January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual temperature.	Average minimum temperature.	Absolute minimum temperature.
Lincoln	Lancaster	21.3	23.5	36.6	51.7	61.8	70.9	76.3	74.7	66.4	55.0	38.7	29.4	50.6	−15.4	−29
Auburn	Nemaha	25.7	25.0	38.0	54.1	63.1	71.9	77.0	75.5	67.2	56.5	39.8	29.6	52.0	−18.2	−35
Crete	Saline	21.1	23.5	35.6	52.3	61.1	70.4	75.7	73.3	65.8	54.0	37.6	27.6	49.8	−15.8	−32
Hebron	Thayer	23.8	25.7	37.2	53.9	62.4	71.7	76.6	74.5	66.5	54.4	38.4	30.0	50.5	−16.7	34
Harvard	Clay	24.4	22.4	34.7	51.1	60.9	70.4	75.5	73.8	64.9	52.5	35.6	27.0	49.5	−18.2	−33
Beaver City	Furnas	28.9	26.6	38.8	51.6	62.8	71.0	76.2	75.3	66.9	54.6	39.6	31.1	52.1	−19.0	−35
Imperial	Chase	27.2	26.3	36.2	49.8	60.0	70.2	75.8	74.6	65.1	51.7	37.0	28.6	50.3	−21.2	−35
North Platte	Lincoln	20.0	25.3	35.1	48.6	58.2	67.9	73.5	71.4	62.4	49.8	35.2	27.1	47.9	[illegible]	−35
Ravenna	Buffalo	24.4	22.9	31.7	50.9	59.6	69.0	74.4	73.0	64.7	52.3	36.0	28.5	49.[illegible]	[illegible]	−38
Genoa	Nance	19.1	22.0	33.2	49.8	60.3	69.9	75.2	73.2	64.0	50.7	34.4	24.4	48.6	–0.2	35
David City	Butler	21.4	20.8	31.8	50.0	58.9	69.1	73.7	70.9	63.0	50.6	33.9	26.1	47.5	......	−30
Fremont	Dodge	18.5	21.0	34.0	50.6	60.2	70.5	75.3	72.6	64.5	52.6	35.6	25.0	48.4	−20.9	−31
Omaha	Douglas	19.2	25.0	35.5	51.0	61.7	71.8	76.2	73.7	64.8	52.9	36.6	26.7	49.6	15.2	26
Stanton	Stanton	20.8	19.5	32.6	49.7	60.6	69.0	73.4	71.6	63.5	51.7	33.9	23.6	44.5	−20.5	33
Oakdale	Antelope	18.9	19.2	31.1	49.6	59.0	68.8	73.8	71.6	62.5	49.8	32.7	25.3	46.9	−22.9	40
Sioux City (Iowa)		16.3	19.0	31.6	50.6	58.4	70.3	74.3	71.6	65.2	51.0	34.3	27.8	47.6	......	....
Santee	Knox	18.3	18.4	32.3	49.0	62.0	71.6	76.4	71.3	64.6	52.1	34.1	21.9	47.9	−21.3	−33
O'Neill	Holt	20.7	19.8	31.1	48.3	58.9	67.8	73.3	71.2	63.4	50.9	33.5	24.9	47.0	−24.0	−33
Valentine	Cherry	16.9	21.5	31.2	47.2	55.8	67.2	73.3	70.3	61.6	49.2	34.3	27.2	46.3	−23.1	−37
Kimball	Kimball	26.9	23.9	33.1	46.3	55.8	65.8	71.6	70.6	61.0	48.6	36.2	28.5	47.5	−20.3	−30
Fort Robinson	Dawes	23.3	22.5	33.2	47.0	56.4	65.9	72.0	70.8	61.2	49.0	35.2	28.2	47.1	−23.8	−37

PHYSIOGRAPHY.

Nebraska lies in the central portion of the Great Plains region, and extends from the Missouri River to the foothills of the Rocky Mountains, 104° west longitude, and between the fortieth and forty-third parallels of latitude. The area is 76,794 square miles.

As to general topography, the State is little diversified, consisting for the most part of undulating prairies. The extreme eastern portion of the State along the Missouri River is forested, or was covered with forest before the timber was removed. These forests extended west along the rivers, the trees becoming fewer in number and species until they finally disappeared about halfway across the State. The prairies are covered with herbaceous vegetation, a large proportion of which consists of various species of nutritious grasses, which will be discussed briefly in another paragraph.

The altitude varies from a little less than 1,000 feet in the southeastern part to about 5,000 feet in the western portion of the State.

For a discussion of the botanical areas of the State and their relation to climatic and soil condition, the reader is referred to various articles by Dr. C. E. Bessey, in the reports of the Nebraska State Board of Agriculture, and more particularly to the Phytogeography of Nebraska by Pound and Clements.

SOIL.

A full discussion of the soils of Nebraska is given in the report of the geologist, E. H. Barbour, in the Annual Report of the State Board of Agriculture for 1894, page 61. It may be remarked that the basis of the agricultural soils of Nebraska is silt rather than clay, such as is found in the Eastern States. The State is divided into five soil regions, two of which—the Bad Lands and the Western Region—are in the extreme western portion of the State, and do not lie in what is now a crop district. The other three are the Drift, Loess, and Sand Hill regions. From the crop standpoint the first is the most important, as it lies in the region of greatest rainfall. The Drift is of glacial origin, and is agriculturally a rich soil. The Loess, or wind drift, is a deposit covering all the southern portion of the State, and is also a rich soil. The Sand Hills, which comprise the northern portion of the State north of the Platte and extend from Holt to Deuel counties, are less adapted to crops, but locally, where the conditions of moisture are favorable, results show that the agricultural possibilities are considerable.

In general, it may be said that the soils of Nebraska are highly favorable for the production of crops and the product is limited chiefly by rainfall and to a less extent by temperature. In many parts of the State there are small areas of soil, known as gumbo, which are poorly suited to crops, being too alkaline or too poorly drained. But such areas are relatively very insignificant.

CROPS.

East of the one hundredth meridian the rainfall is usually sufficient for the cultivation of crops without irrigation. This meridian is approximately that precipitation line for the annual rainfall of 20 inches. West of this, crops of some kinds are uncertain under the present methods of farming, although winter wheat and such drought-resistant plants as sorghum and Kafir corn are grown. The climate here is characterized by being very hot in summer and very cold in winter. The snowfall is usually slight. It is in this region that irrigation has reached its greatest development, although it is practiced occasionally in the eastern portion of the State to supplement the rainfall.

The following tables, taken from the Twelfth Census report, give the available statistics for irrigation in Nebraska:

TABLE IV.—*Number of acres irrigated, by counties, 1899.*

County.	Acres.	County.	Acres.	County.	Acres.
Buffalo	1,393	Holt	2,218	Scotts Bluff	29,214
Cheyenne	21,288	Keith	12,646	Sioux	1,433
Dawes	4,027	Kimball	4,225	All other counties	10,083
Dawson	20,097	Lincoln	22,508	Total	148,538
Deuel	11,791	Platte	1,488		
Dundy	4,552	Redwillow	1,542		

TABLE V.—*Acreage of crops produced on irrigated land, 1899.*

Crop.	Acres.	Crop.	Acres.	Crop.	Acres.
Corn	33,078	Alfalfa or lucern	22,172	Sweet potatoes	5
Wheat	14,143	Clover	47	Onions	68
Oats	5,090	Other tame and cultivated grasses	206	Miscellaneous vegetables	651
Barley	940	Grains cut green for hay	892	Dry peas	2
Rye	741	Forage crops	417	Grapes	7
Buckwheat	10	Dry beans	126	Orchard fruits	1,234
Prairie grasses	47,890	Potatoes	1,075	Small fruits	64
Millet and Hungarian grasses	868				

Most of the irrigation is along the Platte River, from Dawson County to the western border of the State, and is maintained by ditches from the rivers. A few acres are irrigated by windmills and wells (843 acres in 1899).

It follows that in the western portion of the State, aside from the comparatively insignificant irrigated areas, the principal industry is stock raising. The herds are allowed to graze all summer and a considerable portion of the winter upon the open grassy plains or range. The wandering of the herds is usually limited principally by access to water.

Stock raising is also an important industry in the eastern portion of the State, but the amount of open range is becoming much reduced. On the other hand, on account of the greater rainfall and other conditions favorable for growing forage crops, the same area will support more stock than in the western portion.

The principal field crops grown in Nebraska, arranged according to their value, are corn, wheat, oats, hay and forage, potatoes, and vegetables.

The following table gives the acreage and value of these crops for 1899:

TABLE VI.—*Acreage and value of crops for 1899.*

Crop.	Acreage.	Value.
Corn	7,335,187	$51,251,213
Wheat	2,538,949	11,877,347
Oats	1,924,827	11,333,393
Hay and forage	2,823,652	11,230,901
Potatoes	79,901	1,734,666
Vegetables	34,044	1,383,470

Of lesser importance are rye, barley, fruit, sugar beets, and broom corn.

CLASSIFICATION OF FORAGE PLANTS.

Forage plants may be classified, according to duration, into perennials and annuals; according to kind, into grasses, legumes, and miscellaneous; according to use, into pasture, meadow, soiling, and silage plants.

DURATION.

Perennials.—This group includes those plants which live more than one year. The forage plants under consideration are all herbs, of which most of the portion above ground dies during winter, but the roots live and throw up new shoots the following spring. For most purposes it is manifestly an advantage that a crop should yield returns year after year without the expense of reseeding. On the other hand, the actual yield of forage the first season is almost always less with a perennial than with an annual, and furthermore, a perennial may not lend itself to the most desirable rotation. The important perennial forage crops of Nebraska are alfalfa, clover, bromegrass, timothy, and bluegrass. Some of these, such as timothy and clover, are known as short-lived perennials; that is, as a crop they tend to disappear in two or three years to such an extent that they need reseeding. This is also true of such grasses as Italian rye-grass.

Annuals.—These are plants which reach their maturity during the season that they are planted and then die. Common examples of this group are the grains, corn, sorghum, millet, cowpea, soy bean, and rape. Where land is valuable and it is necessary to grow a maximum crop upon a given area, annuals are more profitable as forage crops than perennials; or when it is desired to produce a crop at a given season of the year, such as early or late pasture of rye, a succession of succulent forage for dairy cattle, or a catch crop to utilize the land, annuals are invariably used.

Some plants, which are normally annuals, are sown in the autumn, and after making a growth of foliage that season, lie more or less dormant during the winter and resume growth the following spring, reaching maturity in the early summer. This is true of rye, some varieties of wheat, and some of the grasses. The severity of the winter determines in many cases whether plants may be used in this way. Many crops that are spring sown in the Northern States are fall sown in the South. Furthermore, some plants can be made to live for an abnormally long period by frequent mowing, thus preventing the production of seed.

NATURAL GROUPS.

Legumes.—This important group of plants includes the clovers, alfalfa, the cowpea, soy bean, the vetches, the garden beans and peas, and all similar plants, and it derives its importance from the fact that both the seeds and the foliage are richer in nitrogen than other forage plants. Since the proteids, or nitrogen-containing materials, are the most expensive portion of feeding rations, the growing of legumes for forage has long been recognized as an important factor in the economy of agriculture. But furthermore, as is well known, the legumes have the power, not possessed by other forage plants, of utilizing the free nitrogen of the air by means of the nodules on their roots. (See Pl. II.) When legumes are turned under as green manure, or even if the tops are removed by mowing and the roots allowed to remain in the soil, the nitrogen content of the latter is increased. Since nitrogen is a very essential plant food, and is one of the first to be exhausted in soils upon which crops are grown, and since this element is the most expensive to add in the form of fertilizer, the importance of growing legumes in rotation with other crops for the purpose of renovating the soil is quite evident. These facts emphasize the necessity of adopting a system of agriculture for a given region which shall include the growing of suitable crops of legumes in the rotation, thus utilizing the crop as forage and at the same time keeping up the fertility of the soil. The leguminous forage crops adapted to Nebraska are alfalfa and red clover, which are perennials, the latter usually short lived, and cowpeas and soy beans, which are annuals. In addition to these, white clover and alsike clover are occasionally used.

Grasses.—The great bulk of the forage plants, not included in the above group of legumes, belongs to the natural group of plants known as grasses, which includes besides the common meadow and pasture grasses, both wild and cultivated, such plants as the grains or cereals, sorghum, millet, and the sugar cane of the South. The grasses do not have the power of adding nitrogen to the soil after the manner of the legumes. Most of our native grasses are perennials, as are also our cultivated pasture and meadow grasses, such as brome-grass, orchard grass, meadow fescue, and timothy, though the latter is short lived.

Miscellaneous.—Aside from the two large groups mentioned above there are a few forage plants which bear no close natural relation to these and are most conveniently considered under this heading. The only important plant of this category that is adapted to Nebraska conditions is rape. Australian saltbush belongs here and has received some attention, but as yet it has not shown itself to be of particular value in that State.

METHODS OF UTILIZING THE CROPS.

Pastures.—In general the term pasture may be applied to all cases where stock is allowed to feed directly upon the growing plants. Where the area is unfenced and consists of native vegetation it is called open range, or simply range. In some parts of the United States, especially the Southern States, the range consists of forest, but in Nebraska the range is the unfenced portion of the Great Plains region, the vegetation consisting of native grasses. The subject of the range will be considered in another part of this bulletin.

In the ordinary and popular sense pasture refers to fenced areas of native or cultivated perennial forage crops upon which stock feeds at will. All the perennial forage plants are used for this purpose, although alfalfa and clover must be used with caution in order to prevent bloating.

Another important class of pastures, especially where land is relatively valuable and a more intensive system of agriculture is employed, is that of temporary or annual pastures.

In winter-wheat regions it is a common practice to pasture the grain during favorable portions of the fall and winter. In this case the pasturing is incidental. On the other hand it is a not uncommon practice to sow wheat or, more frequently, rye in the fall for pasture purposes alone, a crop of grain, if secured at all, being secondary. Temporary pastures are used for two purposes. (1) To extend the pasture season over a greater portion of the year than can be done with ordinary permanent pasture. For this purpose wheat or rye give early and late pasture, and certain summer annuals can be used to supplement the permanent pastures during the dry summer season, which usually occurs in July or August. (2) By successive sowing of the proper plants succulent feed may be provided through the season so as to yield a maximum crop from each area. This is particularly applicable to dairy districts. It is often convenient and economical in growing a succession of succulent crops to cut the green feed and supply the stock either in the permanent pasture or in the stalls or yards, as will be referred to under soiling. The proper rotation of such annual pasture for Nebraska will be discussed in a separate paragraph.

The plants which can be used to advantage in Nebraska for temporary pasture are the grains as mentioned above, rape, cowpea, and soy bean. The various kinds of sorghum, especially the ordinary sugar sorghum or cane, are used in Texas and northward for this purpose. In the southern portion of this area sorghum can usually be used for pasture with impunity, but in Nebraska its use in this way is attended with some risk from poisoning. An account of this subject will be found in Bulletin No. 77, Nebraska Experiment Station.

Meadows.—The term meadow is applied to land where the crop is cut for hay, whether fenced or unfenced. When the hay is cut from native grass land, the land is called a wild meadow. As shown by the statistics in the first part of this bulletin, the wild meadow land of Nebraska amounts to over 2,000,000 acres and produces about 2,500,000 tons of hay. Nebraska leads all States in the acreage of its wild meadows. The grasses composing this wild hay will be discussed in another paragraph devoted to the native grasses.

The tame meadows consist in that State of alfalfa, timothy, clover, and brome-grass. Orchard grass and meadow fescue are used to a limited extent and their wider use is to be recommended.

Some annual plants are widely used for hay, such as millet, sorghum, Kafir corn, and corn. For this purpose the last three are sown thickly in order to produce a large number of small stalks.

These coarse plants are often grown in rows and cultivated, the nearly mature stalks being cut by hand or with a corn binder and shocked, when the dried material is called fodder rather than hay. In a general sense, however, it is hay and contributes no inconsiderable amount to the sum total of dry, rough feed. The same remarks are true of the corn fodder which results after the ears have been removed, although such fodder if it is gathered at the time most favorable for grain production from necessity is relatively poorer in nutrient material than that cut earlier. Ordinary corn fodder has about the same feeding value as oat straw. When corn is husked in the field the remaining stalks are usually utilized by turning stock upon them. Aside from the waste grain recovered such stalks have very little nutriment.

In the Southern States the cowpeas and soy beans are widely used for hay, but in Nebraska they have not been used for this purpose, for which they are not so well adapted as other hay plants.

Soiling crops.—The feeding of cut green forage to stock in the stall, yard, or pasture is known as soiling. The advantage of soiling is the saving of fodder when compared with pasturing upon the same field, as in the latter case there is some loss from trampling. This is especially true of the coarse fodders, such as corn and sorghum. Other advantages of minor importance are that by soiling the rations of animals may be more definitely controlled, that fodder may be taken from fields a part of which is to be used for other purposes, and that this method avoids the necessity in pasturing the fields of subdividing them by erecting permanent or temporary fences. The great disadvantage of soiling is the extra expense of the labor necessary in cutting, hauling, and feeding the green forage. For this reason it is not practicable to utilize forage in this way on any large scale except in intensive farming, more particularly dairy farming in Nebraska. On a small scale almost every farmer cuts in early summer green grain, especially oats or rye, to feed to hogs or cattle. Later in the summer corn is cut and fed in the same manner, supplementing the pastures, which usually develop a shortage in August. The sum total of forage used in this way in Nebraska is not inconsiderable, yet in most cases it is incidental and the crops are not sown primarily for soiling purposes; neither is the soiling usually a definite part of the system of agriculture.

In dairy farming it may be advantageous to adopt soiling as a definite system in order to obtain a maximum yield of succulent forage from a small area. For this purpose it is best to plan a series of crops which will form a succession through the growing season. The individual crops depend upon the locality and must be chosen to suit conditions. Near large cities, where land is valuable, it often pays to have such a succession which, combined with silage during the winter, will give green feed the entire year. Usually, however, at least in Nebraska, soiling is resorted to only to fill in the gaps of a succulent pasture series, even in dairy farming. For example, early and late green feed may be produced by a pasture of rye. A proper sowing of oats or rye may then furnish soiling in connection with grass pasture. If there is sufficient area of pasture this may furnish all the feed necessary during May and June, but such pasture usually shows a marked falling off about the 1st of July, as is indicated by the shrinkage in the milk flow. This shrinkage should by all means be avoided, and it is therefore desirable to furnish at this time soiling crops for the rest of the summer in connection with the pasture. Besides the small grains and corn mentioned, there are several other plants that can be used for soiling, particularly sorghum, Kafir corn, cowpeas, soy beans, and rape. The latter is not so well adapted to milch cows, as there is danger of tainting the milk. Alfalfa and clover can be used, but in Nebraska they have no special adaptation for this purpose. Rape is an excellent soiling crop for hogs, sheep, or growing cattle during the autumn. For further information on this subject the reader is referred to the article in the Yearbook of the United States Department of Agriculture for 1899, page 613, entitled "Succulent forage for the farm and dairy," by Thomas A. Williams.

Silage.—Forage preserved in a green state in such a manner as to prevent decomposition or drying is called silage. The pits, rooms, or tanks in which the forage is preserved are known as silos. The advantage of silage is that the benefits derived from feeding succulent forage may be continued through the winter. As in the case of soiling crops, silage is used chiefly in connection with dairy farming. By far the best crop for the silo, where that crop can be raised, is green corn. As it is not the purpose of this bulletin to deal particularly with this subject, the reader is referred for further information to Farmers' Bulletin No. 32 of the United States Department of Agriculture and to other publications dealing with silos and silage.

RESULTS OF EXPERIMENTS WITH GRASSES AND FORAGE PLANTS AT THE NEBRASKA EXPERIMENT STATION.

GRASSES AND FORAGE PLANTS WHICH HAVE GIVEN SUCCESSFUL RESULTS OR ARE WORTHY OF FURTHER TRIAL.

Brome-Grass.

An extended account of brome-grass (*Bromus inermis*) will be found in Bulletin 61 of the Nebraska Station and also in Circular 18 of the Division of Agrostology, United States Department of Agriculture. This valuable grass has been tested over a wide area in the United States, but it finds its best development in the region from Kansas northward in the Great Plains, and west into Montana and eastern Washington. It gives fair results east of this region, but in the Eastern States is unable to compete with timothy and bluegrass. In the Southern States it has not given satisfactory results.

Numerous trials of this grass have been made at the Nebraska Station under varying conditions, both in combination with other grasses and with alfalfa. In general the grass has given good results and has shown that it is better adapted to the conditions obtaining in Nebraska than any other of the cultivated forage grasses, with the exception of meadow fescue and possibly orchard grass, both of which have given good results.

A plot sown in the spring of 1897 (0.136 acre) yielded June 27, 1900, 580 pounds of hay, or at the rate of 2.32 tons per acre. On April 8, 1901, as the grass was turning green, the east half of the plot was disked. During the remainder of the season there seemed to be no difference between the disked and undisked portions. In 1903, the plot yielded 1.32 tons of hay per acre on June 16. Other plots yielded at about the same rate.

One plot sown in April, 1899, and giving a cutting of hay June 27, 1900, at the rate of 3.8 tons per acre (220 pounds on 16½ by 76 feet) was treated October 5 with 300 pounds of well-rotted horse manure, and the following spring with 10 pounds of sodium nitrate (Chile saltpeter). On account of the drought no crop of hay was obtained in 1901, but this plot was distinctly better in appearance than untreated contiguous plots. June 16, 1903, the plot yielded 170 pounds of hay, or 5,666 pounds per acre, while a check plot yielded at the rate of 2,166 pounds per acre.

One plot sown in spring of 1900 and manured in the autumn of 1901, gave June 23, 1902, 1.66 tons of hay per acre, and June 16, 1903, 1.7 tons, and in each case the aftermath was fine and would have produced an excellent pasture.

The plots were all greatly affected by the drought in the summer of 1901, but recovered in the autumn and showed that although they had been dried up they were unhurt.

A sowing at the rate of 14 pounds per acre on one plot showed that much more seed was produced than upon plots more thickly sown. This plot was thoroughly disked in the spring of 1903, with the result that the growth the following season was not improved.

In order to test spring and fall sowing, one plot was sown October 5, 1900, at the rate of 25 pounds per acre, upon disked land, and another April 8, 1901, at the same rate and upon ground prepared in the same way. Although there was a good stand of grass obtained from fall sowing, there was no noticeable difference the following season between the two plots.

In order to test the time of seeding several plots were sown broadcast on the following dates in 1902: March 24, April 8, April 21, May 7, May 19, August 7, August 19, September 15, October 1, and October 21. All showed a good stand on May 1 of the following year and no injury from winter killing, except the last sowing, which had barely sprouted and was then killed by the cold. With this exception all yielded good crops of hay on June 23. (See Pl. III, fig. 1.)

If the soil is in proper condition it is probable that brome-grass may be sown any time from April to the first of October.

Brome-grass was sown in 1898 with bluegrass and with red clover. In both cases there was a good stand of brome-grass at first, but where combined with bluegrass the latter gradually increased in proportion until in 1903 it was estimated that the plot contained two-thirds bluegrass.

The red clover was also able to hold its own with the brome-grass in those years favorable to the growth of clover, but the dry season of 1901 nearly exterminated the clover from the plot.

In the paragraph upon pastures it will be noted that when brome-grass was sown with other grasses it was usually able to crowd out its competitors.

RESULTS OF COOPERATIVE EXPERIMENTS.

The United States Department of Agriculture has distributed seed of brome-grass through the Nebraska Experiment Station to a number of farmers with the understanding that reports upon the results obtained would be made. These cooperative distributions were made between 1898 and 1902.

There were 170 replies received from those who have grown brome-grass, of which 36 reported failures. Of these failures 26 were in the southwestern portion of the State, from McPherson to Chase and Franklin counties. The reasons for failure were mostly because the seed did not germinate or gave a very scattering stand, but 8 failures were due to the depredations of grasshoppers.

The remaining 134 replies have been summarized as follows: The present condition of the field of grass was reported good by 100, while 13 stated that the condition was poor. Spring sowing was recommended by 86 and fall sowing by 22. That a stand of brome-grass is easier to obtain than of other grasses was stated by 48, while 42 thought that this was not the case. A few had tried sowing brome-grass with other crops but with varied results. With alfalfa, there were 5 successes and 2 failures; with clover 3 successes and 2 failures. Three reported a successful stand when sown upon prairie sod, while 5 failed in this. That this is a good hay grass was reported by 42, while 17 thought not. As a pasture grass, all except 2 reported favorably so far as this point was touched upon, while 42 stated that it was good for early and 49 for late pasture. Twenty-four stated that it was good for winter pasture. The drought resistance was reported good by 53 and poor by only one. The reports of 14 farmers showed that it was good for sandy soil and 50 stated that it made a good sod.

ALFALFA.

The well-known perennial legume alfalfa (*Medicago sativa*, Pl. II) is the most valuable forage plant grown in Nebraska. Every effort should be made to extend the culture of this plant to all parts of the State. Being a legume it is highly nutritious; being a perennial it produces a permanent meadow; being palatable it is relished by all kinds of stock. Although it is valuable as a pasture plant it is not entirely suited to this purpose. Close pasturing is likely to kill it out in spots. The great value of alfalfa lies in the production of hay. The reader is referred to Farmers' Bulletin No. 31, United States Department of Agriculture, for details in regard to this plant.

It may be briefly remarked here, however, that in growing alfalfa the ground should be well prepared, as free as possible from weeds, and the seed should be sown when the soil is in favorable condition for germination. The seed should be sown alone at the rate of about 20 pounds per acre, broadcast or, better, in drills. Where possible Nebraska-grown seed should be used, or at least seed grown under about the same conditions.

COOPERATIVE EXPERIMENTS WITH ALFALFA.

Press Bulletin No. 16 of the Nebraska Experiment Station, entitled "Alfalfa Experiences," gives the following summary of results obtained by growers of alfalfa in that State:

During the winter of 1902 a list of between 600 and 700 successful alfalfa raisers in this State was collected, and to each was sent a report blank calling for a definite statement regarding a number of the processes he employed in obtaining his stand of alfalfa, and also regarding his subsequent care of the crop. More than 500 satisfactory replies were received, representing 80 counties in the State. A study of this large number of reports from successful alfalfa raisers gives some valuable information respecting alfalfa culture.

There were 288 stands reported upon upland, and 273 upon bottom land. Even in the western portion of the State the amount of alfalfa on the upland is shown to be considerable, and very satisfactory results are evidently obtained, although naturally the yields of hay are smaller than on the bottom lands of that region. In the eastern part of the State somewhat heavier yields appear to be obtained from bottom land, but loss from winter killing or other cause is greater. Twenty-three reports state that upland is more satisfactory than bottom land. These come principally from the eastern portion of the State or the irrigated land of the western portion.

An astonishing feature of the replies is the large amount of alfalfa that they show to be growing on land with a clay subsoil. Sandy clay, clay loam, clay and lime, etc., were not counted as clay. In spite of this limitation, 245 clay or gumbo subsoils are reported. A clay or even a gumbo subsoil does not appear to be a barrier to successful alfalfa culture.

The seed bed was prepared by plowing and further working in 373 cases, and by disking or cultivating in 75. Among the latter is one method that appears to be popular and satisfactory. This consists in thoroughly disking corn land after all trash has been removed from the field. In the western part of the State there are a number of good stands of alfalfa obtained by breaking prairie sod, disking it, and harrowing in the seed. Also by disking the unbroken sod and harrowing in the seed. The latter commends itself as an easy way of supplementing the native grasses in pastures. The tendency to dispense with plowing on unirrigated land increases with the distance westward from the Missouri.

A study of the dates of sowing alfalfa seed in the spring shows a range from early March to late June, although where advice was volunteered it was practically unanimous in favor of early sowing. There were only 8 reports of summer or fall sowing, of which 1 was sown in July, 4 in August, and 3 in September.

In 108 cases a nurse crop was used, while in 393 cases the alfalfa seed was sown without that of any other crop. The use of the nurse crop was largely confined to extreme eastern Nebraska and the irrigated land of the West. Many persons who used a nurse crop say that they would not do so again. It has been recommended to use a light seeding of small grain, sown earlier or with the alfalfa, to prevent damage by severe winds. When sown in this way the nurse crop is mown when 8 or 10 inches high, to prevent it smothering the alfalfa.

In 55 cases the seed was put in with a drill, and in 447 cases it was sown broadcast. This is at least an indication that if a drill is not available a satisfactory stand can be obtained by broadcasting and harrowing in, provided the other conditions are favorable.

There were 138 reports of less than 20 pounds of seed per acre being used, and 336 reports of 20 pounds or more being sown. The evidence seems to be in favor of the use of at least 20 pounds of seed per acre.

Of the persons replying to the inquiries, 221 have stands of alfalfa that yield more than 4 tons of cured hay per acre each season, while 157 do not get as much as 4 tons of hay per acre.

Of persons having practiced disking alfalfa in the spring or at other times, 138 report that beneficial results have been obtained, while 7 report that disking has been ineffective or injurious. By disking alfalfa is meant going over it in the spring with a disk harrow before growth starts, or during summer immediately after cutting for hay. It is customary to set the disks at a slight angle. This cuts the crown root and stirs the soil. Some of the correspondents prefer harrowing to disking. Where positive objection was made to disking, it was based on the claim that it caused the crowns to become diseased. The great bulk of the evidence was, however, in favor of disking.

Of the persons who have manured alfalfa, either by plowing in the manure immediately before seeding or by spreading it on the field after a stand had been obtained, 110 obtained beneficial results, and 13 found it to be ineffective or injurious. Objections are based on the claim that plowing in manure causes the soil to dry out, but objections to spreading manure on alfalfa are rather indefinite in their nature, except that on low land it makes the growth too rank, and the alfalfa falls down. Many of those who advocate its use specify that the manure should be rotted and fine. One man suggests harrowing after spreading, to fine it. The reports of beneficial results from plowing under manure come largely from the eastern portion of the State, but the use of fine manure applied as a top dressing has proven beneficial in all parts.

ALFALFA SEED FROM DIFFERENT SOURCES.

Turkestan alfalfa.—One plot of one-fifth acre was sown alone with 5 pounds of seed April 8, 1901. There was a good stand and no loss from winter killing in 1901–2 or 1902–3, thus showing its superiority in respect to hardiness during the winter. On the other hand, this plot was injured by the wet weather in the summers of 1902 and 1903 to a greater extent than common alfalfa. On June 12, 1903, a crop of hay was obtained, weighing 605 pounds (3,025 pounds per acre), and a second crop on July 23, weighing 500 pounds (2,500 pounds per acre), making 2.75 tons of hay per acre, besides fall pasturage. It was noted that this plot started one week earlier in the spring than the ordinary alfalfa, but did not continue growth so late in the autumn. At no time did it grow so tall as ordinary alfalfa, but the stand was much thicker, and there appeared to be less tendency for the crowns to become large and crowd out weaker plants, as is the case with ordinary alfalfa. As compared with the latter the leaves and especially the stems are smaller.

A second plot, one-tenth acre,[a] drilled in rows 6 inches apart May 24, 1898, gave a good stand, with no loss from winter killing the first year and yielded 215 pounds of hay (2,150 pounds per acre) on June 17, 1899. The third year the yields of hay from one-eighth acre were

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[a] The plots here, as in several other cases, are 66 feet by 76 feet and contiguous on the longer sides. If the marginal growth was greater than the central, 5 feet was mowed off each end, reducing the plots to 66 by 66 feet, or one-tenth of an acre, and thus eliminating the marginal factor.

as follows: June 14, 515 pounds; July 20, 590 pounds; August 20, 305 pounds, or a total for the season of 5.64 tons per acre.

In 1901 the yield on the one-eighth acre was: June 5, 645 pounds; July 19, 160 pounds; August 20, 125 pounds; a total of 3.22 tons per acre. In 1902 the yield on June 9 was 445 pounds; in 1903, June 11, 475 pounds; July 23, 365 pounds; a total of 3.34 tons per acre. The results of this test are especially satisfactory, as showing that Turkestan alfalfa is well adapted to Nebraska conditions, and that in a dry season such as 1901 it yields larger crops than the ordinary alfalfa.

Peruvian alfalfa.—Seed was obtained from C. Bonifiez, Peru, through the Division of Agrostology of the Department of Agriculture, and was sown on May 11, 1900. The stand was good and the growth vigorous, but the plot was badly injured each winter, till, in 1903, there was none remaining.

Samarkand alfalfa.—Sown May 11, 1900. The stand was good and subsequent growth vigorous, with no loss from winter killing; but the growth was not so tall as common alfalfa, or as Turkestan alfalfa. In 1902 and 1903 crops were obtained from this plot, but the plot is too small for an accurate estimate of the yield to be determined. Owing to the small growth, it was estimated that the yields were less than from the ordinary or the Turkestan alfalfa. To offset the effect of shorter growth the stand is much thicker than that of ordinary alfalfa. It appears to be a strong drought-resisting plant, and if it is to have any value it will be on the highlands of the West.

Seed from different States.—Alfalfa obtained from five different States—Arizona, California, Colorado, Kansas, and Utah—was tested. The plots were sown in 1898 by drilling the seed in rows 6 inches apart. They all grew about equally well until the winter of 1898–99, when the alfalfa from Arizona and California was almost entirely killed out. At the same time the Colorado alfalfa was injured, while the Utah and Kansas plants did not suffer so much as those just mentioned, though more than the Turkestan alfalfa or that from Nebraska-grown seed.

There was no further marked loss from winter killing until the winter of 1902–3, when the remainder of the Arizona and California plants entirely disappeared, the Colorado crop suffered further injury, and both the Utah and Kansas alfalfa were injured to some extent.

The conclusions to be drawn from this experiment are that it is not desirable to bring alfalfa seed from a southern to a more northern region, or from an irrigated to a nonirrigated soil.

OTHER EXPERIMENTS WITH ALFALFA.

A series of experiments was carried on for the purpose of testing the effect of planting alfalfa in rows and the effect of a few kinds of fertilizers. Plot 43, drilled 24 inches apart, and plot 44, drilled 18 inches apart, were cultivated by hand, and plot 45, drilled 6 inches apart, was cultivated by harrowing. The results show that there is little difference in the yield under the different treatments, and that there is no advantage in planting alfalfa in rows and cultivating it, at least under the conditions at the Nebraska Station. The individual plants tend to grow larger and the stems fall over, filling the space between the rows. As the larger crowns with age tend to rise above the soil, the mowing becomes more difficult and there is more loss of foliage than when the seed is sown thickly. It is quite possible that in the drier portion of the State the moisture could be conserved by cultivation and a crop produced when under ordinary methods there would be failure. On the other hand, the extra expense of such treatment is likely to more than offset any such advantage. In the Southern States alfalfa is frequently raised in rows and cultivated, as it can thus be more easily kept free from weeds; but such methods are used only on a small scale.

The treatment of plots with fertilizer showed no marked advantageous effect. Plots 46 to 49 were treated respectively with fertilizer at the following rate per acre: One ton gypsum, 1 ton lime cake, 2 tons lime cake, 3 tons hog manure.

In order to determine the effect of using heavy or light seed, common alfalfa seed was separated by a grain grader into approximately equal parts of heavy and light weight. This was sown by drilling in 1902. On June 23, 1903, a cutting was made from each plot. The light seed yielded at the rate of 2,500 pounds per acre, and the heavy seed at the rate of 3,000 pounds per acre. The notes made at the time show that both plots were weedy the first year, but the second year there was a much thinner stand in the plot from light seeds.

To test the effect of seeding at different times plots of common and Turkestan alfalfa were sown by drilling and by broadcasting from spring till fall, in 1902, on the following dates: March 10, March 24, April 8, April 21, May 7, May 19, August 7, August 19, September 15, October 1, October 21. On account of lack of seed the experiment with Turkestan alfalfa was discontinued after August 19. The plots of this variety showed a good stand in almost every case and no injury during the succeeding winter.

The sowings of common alfalfa during March, April, and on May 7 gave a fair to good stand, but were all seriously injured the following winter. Later sowings gave good results and not much injury from winter killing except that the sowing of October 21 was a failure, as the plants did not reach a sufficient size to withstand the winter. It was also observed that of the fall-sown plots those sown broadcast gave a much better stand than those that were drilled. (See Pl. III, fig. 2.)

These experiments, as well as the experience of alfalfa growers, show that alfalfa may be sown at any time of the year from spring to early fall, provided the soil is in the proper condition as to tilth and moisture. In the eastern part of Nebraska summer and fall sowings may be advantageous because of the weeds. The soil may be freed from weeds during summer and thus the alfalfa is given a chance to get a start.

To test the relative value of sowing seed alone or with a nurse crop, two one-fifth acre plots were planted with 5 pounds of seed on April 8, 1901. On plot No. 1 the seed was sown alone. A good stand followed, with vigorous growth, though some plants were killed during the winter of 1902–3. The result was entirely satisfactory. The plot was disked in the same manner as No. 2. On plot No. 2 the seed was sown with 2 peck of oats. On June 28, 1901, 58 pounds of oats were gathered, followed by a fair stand of alfalfa by October. In the spring of 1902 the stand was very poor, but after being disked and harrowed (March 22) there was some recovery and a good stand resulted in the spring of 1903, though there had been some loss during the preceding winter. The results show that a good stand is more certain to follow sowing alone, the growth of alfalfa being vigorous the first season, while if sown with a nurse crop the alfalfa does not reach its maximum till the second season and there is some risk of a poor stand. The poor results the first season are partly offset by the oat crop gained.

A third plot was treated in the same manner as No. 2, with the intention of mowing the oats for hay, but the dry spring ripened the oats prematurely. The results otherwise were similar to plot No. 2.

A series of experiments has now been in progress for three years to test the effect of combining alfalfa with various grasses. In the spring of 1901 plots one-fifth acre in size were sown with the following mixtures:

Alfalfa, 5 pounds; brome-grass, 3 pounds.

Alfalfa, 4 pounds; brome-grass, 4 pounds.

Alfalfa, 4 pounds; bluegrass, 3 pounds.

Alfalfa, 4 pounds; meadow fescue, 5 pounds.

Alfalfa, 1 pound; brome-grass, ½ pound; red clover, ½ pound; white clover, ¼ pound; bluegrass, ½ pound; meadow fescue, ½ pound; orchard grass, ½ pound; timothy, 1 pound; perennial rye-grass, 1 pound; tall oat-grass, ½ pound.

Alfalfa, 4 pounds; timothy, 5 pounds.

In all cases there was a good stand of alfalfa the first year, and scarcely any of the grasses could be found. All of the plots were disked and harrowed in the spring of 1902. During this season there was a good growth of alfalfa and only a little grass to be seen. This result is especially noteworthy for the plot containing only 1 pound of alfalfa, with several grasses. It was not till the third year that the grasses began to assert themselves. In all the plots the grass constituted a considerable portion of the plots except in the case of the mixture with timothy, which appears to be unable to compete with alfalfa. In the mixture of several grasses it was the orchard grass that took the lead, the plot being estimated to consist of about one-third of this grass.

Another plot of alfalfa and brome-grass sown in equal parts in 1899 has had a similar development, but at the present time the brome-grass has succeeded in nearly crowding out the alfalfa. In the plots where brome-grass was sown with alfalfa—both the common and Turkestan—it was noted that the grass appeared more vigorous in those places where the alfalfa was thickest, and that the grass in these plots appeared also to be more vigorous than in adjacent plots where there was no alfalfa. It would appear that the brome-grass derived some advantage from the fertilizing effect of the alfalfa. (See Pl. IV, fig. 2.)

It will be of interest to record here the results obtained by two correspondents in sowing alfalfa upon native grass in the sand-hill region.

William Fagan, foreman of the Robert Taylor ranch at Abbott, Hall County, states that he disked the sandy sod three times, lapping the disk half each time, and sowed 20 pounds of seed per acre. This was in the spring of 1902. A good stand was obtained, and in 1903 a crop of hay was cut consisting of about one-third prairie hay and two-thirds alfalfa. The alfalfa succeeded better on the knolls where the sod was more thoroughly broken.

Mr. H. W. Sullivan, Broken Bow, Custer County, states: "Beginning in the early spring and continuing up until August, I caused light sandy soil to be broken. I disked this well, harrowed it down smoothly, put seed in with a press drill, 15 pounds to the acre, and got a splendid stand on every foot of it." He remarks that the best stand seemed to follow the August sowing.

Meadow Fescue.

Meadow fescue (*Festuca pratensis*) is a native of Europe and has been cultivated in this country for many years. It can not compete with timothy where the latter is at its best, but being more drought resistant, its range is somewhat more extended in the West, as indicated in the paragraph upon orchard grass. It is more common in the Middle South, where it is grown as a winter grass, being sown in the autumn.

In Nebraska it is recommended that it be sown with orchard grass in the spring. It can also be sown alone or with clover, and in Nebraska is best adapted for pasture, though it can also be used for hay. For the latter purpose, however, brome-grass or alfalfa give better returns.

Many seedsmen sell meadow fescue under the name of English blue-grass, but the latter name is inappropriate, as the grass is not a bluegrass, and the term English bluegrass is sometimes applied to a different plant.

A closely allied grass is tall fescue (*Festuca elatior*). Botanically they are usually considered to be the same species, but agriculturally there is considerable difference, and, for Nebraska conditions, in favor of the meadow fescue.

For further notes upon this grass see the paragraph upon grass mixtures.

One plot, 76 by 132 feet in size, sown in the spring of 1900 and manured in the fall of 1901, gave on June 23, 1902, 750 pounds of hay, or 3,450 pounds per acre. The grass was injured somewhat by the drought of 1901, but recovered sufficiently to give good fall pasture. The fourth year, June 16, 1903, this plot gave a cutting of hay of 670 pounds, or at the rate of 2,836 pounds per acre.

Another plot (one-eighth acre) drilled in rows on May 25, 1897, gave on June 27, 1900, a cutting of 300 pounds of hay, or at the rate of 2,400 pounds per acre. The growth in the following years was good, but the notes show that the grass does not start to grow so early in the spring as brome-grass.

Eight growers of meadow fescue have reported upon their results. All report that their fields are now in good condition, but the reports are equally divided as to the advantages of spring and fall sowing, while five state that it is easier to obtain a stand of this than of other grass. Several have tried meadow fescue mixed with timothy, clover, or alfalfa, all of which trials were successful.

Orchard Grass.

Orchard grass (*Dactylis glomerata*) is a native of Europe, but has been cultivated in this country since the middle of the eighteenth century. It is a bunch grass, and when sown alone forms tufts which in time become large tussocks, considerably raised above the general surface of the soil. This is a hindrance to the mowing machine and also a waste of land. For this reason it is recommended that orchard grass be combined with some other grass, for which purpose meadow fescue and brome-grass are best adapted to Nebraska conditions.

Orchard grass is one of the most nutritious and palatable of the cultivated meadow grasses. It thrives in more shaded situations than other meadow grasses, for which reason it is often planted in orchards; hence the name. It withstands drought better than timothy, and consequently can be grown farther west in Nebraska than can timothy. The chief disadvantage of orchard grass is the greater expense of the seed.

Orchard grass and meadow fescue, sometimes combined with red clover, are to be recommended especially for pasture in that part of Nebraska west of the timothy belt as far as about the ninety-ninth meridian, beyond which the summer conditions become too severe. It is true that fields of these grasses usually dry up more or less during the middle of summer, but the same is true of all available pasture grasses, it being necessary to supplement them during this season with green feed, such as cane or corn. On the other hand, orchard grass and meadow fescue furnish green feed in early spring and late fall, seasons when the wild pastures are not available. The seed should be sown in the spring at the rate of about 20 pounds of orchard grass and 15 pounds of meadow fescue per acre. Unless the ground is free from weeds it will be necessary to mow once or twice during the first season to keep the weeds down until the grass is well established. When grown for hay the grass should be cut in blossom, as at a later period the value of the hay rapidly decreases.

Orchard grass has been grown on the Nebraska Station farm for several years and has given very satisfactory results. (See Pl. IV, fig. 1.) The reader is referred to the paragraph upon grass mixtures for further information as to this grass.

TIMOTHY

Timothy (*Phleum pratense*) is a native of Europe, and is said to have been brought to Maryland in 1720 by Timothy Hanson, for whom it was named. The history of this standard meadow grass is somewhat obscure, however. The name herd's grass, by which it is known in New England, is said to have been derived from a Mr. Herd, who found it growing wild in New Hampshire and introduced it into cultivation. Timothy is cultivated in Europe, while in the United States it is the common meadow grass through all the Northern States as far west as eastern Nebraska and south to Virginia and Tennessee, and even farther in the mountains. It is also cultivated in the Rocky Mountains at high altitudes, in the irrigated districts of the Northwest, and the moist region of western Oregon and Washington.

Timothy is a less nutritious grass than most of the other cultivated grasses, but it has a great advantage from the fact that seed of good quality is easily produced for the market and hence is cheap, and because the grass may be easily grown and handled. In Nebraska timothy can be grown successfully only in the eastern counties, although it is being gradually pushed westward, and there are many fields that give fairly good results as far west as the ninety-ninth meridian, or even farther when there is an abundant water supply near the surface. However, these are isolated cases and represent localities where the conditions are especially favorable, and it can not be said that timothy is to be depended upon much west of the line indicating 30 inches of annual rainfall.

Timothy is chiefly used for meadows, but may be also used for pastures. When sown alone there is some danger of injury from close pasturing, as stock are likely to pull up the bulblets at the base of the stems and thus destroy the crown. It is usually sown, when intended for pasture, with red clover. When used for hay it is also frequently combined with clover, which is very satisfactory for home use, as the clover increases its feeding value. Upon the hay market, however, pure timothy brings a higher price than mixed; hence when grown for sale timothy is usually sown alone.

It may also be remarked that the soil conditions of Nebraska are not suited to the best development of timothy, even where the rainfall is sufficient, as the soil is of a sandy type rather than clay. Timothy may be sown in the autumn or spring. If sown alone it is best to sow in the fall, as a full crop can then be obtained the following year. If sown in the spring there is not generally a full crop till the second year and hence some time is lost. It is usual in Nebraska to combine it with clover and sow with a nurse crop, the object of the latter being to obtain more from the land the first year. As the timothy and clover may not reach their full development the first season, the grain crop is thrown in for economy. Where winter wheat is grown it is common to use this as the nurse crop, sowing the timothy and wheat in the fall and the clover the following spring. The wheat and timothy can not be sown mixed in a drill on account of the difference in the size of the seed, but they may be sown at the same time by using a wheat drill having a special attachment. The timothy may be sown in the spring, but in that case should be sown early, about the time the snow is disappearing and while the ground is wet. If there is no snow and the ground is dry the timothy is likely to fail. The clover is sown in the spring in either case and later than is suitable for timothy, usually the first part of April.

The amount of seed used is from 6 to 8 quarts of timothy and 8 to 10 pounds of clover. When combined with grain the timothy and clover produce a good growth after the grass is cut, and may be lightly pastured the same year. The following year one or more crops of hay may be cut or the field may be pastured, according to circumstances. When timothy is sown alone there is some danger in Nebraska of injury to the roots after the cuttings, as they may be unduly exposed to the hot sunshine during dry weather. There is less danger of this when clover is used in combination.

Clovers.

Red clover (*Trifolium pratense*), the standard forage legume of the Northeastern States, can be grown in the eastern counties over about the same area as timothy. As clover is usually combined with timothy for both pasture and meadow, its cultivation has been considered in connection with the latter plant. In the census returns cited in the introduction to this bulletin mixed timothy and clover are included under "other tame grasses." As Nebraska is credited with 42,000 acres of clover and 92,000 acres of other tame grasses, it is quite likely that a large proportion of the latter area is devoted to timothy and clover mixed. Red clover has been grown upon the Nebraska Station farm for many years with great success.

Mammoth clover is a variety of red clover of more vigorous growth and longer lived than the ordinary kind. The seed was sown at the Nebraska Station in 1900, and gave a good stand, a vigorous growth, with good fall pasture. The following year it was subjected to a severe test by drought, but withstood this better than any other clover upon the farm. It was about half winterkilled in the winter of 1902–1903.

Alsike clover (*Trifolium hybridum*) is a perennial clover, in size and appearance intermediate between red and white clover. It is adapted to more moist ground than red clover and is recommended as a constituent of wet pastures. In Nebraska it does not usually grow tall enough for hay, but is a fine clover for pasture. On the station farm alsike has given good results in low spots in pastures and has withstood drought well.

Kentucky Bluegrass.

Kentucky bluegrass (*Poa pratensis*) is a native of Europe and of the northern part of the United States, but it is now widely cultivated; it is also found as a wild grass throughout all the northern portion of the United States, except the arid regions. Bluegrass is essentially a pasture grass and can scarcely be excelled in regions where it reaches its greatest development. In Nebraska it thrives only in the eastern counties over about the same range as timothy, though it is gradually spreading westward. However, in many places lying west of the normal range it is a common constituent of pastures, and is then usually established in the more shaded situations. If there are shade trees or hedges, the bluegrass is quite certain to obtain a foothold and spread outward, holding its own very well with even the native grasses. It gives early and late pasture, but dries up in summer.

The seed should be sown very early in the spring, on the melting snow if possible, at the rate of about 25 pounds of good seed per acre. If the seed is chaffy more must be used. It is customary to sow with bluegrass a little white clover—2 or 3 pounds. The latter, however, is usually widespread in the bluegrass region and soon comes in itself.

Results at the Nebraska Station show that bluegrass furnishes considerable pasture, especially during spring and fall, as indicated in the paragraph on pastures.

Closely allied to Kentucky bluegrass is Canada or Canadian bluegrass (*Poa compressa*). This differs from the former in having a distinctly flattened stem, being of a bluish-green color, in having smaller flower clusters, and usually growing less tall. It is the common bluegrass of the New England and Northeastern States, and in some localities is called wire grass and also English bluegrass. It is adapted to somewhat more sterile soil than Kentucky bluegrass, but on the whole is scarcely to be recommended for Nebraska. The station trial of this grass was unsatisfactory.

Redtop.

Redtop (*Agrostis alba* and *A. vulgaris*) is a native of Europe and also of the northern parts of North America. In the Eastern States, especially from Pennsylvania southward, this grass is more commonly known as herd's grass. Redtop is widely cultivated and is now found growing wild through all the region indicated for timothy. Like bluegrass and white clover, it is now a common constituent of meadows and pastures even where it was not sown. It is particularly adapted to moist soils and is always recommended as a constituent of meadows or pastures on low ground. It is, however, inferior in quality to the other grasses mentioned, and also on ordinary dry ground it is inferior to them in quantity. It is to be recommended for moist meadows in the eastern part of the State and also for those localities in the sandhills and other portions of western Nebraska where the soil is too moist for the growth of ordinary meadow grasses.

As the seed obtained in the market usually contains a large amount of chaff it is necessary to sow a correspondingly large quantity of seed. A half bushel of clean seed per acre is probably sufficient, but it may be necessary to increase this to 2 bushels if the seed is chaffy. When sown in mixtures, as is usually the case, a much less quantity may be used. A common mixture is 3 pounds of alsike clover, 4 pounds of timothy, and 4 pounds of redtop. Botanically there is a slight difference between *Agrostis alba* and *A. vulgaris*, but the seed upon the market may be of either variety. A variety known as creeping bent (*A. stolonifera*, of the seed catalogues) is often used as a lawn grass in the Eastern States. A related species, Rhode Island bent (*A. canina*), is also used as a lawn grass, but in Nebraska both these grasses are inferior to bluegrass for this purpose.

Redtop has been grown upon the Nebraska Station farm for several years and has been found to be entirely adapted to this region.

Side-oats Grama.

The first seeding of side-oats grama (*Bouteloua curtipendula*), also called prairie oats and tall grama, was made in 1897. It gave the same year a yield of hay amounting to nearly two tons per acre, and the following year the product was nearly four tons per acre. The grass was partially killed during the unprecedentedly cold winter of 1899. Being a native, it is not injured by ordinarily cold weather. Seed sown in 1900 produced a good stand the first year but no crop.

During the second season, 1901, which was very dry during the late summer, the grass continued in good condition in spite of the drought, and produced a crop of seed on August 21 and a second crop October 16, after which it kept green during fall. This plot continued to give good results during 1902 (see Pl. VI, fig. 1), but as it does not form a close sod it gives a chance for various weeds to become established between the bunches. In 1903 the plot had greatly deteriorated and the grass was finally driven out by weeds.

Taking everything into consideration this is a very promising grass for the drier regions of Nebraska. It is a native of the plains and furnishes excellent forage for pasture and also promises well for hay. An important point in its favor is the fact that the plants seed abundantly and the seed is easily gathered—of good quality, and easily sown. On account of the tendency to grow in bunches it may be best to sow this with some other grass, such as brome-grass, or even with alfalfa. Much of the success in growing this grass depends upon securing good seed. In the experiment noted above, the seed was obtained from a plot previously grown upon the farm. Other plots of the same grass sown with seed obtained from the Department of Agriculture were failures on account of low vitality. The Kansas Experiment Station reports good results in the culture of this grass (Bulletin 102).

Wheat-Grasses.

Western wheat-grass (*Agropyron occidentale*) is commonly found in the western portion of the Great Plains, extending into the mountains. It propagates by stout creeping rootstocks, but does not form a close sod. In the west, from Colorado to Montana, it is called bluestem, Colorado bluestem, or Colorado grass, and it forms the bulk of the native hay of this region. It grows on bench land or bottom land, and though the yield per acre is not large it furnishes more hay than any other common grass of this region. The foliage is stiff and harsh, but the quality of the hay is good and it is readily eaten by stock.

The trials on the plots at the Nebraska station were satisfactory. Where a good stand was obtained the plant showed that it could withstand drought and produce a good crop of hay. One plot of one-fifth of an acre, sown in 1901, and on account of the poor stand resown the following year, produced on June 23, 1903, 457 pounds of hay, or at the rate of 2,485 pounds to the acre.

Wheat-grass is in fact one of the most promising of our native hay grasses. The seed is produced in abundance and is easily gathered. Experiments at stations in the arid regions have usually given good results. The rootstocks soon fill the soil and the field may require rejuvenating. This can be accomplished by disking or harrowing to cut up the rootstocks, as is often done upon the native meadows.

Although *Agropyron repens*, known as quack-grass, quitch-grass, and couch-grass, is a pestiferous weed in the Eastern States, yet for Nebraska it shows many qualities which recommend it as a hay grass. The grass is nutritious, palatable, drought resistant, and thickens up readily to form a good stand. It is true that it may tend to spread where it becomes established, but in the semiarid regions such a quality in an otherwise desirable grass would be readily overlooked. Four years' testing of this grass upon the station plots shows that it recovered easily from the drought of 1901 and formed a good growth of hay in 1902 and 1903.

Slender wheat-grass (*Agropyron tenerum*) is a native of the Northwestern States from western Nebraska to Canada and westward. This has been recognized in the region to the north of Nebraska as a valuable wild grass and has already been brought into cultivation, so that the seed can be obtained of several seedsmen in the Northwest. It resembles *A. occidentale* in many respects, but differs in the important fact that it is a bunch grass, and does not spread by creeping rootstocks. Like the other wheat-grasses, the seed habits are good, and it gives promise of meeting the requirements of a hay grass for the Northwest.

One plot at the Nebraska Station, sown in 1897, was apparently much injured by the drought of 1901, but the following spring it quickly recovered and produced a thick stand of excellent hay. Another plot, one-fifth acre in size, sown in 1901, had a similar history, but it was resown in the spring of 1902, produced a good stand, and gave a cutting of hay on July 23 of 457 pounds, or at the rate of 2285 pounds to the acre.

Grasses and Legumes of Less Importance.

Big bluestem (*Andropogon furcatus*).—This is one of the tall grasses common over the prairie region and forms, probably, the most valuable constituent of native hay produced in eastern Kansas, eastern Nebraska, and Iowa. It is usually called bluestem, or bluejoint, and is characterized by having the seed in crowfoot clusters at the top of the stem, by which it may be distinguished from the bluejoint of Colorado, which is a wheat-grass, and from the bluejoint of Minnesota, which is a grass of low grounds rather than prairies. The station plot gave rather unsatisfactory results on account of the poor stand obtained, but the bunches that were produced grew well. Although a valuable grass, the seed habits are such that it is not likely to adapt itself to cultivation. The seed is produced in small quantity, is of uncertain vitality, and the seed stalks vary so in height that it is not readily harvested.

The allied *A. scoparius*, which is another important native hay grass, called little bluestem, or, on the plains, "bunch-grass," has not been tested at the Nebraska Station, but the above remarks concerning the seed habits apply nearly as well to this species.

Indian grass (*Andropogon nutans*). A tall grass growing in the Eastern States and westward nearly to the mountains. It forms an important constituent of all the wild hay of the prairie regions except toward the north. It is of especial value on account of its numerous root leaves. The plot of this grass tested gave finally a luxuriant growth of foliage, although it was injured somewhat by the drought of 1901. The poor seed habits of this grass stand in the way of its cultivation. The seed is usually not very abundant and is often of low vitality.

Tall oat-grass (*Arrhenatherum elatius*).—One of the European meadow grasses which has been grown on a small scale in this country for many years. As it is a bunch grass and does not form a close sod it should not be used alone, but doubtless it will be a valuable addition to a mixture such as orchard grass and meadow fescue. It is fairly drought resistant, and has the quality of producing a comparatively rank growth the first season, for which reason it has found favor as a winter pasture grass in the South. In general, however, it seems to be better adapted to meadows than to pastures. The station plots gave a good growth of forage which produced excellent hay. One plot, one-fifth acre in size, sown in 1901 and resown in 1902, produced on June 23, 410 pounds of hay, or at the rate of 2,050 pounds to the acre. After the cutting a fine aftermath was formed. In 1903 the same plot yielded (June 16) only 310 pounds, or at the rate of 1,550 pounds to the acre, bearing out the experience elsewhere that a meadow of tall oat-grass reaches its maximum development early and then deteriorates.

Blue grama (*Bouteloua oligostachya*).—Blue grama is one of the important constituents of upland grazing regions of the Great Plains and is often called buffalo grass, but it should be distinguished from the true buffalo grass with which it is usually associated. Blue grama does not produce so large a quantity of seed and the seed is not so easily gathered or handled as side-oats grama, but ranchmen state that it is superior to this grass in nutritive qualities and palatability, and furthermore that it forms a thick sod, while the other does not. The growth is short, usually about a foot high, and hence this grass is not adapted for hay except under favorable conditions, though for pasture it is exceedingly valuable. Seed was sown on one plot in 1898 and on a second plot in 1900. The grass was slow to start from seed and the growth in the spring was slow even when the plot was established, but the stand thickened up well, and during the dry season of 1901 it was the only grass besides side-oats grama that gave sufficient growth for pasture during the period of extreme drought.

Western brome (*Bromus carinatus hookerianus*).—Three trials of this gave negative results on account of the failure of the seed to germinate, but one plot sown in the spring of 1902 with seed from the grass garden of the Department of Agriculture at Washington gave good results and showed that the grass is at least promising for the semiarid regions. Trials at stations in the Northwest have also shown that this species gives much promise. This grass is closely allied to *B. marginatus.*

Western brome (*Bromus marginatus*).—Four trials of this grass showed that it is well adapted to the conditions in Nebraska, giving a good growth and resisting the dry weather of 1901, and that it is not injured in the winter. The foliage is rather coarse and not as leafy as would be desirable, but the grass is well worth an extended trial.

Buffalo grass (*Bulbilis dactyloides*).—Buffalo grass is the common "short grass" of the Great Plains, and forms a close, thick sod by means of its numerous creeping stolons. It is entirely resistant to drought, it is very nutritious, and it cures upon the ground, thus furnishing winter feed to the range cattle. The grass forms the seed close to the ground in little nut-like clusters that are likely to escape the casual observer. The staminate or male flowers are produced in little spikes or flags, which are raised a few inches above the ground and are much more easily distinguished than are the pistillate or female flowers that produce the seed. The seed, however, is quite fertile, but is so difficult to gather that it will never be practicable to grow buffalo grass from the seed. If it is desired to produce a field of buffalo grass it should be started from the cuttings. For this purpose the sod should be cut into small pieces and planted upon prepared soil. The pieces can be dropped upon the surface of the soil and forced into the ground by stepping upon them. The distance apart depends upon the desirability of obtaining a thick stand at once. If the pieces of sod are placed 2 feet apart each way, they will thicken up between fairly well in one season. In experiments at the Nebraska Station the seed failed to germinate.

Wild rye (*Elymus canadensis*).—A common grass in many parts of the United States and extending over a large part of Nebraska, where it is found chiefly in draws and low places. It produces a large amount of hay of good quality, though rather coarse. It resists drought quite well and seems well worth an extended trial as a meadow grass. One plot on the station grounds, sown in 1901 (see Pl. VI, fig. 2), was cut on July 26, 1902, and yielded at the rate of 5,875 pounds to the acre (1,175 pounds on one-fifth acre). The same plot yielded on July 23, 1903, at the rate of 3,700 pounds per acre. The shattered seed from the plot germinated in the autumn of 1902 and produced a good stand the following season. The cutting was made after the grass had headed out, but for the best hay the cutting should be made much before the heads appear. The form here cultivated is sometimes referred to as *E. robustus*.

Elymus virginicus.—The same remarks apply to this species as to *E. canadensis*, but this grass shows the effect of drought more quickly than that species.

Elymus virginicus submuticus.—The results with this variety are more satisfactory than with the species.

Eragrostis tenuis.—This grass has given good results in the plots, and promises well as a hay grass, although the foliage is rather wiry. The grass is a native of sandy regions of the plains, and it may prove valuable in the Sand Hills.

Wild timothy (*Muhlenbergia racemosa*).—A native grass found in moist places through the Northern States west to the Rocky Mountains. In Nebraska it is a common constituent of slough-grass hay. The results upon the station plots show that this grass can be cultivated and a fair quality of hay produced.

Japanese barnyard millet (*Panicum crus-galli*).—An annual grass of much nutritive value which gives a luxuriant growth of fodder suitable for coarse hay. The station plot of this grass, one-fifth acre, sown March 22, yielded on July 26, 1902, 1,100 pounds of hay, or at the rate of 5,500 pounds to the acre. The yield should have been much higher, but the stand was not of the best. There is no doubt that this is a good annual hay grass for portions of Nebraska which are not too dry, but as it has no especial advantage over millet and is inferior to sorghum it probably will not be used extensively. Some seedsmen have sold this under the name of Billion Dollar Grass.

Switch-grass (*Panicum virgatum*).—A bunch grass which is one of the important constituents of prairie hay in Nebraska and is well worth cultivating. The plot at the station was unsatisfactory on account of the poor stand, but the bunches present produced a good quality of hay. The grass is quite resistant to drought and produces a quantity of seed which is usually of good quality.

Reed canary grass (*Phalaris arundinacea*).—A native of marshes and sloughs through the northern tier of States. In the northern portion of the Great Plains it forms a large part of the native hay, which is generally recognized as of excellent quality. Although a native of wet soil it gives good results on comparatively dry soil. It is to be recommended for cultivation in the States from Minnesota to Washington, and south probably as far as northern Kansas, but in the southern portion of the range is adapted only to low meadows. The great disadvantage of this grass at present is the difficulty of obtaining good seed. Ordinarily the seed shatters easily at maturity. The results of the trial at the station were unsatisfactory from the fact that there was a very thin stand, which was probably due to poor seed. The common ribbon grass of gardens is a variety of this species.

Stipa robusta.—A native of the Rocky Mountain regions and the western portion of the Great Plains, where it is a common constituent of the native hay. The station plot sown in 1897 withstood the drought of 1901 and gave good crops of hay in 1902 and 1903. This grass is worthy of an extended trial.

PASTURES AND MEADOWS.

NATIVE GRASSES.

Since the native grasses and forage plants play such an important rôle in the agricultural economy of Nebraska, it will not be out of place to discuss them briefly. They have been very thoroughly studied by Dr. C. E. Bessey and other botanists of the State and for detailed information the reader is referred to articles by Dr. Bessey in the reports of the Nebraska State Board of Agriculture from 1886 to 1896, to the Phytogeography of Nebraska, by Pound and Clements, the Flora of the Sand Hills, by Rydberg, and to various articles on the grasses of Nebraska by Webber, Smith, and others.

The agricultural grasses are divided into two types, according to root formation—bunch grasses and sod formers. The bunch grasses form a crown which increases from year to year and becomes in time a raised tussock. Where bunch grasses abound there is no continuous sod but a succession of tussocks with bare soil between which supports a variety of other plants scattered here and there. Some of the common bunch grasses are bluestem, switch-grass, and Indian grass. Sod formers have rootstocks or stolons by which they spread, forming a continuous sod. Buffalo grass and Kentucky bluegrass are examples of this type.

The grasses may also be divided into those which grow tall enough to make hay, and are sometimes called "tall grasses," and the strictly grazing grasses of the western plains, called "short grasses."

Hay is made from the tall grasses which are found on all unbroken prairie of the eastern portion of the State. In the wet places or sloughs, there are various swamp grasses (chiefly slough-grass, *Spartina cynosuroides*), which, when cut young, furnish a fair, though coarse, hay. The most important hay grasses are: Little bluestem (*Andropogon scoparius* Michx.), Big bluestem (*Andropogon furcatus* Muhl.), Indian grass (*Andropogon nutans* L.), Switch-grass (*Panicum virgatum* L.), and Side-oats grama (*Bouteloua curtipendula* Michx.). These five grasses form the great bulk of the prairie hay throughout the eastern half of the State. In the western portion these grasses are confined to the river bottoms, draws, and other moist spots, and often are found in sufficient abundance for mowing. These same grasses are also used for native pasture. But in the grazing portions of the West, except the Sand Hills, the important grasses are: Buffalo grass (*Bulbilis dactyloides* Raf.) and blue grama (*Bouteloua oligostachya* Torr.).

An important grass in the West, especially for hay, is the wheat-grass (*Agropyron occidentale*). This spreads by extensively creeping underground stems. The foliage is stiff and rather harsh, but nevertheless it forms a very nutritious hay. This grass is more resistant to drought than any of the hay grasses of the West.

There are many other grasses which are of more or less agricultural importance, but, compared with those mentioned, they are insignificant.

CARE OF NATIVE PASTURES AND MEADOWS.

Unless proper precautions are taken to prevent it, both meadows and pastures tend to deteriorate. In pastures the stock are continually eating off the most palatable plants and avoiding the others, which are in this respect weeds. To prevent such exhaustion it is necessary to limit the number of stock to the forage-producing power of the pasture. The same is true of the open range. Great harm has resulted in many instances from overstocking. Particular care must be exercised in this respect at what might be called critical periods, or when unfavorable conditions, such as drought, curtail the production of grass. In pastures this exhaustion can be avoided by supplementing the grazing by soiling crops. An excellent way to encourage the recuperative power of the native grasses is to give the pasture a rest by providing two pastures, which may be used alternately for periods of from two to four weeks.

With meadows deterioration is less marked, as the weeds are cut at the same time as the grass. However, it is advisable to allow the grasses to go to seed occasionally. It is a bad practice to pasture the aftermath during the autumn, as this encourages the growth of weeds.

The burning off of pastures or meadows is not to be recommended, as experience has demonstrated that though a green growth can be induced earlier the final results are harmful. The crowns of the grasses are injured and the fertilizing effect of the dried leaves is lost.

On the other hand, the practice of mowing the weeds in pastures in summer is good, as they are thus prevented from going to seed.

If the number of stock limited to its capacity is allowed to use the pasture, the manure thus distributed tends to keep up fertility; but meadows are constantly giving up nutriment drawn from the soil, the loss of which must in time visibly affect the capacity. Therefore, wherever the value of the hay is a sufficient recompense, it is well to supply barnyard manure to make up this loss.

TAME PASTURES AT THE NEBRASKA EXPERIMENT STATION.

A field of 30 acres was sown in April, 1899, with a mixture of 2 pounds each of orchard grass, timothy, bluegrass, tall oat-grass perennial rye-grass, and white clover, 4 pounds of red clover, and 1 pound of alsike. Three pounds of alfalfa were added to 5 acres of this mixture. In 1900, 30 tons of hay were cut and excellent pasture was obtained through the fall. In 1901, the pasture was in excellent condition, supporting 25 to 35 head of cattle and giving 14 tons of fine hay. This pasture has been top-dressed with barnyard manure about every other winter, and during the summer the weeds have been mown two or three times. In the spring of 1900 the field was disked and sown with brome-grass and meadow fescue. These grasses have gradually gained the ascendency until now the alfalfa has disappeared and there is little to be seen besides the grasses mentioned.

This tendency for certain grasses to predominate in a mixture is shown by the history of a 30-acre field of native pasture. About 1887 a portion of this pasture on the south side was sown with bluegrass and white clover. The bluegrass has gradually spread over the whole field, and at present the pasture appears to be mostly bluegrass, which is especially in evidence during early spring and late fall, while during the summer, particularly if the season is dry, the native grasses are conspicuous. This is the usual tendency where bluegrass is able to thrive. It holds its own with other cultivated grasses, and may even crowd out its competitors; but when combined with native grasses, these are able to hold their own in the prairie region of the State. The bluegrass starts to grow much earlier than the native grasses and gives in early spring an excellent quality of pasture. In the dry part of the summer the bluegrass dries up and becomes dormant while the native grasses continue to vegetate. In the autumn as the weather becomes cooler the bluegrass again starts up and gives late pasture. The experimental pasture had been top-dressed with barnyard manure about every third winter, and during the summer the weeds were mowed two or three times. In 1898, 4 acres of the above fields were plowed and sown to brome-grass. In the spring of 1901, 3 acres of alfalfa were added from an adjoining field. This portion was disked the following spring and sown with brome-grass and meadow fescue. These grasses have driven out the alfalfa, and now none of the latter can be found in the field. During the season of 1903 this field carried 40 head of cattle all summer, and also yielded a crop of hay estimated at one-fourth ton per acre.

Another field sown with timothy, orchard grass, bluegrass, meadow fescue, and brome-grass is now nearly all brome-grass.

THE SEED BED FOR GRASSES AND CLOVERS.

The ideal seed bed for grasses and clovers is a firm but friable lower soil, with loose, well-tilled top soil. To produce this condition requires careful tillage for several years preceding the sowing. The soil should contain sufficient moisture to insure the young plants a good start in case there should be a deficient rainfall after sowing. Seed sown on a dry soil may receive sufficient rainfall to germinate, but not enough to supply the young plants with the necessary moisture. Careful preparation of the seed bed is more essential in seeding grasses than in seeding almost any other crop, and failure to obtain a stand entails a greater loss. Land that has been planted to a cultivated crop, for which the soil has been well tilled and which has received clean and level cultivation, may in most cases be well fitted for seeding grasses by disking and harrowing without plowing, provided the trash be removed. When disking the disk should always be lapped one-half on each round, thus covering the field twice, and generally it is well to go over the field a second time at right angles to the first disking. A smoothing harrow should follow the disk. Well-cultivated land has these advantages: The weeds have been exterminated, the moisture has been conserved, and the top soil is in good tilth. Fall plowing is desirable on land that settles well through the winter and that does not blow badly, but there is much soil on which fall plowing can not be done advantageously when spring seeding is intended. In any case as long a period as possible should elapse between plowing and seeding, but during that time the top soil should be kept loose and clean with the disk or drag. During this period the soil settles, the large spaces are filled, and the moisture is diffused through the plowed soil. Disking the soil before plowing is advisable, as it cuts up the trash if there is any, and pulverizes the soil turned under so that it settles more quickly. The use of the subsurface packer or the disk set straight and run in the direction of the furrow also helps greatly to firm the soil. The use of either of these implements should follow the plow by the least possible number of hours. Stubble land for fall seeding may in some cases best be plowed and in others disked, depending on a great variety of circumstances, but in any case the sooner the soil is prepared after cutting the grain the better, and it is imperative that the surface be kept stirred and clean up to the time of seeding.

ANNUAL FORAGE CROPS.

Sorghum.

Sorghum (*Andropogon sorghum*) is one of the most important annual forage grasses of the United States. It is grown throughout the South and well to the west on the Great Plains. It resists drought better than any other succulent forage crop and gives large yields of excellent hay. Sorghum may be used for soiling and for pasture, but its most important use is for cured fodder or hay. For this purpose it may be sown thickly and mowed with a mowing machine. The hay is succulent and requires some time for curing, but in the drier portions of Nebraska it can be thrown into bunches or cocks and allowed to remain until cured.

Kafir corn, a variety of nonsaccharine sorghum, is also quite drought resistant and is frequently grown for forage, but under the same conditions the sorghum gives a greater yield of fodder. Sorghum can also be planted in rows and cultivated. The forage can then be gathered by cutting and shocking, preferably with a corn harvester. The ordinary sugar sorghums, such as Early Amber, Colman, and Orange, are used for this region. Sorghum is frequently referred to as "cane."

Other races of sorghum are milo maize, Jerusalem corn, and dhoura, but in Nebraska none of these is equal to sorghum for fodder.

Sorghum was tested in the series of pasture tests already mentioned (Bulletin 69 of the Nebraska Experiment Station), as were also white Kafir corn and milo maize. One-fifth acre of sorghum gave twenty-five days' pasturage and was, along with rye, one of the crops giving the greatest quantity of forage. Some experiments were also tried with sorghum for soiling, which indicated that the quantity of forage thus obtained was two to three and one-half times as much as when the crop was pastured.

The possible injurious effects of pasturing sorghum have already been alluded to in another paragraph. (See also Bulletin 77 of the Nebraska Experiment Station.)

An acre of Early Amber sorghum, drilled with a corn planter in double rows, 6 inches between rows, 3 feet apart, June 12, was cut on September 19 with a corn binder and shocked in the field. The weight of this, taken December 1, was 8,715 pounds.

A similar plot was treated in the same manner, except that the seed was planted with a grain drill in rows 8 inches apart. The forage was cut the same as the other plot but with a mowing machine, and was put in cocks, where it remained till December 1. The weight was then found to be 12,350 pounds, or over 6 tons per acre.

In the drier portions of the State where it is necessary to conserve the moisture, it is advisable to plant the seed in rows in order to admit of cultivation. The crop is thus made more certain.

Millet.

Common millet (*Setaria italica*) is much grown in eastern Nebraska as a summer hay crop and frequently as a catch crop after grain. It can be cut in about two months from the time it is planted, and is an excellent hay plant. It should be cut between the time of heading out and that of late bloom, for if cut too early the hay is too laxative in its effect and if cut too late the seed has injurious effects, especially upon horses. The hay is succulent and requires more time to cure than does timothy. About one-half bushel of seed per acre is used. Different varieties are called Hungarian grass, German millet, Siberian millet, etc.

In the pasturing tests (see Bulletin 69 of the Nebraska Experiment Station) millet gave eighteen and a half days' pasturage for one cow and was available at the same time as sorghum, Kafir corn, and cowpeas. "It did not have as favorable an effect upon the milk flow or butter fat production as did any of these crops or as did the mixed grasses."

Broom-corn millet (*Panicum miliaceum*) is a different species, sometimes called hog millet. This gives good results in the Dakotas and other Northern States and also promises well for Nebraska. In 1903, a one-half acre plot of Red Orenburg (S. P. I. 9423) sown June 12 and cut August 15 yielded at the rate of 3,250 pounds of hay to the acre.

Cowpea.

Cowpea (*Vigna catjang*) is an annual legume which has been grown in oriental countries for an indefinite period. It is now one of the standard forage plants of the South, being extensively cultivated as an annual summer crop for hay, pasture, and green manure. During recent years its range has been steadily pushed northward, until now it is grown with more or less success as far north as Wisconsin and New York. There are a large number of varieties, differing greatly in their method of growth, time necessary to reach maturity, hardiness, and many other characters that affect the adaptability to conditions.

Although one of the standard hay plants of the South, it is not adapted for hay in Nebraska. It is difficult to cure and can not compete with alfalfa and clover. It is an excellent soiling plant, but under present conditions of agriculture it is not likely to be needed for this purpose in Nebraska in the near future, except possibly on a small scale in dairy districts. It is not well adapted for silage on account of its succulence, but has been used in this way when mixed with other plants. (See Circular 24 of the Division of Agrostology, U. S. Department of Agriculture.)

The chief field of usefulness of the cowpea in Nebraska is for pasture during the autumn. The seed must be sown when the ground is well warmed, which in Nebraska may not be until June. Although late varieties, which produce no pods in this State, can be utilized for forage, yet the plant gives best returns when the pods are forming. Hence, those varieties should be grown which mature at least a part of the seed before frost. This is especially advisable, because of the high price of seed. Where adaptability to climate is so important as in the case of the cowpea, growers should endeavor to use home-grown seed, which always aids in such adaptation. For pasture the cowpea is well adapted to cattle, sheep, and, especially when the pods are ripening, to hogs. Poultry readily eat the seeds.

The pasture tests of 1900 (see Bulletin No. 69 of the Nebraska Experimental Station) showed that one-fifth acre furnished twenty days' pasture—July 24 to August 13. There was a highly favorable effect upon the milk flow and the butter fat produced, in which respect "the forage far surpassed all of the other crops except alfalfa, and was even slightly superior to that very valuable forage plant." In this test the variety used was the Whip-poor-will.

Two plots of the above variety were sown in 1897 to test the yield of fodder. They were harvested on September 23 and gave at the rate of 4.37 tons and 4.62 tons to the acre. A plot grown in 1896 gave a yield of green fodder amounting to 22,850 pounds per acre, or something over two tons of hay.

Small Grains.

For late fall and early spring pasture nothing excels the winter grains in palatability, nutritive qualities, and in quantity of forage. It is customary to utilize winter wheat incidentally for pasture at such seasons of the year in localities where this crop is grown for grain. Rye is frequently used for pasture, and this plant is to be highly recommended wherever it can be grown as a winter crop. The grains can also be used to advantage as a spring crop, but in this case the pasturage comes later in the season when the want is less keenly felt. Rye sown in the autumn produces pasture at a season when permanent pastures are dormant or giving only meager returns.

In the pasturing tests, a one-fifth-acre plot gave about twenty-seven days' pasturage. "It furnished the earliest pasturage of any of the annual forage crops and could have been pastured in the fall."

The small grains make an excellent quality of hay and in Nebraska are not infrequently used for this purpose. In California the great bulk of the hay upon the city markets is grain hay made from wheat and oats.

Oats and rye are also used in Nebraska as soiling crops during spring and early summer. Although the amount used by each farmer in this way may be small, yet the aggregate must be considerable.

Corn.

This is by far the most valuable plant grown in Nebraska, as it is also of the United States. It is grown chiefly for the grain, but in this bulletin we are concerned with its forage value. Where corn is grown for the grain there are two common methods of utilizing the stalks. The corn may be allowed to mature in the field and the ears husked from the standing stalks during the autumn, or as soon as convenient. After the ears have been harvested, the remaining stalks are utilized by turning cattle, sheep, or horses upon them to secure what they can from the waste grain and the dry fodder. The nutritive value of such fodder is slight, especially during the winter. The second method of harvesting corn is to cut the stalks a short time before the grain is mature and while the foliage is still green. The stalks are placed in shocks to cure, after which the ears are husked out and the remaining stalks may be reshocked, or placed in stacks or barns, and constitute what is usually known as corn fodder or, more properly, corn stover. Properly cured corn stover is quite nutritious and compares favorably with hay. When the fodder is shredded a greater proportion is utilized. There is considerable deterioration in the nutritive value of stover during storage in the field or even in barns.

The value of corn grown for hay should not be underestimated. When planted thickly so that the ears are reduced to one-half or one-fourth the normal size and the stalks cut earlier than when grown for grain, the fodder is large in quantity and very excellent in quality. Besides its value for hay, corn is one of the best plants for silage or ensilage and for a soiling crop.

The pasturing tests at the Nebraska Station show that one-fifth acre plot gave eighteen and one-half days' pasturage for one cow, but though "It may be of value to furnish feed between the periods of rye and sorghum pasturage, it is not equal to either of these."

Soy Bean.

Soy bean (*Glycine hispida*)[a] is a leguminous plant grown for forage and for grain. For forage it is much used in the Middle South, but has not thus far given much promise for this purpose in Nebraska. For seed or grain it has given fairly good results in Kansas. (See Bulletin No. 100 of the Kansas Experiment Station.) In that State the Early Yellow variety has given the best returns. There is some difficulty in harvesting the crop, as a special harvester is required if the beans are raised on a large scale.

Soy beans (American coffee berry) were tested in 1898 to determine their value as summer feed, but the results were not sufficiently satisfactory to warrant the continuance of the experiment. (See Bulletin 69 of the Nebraska Experiment Station.) In 1896 a plot of soy beans yielded at the rate of 15,000 pounds of green fodder per acre.

Several varieties have been grown at the Nebraska Station to test their seed production, but the results were not satisfactory, as none gave a sufficiently high yield to be profitable for this purpose.

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[a] For a full account, see Farmers' Bulletin No. 58, United States Department of Agriculture.

Rape.

Rape (*Brassica napus*) is a succulent plant, resembling the turnip, which is used for pasture in the cooler parts of the United States. It has been grown upon the station farm and is to be recommended for fall pasture for hogs and sheep. It is also useful for calves and growing cattle, but there is much loss from the trampling of the larger stock. The milk is likely to be tainted when rape is fed to cows, although this may be avoided by feeding (soiling) just after milking. The chief value of rape in Nebraska, however, is as fall pasture for hogs and sheep. It gives succulent feed until frost or even somewhat later. A succession of pasture may be produced by planting the seed at different dates. It is ready to use about ten weeks after planting. For further information as to rape see Farmers' Bulletin No. 164, United States Department of Agriculture.

Canada Field Pea.

Canada field pea (*Pisum arvense*), a legume, resembling the garden pea, has proved very successful in Canada and the cooler parts of the United States. It is adapted to a cool, moist climate, though it can be grown with some success in the Middle South as a winter crop. It is usually sown with grain, especially oats, the grain serving to hold up the peas, the combination being very satisfactory for forage. The peas and oats are usually made into hay, although they may be used for pasture or soiling.

Experiments were tried at the station in the pasture tests. (See Bulletin 69 of the Nebraska Experiment Station.) One-fifth acre plot of oats and peas gave twenty-one and one-half days' pasturage, which was available in June, somewhat later than rye. Although peas can be used in this way in moist years, the conclusion was reached that Nebraska is too far south for the best results with this crop.

Vetch.

Hairy vetch (*Vicia villosa*) is an annual legume more drought resistant than the common vetch and better adapted to sandy soils, for which reason it is sometimes called sand vetch. It has proved very successful in eastern Washington and is much used as a winter crop in the Middle South. It gives the best results when combined with grain. Although it can be grown in eastern Nebraska, experiments show that the forage produced is inferior in quantity, and that it can not compete with other legumes.

Spring vetch (*Vicia sativa*) is not suited to Nebraska, as it requires a cool, moist climate. Winter vetch (*Lathyrus hirsutus*) is not to be recommended for that region.

PLANTS WHICH CAN NOT BE RECOMMENDED.

The following grasses and forage plants have been tested, but the results are not such that they can be recommended for Nebraska. Some of the trials were failures because the seed did not germinate. In such cases judgment upon the value of these plants must be reserved. The experiments were based upon trials extending, in many cases, over as many as six years:

Agropyron caninum.—The tests with this wheat-grass were unsatisfactory on account of a mixture of seed, but it showed no evidence of value.

Agropyron divergens.—There was no stand produced with this grass, but experiments at other stations in the Northwest, notably at Pullman, Wash., have shown that it can be grown successfully from the seed and is well adapted to the semiarid conditions of that region. Although with seed of good vitality it may prove successful here, it probably has no advantage over *Agropyron occidentale*. *Agropyron divergens inermis* was also tried, but it produced a poor stand and was not promising.

Agropyron violaceum.—Several trials were made, but the results were unsatisfactory.

Johnson grass (*Andropogon halepensis*).—A common and valuable hay grass for the Southern States, but it has shown itself to be a difficult plant to eradicate, and hence has become in many sections a great pest. In Nebraska it will not usually survive the winter. This grass was sown at the station in the spring of 1897 and survived the winter of 1897–98, but it was killed out during the next winter. Other attempts to raise it resulted in continual loss during the winter.

Sweet vernal grass (*Anthoxanthum odoratum*).—This grass has little forage value anywhere, but it is sometimes used in the Eastern States to impart a pleasing odor to the hay, for which purpose a small quantity suffices.

Australian saltbush (*Atriplex semibaccata*).—This forage plant has proved quite successful in California and in some other parts of the Southwest, especially in alkali soil. However, in States as far north as Nebraska it is unable to survive the winters, and hence must be grown as an annual, but the uncertainty of germination and the rather meager growth the first season render it unsatisfactory as an annual forage plant. The trial at the station extended over four years, but in no case were the results at all promising. The plants were killed out every winter except in 1900–1901. Even the second year's growth was too small to be of much value.

Swamp-chess (*Bromus ciliatus*).—The plots gave a fairly good stand, but the plants do not thicken up in the plot, and the individuals are coarse and not leafy enough for hay. Although this grass might be grown for hay, it shows nothing to recommend it to favor compared with other grasses better adapted to the purpose.

Rescue grass (*Bromus unioloides*).—A fairly good grass, but it will not endure the winters in Nebraska.

Bluejoint (*Calamagrostis canadensis*).—This is a common prairie grass of the Northern States, extending west into eastern Nebraska. In Minnesota and Iowa it is a valuable wild hay grass and there called bluejoint (not to be confused with the bluestem of Nebraska, *Andropogon furcatus*, nor the bluestem of the foot hills, *Agropyron occidentale*). It thrives particularly on moist prairie and swales. Attempts to grow this grass from seed have usually been unsuccessful, as the seed seems to lack vitality. At the Nebraska Station the seed produced a very poor stand.

Bermuda grass (*Cynodon dactylon*).—The best grass for summer pasture in the South, but not hardy in Nebraska.

Crested dog's-tail grass (*Cynosurus cristatus*).—No improvement over Nebraska grasses and not to be recommended.

Florida beggar-weed (*Desmodium molle*).—An annual leguminous plant of Florida and the West Indies, where it is frequently used for forage. It can be grown throughout the Southern States and even as far north as Nebraska. For the latter State, however, it is not likely to be grown extensively, as it does not meet the requirements so well as other plants. On the station plots this made quite a heavy growth of woody, unpalatable forage.

Elymus glabriflorus and *Elymus glaucifolius*.—A poor stand was obtained of both these grasses, but they should be tested further.

Eriocoma cuspidata.—A common range grass in the Rocky Mountain region, but it does not give promise under cultivation.

Eriochloa punctata.—A promising grass for the South, but scarcely able to endure the winters of Nebraska.

Teosinte (*Euchlæna mexicana*).—A tropical annual forage plant which is often grown in the rich bottom lands of the Southern States and is frequently advertised by seedsmen for the North. It produces under favorable conditions a large quantity of forage, but in Nebraska it is far inferior to sorghum for this purpose. It is a coarse grass, resembling corn.

Eurotia lanata.—This is not a grass, but a forage plant, well known under the name of "winter fat." In the Western States, where it furnishes excellent feed upon the range, attempts to cultivate it have not been attended with much success. Seed planted at the Nebraska Station failed to germinate.

Horse bean (*Faba vulgaris*).—The common field bean of Europe, where it is a staple forage plant; but in this country it has not given satisfactory results.

Tall fescue (*Festuca elatior*).—Results unsatisfactory and plot finally discarded.

Reed fescue (*Festuca elatior arundinacea*).—A tall form of *Festuca elatior*, which gives good results in the Eastern States, but is much inferior in Nebraska to *Festuca pratensis*, the meadow fescue.

Sheep's fescue (*Festuca ovina.*)—A bunch grass of low growth, cultivated in Europe and recommended frequently for the northern portion of the United States. It is not suited for hay, but is of some value for pasture in mountain regions and in the cooler parts of the country, especially in mixtures for sterile soil. But it appears to be entirely unsuited to conditions in Nebraska. Several varieties or related species of this grass (*Festuca sulcata*, *Festuca duriuscula*, *Festuca rubra*) have been tried at the Nebraska Station, but none is to be recommended.

Curly mesquit (*Hilaria cenchroides*).—The common upland grass upon the plains of Texas, where it replaces buffalo grass, which it much resembles in appearance. The plots gave only a thin stand. This species is not hardy as far north as Nebraska.

Velvet grass (*Holcus lanatus*).—A native of Europe and cultivated occasionally in this country, especially in the Puget Sound region, where it is also now growing without cultivation. It has little to recommend it anywhere, and is certainly not worthy of cultivation in Nebraska.

Hordeum bulbosum.—This grass gave a fair stand, but seems not well adapted to the climate, being injured by cold winters.

Wild barley (*Hordeum nodosum*).—Growth not sufficiently rank for a forage grass.

Koeleria cristata.—A common native grass upon the prairies throughout Nebraska. It is a small, slender perennial, flowering in June and not sufficiently rank in its growth to warrant cultivation. The plot of this grass gave a fair early growth, but disappeared the latter part of the summer.

Winter vetch (*Lathyrus hirsutus*).—This vetch has not been tried at the Nebraska Station, as it is unsuited to the climate.

Bitter vetch (*Lathyrus sativus*).—A good stand was obtained, but the climate is entirely too hot and dry in Nebraska for this legume.

Flat pea (*Lathyrus sylvestris wagneri*).—A strong growing perennial which has given excellent results at several experiment stations in the arid regions. The plant seems to be very resistant to drought, but those who have tried it report that it is not palatable to stock and that they have been unable to utilize it as a forage plant.

Leptochloa dubia.—A grass of the Southwestern States which is not adapted to the Nebraska climate.

Japan clover (*Lespedeza striata*).—An annual legume, but not resembling clover very closely. It is frequently grown in the Southern States but is not hardy in Nebraska.

Perennial rye-grass, *English rye-grass* (*Lolium perenne*).—A well-known cultivated grass in England and other European countries. In the United States it has been cultivated for many years. On the station plot there was a good stand produced, but the grass was soon run out by other plants.

The Italian rye-grass (*Lolium italicum*) was not tried at the station, but its characters are similar to those of perennial rye-grass. Both are short-lived perennials and are not well suited to permanent pasture. Where the climate is adapted to their growth, they have the advantage of giving an abundant early growth, for which reason they are to be recommended for mixtures, as they give a luxuriant growth the first season and then give way to the other grasses. The climate of Nebraska is too dry for successful results with these grasses.

Lupines (*Lupinus spp.*).—None of the lupines has given satisfactory results in America.

Bur clover (*Medicago denticulata*).—An annual clover, frequently grown for winter forage in the Southern States, but not suited to Nebraska conditions. The station plot produced a thin stand and unsatisfactory growth.

Melica altissima.—A fair stand was obtained, but it soon disappeared.

White sweet clover or *Bokhara clover* (*Melilotus albus*).—An excellent legume for renovating clay lands, and fairly drought resistant. The great objection to its use as a forage plant in the West has been the fact that stock will not eat the plant. However, it is not infrequently reported that it has been fed to stock with success. The foliage contains a bitter substance which is disagreeble to animals, and it seems necessary that the taste for the plant be acquired. It is reported by some that if stock are turned into a field early in the spring such a taste is easily acquired. The plant has not been sufficiently tested in Nebraska. Besides its possible forage value it is an excellent bee plant.

Velvet bean (*Mucuna utilis*).—An annual legume which forms long trailing vines, and is much used in Florida for a green fertilizer and as a forage plant. It has been recommended for growing much farther north; but though it produces a good growth of vine it is less valuable than the cowpea for the same purpose. This has not been tested at the Nebraska Station.

Sainfoin (*Onobrychis sativa*).—A legume cultivated in Europe and advertised by most seedsmen in this country. The results of the trials in Nebraska are too unsatisfactory to recommend it for use in that State. In fact, there has been little success with this plant anywhere in this country.

Panicum bulbosum.—A native hay grass of Texas, and quite promising for cultivation in the Southwest, but Nebraska is evidently too far north for its successful growth.

Pearl millet or *penicillaria* (*Pennisetum spicatum*).—A coarse annual forage plant, resembling sorghum. Some extravagant claims have been made for this plant, but though it has much to recommend it in the Southern States, in Nebraska it is inferior to sorghum. At the station, in 1903, it made a large growth of forage, but it was not of great food value. For a full account of pearl millet the reader is referred to Farmers' Bulletin No. 168, U. S. Department of Agriculture.

Poa lævigata.—Three years' trials show that this grass would be excellent for pasture, but does not grow tall enough for hay. It showed great drought resistance during the dry period in 1901.

Sacaline (*Polygonum sachalinense*).—This plant, which resembles a large smartweed, has been occasionally advertised by seedsmen, but it has no value as a forage plant in Nebraska.

Burnet (*Poterium sanguisorba*).—A plant belonging to the rose family and used in Europe for pasture, for which purpose it has been recommended in this country. The trials at the Nebraska Station show that the plant gave a fair stand and is able to resist the winter, and also seems fairly drought resistant. Nevertheless, its good qualities are not sufficiently marked to warrant its being recommended for Nebraska. The trials at other stations have resulted much the same. For ordinary pasture purposes the growth is not sufficiently rank nor is the foliage as palatable to cattle as are the grasses. It may have a place as a constituent in sheep pasture upon sterile sandy or rocky soil in the Northeastern States, but in Nebraska it is not likely to be of much value.

Slough-grass (*Spartina cynosuroides*).—A native grass, common in sloughs and marshes, that furnishes considerable coarse hay when mowed early. The grass is commonly used for thatching sheds and for topping haystacks. In the trials at the Nebraska Station the seed failed to germinate.

Giant spurry (*Spergula maxima*).—This annual plant has some value for forage upon sandy land, but it is scarcely drought resistant enough for Nebraska.

Sporobolus cryptandrus.—A grass especially adapted to sandy soils, and one of the common native grasses of the Sand Hill region. It furnishes valuable grazing when young, but becomes dry and coarse by middle summer. At the Nebraska Station the seed did not germinate.

Saccaton (*Sporobolus wrightii*).—An important native forage grass of the Southwest, but not hardy as far north as Nebraska. There was no germination on the station plot.

Crimson clover (*Trifolium incarnatum*).—An excellent annual clover for the middle South, but not hardy in Nebraska.

The following plants were sown, but gave negative results, because the seed failed to germinate or gave only a thin or scattering stand:

Agropyron dasystachyum.
Agropyron dasystachyum subvillosum.
Agropyron riparium.
Agropyron vaseyi.
Agrostis exarata.
Alopecurus occidentalis.
Atriplex holocarpa.
Atriplex nuttalli.
Atriplex pabularis.
Beckmannia erucaeformis.
Bouteloua polystachya.
Bromus kalmi.
Bromus vulgaris.
Bromus richardsoni.
Bromus richardsoni pallidus.
Calamagrostis hyperborea americana.
Dactyloctenium australense.
Deschampsia cæspitosa.
Eleusine coracana.
Elymus ambiguus.
Elymus condensatus.
Elymus glaucus.
Elymus macouni.
Elymus simplex.
Muhlenbergia gracilis.
Panicularia americana.
Panicularia nervata.
Panicum obtusum.
Phleum alpinum.
Poa fendleriana.
Poa læviculmis.
Poa lucida.
Poa macrantha.
Poa nevadensis.
Poa pratensis var. (Washington bluegrass.)
Poa wheeleri.
Polypogon monspeliense.
Puccinellia airoides.
Triodia mutica.
Trifolium involucratum.

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DESCRIPTION OF PLATES.

PLATE I. *Frontispiece.* Grass garden at the Nebraska Experiment Station. The forage plants are first tested on these plots, which are 3 feet square. Those which give favorable results are given a further trial on larger plots, some of which are seen in the background.

PLATE II. An alfalfa plant from seed sown August 19, 1902, and dug up April 13, 1903, showing the tubercles upon its roots by means of which nitrogen is gathered from the air.

PLATE III. Fig. 1.—Three plants of brome-grass (*Bromus inermis*) from seed sown August 19, September 19, and October 1, 1902, respectively. They were taken up and photographed April 13, 1903. The plant at the right from the last sowing had barely enough vitality to survive the winter. Fig. 2.—Three alfalfa plants from seed sown at the same date as the brome-grass, and also taken up and photographed April 13, 1903. A later sowing, October 21, was almost entirely winter killed, as the young plants had not sufficient vitality to withstand the cold.

PLATE IV. Fig. 1.—Plots of *Bromus inermis* showing the effect of fertilizers. The plot at the left is a mixture of brome-grass and alfalfa; the plot at the right is brome-grass fertilized with sodium nitrate; the plot in the center is brome-grass alone and unfertilized. The effect of an admixture of alfalfa is about the same as an application of sodium nitrate. This seems to indicate that the brome-grass is able to share with the alfalfa the nitrogen which the latter obtains from the air. The plots were sown April 21, 1899, and photographed June 12, 1903. Fig. 2.—A pasture containing orchard grass, showing the growth of this grass upon low land. The pasture was seeded in 1898 with several grasses, among which was orchard grass, but in this part of the field the latter was especially rank. The photograph was taken in June, 1901.

PLATE V. Fig 1.—A field of brome-grass sown in the spring of 1898 and broken in the fall of 1901. The picture was taken in January, 1902. Brome-grass forms a thick, firm sod, resembling that of native prairie. Fig. 2.—A field of brome-grass. The seed was sown in the spring of 1902, and the picture was taken June 15, 1903.

PLATE VI. Fig. 1.—A field of side-oats grama (*Bouteloua curtipendula*) just before ripening. The seed was sown in the spring of 1900, and the photograph taken July 17, 1902. Fig. 2.—A field of wild rye (*Elymus canadensis*). The seed was sown in the spring of 1901, and the photograph taken July 17, 1902.

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ALFALFA, SHOWING NITROGEN-GATHERING TUBERCLES.

FIG. 1.—BROME-GRASS PLANTED IN THE AUTUMN.

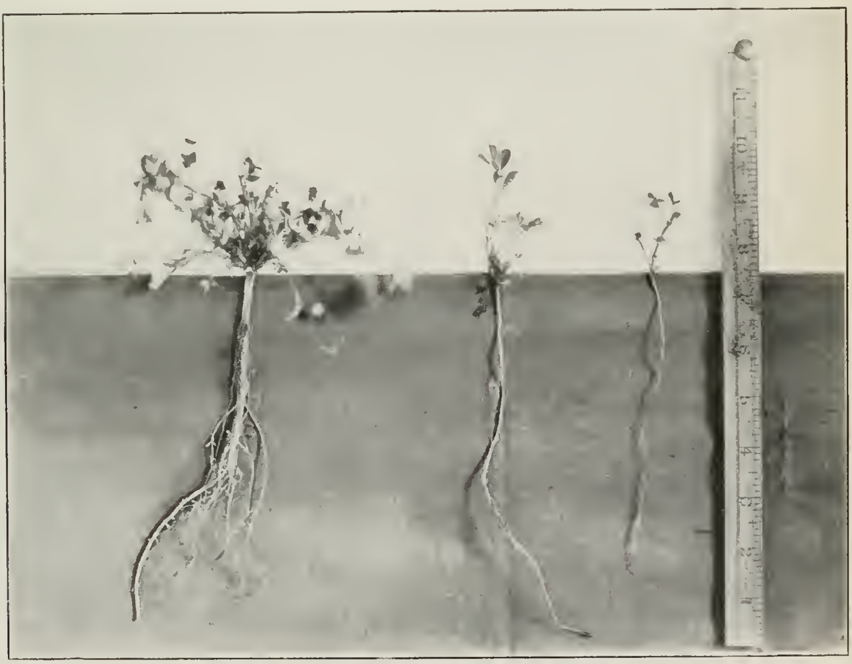

FIG 2.—ALFALFA PLANTED IN THE AUTUMN.

FIG. 1.—BROME-GRASS, FERTILIZED AND UNFERTILIZED.

FIG. 2.—FIELD OF ORCHARD GRASS.

FIG. 1.—BROME-GRASS. NEWLY TURNED SOD.

FIG. 2.—BROME-GRASS. A HAY FIELD.

FIG. 1.—SIDE-OATS GRAMA, GROWN FROM SEED.

FIG. 2.—ELYMUS CANADENSIS, GROWN FROM SEED.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 60.

B. T. GALLOWAY, *Chief of Bureau.*

A SOFT ROT OF THE CALLA LILY.

BY

C. O. TOWNSEND, Pathologist.

VEGETABLE PATHOLOGICAL AND PHYSIOLOGICAL INVESTIGATIONS.

Issued June 30, 1904.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1904.

BULLETINS OF THE BUREAU OF PLANT INDUSTRY.

The Bureau of Plant Industry, which was organized July 1, 1901, includes Vegetable Pathological and Physiological Investigations, Botanical Investigations and Experiments, Grass and Forage Plant Investigations, Pomological Investigations, and Experimental Gardens and Grounds, all of which were formerly separate Divisions, and also Seed and Plant Introduction and Distribution, the Arlington Experimental Farm, Tea Culture Investigations, and Domestic Sugar Investigations.

Beginning with the date of organization of the Bureau, the several series of Bulletins of the various Divisions were discontinued, and all are now published as one series of the Bureau. A list of the Bulletins issued in the present series follows.

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[Continued on page 3 of cover.]

THIRD CROP OF HEALTHY CALLAS GROWN IN THE SAME SOIL ACCORDING TO METHODS ADVOCATED IN THIS BULLETIN.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 60.

B. T. GALLOWAY, *Chief of Bureau.*

A SOFT ROT OF THE CALLA LILY.

BY

C. O. TOWNSEND, PATHOLOGIST.

VEGETABLE PATHOLOGICAL AND PHYSIOLOGICAL INVESTIGATIONS.

ISSUED JUNE 30, 1904.

WASHINGTON:
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BUREAU OF PLANT INDUSTRY.

B. T. GALLOWAY, *Chief.*

J. E. ROCKWELL, *Editor.*

VEGETABLE PATHOLOGICAL AND PHYSIOLOGICAL INVESTIGATIONS.

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GEORGE T. MOORE, *Physiologist in Charge of Laboratory of Plant Physiology.*
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FLORENCE HEDGES, *Scientific Assistant, Bacteriology.*
CHARLES J. BRAND, *Scientific Assistant in Physiology, Plant Life History.*

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[a] Detailed to the Bureau of Forestry.
[b] Detailed to Botanical Investigations and Experiments.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., March 31, 1904.

Sir: I have the honor to transmit herewith the manuscript of a technical paper submitted by the Pathologist and Physiologist on "A Soft Rot of the Calla Lily," by Dr. C. O. Townsend, Pathologist, Vegetable Pathological and Physiological Investigations, and recommend its publication as Bulletin No. 60 of the series of this Bureau. The accompanying nine plates and seven figures are necessary to a clear understanding of the subject-matter of the text.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

PREFACE.

Growers of the calla lily have suffered serious losses for several years from a soft rot which frequently destroys the plants just before or during the flowering period. A bacillus has been separated from the decayed portion of the calla in pure cultures and by repeated inoculations has been shown to be the cause of this destructive disease.

In addition to the principal morphological and physiological characters of the organism which are described in this bulletin, several preventive measures are suggested which have been found to be satisfactory in holding the disease under control. As the bacillus producing this disease is also capable of attacking many of our food plants, growers of vegetables should guard against any possible contamination of the soil with it.

A. F. WOODS,
Pathologist and Physiologist.

OFFICE OF VEGETABLE PATHOLOGICAL
AND PHYSIOLOGICAL INVESTIGATIONS,
Washington, D. C., March 30, 1904.

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A SOFT ROT OF THE CALLA LILY.

INTRODUCTION.

Under favorable conditions the calla lily has heretofore been one of the most satisfactory plants produced either in the open or under glass. In most parts of the United States the calla will grow out of doors and will live and thrive from year to year even in the northern latitudes, especially if the corms[a] are protected during the winter season. As a marketable product, however, it is more profitable if grown under glass, where under proper conditions the plants may be forced and the flowers consequently produced in great abundance at the time when they will be in greatest demand. It is under these conditions of forced growth that the plants seem to be most susceptible to disease.

The profits which arise from calla growing are derived either from the sale of the corms or of the flowers, or from both. A bed of a thousand corms, for example, will under normal conditions produce 5,000 flowers, which ordinarily will sell for about $1,000. The corms are grown either in solid beds or in pots. As a rule the best results both as regards the size and the number of flowers produced are obtained from the solid bed. The flowers are always delicate and can not be satisfactorily shipped long distances, while the corms, on the other hand, may be transported for thousands of miles without injury.

There are several diseases to which the calla is susceptible, but the most serious one with which the growers have had to contend is the soft rot that forms the subject of this bulletin. This disease has recently made its appearance in the various parts of the United States where callas are cultivated and has caused enormous losses to the growers, rendering the production of this hitherto profitable plant very uncertain.

The soft rot of the calla was brought to the attention of the writer in the autumn of 1899, and it has been under his observation and study since that time. While there are some points that need further

[a] The true botanical name *corm* is used in this bulletin instead of the common but incorrect term *bulb*.

investigation, it has been deemed best to place the following results before the public, with the hope that the suggestions herein contained may be of value to the industry.

CAUSE OF THE CALLA ROT.

Upon examining microscopically the decayed portions of the calla corms myriads of bacteria were found to be present. In order to obtain cultures of the organism in the best possible condition a partly decayed corm was thoroughly washed with tap water, then with corrosive sublimate (1 part in 1,000), and afterwards with distilled water. A small opening was then made with a sterile knife through the sound part of the corm into the inner marginal part of the decayed spot. A little of the soft tissue just at the border between the decayed and healthy portions of the corm was obtained on a sterile needle and placed in sterile beef broth. Agar plates were then made from this culture, and but one kind of colony was obtained, indicating that the organism was present in the recently decayed portion of the corm in a pure culture. A few days after the colonies had formed, subcultures were made in beef broth and minute portions of these were introduced into various parts of healthy callas. The inoculations were made by placing a drop of the beef-broth culture on the part of the plant to be inoculated, and with a sterile needle punctures were made through these drops into the tissues of the plants. For control, punctures were made in similar parts of healthy plants without adding the broth culture. In a few days the inoculated spots had turned brown and decay had begun, while the controls in all cases remained healthy. Plate cultures were again made from the inoculated spots after decay had begun, and apparently the same organism in pure culture was obtained. This process was repeated many times—i. e., until there was no doubt that this organism was the cause of the soft rot of the calla.

Upon looking up the literature regarding calla diseases it was found that Halsted had discovered a soft rot of the calla corm in 1893.[a] Although Halsted's description is very brief, he undoubtedly refers to the same disease as that which forms the subject of this bulletin. He ascribes the cause of the affection to a bacterium which is found in great abundance in the diseased portions of the corm. A disease of similar nature is also mentioned by Selby.[b] This is referred to as a root rot of the calla, and as no description is given either of the disease or of the organism producing it, it is impossible to determine whether this is the disease now under consideration. The soft rot of the calla and the organism producing it have been observed by Dr. Erwin F. Smith, the pathologist in charge of the laboratory of plant pathology of the United States Department of Agriculture, and by Mr.

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[a] Diseases of Calla. New Jersey Experiment Station Report for 1893, p. 399.

[b] Selby. Calla. In Condensed Handbook of Diseases of Plants in Ohio, 1900, p. 21.

Newton B. Pierce, the pathologist in charge of the Pacific coast laboratory of the Department, and probably by others, but so far as can be determined it has not hitherto received careful investigation.

GENERAL APPEARANCE OF THE DISEASE.

Several greenhouses where the disease was reported to be present were visited by the writer, who found the callas rotting off usually at or just below the surface of the ground, the disease sometimes extending down into the corm, sometimes upward into the leaves, and frequently in both directions. Occasionally the disease seemed to start in the edge of the leafstalk (fig. 1), in the flower stalk, or in some underground part of the corm, though as a rule it started at the top of the corm just above but near the surface of the ground. It was also noticed that the disease was worse and spread more rapidly in those houses where the callas were grown in solid beds.

Fig. 1.—A slightly diseased calla plant.

When a diseased corm was cut open it was found that there was a distinct line between the healthy and the diseased portion of the corm (fig. 2). The healthy portion of the corm is firm and nearly white, while the diseased part has a decidedly brown color and is soft and watery. When the disease extends upward into the leaves it is the edge of the petiole that first becomes involved, the affected part becoming slimy without immediately losing its green color. As the disease progresses it extends inward toward the center of the petiole and interferes with the transference of material between the corm and the leaf, the edges of the leaf becoming pale, then brown. Pale spots becoming brown then appear in other parts of the leaf blade, and finally the whole leaf becomes brown and dead. Frequently the disease develops so rapidly that the leaf rots off at the base and falls over before it has time to lose its green color. When the disease has progressed far enough to attack the flower stalk, the flower turns brown and the stalk, without having lost its color and frequently without having decayed upward more than a fraction of an inch, eventually falls over. When the disease works downward through the corm it sooner or later reaches the roots, which become soft and slimy within, while the epidermis remains intact, thus presenting the appearance of thin-walled tubes filled with a soft substance. The roots remain attached to the corm and eventually the slimy contents dry up and only the dead skin of the roots remains. When the disease begins its attack below the surface of the ground the lower portion of the corm frequently rots away, causing the plant to fall over without having previously given any indication of disease. An examination of the decayed corm shows that only a small part of the upper portion of the corm, with a few side roots, remains. The

FIG. 2.—A partly decayed calla corm.

latter become less and less numerous as the disease advances, until at last they are unable to support the weight of the leaves and flower stalks.

If the conditions for the development of the disease are unfavorable after the corms are affected, the softened spots will dry down, sinking below the surrounding portion of the corm and becoming darker colored. In these spots the disease will often remain dormant until the conditions for the development of the organism again become favorable. In this way the disease is carried over from season to season, and it may be transported long distances.

EFFECT OF THE ORGANISM ON THE CALLA.

As already stated, the part of the plant usually attacked first is the upper portion of the corm at or just below the surface of the ground. A microscopic examination of the affected part, whether root, corm, leafstalk, or flower stalk, shows that the organisms occupy the intercellular spaces and by some means dissolve the intercellular layer, causing the cells to separate easily, so that when the diseased tissue is placed in a liquid each cell floats out by itself. The cell wall, however, remains intact, but the cell contents are contracted. The rapidity with which the disease advances depends to a large extent upon the external conditions surrounding the plants. Under favorable conditions—a warm

Fig. 3.—Calla leaf twenty-two hours after inoculating with the calla organism. The point of inoculation is shown by X.

Fig. 4.—Calla flower stalk twenty-two hours after inoculating with the calla organism. The point of inoculation is shown by X.

atmosphere and an abundance of moisture—the disease may completely rot the corm in from three to four days, while under less favorable conditions it may be several weeks in destroying the corm, or, indeed, the progress of the disease may be entirely arrested for a period of several months. While the organism usually attacks the corm first, it may also attack either the leafstalk or the flower stalk and cause it to become discolored and decayed. (See figs. 3 and 4.)

MORPHOLOGICAL CHARACTERS OF THE ORGANISM.

The organism which causes the rotting of the calla corm is a very short rod, with rounded ends, as shown in figure 5, and also in Plate II, figure 1. The width of the rods is very nearly uniform.

In a 24-hour-old beef-broth culture they measure about 0.5μ in width. In the same culture the length varies from 2μ to 3μ. The very short ones, as shown by the measurements, are round, or nearly so; these eventually elongate, becoming rods. After the organisms have elongated, cross walls are formed and as a rule they soon break in two, forming separate organisms; but occasionally they remain intact until a long chain is formed, which may finally break up into individual cells (Pl. II, fig. 1). This organism moves with a gliding motion, and upon staining for flagella it is found to possess from two to eight wavy flagella scattered over the surface of the body (Pl. II, fig. 1). The flagella vary in length from 4μ to 18μ, i. e., two to six times the average length of the body. No spores belonging to this organism have been found in any of the artificial cultures or in the diseased plants.

FIG. 5.—*Bacillus aroideæ* with flagella × about 600.

PHYSIOLOGICAL CHARACTERS OF THE ORGANISM.

Certain physiological characters of the organism have been determined by growing it on different media and under various conditions of light, heat, etc., as described in the following pages.

NUTRIENT MEDIA.

In studying the physiology of this organism the following media have been used, viz, beef broth, agar, gelatin, Uschinsky's solution, Dunham's peptone solution, peptone water with rosolic acid, peptone water with methylene blue, simple peptone water,[a] milk, litmus milk, indigo-carmine peptone, and egg albumen. All these culture media were carefully prepared. The beef-broth stock was made from lean beef, the chemicals were "c. p.," and only distilled water was used. In addition to these media the following vegetables and fruits were used, viz, potatoes, onions, turnips, celery, cucumbers, peppers (green fruits), pieplant, beets, radishes, cauliflower, cabbage, eggplant, tomatoes, salsify, carrots, parsnips, apples, pineapples, and bananas.

In nearly all cases both the fruits and vegetables were used raw, but in some instances the vegetables were cooked. Usually the raw fruits and vegetables were sterilized by removing the outer layer with a sterile knife and washing thoroughly with corrosive sublimate (1 part in 1,000) and then with sterile water. They were then cut in thick slices and placed in deep petri dishes and inoculated with one or more loops of a 24-hour beef-broth culture of the organism. When the vegetables were cooked they were cut into cylinders and placed in test tubes with distilled water, then thoroughly sterilized, and when cool inoculated with fresh cultures of the organism.

[a] Witte's *Peptonum siccum* was the only peptone used.

Beef-broth.—Ten cubic centimeters of standard beef broth inoculated with a 1-mm. loop of a fresh culture fluid of the organism was distinctly clouded in from four to eighteen hours at a temperature of 35° to 18° C. If the temperature was raised or lowered through several degrees above or below the limits indicated or if the inoculation was made from a less active culture, the clouding took place less rapidly. Indeed, the clouding was delayed indefinitely by lowering the temperature to 5° C. or by raising the temperature to 41° C. If the beef broth was kept at room temperature (18° to 24° C.) the organism remained alive for several weeks and a nearly white deposit several millimeters in depth formed in the bottom of the tube.

Agar plate cultures.—On the ordinary nutrient agar poured plates made from a 24-hour-old beef-broth culture colonies were distinctly visible in twenty-four hours at room temperatures of 18° to 20° C., and plates made in the same way and kept at 30° to 35° C. showed colonies distinctly in from fifteen to eighteen hours. The form and size of the colonies on the agar plates depended upon certain conditions—e. g., if the colonies were numerous they were small and round, while if there were but few colonies in each plate they were sometimes round and sometimes radiating. They were usually radiating if the plates were made from fresh cultures and kept at a temperature of from 22° to 35° C. On the other hand, if the plates were made from an old culture or if they were kept at an abnormally high or an abnormally low temperature the colonies were round, even if there were but few in each plate. Agar plate cultures made from Uschinsky's solution or broth cultures that had been kept dormant for several months produced round colonies, but after a few transfers from the dormant state to fresh media the agar plate cultures became characteristically radiating (Pl. II, figs. 2, 3, 4, and 5, and Pl. III, fig. 1).

The foregoing applies to the surface colonies, but in addition to these there were some embedded colonies in practically all poured plates. The embedded colonies were all spindle shaped unless viewed end on, when they appeared to be round, with sharp, distinct outlines. They had a faint yellow tinge, and were much smaller than the surface colonies. If the embedded colonies broke through the surface, they spread out and behaved in the same manner as if they had been originally surface colonies. (See the small colonies on Pl. II, figs. 2 and 5.) Some of the colonies lying at the extreme bottom of the agar—i. e., between the agar and the bottom of the petri dish—spread out, forming a thin layer which eventually gave to the plate a milky appearance when held up to the light. (See Pl. II, fig. 2, and Pl. III, fig. 2.) The surface colonies, whether round or radiating, had a shiny white surface and were only slightly opalescent. If radiating, they usually had a central body, from which the branches radiated (Pl. III, fig. 1). The central body was more dense than the arms or branches and the whole colony was slightly elevated above the surface of the agar. The outlines were sharp and when magnified 125 times the 48-hour-old colonies had a granular appearance.

Agar streak cultures.—In addition to beef broth, peptone, etc., some of the agar tubes contained 5 per cent of grape sugar and others contained 5 per cent of glycerin. These were slanted and inoculated by dipping a sterilized needle in a 24-hour-old beef-broth culture and drawing it lightly over the surface of the slant agar. Streaks became distinctly visible in twenty-four hours at 20° to 25° C. in all the tubes inoculated. The outlines of the streaks were entire at first, but became more or less irregular in from two to four days at 18° to 25° C. Growth was elevated above the surface of the agar and had a shiny appearance, as if wet. It was of a white or grayish-white color and did not discolor the agar nor tend to grow into it. The condensation water became distinctly milky and more or less deposit was formed in it. On the other agars the organism remained alive for several months at room temperatures (20° to 25° C.) if the culture was not allowed to become dry.

Agar stab cultures.—At room temperatures (20° to 25° C.) growth was apparent in from eighteen to twenty-four hours near the top of the stab, and within twenty-eight hours it was distinctly visible throughout the entire length of the stab. The stab increased in size from day to day and in a week was from 1 to 2 mm. in diameter, slightly tapering toward the bottom. The "nail head" gradually increased in size and in from three to five days covered the surface of the agar in the tube. This growth was slightly elevated, grayish-white, with a wet, shining surface and an entire margin. It was thicker in the center, forming a convex layer on the agar. Growth continued for several weeks, with no change in the color of the agar and no change in the stab or line of growth except that it gradually increased in size, retaining its tapering form and its slightly serrate outline with no elongated projections into the agar.

Beef agar, with iron sulphate.—Several slant tubes containing 10 c. c. of nutrient agar plus 1 drop of a saturated solution of ferrous sulphate, and several slant tubes containing 10 c. c. of nutrient agar plus 2 drops of the iron sulphate solution, were inoculated with a fresh culture of the calla organism, while several tubes of each were left for control. In forty-eight hours the organism had spread over the surface of the agar in all inoculated tubes and the inoculated surfaces showed a copious growth for several weeks, but no change was produced in the color of the medium.

Gelatin stab cultures.—These cultures were made with gelatin of different kinds. The first was −10 on Fuller's scale, the second was neutralized with sodium hydroxid, while the third was the same as the second except that another kind of gelatin was used. Growth was apparent within twenty-four hours (at 18° to 22° C.) in all the tubes inoculated. At the end of twenty-four hours the stabs were distinctly visible throughout their entire length in all the inoculated tubes (Pl. IV, fig. 1, A). In forty-eight hours from the time of inoculation the gelatin in all the tubes began to liquefy (Pl. IV, fig. 1, B). Liquefaction advanced most rapidly in No. 3 and least rapidly in No. 1. In three days No. 3 had entirely liquefied, and in five days No. 1 and No. 2 had also liquefied (Pl. IV, fig. 1, C). After the gelatin had liquefied a cloudy mass floated about in the clear liquid. This finally settled, forming a copious white deposit. The deposit was most abundant in No. 3, but in No. 1 it formed a layer from 2 to 5 mm. deep.

Egg albumen.—Several tubes of solidified egg albumen were inoculated with a fresh culture of the organism, but only a feeble growth appeared and no change had been produced in the color of the albumen at the end of eight weeks.

Milk.—This medium was sterilized by heating for ten minutes at 100° C. in a steam sterilizer on three successive days, the milk having been previously placed in test tubes (10 c. c. in each tube), and the tubes closed with cotton plugs. The milk was inoculated by placing a 1-mm. loop of a 24-hour-old beef-broth culture in each of several of the tubes. The curdling of the milk began to take place in from two to three days in all parts of the inoculated tubes. Two days later the entire 10 c. c. of milk was solidified and a layer of whey about 1 mm. deep rested upon the top of the curd. These experiments were repeated from time to time, with the same results. Whey continued to be separated for several days until from one-third to one-half the space formerly occupied by the milk was occupied by the liquid; but no abnormal coloring was produced in any of the tubes. None of the control tubes curdled in any case.

Litmus milk.—This medium was prepared in the same manner as the milk, except that a few drops of strong litmus solution were added to each tube of milk before sterilizing. Several of the tubes were inoculated with a 1-mm. loop of a 24-hour-old beef-broth culture. Within forty-eight hours the blue began to give way to a reddish color near the surface, which within three days had extended throughout the inoculated tube. At the end of five days from the time of inoculation the red color had decidedly faded throughout, so that the tubes that were litmus blue when inoculated were now only faintly pink, and the milk had curdled throughout. The curdling of the milk and the separation of the whey took place in the same manner as if the litmus had not been present. In nine days even the pink color had disappeared, with the exception of a faint rim near the surface. These discolored litmus tubes were then allowed to stand until the organism had died. The red litmus color, eventually becoming blue, gradually returned, although the milk remained curdled and the whey separated—about one-half whey and one-half curd.

Litmus milk in nitrogen.—It was noticed that the litmus milk tubes, whether they had been inoculated or not, contained a deposit of blue litmus. The calla organism that bleached the litmus in the milk failed to attack this deposit, so that it remained blue. It was suggested that the milk possibly contained an anaerobic bacterium that was not destroyed by sterilizing and that it favored the formation of the blue deposit. The two control tubes of litmus milk were placed in a bottle holding about a quart. The bottom of the bottle was covered with pyrogallic acid (powder) to a depth of about one-half inch. To this 50 c. c. of a 10 per cent solution of caustic potash were added, and the bottle was quickly sealed with Darwin's wax. The mixture was shaken for some time to enable it to take up the oxygen without forming much carbon monoxid. If the deposit were due to an anaerobic bacterium, it should increase farther up in the tubes. At the expiration of twelve months the jar was opened. A lighted match thrust just below the level of the opening in the jar was immediately extinguished, showing that the jar still contained nitrogen and had not allowed oxygen to enter during this time. An examination of the tubes showed that the blue deposit had not changed. This indicated that the deposit was undoubtedly a mechanical one and was not due to the presence of an organism. The inoculated tubes that were left in the ordinary air gradually regained their blue color after the organism died. The return of the color (first red, then blue) was apparent whether the organisms were left to die of their own accord or whether they were destroyed by heating; e. g., if an inoculated litmus tube had entirely faded and was then heated for ten minutes at 100° C., the color returned within twenty-four hours.

Uschinsky's solution.—Several tubes of Uschinsky's solution were inoculated with a 1-mm. loop of a 24-hour-old beef-broth culture. Seventeen hours later at 25° C. all inoculated tubes were slightly clouded. Thirty-six hours after inoculation the tubes were decidedly clouded throughout, with a slight whitish deposit in some of them. The cloudiness was not uniform in all parts of the same tube, but was somewhat stratified. Both the cloudiness and the deposit increased from day to day, until at the end of one week the solution was uniformly clouded, milk-white, with a copious white deposit in the bottom of the tube. Even at the end of three months at normal room temperatures the organism was still alive, as indicated by the fact that the tubes were still clouded and a 1-mm. loop placed in beef-broth caused a distinct clouding in twenty-four hours. At this time the precipitate was 3 mm. deep. Plating and inoculating into callas showed it to be the calla organism. This experiment was repeated several times with identical results both in regard to the clouding of the Uschinsky solution and the longevity of the organism in this medium.

Dunham's solution.—Several tubes of Dunham's solution were inoculated with a 1-mm. loop of a 24-hour-old culture of the calla-rot organism in beef broth. In twenty-four hours at 20° C. a faint cloudiness was perceptible. This increased slightly from day to day for about six days. The temperature during this time ranged from 18° to 25° C. The cloudiness then seemed to remain practically constant for about one week. A deposit was gradually formed, and in one month from the time of inoculation the solution became almost clear, showing that the organism had ceased to live. The deposit formed was about 1 mm. in depth and had a faint brownish tinge.

Dunham's solution, with acid fuchsin.—This solution was inoculated the same as above. At the end of one week the solution in the inoculated tubes was lighter colored than in the control tubes. At the end of one month after inoculation the bleaching seemed to have ceased. The organisms were nearly all dead, as indicated by the fact that the liquid was practically clear. While the solution in the inoculated tubes was somewhat pinkish in color, it was decidedly lighter than the solution in the control tubes. The deposit was the same in color and in quantity as in the Dunham solution given above.

Dunham's solution, with indigo-carmine.—Sterile tubes of this solution were inoculated in the same manner as the Dunham's solution. In two days the inoculated tubes were slightly blue when seen by reflected light. This color deepened from day to day for about one week, after which time it remained practically constant. The inoculated tubes were only slightly clouded at the end of two weeks, and a small quantity of deposit with a faint brownish tinge had formed in the bottom of the inoculated tubes.

Peptone solution, with rosolic acid.—A nutrient solution containing rosolic acid was inoculated with a 1-mm. loop from a 24-hour-old beef-broth culture, and at the end of one week the solution had a milky appearance, due to the presence of a large number of organisms. Ten days later there was no change, except the formation of a small amount of white deposit. At the end of thirty days after inoculation the tubes were still slightly clouded, but no change in color was apparent. The deposit had increased and had assumed a faint brownish tinge.

Dunham's solution, with methylene blue.—Two preparations containing peptone and methylene blue were used. The first consisted of a 1 per cent solution of Witte's peptone, to which was added 0.5 per cent c. p. sodium chlorid and 3 c. c. of a 1 per cent aqueous solution of methylene blue. Sterile tubes of the solution were inoculated with pure 24-hour-old beef-broth cultures of the calla-rot germ. These inoculated tubes were compared with the controls for two months subsequent to inoculation, but no change in color could be detected.

The second preparation was the same as the first, except that it contained 1 per cent of grape sugar. Three days after inoculation there was no apparent change in color, but at the end of five days the inoculated tubes had a greenish tinge. This became more distinct from day to day for several weeks, and at the end of two months the inoculated tubes were entirely green, while the control tubes remained blue. The blue color of the inoculated tubes was not restored upon shaking.

Steamed potato cylinders.—Potato cylinders were sterlized by steaming on three consecutive days in the sterilizer. Some of these were inoculated with a 1-mm. loop of a 24-hour-old culture of the calla-rot organism in beef broth. Twenty-four hours after inoculation the organism had spread over about two-thirds of the slant surface of the inoculated cylinders. The rate of growth was slow as compared with that on other media. The surface of the growth had a shiny appearance and a faint tinge of yellow which corresponded very closely to Ridgway's Cream Color, No. 20, Plate VI, or Saccardo's Cremeus, No. 27, Table II. The inoculated cylinders began to turn gray toward the inoculated ends. Even in twenty-four hours the discoloration extended from one-third to two-thirds of the length of the cylinders. The color deepened from day to day until at the end of two weeks the upper ends of the cylinders were distinctly brown, the color fading into a gray toward the lower ends of the cylinders. All the many inoculated cylinders retained their shape, and the control cylinders remained firm and white throughout the experiment.

In testing the potato cylinders for starch the reaction was immediate in both the inoculated and the control cylinders and the color was nearly the same, but less purple and more blue in the control than in the inoculated tubes. These tests were made at the end of the second week and later. The odor of the inoculated cylinders at the end of two weeks was sour and disagreeable, resembling spoiled paste.

Raw potato.—A fairly smooth potato was selected and thoroughly washed with tap water to remove the surface dirt. It was then washed with distilled water and the surface was sterilized with a solution of corrosive sublimate (1 part in 1,000), after which it was rinsed with sterile water. It was then cut with a sterilized knife into slices about 2 cm. in thickness. Each slice was divided into four parts and placed in a deep sterilized petri dish. Several petri dishes were prepared in this manner. Two of the pieces in each were inoculated with a 24-hour-old beef-broth culture of the calla organism by placing several drops of the beef-broth culture on the surface of the pieces and then stabbing through these drops into the potato with a sterile needle. Two pieces were left for control. In twenty-four hours the inoculated and control pieces showed a slight discoloration owing to the action of the air, but only the inoculated pieces decayed.

At the end of five days the decayed portions closely resembled Ridgway's Broccoli Brown, No. 15, Plate III. It was not quite as dark as Saccardo's Umbrinus, No. 9, Table I. The inoculated pieces had the odor of decaying vegetables and were alkaline to litmus.

Raw eggplant.—A ripe fruit of the eggplant was obtained from the market, the surface was washed and sterilized as described above, and it was then cut with a sterile knife into slices of thickness suitable for placing in petri dishes. In some instances the slices were pared with a sterile knife so as to remove the outside skin, and in other cases the skin was left on. All slices were cut into four pieces, two of which were inoculated with a 24-hour-old culture of the germ in beef broth and two were left for control. Within eighteen hours at from 20° to 24° C. the inoculated pieces were discolored, and in forty-eight hours the discoloration had extended entirely through them. In three days some of the inoculated pieces were somewhat split and shrunken, as shown in Plate IV, figure 2. In color the interior—i. e., the part that was the center of the fruit—was Broccoli Brown, No. 15, Plate III, of Ridgway's tables, a little lighter than Saccardo's Umbrinus No. 9, Table I. The portion toward the margin was nearly Clove Brown, No. 2, Plate III, Ridgway's tables, or a little darker than Saccardo's Castaneus, No. 10, Table I. There was no sharp line between these two shades of brown, but one graded into the other. The inoculated pieces at the end of three days had a decidedly soapy odor and the reaction was alkaline to litmus. The checks remained perfectly sound.

Raw cauliflower.—A large head of cauliflower that had been three weeks in cold storage was obtained from the market. A portion of the main stalk was thoroughly washed with corrosive sublimate, and then with sterile water. With a sterile knife the outside was pared off and the remaining part was then cut into slices that could be conveniently placed in petri dishes. These were then inoculated with the calla-rot germ from a pure culture in beef broth, leaving a number of pieces for control. The culture used in this case was three days old. In twenty hours at 20° to 24° C. the inoculated pieces began to show a faint discoloration, turning slightly brown. This continued until at the end of about two and a half days the whole of each piece inoculated had become discolored. At this time the inoculated pieces were decidedly alkaline in reaction, gave a very strong odor of decaying vegetable matter, and on comparing with Ridgway's plates the color was found to correspond very closely to the Ecru Drab, No. 21, Plate III, or to Saccardo's Avellaneus, No. 7, Table I. The control pieces were still healthy. In several cases the inoculations did not take. Several branches from the head were sterilized and the lower part was inoculated with the same germ. In all these cases the inoculation was successful, with the same characteristic odor, color, and reaction.

Raw radish.—Several red, so-called "white tip," round radishes were obtained from the market. These were washed and the surfaces sterilized in the same manner as the raw potatoes. They were then pared with a sterile knife, cut in half, and placed in petri dishes, four halves in each dish. Immediately after preparing these specimens, two in each dish were inoculated with the calla-rot organism, using a 24-hour-old beef-broth culture, and in eighteen hours at 20° to 25° C. all the inoculated pieces showed slight discoloration. In forty-eight hours the disease had advanced so that the whole of each inoculated piece was discolored. None of the uninoculated pieces showed any signs of disease. Some of the inoculated pieces were inoculated by contact and others by stab. The disease progressed as rapidly in the contact as in the stab cultures. The inoculated pieces only were affected; color, Cinnamon, No. 20, Plate III, Ridgway, a little lighter than Saccardo's Umbrinus, No. 9, Table I. In reaction the discolored pieces were strongly alkaline to litmus, and had the very disagreeable odor of decaying vegetables. All the inoculated pieces were involved (see Pl. V, fig. 1), gradually disintegrated, and settled down upon the bottom of the petri-dishes, as shown in Plate V, figure 2.

Raw cucumbers, sliced.—A green cucumber about 5 inches in length was thoroughly washed with distilled water and the surface sterilized with corrosive sublimate (1 part in 1,000). The outer rind was peeled off with a sterile knife, and the material was then cut into slices from 1½ to 2 cm. in thickness. Each slice was divided into two parts and placed in sterile petri dishes, four pieces in each dish. Two of these pieces in each dish were inoculated with the calla disease germ, using a 24-hour-old beef-broth culture. All the inoculated pieces began to show slight discoloration in eighteen hours at 20° to 25° C., and in forty-eight hours the disease had progressed rapidly, having discolored in some cases the whole of each inoculated piece. The color of the inoculated pieces at this time was light brown or yellowish, closely resembling Ridgway's Buff, No. 13, Plate V, or Saccardo's Ochroleucus, No. 28, Table II. The inoculated pieces had a peppery, pungent odor, and were strongly alkaline to litmus.

Raw cucumbers, whole.—The effect of the calla germ on whole cucumbers fresh from the vines was tried by taking nearly ripe cucumbers, sterilizing a spot near the stem by washing with corrosive sublimate (1 part in 1,000), and then washing with sterile water. Several punctures were made in the sterilized spot with a sterile needle to the depth of from one-half to 1 inch, and two 1-mm. loops of a 24-hour-old beef-broth culture of the calla organism were applied to the sterile surface over the punctures. For control several cucumbers were treated in exactly the same manner, except that the organism was not applied. At the end of twenty-four hours at 20° to 25° C. a watery spot about one-half an inch in diameter appeared around the punctures in the cucumbers that were inoculated. In three days from the time of inoculation the cucumbers were soft about one-half their length, and in five days they were soft throughout. The skin, however, remained intact, so that the inoculated cucumbers represented closed sacks containing a watery, pulpy mass (Pl. VI). If an opening were made in the sack the contents would flow out, leaving a semitransparent bag which could be filled with water and handled. All controls remained entirely unaffected. A drop of the watery substance from one of the inoculated cucumbers placed under a low power of the microscope showed that the cells had become separated so that each individual cell floated out by itself. The cells themselves were not collapsed, however, showing that the action of the organism had been upon the lamella connecting the cells, causing them to dissolve. This action was apparent not only upon the cucumber but upon all the raw vegetables which were rotted under the influence of this organism. The color of the cucumbers, both upon the surface and in the interior, remained unchanged. The odor of the soft contents of the inoculated cucumbers was strikingly like that arising from cucumbers that sometimes soften when pickled in brine. The reaction was distinctly acid to litmus.

To determine whether the organism that had caused the softening of the inoculated cucumbers was the calla-rot germ, a spot was sterilized on the surface of one of the soft cucumbers before the skin was broken. With a sterile needle a puncture was then made in the sterilized spot in the skin and a loop of the soft interior was removed with a sterile needle and placed in 10 c. c. of beef broth. In the usual way eight poured plates of beef agar were at once prepared from the dilutions of this beef-broth culture. In from twenty-four to forty-eight hours at 20° to 25° C. colonies appeared in all the plates. These colonies were all radiating and were alike in all respects, indicating that the cucumber contained a pure culture of an organism similar at least to the calla-rot germ. Twelve callas were inoculated with 24-hour-old beef-broth cultures made from these colonies, and in twenty-four hours the characteristic calla rot appeared in all cases, as indicated in the watery discoloration around the inoculated spots and by the subsequent decaying of the parts inoculated. In twenty-four hours more the inoculated leaves had entirely rotted off. The only part of the interior of the inoculated cucumbers not softened was the portion immediately beneath the spot sterilized for inoculation (Pl. VI, A). Here the interior remained firm, sometimes to a depth of one-half inch or more, showing that the corrosive sublimate had penetrated to a considerable depth and that the organism was unable to attack this part of the cucumber even after several days.

This series of experiments was repeated many times with practically the same results. Sometimes the action was a little slower and sometimes a little more rapid. It was found that the action was more rapid if the cucumbers were nearly ripe before inoculation and when the temperature of the air in which they were kept after inoculation was about 30° C. Some of the experiments were carried on in the dark and some in diffused light, but there was no apparent difference in the time required for the inoculation to take, nor in the rate of progress made in softening the cucumbers in the two cases. The rate of disintegration was the same on both the upper and the lower sides of the cucumbers.

Raw green peppers.—These peppers were obtained from the market, thoroughly washed with distilled water, and afterwards with corrosive sublimate, and again rinsed with distilled water. With a sterile knife they were cut into slices and placed in sterile petri dishes, two pieces in each dish. One piece in each dish was inoculated immediately with the calla-disease organism. In twenty-four hours at 20° to 25° C. it was seen that the inoculated pieces were slightly attacked by the germ, and in forty-eight hours the disease had progressed, although not as rapidly as in the cases of the cucumber, potato, carrot, and some other vegetables. The organism attacked both the central and the outer parts of the pepper, but the change in color was not sufficient to show in a photograph even after five days. The inoculated parts were all darker than the controls (Ridgway's Parrot Green, No. 7, Plate X, or Saccardo's Atro-virens, No. 34, Table II), while the original was nearly grass green toward the outside. The interior of the pepper, originally nearly white, was changed to Cream Buff, Ridgway's No. 11, Plate V, or Saccardo's Cremeus, No. 27, Table II. The inoculated parts were also soft, had the odor of decaying peppers, and were strongly alkaline to litmus.

Raw mature onion bulbs.—The outside layers were removed and the onion was then cut into pieces of convenient thickness and placed in petri dishes, three pieces in each dish. Two of these pieces were inoculated with a 24-hour-old culture of the calla germ and one was left for control. Several dishes were prepared in this manner. The organism grew on the onion, but not rapidly, and at the end of five days at a temperature of from 20° to 25° C. the decay was apparent, although the layers of the onion were not broken down. The color was Cream Buff, No. 11, Plate V, Ridgway, or Saccardo's Cremeus, No. 27, Table II. The odor was that of decaying onions. In reaction the inoculated pieces were moderately alkaline to litmus.

Raw young onions.—Several onions were grown from seeds, and when the young plants were about two weeks old they had produced three leaves each and the longest of the leaves measured from 6 to 8 inches. These plants were inoculated with the calla organism by placing a drop of a 24-hour-old beef-broth culture on a leaf with a sterile needle and puncturing the leaf several times through the drop of bacteria-laden broth. No sign of disease appeared in any case, although the plants were kept under observation for several weeks. This experiment was repeated several times with negative results, indicating that this organism is not a producer of disease in young green onions.

Raw pieplant.—Stalks of raw pieplant were washed with corrosive sublimate and then in distilled water. With a sterile knife the outside was removed and the stalks were then cut into slices about 2 cm. thick and four placed in each petri dish. Two of each four were inoculated with a 24-hour-old beef-broth culture of the calla germ. In two cases only was there any growth, and this was very feeble, resulting at the end of five days in a slight brown discoloration. The experiment was repeated several times, but in all cases the growth was very feeble and hardly perceptible.

Raw cabbage.—Cabbage heads were obtained from the market, the outer leaves were pulled off, and inoculations were made into the stumps and leaves of several plants, using a 24-hour-old beef-broth culture of the calla germ, several heads being left for control. In twenty-four hours the inoculated spots were slightly discolored. The color deepened for nine days (temperature, 18° to 27° C.), at the end of which time the rot had spread over the whole surface of the stumps and entirely through them. The color was Drab, No. 18, Plate III, Ridgway, or somewhat darker than Saccardo's Avellaneus, No. 7, Table I. At the same time the decay progressed in the leaves, producing the same color and advancing from leaf to leaf until at the end of nine days the whole of each inoculated head was affected. None of the control plants was affected during this time. The decayed specimens had the odor of rotten cabbage and in reaction were strongly alkaline to litmus.

In addition to these experiments with cabbage, pieces of stumps and leaves were washed with corrosive sublimate, then with sterile water, and placed in petri dishes, four pieces in each dish, two of which were immediately inoculated with a 24-hour-old beef-broth culture of the organism and two left for control. In twenty-four hours at 20° to 25° C. the inoculated pieces began to show discoloration and in five days the inoculated pieces were decayed throughout. The control pieces remained sound, except in a few instances in which the exuding juice from the decayed pieces came into contact with the controls, in which cases the latter decayed. The color, odor, and reaction were the same as in the experiments with the whole heads, as previously described.

Raw parsnips.—Raw parsnips were obtained from the market and treated in the same way as the raw potatoes. With a sterile knife pieces of convenient thickness were cut and placed in sterile petri dishes, four pieces in each dish. Two pieces in each dish were inoculated with the calla-rot germ, using a 24-hour-old beef-broth culture. At the end of twenty-four hours after inoculation the inoculated pieces began to show discoloration at the points of infection, and at the end of three days (temperature, 18° to 25° C.) the discoloration was very marked (Pl. VII, fig. 1). The inoculated pieces had a pungent, sweetish odor and were plainly alkaline to litmus. The color corresponded to Ridgway's Mummy Brown, No. 10, Plate III, or nearly to Saccardo's Fuligineus, No. 11, Table I.

Raw carrots.—Several roots of carrots were obtained from the market and prepared in the manner indicated above. Slices of suitable thickness to be placed in petri dishes were then cut off with a sterile knife. Four pieces were placed in each petri dish, and as in the other experiments two out of each set were inoculated with the calla-rot organism and two left for control. In twenty-four hours at 20° to 22° C. the inoculated pieces began to discolor at the points of inoculation, and in three days the discoloration was very striking over the entire surface of the inoculated pieces (Pl. VII, fig. 2). In the central part of the root the discoloration had extended entirely through, a distance of 2 cm., while toward the outer surface the progress was not so rapid, the discoloration having extended only about 1 cm. The color of the inoculated pieces three days after inoculation was Vandyke Brown, No. 5, Ridgway's Plate III, or nearly Saccardo's Fuligineus, No. 11, Table I. The decayed part was distinctly alkaline to litmus. At the end of eight days the inoculated pieces were entirely discolored and soft, while the uninoculated pieces still retained their normal color and were sound. At this time the inoculated pieces had changed in color from Vandyke Brown or Fuligineus to Olive, No. 9, Ridgway's Plate III, or to Saccardo's Olivaceus, No. 39, Table II.

Raw turnips.—A firm, white turnip was obtained from the market, prepared for the petri dishes, and inoculated in the same manner as the other vegetables. In twenty-four hours discoloration was distinctly noticeable at the points of inoculation, and in three days the discoloration was very striking and had progressed downward from 2 to 3 mm., while the uninoculated pieces were still white and sound (see Pl. VIII, fig. 1). The color of the inoculated pieces at this time closely resembled Ridgway's Olive, No. 9, Plate III, or Saccardo's Olivaceus, No. 39, Table II. The discolored parts were strongly alkaline to litmus and had a striking odor of decayed turnips.

Raw salsify.—Several roots of salsify were obtained from the market and the same method was used in preparing and inoculating them that was employed with the other vegetables. In twenty-four hours the inoculated pieces were discolored and in three days all had discolored but only the inoculated pieces had decayed, and as these kept their shape it was impossible to bring out the difference in color by means of a photograph. The growth of the organism, however, was apparently just as rapid in the salsify as in the parsnips, carrots, etc. The inoculated pieces were alkaline to litmus and had an odor of decaying salsify.

Raw tomatoes, ripe.—Several ripe tomatoes were inoculated with a 24-hour-old beef-broth culture of the calla germ. Before inoculating, a spot about one inch in diameter on the surface of the fruit was washed with a dilute solution of corrosive sublimate and then with sterile water. A loop of the culture was then placed on the sterilized spot and a sterile needle was used to puncture the skin through the drop of beef-broth culture. Some of the tomatoes so inoculated were left in diffused light, some were placed in a dark room, and all were maintained at a temperature of about 18° C. Twenty-four hours after inoculation each infected spot was surrounded by a watery area about 1¼ inches in diameter. The contents of the inoculated tomatoes softened rapidly, so that at the end of four days after inoculation openings were made in the skins of some of the infected fruits and the contents were poured out, leaving the skins intact. The cell contents of the inoculated tomatoes were apparently acted upon by some substance that dissolved the intercellular layers and allowed the individual cells to become entirely separated, as in the case of the cucumbers already cited. The cell contents did not seem to be affected, nor did the substance act upon the skin of the tomato.

Raw tomatoes, green.—Some tomato plants growing in the Department greenhouse bore a number of unripe tomatoes varying from 1 to 2 inches in diameter. Six of these were inoculated on the plants in the same manner as the ripe tomatoes described above. Twenty-four hours after inoculation (temperature, about 30° C.) all the infected tomatoes had small watery spots at the point of inoculation. Twenty-four hours later the watery spots appeared sunken and whitish. In another twenty-four hours the spots began to turn brown, the skin cracked, and the juice began to ooze out. In twelve days after inoculation the contents had oozed from all the inoculated tomatoes, leaving the skins still clinging to the vines. Plate VIII, figure 2, shows a photograph of one of the skins (No. 2) and of an uninoculated tomato (No. 1) on a piece of one of the vines. The skins did not cling firmly to the vines, but could be easily removed. The stems to which the skins were attached had a discolored and dead appearance, but were not at all soft. Green tomatoes brought into contact, either artificially or naturally, with a decayed tomato did not take the disease. While the general effect of the organism is the same upon the green as upon the ripe tomato, the progress is much more rapid in the case of the ripe fruits.

Raw apples (York Imperial).—The outside of the apple was washed with corrosive sublimate (1 part in 1,000) and then with sterile water.

Several pieces were then cut out with a sterile knife and placed in sterile petri dishes, four pieces in each dish. Two pieces in each dish were inoculated with a 24-hour-old culture of the calla-rot germ in beef broth and two pieces were left for control. After four days a slight growth was noticeable, but the rate of growth was very slow.

Raw pineapples.—The outside was removed and several pieces were cut from the interior with a sterile knife. As in the previous case, four pieces were placed in each of several petri dishes. Two pieces in each dish were inoculated as above and two left for control. These preparations were kept for about ten days, but no growth appeared on any of the pieces.

Raw yellow bananas.—The outside of the bananas was carefully peeled off, and with a sterile knife cross sections from 1½ to 2 cm. thick were cut off and placed in sterile petri dishes, four in each dish. As in the preceding cases, two pieces in each were inoculated with a 24-hour-old culture of the calla-rot germ in beef broth and two were left for control. After ten days no growth was noticeable on any of the pieces.

GAS.

To determine whether or not the calla-rot organism is a gas producer, six solutions were used, viz, peptone water +1 per cent mannite, peptone water +1 per cent maltose, peptone water +1 per cent dextrose, peptone water +1 per cent cane sugar, peptone water +1 per cent milk sugar, and peptone water +1 per cent glycerin. A half dozen fermentation tubes were filled with each of these solutions, and after sterilizing for fifteen minutes on three consecutive days several tubes of each set were inoculated with a 1-mm. loop of a 24-hour-old beef-broth culture of the calla-rot organism. A part of each set was left for control. In eighteen hours after inoculation of the infected tubes (temperature, 20° C.) they were clouded in the bulb, and the clouding extended from one-half to 1 inch into the closed ends of the tubes. In forty hours the clouding extended to the top of the closed end of each inoculated tube, but no gas had formed in any case. (Fig. 6.) The control tubes were all clear and free from gas. These tubes were kept under observation for two weeks, but no gas formed in any of the tubes, and the control tubes were still clear and free from sediment. The inoculated peptone-mannite tubes began to clear at the top of the closed ends in from twenty to thirty weeks after inoculation. The deposit formed from a settling of the sediment was cream buff in color, as seen by reflected light, and corresponded very nearly to Ridgway's No. 11, Plate V. The reaction of the contents of the tube was slightly acid to litmus at the close of the experiment. The inoculated peptone-maltose tubes began to clear in from ten to twelve weeks, and by the end of twenty weeks were entirely clear. The deposit formed was only about one-half the bulk of the deposit in the peptone-mannite tubes. It was of a drab color, corresponding very closely to Ridgway's Ecru Drab, or a little darker than Saccardo's Avellaneus, No. 7, Table I, when viewed by reflected light. The reaction of the contents of the tubes was slightly alkaline to litmus at the close of the experiment. The peptone-dextrose tubes began to clear in from ten to twelve weeks after inoculation, and in twenty weeks were entirely clear. A large part of the sediment clung to the back of the upright part of the tube instead of settling completely, as in the other inoculated tubes. The color of the deposit was also drab, corresponding very closely to Ridgway's Ecru Drab, No. 21, Plate III, or a little darker than Saccardo's Avellaneus, No. 7, Table I, when seen by reflected light. The reaction of the contents of the tube at the close of the experiment was slightly acid to litmus. The cane sugar, milk sugar, and glycerin tubes cleared in from one to six weeks. The glycerin tube cleared first, then the milk-sugar tube, and lastly the cane-sugar tubes. The deposit was heaviest—about 4 mm. deep—in the cane-sugar tubes, about 2 mm. deep in the milk-sugar tubes, and only 1 mm. deep in the glycerin tube. The color of the deposit was the same as in the other cases, viz, Ridgway's Ecru Drab, No. 21, Plate III, or a little darker than Saccardo's Avellaneus, No. 7, Table I. Each inoculated tube gave an acid reaction with litmus at the close of the experiment. No gas formed in any of the tubes. It is therefore apparent that the calla-rot organism is not capable of splitting up mannite, maltose, dextrose, cane sugar, milk sugar, or glycerin so that a gas will form.

FIG. 6.—Fermentation tube ten days after inoculating with the calla organism.

ACTION ON LEAD ACETATE.

Slant tubes of lactose agar, colored with litmus, were inoculated with the calla-rot organism, and at the same time slips of filter paper saturated with lead acetate were introduced into the tubes. These paper strips were held at one end by a cotton plug, so that they did not come into contact with the medium. In twenty-four hours the color began to fade from the litmus-lactose agar, and in three days the agar was practically colorless, except a small area near the top, which was still slightly tinged. At the same time the lead acetate paper began to blacken around the edges. Twenty-four hours later the margins of the paper strips were still darker and the discoloration extended a little farther from the edge. At the end of eight days from the beginning of the experiment the color had entirely disappeared from the inoculated tubes, while it remained unchanged in the controls. The lead-acetate papers were blackened about three-fourths of an inch from the lower end upward, the color fading out and leaving no sharp line of demarcation. The liquid that settled in the angle of the inoculated tubes at the end of eight days had become nearly cream color, corresponding closely to Ridgway's No. 20, Plate VI, or Saccardo's Cremeus, No. 27, Table II, while in the control tubes the liquid was still litmus color. At the expiration of twenty-seven days from the beginning of the experiment the color began to return in the agar, and seven days later the original color had returned throughout the agar and also in the liquid that had previously been cream color. As soon as the color began to return to the agar the discoloration of the lead-acetate slips ceased to develop. The black color in the lead-acetate papers was undoubtedly due to the formation of hydrogen sulphid, which develops on certain media during the activity of the calla-rot organism. As soon as the organism became inactive the hydrogen sulphid ceased to form, and what had formed passed off from the agar, allowing the litmus color to return. Beef broth inoculated with the calla-rot organism discolored the margins of lead-acetate paper in twenty-four hours, the discoloration extending about one-fourth of an inch from the margin. This gas forms much more rapidly in beef broth than in litmus-lactose agar, while the organism growing on potato cylinders produced no blackening of lead-acetate strips, even at the end of three weeks after inoculation.

INDOL.

Several tubes of peptonized Uschinsky's solution were inoculated with fresh cultures of the calla-rot organism. The inoculated tubes clouded within twenty-four hours, and tests were made from day to day for indol, using concentrated sulphuric acid and sodium nitrite, but even at the end of twenty-four days no trace of indol could be detected, although the tubes were heated to 80° C. after the application of the acid and the nitrite.

NITRATES REDUCED TO NITRITES.

Four tubes of nitrate bouillon were inoculated with the calla germ. These became distinctly clouded in the usual time, and at the end of two days were tested for nitrites as follows: To 10 c. c. of the clouded bouillion 1 c. c. of starch solution and 1 c. c. of potassium iodid solution were added. One drop of sulphuric acid was then sufficient to give an intensely blue color, indicating that the nitrates had been changed to nitrites. The control tubes treated in the same manner gave no reaction.

MAXIMUM TEMPERATURE.

In determining the maximum temperature at which the calla-rot organism will grow several media were used, viz, agar, gelatin, beef broth, and Uschinsky's solution. These media were inoculated with a 24-hour-old culture of the calla-rot organism in beef broth, and several tubes of each medium were placed in an incubator which registered 40° C. At the expiration of forty-eight hours the temperature still remained at 40° C., and there was no visible growth in any of the media. Growth was apparent in all the control tubes at the end of twenty-four hours after inoculation. On the third day after the tubes were placed in the oven the temperature fell to 38° C., and at the expiration of twenty-four hours thereafter there was a visible clouding of the beef broth and of the Uschinsky solution, but no growth appeared on the other media. When the incubator had again become steady at 40° C., fresh cultures were introduced, including, in addition to the above mentioned media, milk, litmus milk, and poured-agar plates. At the end of forty-eight hours there was a slight clouding of the beef broth and of the Uschinsky solution, but no growth was yet apparent in the other media. Twenty-four hours later the clouding in the beef broth and in Uschinsky's solution had increased and minute colonies began to appear in the poured plates, slight growth being apparent also on slant agar and stab gelatin cultures. At the end of another twenty-four hours the milk was slightly curdled and the litmus milk was beginning to redden. The temperature remained constantly at 40° C., and growth advanced slowly in all cases for several days. The colonies in the poured plates increased in size until they were from 2 to 3 mm. in diameter. It should be noted that all the colonies produced on the agar plates at this high temperature were round, none of them showing any tendency to radiate as they did under temperatures from 20° to 30° C. While 40° C. retards the growth of the organism it does not prevent it. The incubator was next regulated at 41° C. and fresh cultures of the organism on the various media were placed in it. After forty-eight hours there was a slight growth in the Uschinsky solution and on the slant agar, but it was very slight as compared with the controls. No growth appeared in the other media. At the end of another forty-eight hours, growth in the agar and in the Uschinsky solution was not perceptibly advanced and no growth appeared in any of the other media. Upon removing all these cultures to conditions of normal temperature at the end of the fourth day, growth advanced rapidly in those cases where it had started and appeared in all the other media used within twenty-four hours after removal. When fresh cultures were kept constantly at 42° C. no growth appeared, but exposure to this temperature for twenty-four hours did not destroy the life of the organism, as evidenced

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by the fact that when the cultures were removed from the incubator at 42° and kept at 20° C. growth began within a few hours. If fresh cultures were placed in the incubator at 43° C. life was not destroyed within fifteen hours, but cultures removed at the end of twenty-four hours and placed under normal conditions failed to grow. If the temperature was kept constantly above 41° C. no growth appeared in any of the media used. Hence after many repeated tests it was decided that 41° C. is the maximum temperature at which this organism will grow.

MINIMUM TEMPERATURE.

To determine the lowest temperature at which the calla-rot organism will grow, fresh cultures were placed in the ice box at different elevations, with as little variation as possible in the quantity of ice, so that the temperature remained fairly constant for each set of cultures, but varied for the different sets from about 3° to 9° C. Set 1 consisted of cultures of beef broth, Uschinsky's solution, gelatin stab cultures, and slant agar, and was kept at a temperature between 3° and 5° C. for twenty-four days. The control cultures at room temperatures of 20° C. produced growth as usual within twenty-four hours, while the cultures at the low temperature showed no signs of growth until they were removed from the ice box at the expiration of twenty-four days, when all produced growth within twenty-four hours. Set 2 was kept at approximately 6° C. for nine days, at the end of which time growth appeared, slightly clouding the beef broth. The temperature sometimes fell to 5° C., but did not at any time during the nine days exceed 6½° C. Set 3 was kept at approximately 9° C. Slight growth began in from two to four days. Beef broth was the first to show the growth in the low temperatures, while in the high temperatures it was usually the Uschinsky solution that clouded first. Six and one-half degrees centigrade seems to be the lowest temperature at which growth will take place. At 9° C. growth takes place slowly and the colonies in agar-plate cultures at this temperature are small and round, as was found to be the case in the high temperatures.

OPTIMUM TEMPERATURE.

The calla-rot organism grows readily between 15° and 37° C. Fresh cultures of beef broth, Uschinsky's solution, and agar inoculated with a 1 mm. loop of a 24-hour-old beef-broth culture, placed in an incubator at 37.5° C., showed signs of growth within six hours. Similar cultures at 35° C. showed a distinct growth in four hours. As it is sometimes difficult to compare culture solutions accurately with reference to the intensity of clouding, agar-plate cultures were also used. The fresh cultures were placed at different temperatures—some at 20°, some at 30°, some at 33°, some at 35°, and some at 37.5° C. In fifteen hours the plates at 35° C. showed the colonies most distinctly.

The colonies measured from 1 to 3 mm. in diameter. Colonies were also visible in the plates at 20° and 30° and at 37.5° C., but they were smaller—scarcely larger than pin points. Similar tests were made of other temperatures above and below 35° C. with like results. Since all growth above and below 35° C. is slower than at this temperature, it appears that 35° C. is the optimum temperature for the growth of the calla-rot organism. In thirty-four hours the colonies at 35° C. had the characteristic radiating form, while those at and above 37.5° C. were round.

THERMAL DEATH POINT.

The thermal death point is the lowest temperature at which the life of the organism will be destroyed when a fresh culture is exposed to that temperature for ten minutes. To determine that point with the calla-rot organism fresh beef-broth cultures were made from a 24-hour-old culture of beef broth, each culture consisting of 10 c. c. of broth inoculated with a 1-mm. loop of the 24-hour-old culture. The tubes containing these fresh cultures were placed in water at constant temperature for ten minutes. In the first experiment three sets of tubes were used. One set was exposed to a temperature of 49°, another set was exposed to 49.20°, and the third set was exposed to 49.40° C. After exposing the tubes to these temperatures they were placed at room temperature of about 20° C., and at the expiration of eighteen hours all control tubes were clouded and all exposed tubes were clear. Six hours later set 1 (49° C.) was clouded slightly; sets 2 and 3 were still clear. Twenty-four hours later—i. e., forty-eight hours from the time the tubes were exposed to the heat—all inoculated tubes were clouded. In the second experiment three sets of tubes were again used. After inoculating in the same manner as above, one set was exposed for 10 minutes to a temperature of 49.50°, another to 50°, and a third to 50.20° C. Several inoculated tubes were left untreated for control. At the expiration of twenty-four hours all control tubes were clouded, and all exposed tubes were clear. Twenty-four hours later four tubes in set 1 (49.50° C.) were clouded and two were clear. All tubes in sets 2 and 3 (12 in all) were still clear. At the expiration of two weeks all tubes in sets 2 and 3 were still clear, and the two tubes in set 1 were also clear. Agar plates were made from the clouded tubes that were heated to 49.50° C., and in all cases pure cultures of the calla organism were obtained, as indicated by the shape of the colony and by the fact that inoculations into calla plants produced the characteristic symptoms of the disease. Several sets of cultures were subsequently exposed to a temperature of 50° C. for ten minutes, but always with the result that they all remained clear indefinitely, while a part, at least, of the cultures exposed below 50° C. clouded in a longer or shorter time, showing that 50° C. is the thermal death point for this organism.

DIFFUSED LIGHT.

Diffused light had no effect upon the development of the organism in any of the media used, i. e., beef broth and other liquid media, clouded or otherwise, showed the presence of the organism as readily under one condition as the other, and in the agar plates the colonies formed as quickly and grew as rapidly in diffused light as in the dark.

DIRECT SUNLIGHT.

To determine the effect of direct sunlight upon the organism several tubes, each containing 10 c. c. of agar, were inoculated and poured into thin petri dishes. One-half of each dish was covered with black paper and the dishes were then exposed to the direct sunlight. Some of the dishes were removed from the direct sunlight at the end of five, ten, fifteen, twenty, and sixty minutes. In those dishes that were exposed five minutes only, colonies appeared in all points of the plate in twenty hours. The colonies appeared just as readily and grew just as rapidly in the exposed as in the unexposed part of the plate, but were a little less numerous, showing that a few of the organisms had been killed by the direct light in five minutes. In the plates that were exposed ten minutes colonies appeared in the covered part of the plate within twenty-four hours, but none appeared in the exposed part of the plate until nearly forty-eight hours after being placed in diffused light. The colonies which finally formed in the exposed part were much less numerous than those in the shaded part. In the covered part of the plate that was exposed fifteen minutes colonies appeared within twenty hours, but no colonies appeared in the exposed side, even at the end of a week, except a few around the edge of the plate, which were apparently protected slightly either by the shadow of the margin of the petri dish or by the organism being several deep around the margin of the plate, so that the upper layers protected those below from being destroyed by the direct rays of the sun. The same was true of the plates exposed twenty minutes. It appears, therefore, that from five to fifteen minutes of direct sunlight are sufficient to destroy the life of the organism, but that a very slight protection only is necessary to prevent them from being destroyed. Even in the plates exposed for sixty minutes the organisms around the margin of the plate were likewise protected. In all cases colonies appeared close to the dividing line between the exposed and the shaded part of the plate, and growth extended in every instance from these marginal colonies into the exposed part of the plate, showing the characteristic radiation of the colonies when not crowded.

EFFECT OF NITROGEN.

Several tubes of beef broth were inoculated with the calla-rot germ and the tubes were placed immediately in a jar from which the oxygen was removed by the aid of pyrogallic acid and sodium hydrate, thus leaving practically an atmosphere of nitrogen. The jar was placed in diffused light at a temperature of from 18° to 25° C. At the expiration of thirty-five days it was opened and the beef broth was as clear as if it had not been inoculated, showing that no growth had taken place in the absence of oxygen. Twenty-four hours after the jar was opened the tubes were clouded as deeply as if the inoculation had been made the day the jar was opened instead of thirty-five days prior to that time. Hence, while nitrogen will not enable the organism to grow, its life is not destroyed by the action of this gas, and when inoculations were made from these cultures into callas the disease promptly appeared, and in forty-eight hours the inoculated leaves and flower stalks had rotted off. Agar-poured plates made from the clouded tubes and from the diseased portion of the inoculated calla showed the same characteristic pure cultures composed of radiating colonies. To determine how much longer the organism would live in the absence of oxygen, cotton-plugged tubes of beef broth, Uschinsky's solution, and a mixture of Dunham's and Uschinsky's solutions (half and half) were inoculated with the calla organism and were kept in an atmosphere of nitrogen two hundred and seventy-five days, in the manner described above. At the expiration of this time the tubes, all of which were clear, were exposed to the air at room temperature, i. e., 18° to 25° C., the same temperature at which they had been kept in the atmosphere free from oxygen. The atmosphere in the jar would not support combustion at the moment it was opened, indicating that the oxygen had not diffused into it. In twenty-four hours after exposing the tubes to the air the Uschinsky solution and the mixture of the Uschinsky and Dunham solutions were all clouded, but the beef-broth solutions were not clouded. The clouding increased for several days in those tubes in which it had begun, but no growth appeared in the beef broth even after several weeks of exposure to the air. Poured plates and inoculations into healthy callas from the clouded tubes showed that this was the calla organism.

EFFECT OF CARBON DIOXID.

Freshly inoculated tubes of slant agar, Uschinsky's solution, nitrate bouillon, and common bouillon were placed in an air-tight jar into which carbon dioxid was passed. Before the gas entered the jar containing the tubes it was passed through solutions of potassium permanganate, sodium hydrate, and distilled water. After being filled and exhausted six times, to insure an atmosphere of pure carbon dioxid, the jar was filled with the gas, sealed, and allowed to stand for fourteen days. At the expiration of this time it was opened and the tubes were examined. The slant agar showed a thin, pure white growth the whole length of the streak and a small amount of whitish precipitate in the fluid in the angle formed by the agar and the side of the tube. The amount of growth was only moderate. The Uschinsky's solution showed no growth at this time. In twenty-four hours the tubes of Uschinsky's solution were still clear, but at the end of forty-eight hours after exposure to the air the solution was distinctly clouded, showing that free oxygen is necessary for the growth of the calla organism in Uschinsky's solution.

In the nitrate bouillon there was only a moderate amount of growth at the time the jar was opened, but the solution was distinctly clouded. There was a white precipitate 7 mm. in breadth, but no pellicle or rim had formed. The nitrates were reduced to nitrites, as shown by the usual test. The common bouillon was distinctly and uniformly clouded. Apparently the growth had been twice as rapid as in the nitrate bouillon, as indicated by the degree of cloudiness of the tubes and by the large amount of white precipitate, which was fully twice as abundant as in the nitrate bouillon tubes. No rim or pellicle formed in any of the tubes.

EFFECT OF HYDROGEN.

Tubes of slant agar, Uschinsky's solution, ordinary bouillon, and nitrate bouillon were inoculated with the calla organism and placed in a hydrogen atmosphere. The hydrogen was generated by the action of dilute sulphuric acid upon zinc. The gas thus produced was passed through solutions of silver nitrate, potassium permanganate, sodium hydrate, and distilled water into a chamber containing the inoculated tubes. The chamber was filled and exhausted six times, thus insuring practically a pure atmosphere of hydrogen. The chamber was then sealed and left undisturbed for twenty days, at the end of which time the following results were noted:

The organism had made a feeble growth on the slant agar, as indicated by a very faint streak along the surface of the medium, and a small amount of whitish precipitate to the depth of 2 mm. had been deposited in the angle between the agar and the side of the tube. Uschinsky's solution was feebly clouded throughout. A small amount of deposit to the breadth of 7 to 8 mm. had formed in the bottom of the tube. The ordinary bouillon was feebly clouded throughout and a white precipitate 8 mm. in breadth had been deposited. The nitrate bouillon was feebly clouded, with a small amount of white deposit 12 mm. broad in the bottom of the tube. No rim or pellicle had formed in any of the fluids.

COMPARISON OF CALLA-ROT GERM WITH SIMILAR ORGANISMS.

Bacillus carotovorus Jones.[a]—Upon comparing the calla organism with the carrot-rot germ, as described by Jones, it is found to differ in

[a] Jones, L. R. A Soft Rot of Carrot and Other Vegetables Caused by Bacillus Carotovorus, Jones. Thirteenth Annual Report of the Vermont Experiment Station, 1900, p. 299.

several particulars—i. e., the calla rot does not, while the latter does produce gas. The former is not affected by diffused light, while the latter is affected, etc. The shape of colonies differs. There are, of course, numerous points in which the two organisms agree, but they differ in enough essential points to show that they are not the same.

Bacillus oleraceæ Harrison.[a]—Cultures of this organism were obtained, and repeated inoculations were made with fresh cultures into various parts of calla plants. At the same time parallel inoculations were made with similar cultures of the calla-rot germ. In twenty-four hours after inoculation nearly all the plants inoculated with the calla germ showed the characteristic symptoms of disease, and the decay continued to progress until the plants were practically destroyed. On the other hand Harrison's organism did not affect the plants in any way, showing that the two organisms are not identical.

Heinz's hyacinth germ (*Bacillus hyacinthi septicus*).[b]—In order to learn the effect of the calla organism on hyacinths, more than 100 hyacinths were inoculated with fresh cultures of the calla germ. The leaves, flower stalk, and flowers were inoculated. Most of the inoculations were made in plants growing in the open when the weather was bright and warm. A few hyacinths were potted and placed in a greenhouse. The flowers were inoculated by dropping a single drop of a 24-hour-old beef-broth culture into the flower. The leaves and flower stalks were inoculated by scraping a quantity of the fresh growth of the organism from a slant-agar surface, applying it to the diseased spot, and then puncturing the plant with a sterile needle through the mass of organisms. None of the plants in the open showed any symptoms of the disease whatever, although they were watched daily for more than two weeks. The inoculated plants in the greenhouse did not show any symptoms of disease until the expiration of five days, when a few of the leaves and flower stalks began to soften. The affected parts gradually decayed throughout (fig. 7). Pure cultures of the calla organism were obtained from these diseased parts of the hyacinths. The difficulty with which this organism

FIG. 7.—Hothouse hyacinth inoculated in a flower with the calla organism.

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[a] Harrison, F. C. Preliminary Note on a New Organism Producing Rot in Cauliflower and Allied Plants. Science, n. s., Vol. XVI, July 25, 1902, p. 152.

[b] Heinz, A. Zur Kenntniss der Rotzkrankheiten der Pflanzen. Centralblatt f. Bakt. u. Parasitenkunde, Bd. V, 1889, p. 535.

affects the hyacinths indicates that it is not the same as Heinz's hyacinth germ, which attacked the plants readily and destroyed them rapidly when inoculated by either of the methods used in these tests. Heinz's organism (*Bacillus hyacinthi septicus*) does not liquefy gelatin, while the opposite is true of the calla organism. The colonies in plate cultures are round and when grown on sterile potato they are a dirty yellow color. The colonies of the calla organism are usually radiating and on potato they produce a brownish color.

Potter's Pseudomonas destructans.[a]—Potter's organism, when grown in a solution containing sugar, liberates carbonic acid gas. The calla organism is not a gas producer. Colonies in plate cultures are round, and when grown on vegetables the end reaction is acid. The calla organism usually produces radiating colonies, and on vegetables the end reaction is generally alkaline. *Pseudomonas destructans* has but one flagellum while the calla organism has several flagella.

Likewise in comparison with other forms the calla germ does not agree in all particulars with any other known organism, and the writer therefore proposes for the calla-rot germ the name *Bacillus aroideæ*.

ORIGIN AND SPREAD OF THE DISEASE.

The calla rot has been reported from the Western, Central, and Eastern States, i. e., from the Atlantic to the Pacific. It therefore appears to have spread over the entire calla-growing section of the United States, but it is much more destructive in some portions of the country than in others. It causes a loss of thousands of dollars annually and has become so destructive in some sections that the growers have either abandoned the calla altogether or have greatly reduced the space and time that they have heretofore devoted to this plant. It is therefore of the highest importance that the grower should know the source of this disease and the ways in which it may spread from place to place and from plant to plant.

Calla corms that are attacked late in the season go into their resting stage in a partly decayed condition. If the attack has been slight the infected spot will dry down and may be overlooked when corms are selected the following season for growing calla plants. When callas begin to grow from such corms the organisms which have remained dormant during the resting period of the corm are revived and decay is started afresh. Since this organism may remain dormant for months without its life becoming extinct, it may be spread from one locality to another, and even from country to country, whenever diseased corms are transported. It is undoubtedly in this manner that the disease has become so widespread in this country.

[a] Potter, M. C. Ueber eine Bakterienkrankheit der Ruben. Centralblatt f. Bakt. u. Parasitenkunde, Bd. VII, II. Abt., 190¹ pp. 282, 353.

The spread of the disease from plant to plant in the same house seems to be accomplished mainly through the soil. One reaches this conclusion from the fact that healthy calla plants growing in pots and standing near diseased callas are less likely to become infected than when similar healthy plants are growing in a solid bed with diseased corms. Furthermore, it is almost always the case that the disease, if undisturbed, first attacks the corm beneath or just at the surface of the ground.

Usually the first season that the disease appears only a few of the plants are actually destroyed, but the millions of organisms which are produced during the process of decay remain in the soil, and some of them reach corms that were perfectly healthy when planted. These infections, as already indicated, often produce the hold-over cases, which develop the following season. The organism may be carried from plant to plant by stirring the soil after some of the corms have become well rotted, or simply by walking about on the bed in cutting the flowers.

The nature of the soil apparently has much to do with the spread of the disease in the bed. A soil that is rich in vegetable matter is a better medium for the organism to grow and spread in than a soil that is poor in such material. Furthermore, a soil filled with humus retains the moisture better than one that is lacking in vegetable matter, a condition that greatly aids the multiplication of the organism. It often happens that the roots reach from corm to corm through the soil of the solid bed. Usually the corms are placed about 12 inches apart each way, and it is not uncommon for the plants to produce roots from 6 to 12 inches in length. Plate IX shows a small plant with a root more than 6 inches long. The writer has frequently been able to follow the progress of the disease through these roots from plant to plant. The contents of a calla root affected with this disease become soft, while the epidermis remains intact. The diseased roots are also somewhat darker than the healthy ones, so that they can be distinguished readily by sight as well as by touch. These appear to be the principal methods by which this disease is spread from plant to plant in the solid bed.

The only insect that has been observed by the writer in connection with the diseased plants is the so-called bulb-mite, but in no case has this insect been found on any part of a healthy plant and only on the decayed part of the diseased plants. To determine whether or not those insects were at all responsible for the spread of the disease a large number of mites were placed in petri dishes containing pure cultures of the calla organism. After the mites had come into contact with the colonies of bacteria they were transferred to healthy callas. Some were placed on the corms, others on the leaves, and still others on the flower stalks, but in no case did any of these plants develop the rot.

REMEDIES.

Various methods have been used with the hope of finding some remedy by which the progress of the disease could be stopped after the plants became infected. With this end in view the following treatments were used: The partly decayed corms were treated with the following substances, viz, air-slaked lime (two parts of the same with one part sulphur), formalin (varying from 1 to 10 per cent), corrosive sublimate, Bordeaux mixture, and copper sulphate solution. These were used on plants in different stages of decay. In some cases the soft part of the bulb was scraped away with a clean knife before the substance was applied, and in other instances the material was placed on the decayed part without in any way distuibing it. Sometimes the softened part was scraped away and nothing was applied, simply leaving the exposed surface to dry down. None of the treatments, however, was entirely successful. The lime and the lime and sulphur retarded the progress of the disease, but in a few cases only did the disease seem to be entirely eradicated. The solutions used appeared to make no impression upon the disease unless they were of sufficient strength to kill the plant. A few of the plants that were scraped and left without further treatment did not suffer further decay, but the percentage of cases of this kind was very low.

The successful treatment of the diseased plants in the bed was considered impracticable, and preventive measures were then resorted to. The soil was all removed from the solid bed in which practically all the callas had decayed, and this was replaced with fresh soil. At the proper time a new set of corms was obtained, but they were not planted directly in the bed. They were first carefully examined and all that showed suspicious dark-colored spots were discarded. The remainder were started in pots and then transplanted. This made it possible to discard all plants which showed any indication of the rot after growth began. As a result no disease appeared in the bed of 1,000 callas during the entire season. The same soil was used the second and third years and the same precautions were taken in regard to putting into the bed only healthy bulbs, so far as possible, with the result that while a few diseased plants appeared successful crops of callas were grown. Plate I shows the third consecutive lot of callas in the same bed since the crop was entirely destroyed by the soft rot. Very little of the disease has appeared owing to the precautions that were taken in changing the soil and in selecting healthy corms.

It is safe, therefore, to state that the soft rot of the calla may be prevented or held in check sufficiently for all practical purposes by changing the soil every third or fourth year, depending upon the number of cases of rot that appear, and by exercising due caution in selecting only healthy plants for the bed. Diseased corms may often be detected, even in the dormant state, by examining for discolored spots, but it is safer to start the plants in pots, even after the corms having discolored areas have been rejected, to insure getting as few diseased plants as possible in the bed, since experience shows that some corms are so slightly affected that the disease is not easily detected in the dormant state. Some growers prefer to keep their plants in pots throughout the season as a preventive measure against the rot, but as a rule callas grown in this manner do not produce as large flowers as when grown in a solid bed. Hence, if the trade demands a large flower, the solid bed is preferable.

In conclusion, the writer wishes to express his acknowledgment to Dr. Erwin F. Smith, pathologist in charge of the laboratory of plant pathology, for his many helpful suggestions and his assistance in carrying on this work, and also to Mr. Alexander B. Garden, of Anacostia, D. C., for his kindness in allowing free access to his calla house during the past four years.

SUMMARY.

(1) The soft rot of the calla is a bacterial disease.

(2) The organism that produces the calla rot is a short rod bearing peritrichiate flagella.

(3) The organism occupies the intercellular space in its host and dissolves the layers that connect the cells, causing the affected tissue to break down into a soft, slimy mass.

(4) The organism is able to attack a large number of raw vegetables, and is capable of producing soft rot in many of our useful plants. Care should therefore be taken not to throw any decayed or partly decayed callas or the soil from a bed in which callas have decayed in any place where the vegetables mentioned in this bulletin are to be grown.

(5) It does not attack tree fruits readily, and hence is not likely to produce fruit rots.

(6) It grows readily on beef agar, forming at room temperature (18° to 25° C.) radiating colonies, while on the same medium at extreme temperatures (8° or 37°) the colonies are usually round.

(7) It liquefies gelatin.

(8) It coagulates milk, and first reddens, then bleaches blue litmus milk.

(9) A 1-mm. loop of a fresh fluid culture of the organism placed in 10 c. c. of beef broth will distinctly cloud it in four hours at 35° C.

(10) The organism does not produce gas when grown in a peptone solution containing 1 per cent of cane sugar, milk sugar, glycerin, maltose, dextrose, or mannite.

(11) It bleaches litmus lactose agar.

(12) It will not grow at a temperature below 6° C., nor at a temperature above 41° C., and grows best at 35° C.

(13) The life of the organism is destroyed if it is kept for ten minutes in tubes of beef broth at or above 50° C.

(14) Its growth is not affected by diffused light, but direct sunlight will kill the organism in from five to fifteen minutes.

(15) It will not grow in an atmosphere from which the oxygen has been removed, but will remain alive for many months in this condition at a room temperature of 18° to 25° C.

(16) It does not grow well in an atmosphere of pure hydrogen.

(17) Its growth is very slight in an atmosphere of carbon dioxid.

(18) When grown on vegetables the end reaction is usually alkaline to litmus.

(19) The organism may remain dormant for many months in partly decayed corms, a condition which enables the disease to be transported long distances and to be held over from year to year.

(20) The soft rot of the calla may be prevented by a careful selection of sound corms and by changing the soil in the calla beds at intervals of three or four years.

(21) Brief description of the organism:

B. aroideæ n. sp. A short rod with rounded ends, generally single or in doublets or 4's, but under certain conditions growing in chains. Usual length when taken from a beef-broth culture 24 hours old 2μ–3μ, breadth about 0.5μ and fairly constant. Organism motile, flagella 2 to 8, peritrichiate. Growth white or nearly so on the various solid media. Aerobic and facultative anærobic. Not a gas producer. Liquefies gelatin; reddens litmus milk, separates the casein from the whey and solidifies the former. Grows slowly on potato cylinders, where it is white with a tinge of yellow, the potato being distinctly grayed. Growth good and vitality long in Uschinsky's solution. No indol produced. Nitrates reduced to nitrites. Methylene blue in Dunham's solution is changed to green on addition of grape sugar. Does not grow in nitrogen but remains alive many months. Grows feebly in hydrogen and carbon dioxid. Minimum temperature for growth about 6° C.; optimum, 35° C.; maximum, 41° C., thermal death point, 50° C. Surface colonies on agar, round at temperatures near the maximum and minimum, but fimbriate at optimum temperature.

B. aroideæ was isolated from rotting calla corms and is the cause of a soft rot of the corm, petiole, and flower stalk of the calla lily. It also causes a soft, dark colored rot when inoculated into many raw vegetables, such as carrot, potato, turnip, radish, cabbage, and cauliflower. It also causes a soft rot of certain green fruits, such as the tomato, eggplant, and cucumber.

PLATES.

DESCRIPTION OF PLATES.

Plate I. *Frontispiece.* Calla bed in which all the callas, 1,000 in number, were destroyed by the soft rot four years ago. Since that time three successful crops of the plant have been grown in this bed under the writer's direction, this being the third crop.

Plate II. Fig. 1.—The organism that produces the soft rot of the calla, showing the form of the individual, the development in chains, and the presence of flagella ($\times$ 1,000). Fig. 2.—Development of colonies of the soft-rot organism on agar plates at 18° to 25° C. The organism with which these plates were inoculated had been kept dormant for two hundred and seventy-five days by withholding oxygen. Nearly all the colonies are round. Only a few show a slight tendency to radiate. Photographed three days after the plates were poured. (Natural size.) Figs. 3, 4, and 5.—These figures were made from agar plates which were inoculated with the same organism as figure 2, but after it had been for a longer time exposed to the air and had been transferred several times to fresh sterile beef broth. These plates were three days old and had been kept at a temperature of from 18° to 25° C.

Plate III. Fig. 1.—Agar plate colony of the calla organism three days old at room temperature of about 20° C. The organism had been grown in beef broth previous to making the agar plate. (Natural size.) Fig. 2.—Agar plate colonies of the calla organism three days old. Grown at a temperature of 37° C. for three days, then kept for two days at about 20° C. (Natural size.) Fig. 3.—Tubes from which agar plates were poured photographed three days after pouring the plates; temperature, about 20° C. The agar was inoculated with a beef-broth culture of the calla organism. (Natural size.)

Plate IV. Fig. 1, A.—Stab culture of the calla organism in neutral gelatin twenty-four hours after inoculation at 18° to 20° C. Fig. 1, B.—Stab culture of the calla organism in neutral gelatin three days old at 18° to 20° C. Fig. 1, C.—Stab culture of the calla organism in +15 (acid) gelatin twenty-four hours after inoculation at 18° to 20° C. Fig. 2.—Raw eggplant in petri dish. Pieces 1 and 4 were inoculated with the calla organism, while pieces 2 and 3 were left for control. The photograph was made three days after inoculation.

Plate V. Fig. 1.—Raw radish in petri dish. Nos. 2 and 3 were inoculated with the calla organism, while Nos. 1 and 4 were left for control. Photographed three days after inoculation. Fig. 2.—Side view of same plate nine days after inoculation. No. 2 was inoculated and No. 1 was left for control.

Plate VI. A.—A cucumber inoculated with the calla organism. Photographed two days after inoculation, when the contents were soft throughout, except the spot near the stem end where the cucumber was inoculated. B.—A cucumber used for control; i. e., it was treated in the same manner as A, except that the calla organism was not applied to the punctures.

Plate VII. Fig. 1.—Raw parsnip root in petri dish. The discolored pieces at right and left were inoculated, while the upper and lower pieces were left for control. Photographed three days after inoculation. (Natural size.) Fig. 2.—Raw carrot root three days after inoculation with the calla organism. Pieces 2 and 3 were inoculated, while pieces 1 and 4 were left for control. (Natural size.)

PLATE VIII. Fig. 1.—Raw turnip root in petri dish. The discolored pieces were inoculated with the calla organism, while the other pieces were left for control. As shown in this figure it is the center of the root that is most readily attacked by the organism. Fig. 2.—Green tomato fruit infected on the plant. The shriveled fruit shown at the base of the stem was inoculated with the calla organism. Photographed ten days after inoculation. The fruit at the left of the one inoculated remained sound in spite of the fact that it was in contact with the diseased fruit.

PLATE IX. Small calla plant, showing roots about 8 inches in length. The corm shows scars where it had evidently been attacked by the soft rot and had either recovered or the organism was dormant at the time the photograph was taken.

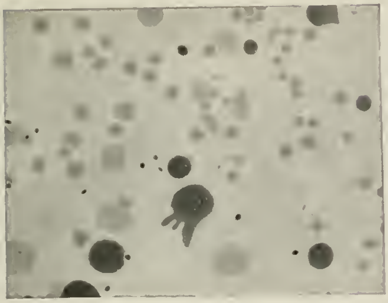

FIG. 2.—AGAR PLATE COLONIES.

FIG. 3.—AGAR PLATE COLONIES.

FIG. 1.—THE CALLA ROT ORGANISM × 1,000.

FIG. 4.—AGAR PLATE COLONIES.

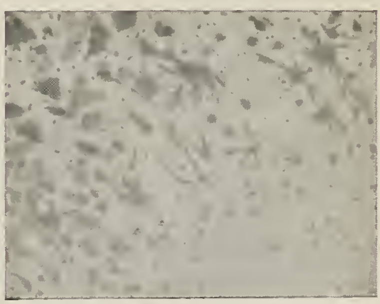

FIG. 5.—AGAR PLATE COLONIES.

FIG. 1.—AGAR PLATE COLONIES OF THE CALLA ORGANISM GROWN AT 25° C.

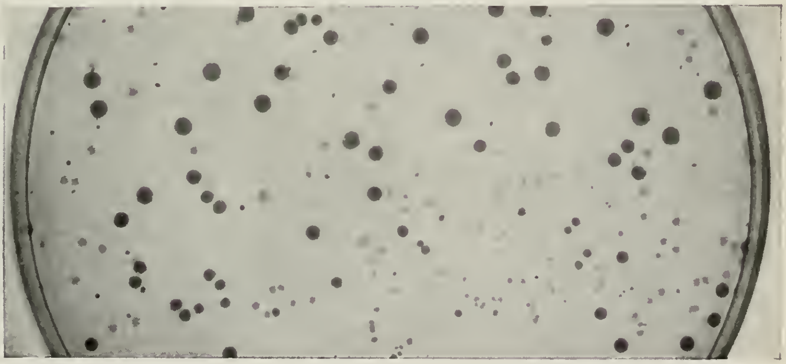

FIG. 2.—AGAR PLATE COLONIES OF THE CALLA ORGANISM GROWN AT 38° C.

FIG. 3.—COLONIES OF THE CALLA ORGANISM IN TEST TUBES.

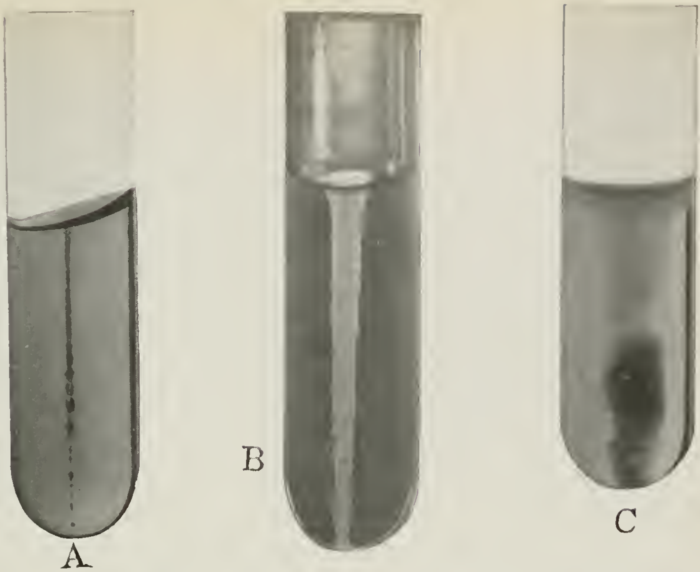

FIG. 1.—STAB CULTURES OF THE CALLA ORGANISM IN GELATIN.

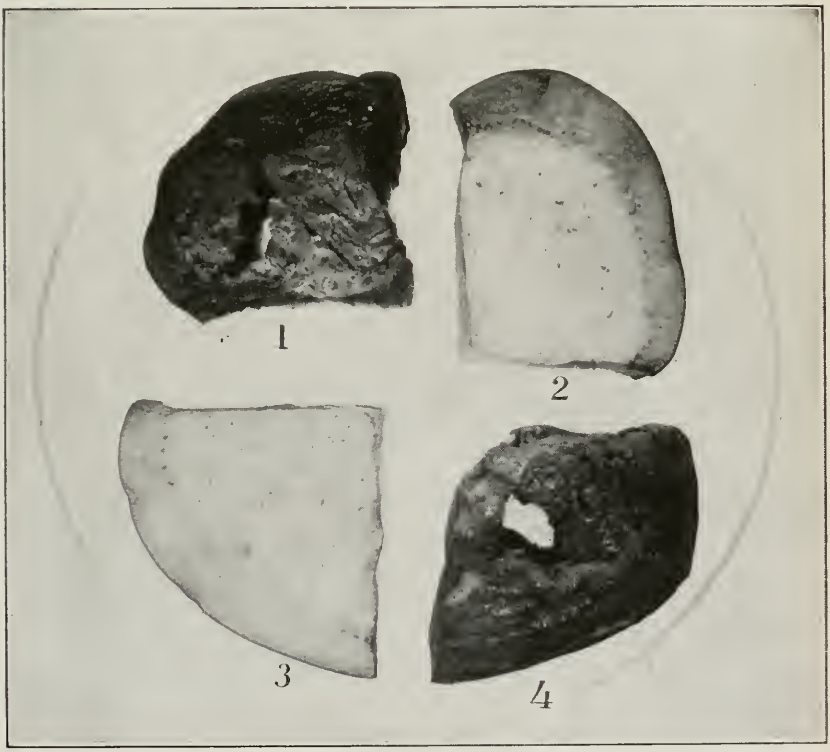

FIG. 2.—RAW EGGPLANT INOCULATED WITH THE CALLA ORGANISM. (NATURAL SIZE.)

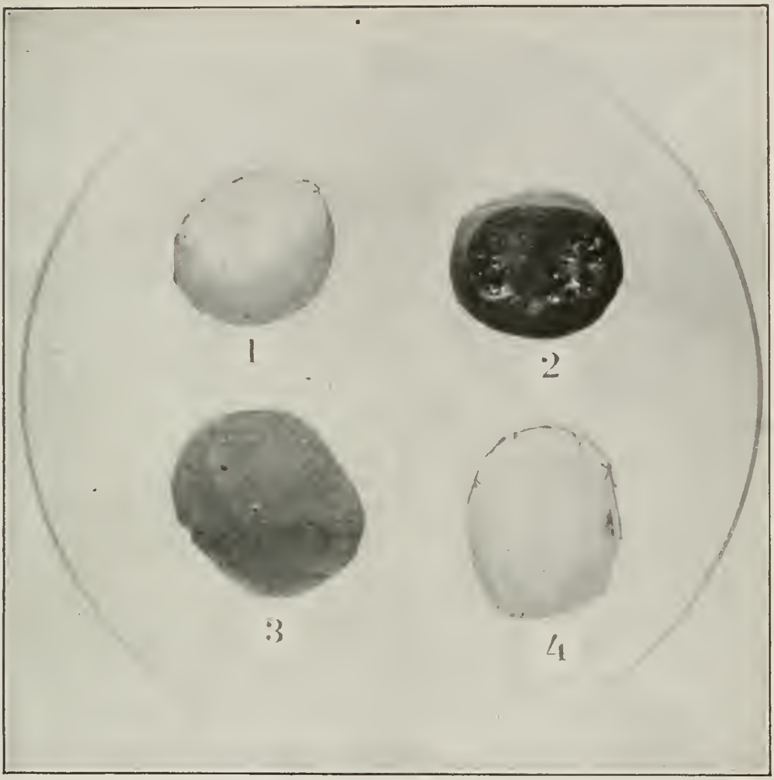

FIG. 1.—RAW RADISH THREE DAYS AFTER INOCULATING PIECES 2 AND 3 WITH THE CALLA ORGANISM.

FIG. 2.—SIDE VIEW OF PIECES 1 AND 2 NINE DAYS AFTER INOCULATING NO. 2.

EFFECT OF CALLA ORGANISM ON CUCUMBER: A, INOCULATED; B, CONTROL.

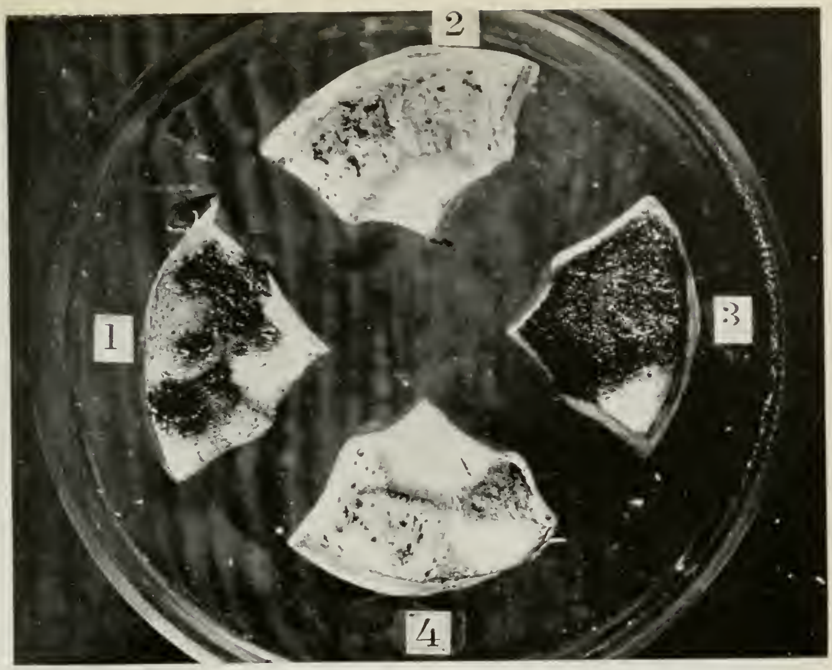

FIG. 1.—RAW PARSNIP THREE DAYS AFTER INOCULATING PIECES 1 AND 3.

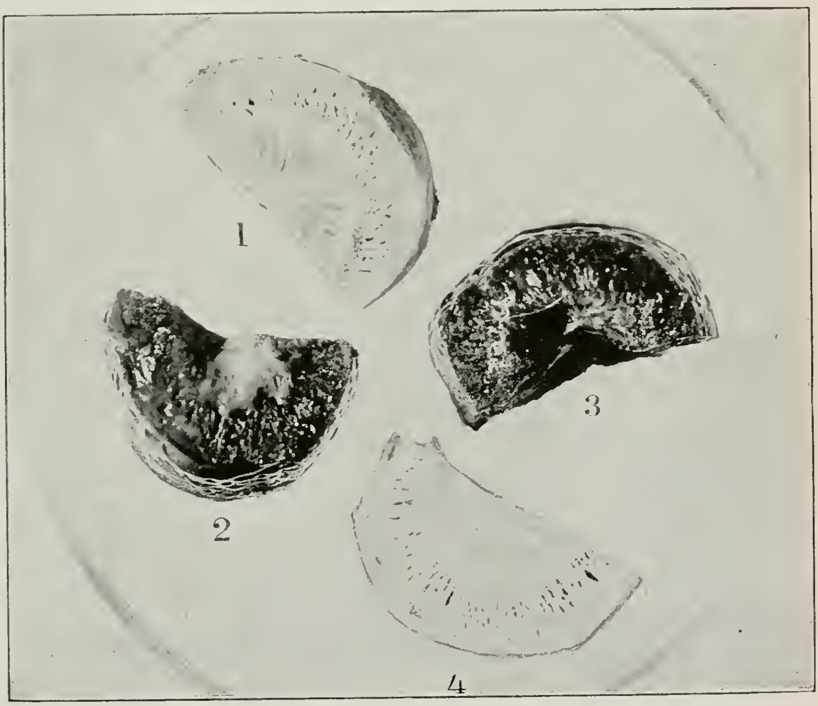

FIG. 2.—RAW CARROT THREE DAYS AFTER INOCULATING PIECES 2 AND 3.

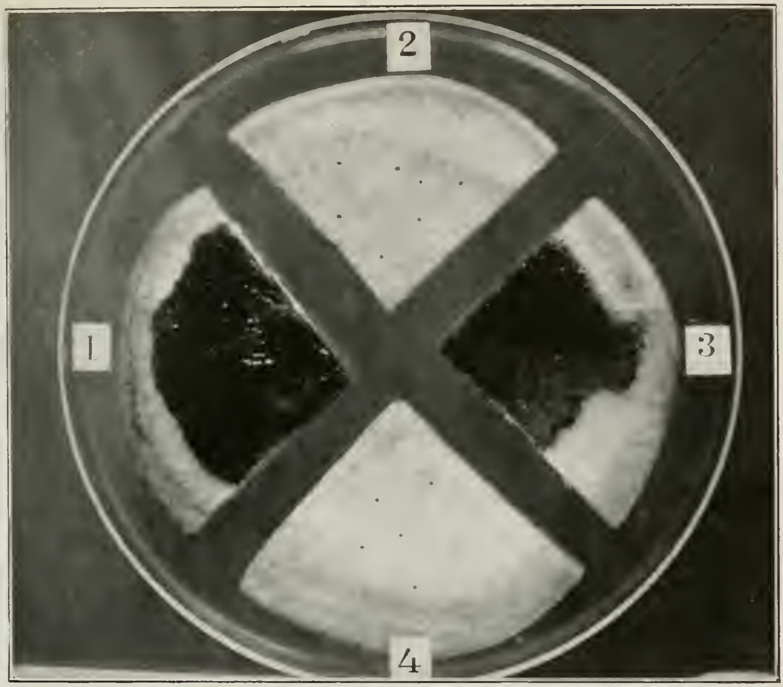

FIG. 1.—RAW TURNIP THREE DAYS AFTER INOCULATING PIECES 1 AND 3.

FIG. 2.—GREEN FRUIT AND BRANCH OF TOMATO: NO. 2, INOCULATED; NO. 1, CONTROL. (ONE-FOURTH NATURAL SIZE.)

SMALL CALLA PLANT, ABOUT TWO-THIRDS NATURAL SIZE.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN No. 61.

B. T. GALLOWAY, *Chief of Bureau.*

THE AVOCADO IN FLORIDA;

ITS PROPAGATION, CULTIVATION, AND MARKETING.

BY

P. H. ROLFS,

PATHOLOGIST, IN CHARGE OF SUBTROPICAL LABORATORY.

POMOLOGICAL INVESTIGATIONS.

ISSUED JULY 7, 1904.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1904.

BULLETINS OF THE BUREAU OF PLANT INDUSTRY.

The Bureau of Plant Industry, which was organized July 1, 1901, includes Vegetable Pathological and Physiological Investigations, Botanical Investigations and Experiments, Grass and Forage Plant Investigations, Pomological Investigations, and Experimental Gardens and Grounds, all of which were formerly separate Divisions, and also Seed and Plant Introduction and Distribution, the Arlington Experimental Farm, Tea Culture Investigations, and Domestic Sugar Investigations.

Beginning with the date of organization of the Bureau, the several series of bulletins of the various Divisions were discontinued, and all are now published as one series of the Bureau. A list of the bulletins issued in the present series follows.

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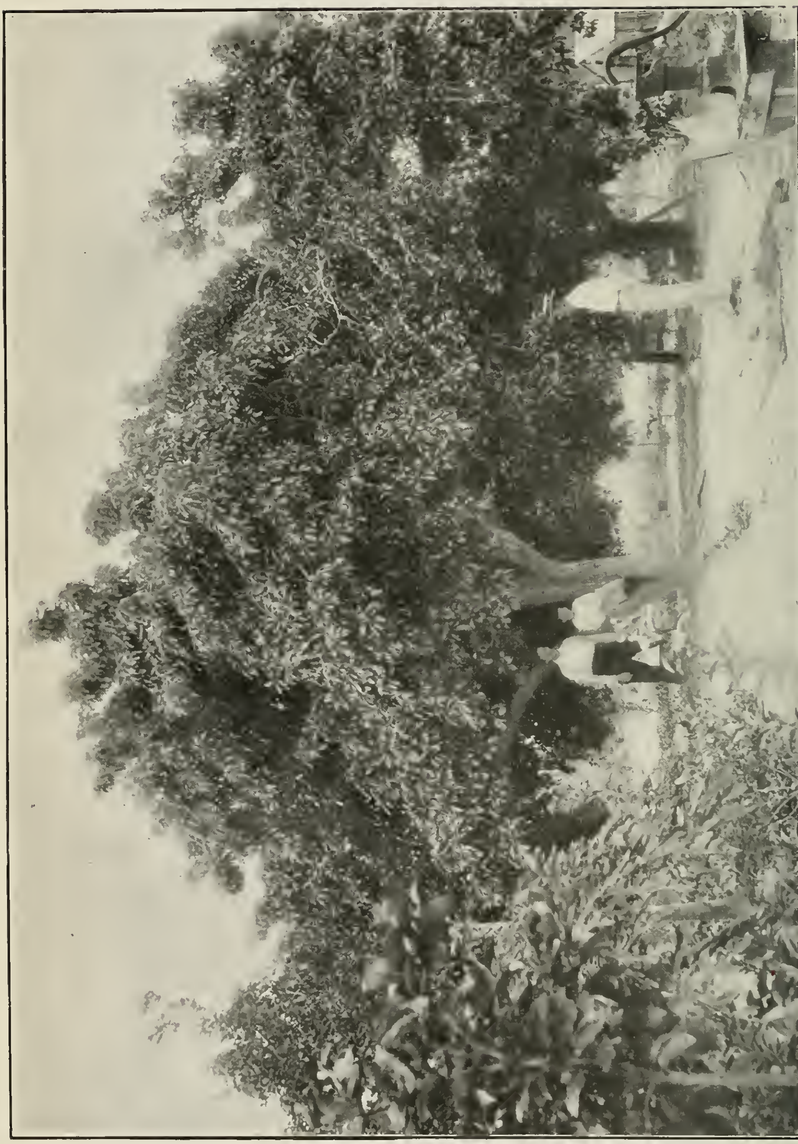
[Continued on page 3 of cover.]



WEST INDIAN-SOUTH AMERICAN AVOCADO TREE, 35 YEARS OLD, GROWING ON A CORAL BRECCIA REEF.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN No. 61.

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POMOLOGICAL INVESTIGATIONS.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., April 7, 1904.

Sir: I have the honor to transmit herewith a paper on "The Avocado in Florida; its Propagation, Cultivation, and Marketing," and respectfully recommend that it be published as Bulletin No. 61 of the series of the Bureau.

This paper was prepared by Prof. P. H. Rolfs, Pathologist in Charge of the Subtropical Laboratory at Miami, Fla., under the direction of Dr. A. F. Woods, Pathologist of this Bureau, but as the subject is pomological rather than pathological, it was submitted to the Pomologist with a view to its publication from his office.

The accompanying illustrations are essential to an intelligent understanding of the text.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

PREFACE.

The avocado (*Persea gratissima*) is one of the most recent fruits to receive intelligent and systematic treatment from American fruit growers. Though long held in high regard by persons living in southern Florida, the West Indies, and most portions of tropical America, it has not until recently attracted the attention of northern consumers, and is, in fact, at this time an interesting novelty rather than a recognized staple of commerce. This is probably due to the fact that it lacks those characteristics of texture and flavor which are sought for in most dessert fruits, so that a taste for it must be acquired by most persons. In recent years, however, its usefulness as a salad fruit has gradually been recognized, so that a growing appreciation of its value in this regard has led to an increasing demand for it in our larger cities.

Until very recently the principal supply for these markets has come from the West Indies, chiefly because of cheaper transportation from those islands than from Florida. The recent extension of railroad facilities to far southern Florida has made possible the safe shipment of this fruit from that section to practically all parts of the country, and interest in its commercial culture there has therefore largely increased.

As it provides a wholesome and nutritious food, which, judging from present demand and prices, will afford a profitable crop in locations suitable to its production, its culture on a commercial scale appears worthy of encouragement in Porto Rico, southern Florida, Hawaii, and such locations in California as are practically free from frost during the blossoming season.

The greatest need at present appears to be the propagation of productive varieties of desirable size, form, and quality, ripening at an opportune time—that is, late in autumn or early in winter, when the demand in northern markets at high prices appears to be best. As the bud propagation of this fruit in a commercial way has but recently commenced, it is believed that this publication, which deals largely with that subject, will be of distinct value to those who desire to engage in its production.

G. B. Brackett,
Pomologist.

Office of the Pomologist,
Washington, D. C., March 29, 1904.

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THE AVOCADO IN FLORIDA; ITS PROPAGATION, CULTIVATION, AND MARKETING.

INTRODUCTION.

The avocado (*Persea gratissima* Gärtn.) might almost be called a new fruit, for, while it has long been used as a food by the American aborigines, it has never been subjected to cultivation and careful breeding. Its value as a food is rapidly becoming known, and it is apparently only a question of time until it will be used extensively. Its shipping qualities permit it to be sent to all the large consuming centers of the United States, while its food value will make it a favorite with all lovers of good salad fruits. These pages have been prepared with a view to systematizing our knowledge of the avocado, and to point out the directions for its improvement.

South Florida seems to be the only region in which the propagation of the avocado has been undertaken in a systematic way and on an extensive scale. Nurseries in that section have thousands of seedlings growing and hundreds of budded trees to put on the market. In addition to this, it seems to be the only region where budded trees have fruited.

The Pollock avocado, grown in South Florida, was exhibited at the meeting of the American Pomological Society in September, 1903. The original tree bears fruit of large size, the largest having approximated 3 pounds in weight. The Trapp avocado, also grown in South Florida, is noteworthy in that it matures late, holding some of its fruit until January.

The essential work of selecting and breeding varieties that are especially adapted to certain sections and that are wanted by the most desirable markets can now be pushed forward.

The fact that it can now be definitely stated that seedlings do not come true to seed and that propagation by budding is possible marks a distinct epoch in the progress of growing this fruit. Another distinct advance in the development of this salad fruit is that seedless fruit has been grown by the writer.

The selling price of avocados varies considerably, the latest ripening ones bringing much the best prices in American markets. Extremely late ones have brought as high as $3 a dozen when shipped in lots of several crates at a time. This price gives the grower $6 to $8 net per crate at the shipping station. The price for good fruit in sound condition has never fallen so low as to make it unprofitable to ship it to markets that use it. In many large cities in the United States the avocado can not be found at all, and as the dealers in Boston, New York, Washington, and New Orleans have been able to handle all the good fruit that has been sent to them, it is not probable that the avocado will be introduced into other centers until these markets have been fully supplied.

THE NAME AVOCADO.

This fruit has been called by various names—avocado, avocado pear, avocate, aguacate, alligator pear, midshipman's butter, etc. As early as 1696 Hans Sloane[a] speaks of the "avocado or allegator pear-tree" and catalogues about a dozen other names by which it is known in literature. Previous to this date the avocado was known from "Nicaraguae and other portions of the American continent."

Murray's New English Dictionary prefers the name avocado and gives the following reference:

> Taylor *Anahuac* IX, 227 (1861). This is a well-known West Indian fruit which we call an avocado or alligator pear, and which the French call "avocat" and the Spanish "aguacate." All these names are the corruption of the Aztec name of the fruit "ahuacatl."

Meissner[b] gives the following names as being used in various parts of America:

> In Peru, Palto and Aguacate; in Central America, Aguacate de Anis; in Mexico, Aguacate; in Brazil, Avocate; in Antigua and British Guiana, Avocado Pear and Alligator Pear; in French Guiana, Laurier Avocat.

The Florida State Horticultural Society[c] prefers the name avocado, while the American Pomological Society[d] gives preference to aguacate and uses avocado as second choice. When the Catalogue of Fruits shall be again revised, avocado will doubtless be given preference.

According to the Century Dictionary, avocado is a corruption from the Mexican. The addition of the word pear, while describing the shape of the fruit in some varieties, is otherwise inappropriate, since the avocado belongs to the laurel family, while the pear belongs to the rose family. How such a barbarism as "alligator pear" could have been perpetrated upon this salad fruit it is difficult to imagine. The name avocado is short, concise, and has the advantage of being largely used by the American growers of this fruit.

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[a] Catalogus Plantarum quae in Insula Jamaica Sponte Proveniunt, Pars Prima, London, 1696, p. 185.

[b] Martius, Flora Brasiliensis, Vol. V, pt. 2, fasc. 41, p. 159.

[c] Transactions, 1902, p. 20.

[d] Proc., Am. Pom. Soc., 1901, Part II, p. 59.

Mr. C. P. Taft[a] says of the avocado in California:

The avocado, or alligator pear, is destined to receive more and more attention as it becomes better known. It is fairly hardy, and a good grower and bearer. Importations from Mexico are frequent in the Los Angeles markets, where they sell for fancy prices.

Mr. A. A. Boggs[b] says:

The avocado or alligator pear (*Persea gratissima*) is already growing rapidly in favor in a few of the larger cities where people are beginning to learn its superior excellence as a salad fruit, and it bids fair to become an important market crop. It has, however, been grown entirely from seed, and as it varies widely in size and quality, there is urgent need of improvement in method of propagation. All efforts to bud or graft have hitherto proved abortive. The Department of Agriculture made an importation of seed of a Mexican variety about three years ago. Some trees from these have already come into bearing, and proved a disappointment. The fruit is entirely too small and the flavor certainly not superior to the average of the old type.

Mr. Byron O. Clark[b] says of this fruit in Hawaii:

The avocado or alligator pear is the one fruit which captures the palate of the visitor to the Tropics more firmly than any other, provided he acquires a liking for this fruit. With the richness and consistency of butter, and a flavor of nuts, it is undoubtedly one of the most popular fruits, if not the most popular with residents, and acquires such popularity with persons who visit the islands that a good market for shipment to the coast is open at any time the fruit can be had. Like almost all other kinds of fruit here, the home market is not nearly supplied, and the prices are so high that none but the wealthy can use them, except as a luxury.

LITERATURE.

Very little has been written about the propagation of the avocado. It was introduced into Europe as early as the seventeenth century, but has not yet been generally disseminated. Simmonds's "Tropical Agriculture" does not mention it at all. Woodrow's "Gardening in India," published in 1899, does not refer to it.

Dr. F. Franceschi[c] speaks of its having fruited in southern California. He also points out that the demand for it in the larger cities of the United States is greater than the supply.

In 1899 Capt. John J. Haden[d] exhibited fruit of the avocado in Philadelphia.

The Botanical Register of 1829 published a colored plate of this fruit (No. 1258), and referred to it as having been introduced from the continent [America], and as one of the rarest species cultivated in the greenhouses.

Curtis's Botanical Magazine for May 1, 1851, published a colored plate of an avocado presenting rather an unusual combination. The

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[a] Proc., Am. Pom. Soc., 1901, p. 92.

[b] Proc., Am. Pom. Soc., 1901, p. 88.

[c] Proc., Am. Pom. Soc., 1897, p. 100.

[d] Proc., Am. Pom. Soc., 1899, p. 88.

figures of the branches, including the leaves and infloresecence, are undoubtedly the West Indian–South American form. The size of the fruit is that of the West Indian–South American form, while the color of the skin is exactly that of the Mexican avocado. This publication also suggests that "it is increased by cuttings, treated in the usual manner." So far as the writer's experience goes, the cuttings are difficult to strike without bottom heat.

In the Yearbook of the United States Department of Agriculture for 1901, page 354, Mr. O. F. Cook refers to the avocado as one of the important fruits of Porto Rico, and says:

> The alligator pear, also called butter pear, aguacate, and avocate, is a tropical fruit now relatively little known, but with every prospect of a gradually increasing popularity. It is a pear only in shape, and might better be compared to the olive, because it serves as a salad or a relish rather than a fruit in the ordinary sense, and frequently becomes a favorite, even with those who do not like it at first. The flesh has a delicate buttery consistency, and is eaten with vinegar, salt, and other condiments, or is used as an ingredient of other salad compounds. The promise of agricultural and commercial importance for this fruit lies in the fact that it already has a distinct, if limited, place in the markets of our larger cities at from 30 to 60 cents apiece, prices which might be halved or quartered and still leave good profits for both grower and dealer. Moreover, even at these large prices the supply of first-class fruit seems to be unequal to the demand.
>
> The alligator pear is perhaps the one fruit which Porto Rico is ready to send to market in considerable quantity and of prime quality. The tree is easily propagated from seed, is a vigorous grower, and a free bearer, and there is no apparent reason why the alligator pear may not become almost as cheap and nearly as popular as the orange.

In the Report of the Florida State Horticultural Society for 1902, Mr. Boggs says:

> Of equal promise and of greater present market importance is the avocado pear, which is to-day the most costly fruit on the American market, and is making more friends every season. The importance of budding and grafting as applied to this fruit is greater than the securing of better varieties from abroad, for Florida now produces the best in the world, but in eliminating the inferior sorts which form a large proportion of seedling orchards and in regulating by selection the season of fruitage. There are now trees in Dade County which ripen fruit as early as July 15 and others as late as January 15. The significance of this fact needs no comment.
>
> Choice avocados retailed last season at from 35 cents to 75 cents each in the cities, and the demand seems to outgrow the supply. It is urged that this society, in its catalogue, should encourage the use of the name avocado, both on the score of correctness and of euphony, in place of the absurd misnomer "alligator pear," which leads to many mistakes.

Mr. W. A. Marsh also makes reference to this fruit in the Report of the Florida State Horticultural Society for 1896, as follows:

> The alligator or avocado pear (*Persea gratissima*) is one of the most highly prized of all tropical fruits. It belongs to the order of Lauraceæ. The fruit is sometimes round, also pear-shaped, containing one large seed about the size and shape of a hulled walnut. The fruit when mature varies in color from a bright green to a deep rich brown, sometimes mottled with both colors. Its flesh is a vegetable marrow,

sometimes called midshipman's butter, and held in various degrees of appreciation by different persons. It is also used as a salad, being dressed with pepper, salt, and vinegar, in which style it is relished by most people. The tree is of stately growth, often reaching the height of 40 or 50 feet in Florida. It is an American fruit; it was introduced into the gardens of Spain in 1601, and into the Sunda Isles about the middle of the eighteenth century. At the beginning of the eighteenth century this tree did not exist in the gardens of British India. In America its actual area in a wild state is of uncommon extent. It has been found in the forests, on the banks of rivers, and on the seashore from Mexico and the West Indies to the Amazon. At the time of the discovery of America it was found both wild and cultivated in Mexico. According to Hernandez it was cultivated by the people of Peru under the name of "palto," but there is no proof that it was wild in that country.

Mr. W. Harris refers to it in Bailey's Cyclopedia of American Horticulture as follows:

The avocado or alligator pear is a native of the West Indies, Mexico to Peru, and Brazil. It is very common in Jamaica, being found in every settlement or plantation. The tree grows to a height of 25 to 30 feet. It has elliptical or elliptical-oblong leaves, 4 to 7 inches long, glabrate and pale beneath. The fruits are large, more or less pear-shaped, and covered with a green or deep purple skin and containing a large quantity of a firm yellowish-green pulp, inclosing a single large seed. This fruit is highly esteemed by all classes in the West Indies. The pulp is marrow-like, and is eaten as a salad, usually with the addition of pepper, salt, and vinegar. Europeans as a rule do not like the fruit at first, but once the taste is acquired they become exceedingly, often excessively, fond of it. The pulp contains an abundance of oil, which may be used for illuminating purposes; also for soap making. The seeds yield a deep, indelible black stain, and are used for marking linen. Plants are easily raised from seeds, and in good soil in warm situations they grow rapidly and begin to fruit when about 5 years old. There are a good many varieties, differing from each other in size, shape, and quality of fruit. These differences are not due to careful cultivation and selection in all cases, however, but to natural variation and accidental intercrossing.

DISTRIBUTION AND TIME OF BLOOMING.

Meissner[a] gives the habitat of the avocado as "the forest, especially on the seacoast and following the rivers of tropical America, as well as in Mexico, Peru, Colombia, Guiana, and the islands of the Antilles, thence to subtropical localities where this agreeable fruit is cultivated. It is found in Brazil, about Peru, and elsewhere; also about Yurimagnus, in Peru, and in English Guiana."

Emile Rodigas[b] thinks that the avocado is native to Brazil. He figures a large green fruit without a seed cavity. It is interesting to note that according to this author it was introduced in France in 1750.

An herbarium specimen in the New York Botanical Garden, collected by Mr. H. H. Smith, in Colombia, is accompanied by a note stating that the species has every appearance of being native to the mountain forest at an altitude of from 1,500 to 2,500 feet. The time

[a] Translation from Martius, Flora Brasiliensis, Vol. V, Part II, p. 159.

[b] L'Illustrations Horticole, XXXVI: 15 (1889).

of blooming is given as from December to April. The specimen is in full bloom and bears the date of December 7, 1898.

Dr. William Trelease, Director of the Missouri Botanical Gardens, who has made repeated excursions to Mexico in connection with the study of agaves, informs the writer that the smaller avocado with the bluish or blackish fruit (the Mexican avocado) is most commonly found in the markets on the eastern side of the country, while the larger forms occur on the western slope.

Specimens in the herbarium of the New York Botanical Garden and in the United States National Museum indicate that the avocado has been widely disseminated. Among those occurring in the herbarium of the New York Botanical Garden are some collected at the following places and on the dates given, which are of special interest: Colombia, December 7, 1898; Nassau, N. P., March 12, 1903; Key Largo, Fla., March 26–29, 1898; island of Saint Croix, March 4, 1896; Porto Rico, March 8, 1899; Porotonga, Cook Islands, June, 1899; Monterey, Mexico, January 10, 1828; San Luis Potosi, Mexico, 1879; Nicols Town, Andros (Bahamas), March 24, 1890; St. Vincent, British West Indies, April, 1890; Java, 1865; Jamaica, 1827. The following specimens were found among those in the herbarium of the United States National Museum: Martinique, 1871; Danish West Indies, March 4, 1896; Santo Domingo, March, 1871; Colima, Mexico, March, 1841.

The foregoing fifteen localities from which specimens of this species have been collected show how widely it has been distributed. The fact that specimens were collected in Java as early as 1865 shows that the plants had been imported a considerable time previous to that date. While no specimens from the Hawaiian Islands were found in the herbaria referred to, it is well known that the species occurs there in large quantities. It is also said to occur in the Seychelles Islands and in Madagascar, and it is doubtless found in all other tropical islands, and to some extent on the seaboard of almost all tropical countries.

The herbarium specimens referred to give some interesting information regarding the time of blooming. Those collected in Colombia show a date of blooming of December and January, while a note upon one of the herbarium sheets indicates that the time of blooming extends from December to April. In Mexico the period of blooming seems to be about the same as in Colombia. In the West Indies, except the Bahamas, the earliest bloom may occur as early as February, but the season of bloom closes in April. In the Bahamas and Florida the flowers usually appear about the first of March, though sometimes blooms occur as early as February, while the blooming period closes in April.

The season near the equator appears to be lengthened into five months. A shortening of the period of blooming seems to have occurred by crowding the entire period into the las' two months when the species is taken to the northern limit of its zone. Some allowance must be made for variations that occur from year to year, but this does not amount to more than two or three weeks in South Florida. The commercial importance of having this fruit come into the market as late in the season as possible and in considerable quantity can not be overestimated.

THE AVOCADO FOR WIND-BREAKS AND SHADE TREES.

Nearly every orchardist is confronted with the necessity of securing good shade trees about his premises, and especially a screen for outbuildings and for servants' houses. In addition to shade the question of wind-breaks is of great importance where high winds are almost certain to occur every year. The vigorous-growing varieties of avocados meet these needs as satisfactorily as the purely ornamental trees, and in addition may be expected to give a return of fruit. The fact that the avocado can utilize almost any kind of organic fertilizer without becoming diseased makes it much more desirable for these purposes than mangoes and citrous trees. The tall, sturdy growth makes free pruning of the lower limbs possible, so as to permit the passage of persons and animals under the trees, while the abundant growth of leaves will still produce a dense shade.

METHODS OF STARTING AN ORCHARD.

The general method of securing an orchard of avocados in Florida is to germinate seed in a quart or a two-quart tin can, and after the seedling has attained the height of a foot or two the can with its contents is transferred to the field where the tree is to grow. A still more primitive way of starting an orchard is to plant the seed in the soil where the tree is to stand. There is no great difficulty in starting an orchard in either way, since the largest seeds (fig. 1) weigh several ounces and have great vitality. If it does not happen to become infected by some germs of decay the seed may lie in the soil for an entire year awaiting a time favorable for germination. The unusual amount of nourishment stored up in the seed enables the seedling to make repeated starts after being dried off. It is capable of renewing its roots several times, as well as its top.

This method of starting an orchard is quite certain and inexpensive. When the trees are one or two years old they may be budded to any desired variety. While this is better than to await the uncertain results and certain disappointment of a seedling orchard, yet top-working is expensive, and if budded trees of known variety can be obtained from a good nursery they will be found cheaper in the end and much more satisfactory.

THE SEED BED.

Seed may be obtained in large quantities during the ripening season from southern Florida, Cuba, and other places in the Antillean region. At the present time good seeds cost from $1\frac{1}{2}$ to 2 cents each. These prices seem somewhat high, but every seed is nearly certain to make a seedling.

The seed bed should be made in some moist locality, in soil free from rocks and containing an abundance of vegetable matter. The rows may be made such distances apart as will suit convenience—from 1 to 4 feet. Place the seeds from 4 to 6 inches apart in a drill 3 or 4 inches deep; firm the soil about the seed and cover 2 or 3 inches deep. Supply a heavy cover of mulch.

As soon as the seedlings (see fig. 1) appear above ground, fertilizer may be applied. The mulch should be turned back, the fertilizer raked in or cultivated in, and the mulch replaced. If the seedlings are to be removed to the nursery soon, fertilizing and cultivating may be omitted. Removal to the nursery may be deferred until seasonable weather.

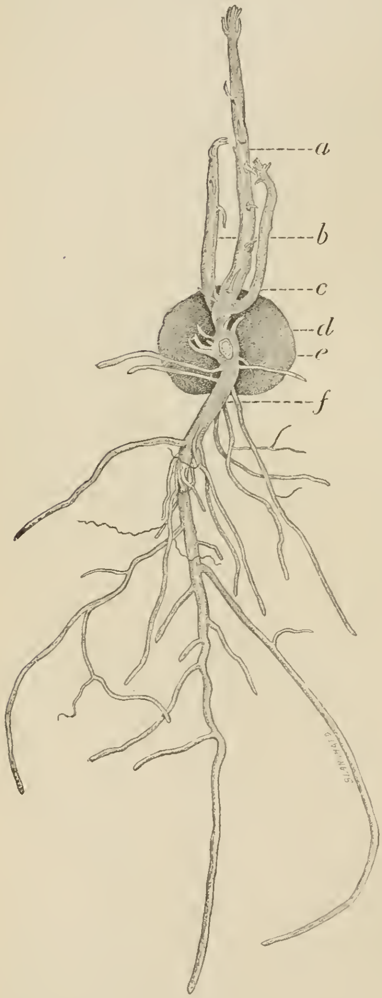

FIG. 1.—Seedling avocado in December from seed planted in September (somewhat slow in starting, but otherwise apparently normal): (*a*) First shoot to start; (*b*) second shoot starting from the axil of the incipient leaf; (*c*) third shoot to start—in case of severe drought or other adverse conditions, all of these shoots may fail and some other bud grow into a new shoot; (*d*) scale-like leaf; (*e*) one of the cotyledons, the other having been removed, scar opposite *e*; (*f*) primary root. (Reduced to one-third natural diameter.)

THE NURSERY.

For starting a nursery the best land should be selected, especially such as is fairly dry though never suffering from drought. Land that is subject to flooding should by all means be avoided. While the trees are able to live in standing water for two or three weeks, they become subject to attack by various forms of disease. When practicable, a generous application of fertilizer should be made two or three weeks before the trees are set out. It should be scattered down the row and raked in, in the usual way. The land should be thoroughly grubbed and put into a first-class state of cultivation.

Transplanting to the nursery should be done when the seedlings are 6 inches to a foot high. After this time the taproot (see fig. 1, *f*) will have formed and the transplanting will disturb this and prevent it from growing to the large size that it would attain if the seedling were not removed.

For transplanting, rainy weather should be chosen; otherwise much watering will be necessary or many trees will be lost. From the nurseryman's point of view the planting in a seed bed seems unnecessary, but seeds planted in a nursery produce trees with large taproots and few fibrous roots; this is especially the case on land that is more or less sandy.

In the nursery the rows should be from 4 to 6 feet apart and the trees set about a foot apart in the row. By thorough cultivation and generous fertilizing an abundance of fibrous roots will be produced, and if the nursery is located on moist land most of the trees will produce many branched roots and very few large roots.

CULTIVATION IN THE NURSERY.

After planting in the nursery, cultivation should be thorough and frequent. The implements should not be permitted to go deeply into the soil if it is sandy, but in marl or heavy lands cultivation should be as deep as is practicable.

BUDDING.

There have been many and varying reports regarding the possibility of budding and grafting the avocado. A few years ago it was thought impossible to bud it at all. More recently statements have been made that 90 to 100 per cent of the buds had "taken." These reports when investigated have been only partially verified, since a large percentage of the buds that take fail to develop. In the avocado there seems to be no difficulty in making the buds take, but there is considerable difficulty in making them start. The buds placed in a vigorous stock are frequently grown over, thus obliterating the bud. Or again, the stock on being lopped to induce the bud to start often dies back to below the bud. Experience indicates that budding at or near the crown is preferable to top-working.

The difficulty is not with budding but with the want of experience up to the present time. The nurserymen do not fully understand the time and manner best suited for budding their stock. Some buds respond promptly, while others are very dilatory about starting and may finally fail.

Shield buds (fig. 2) inserted in the spring when the bark slips well and before the first flush, usually take well and make an excellent growth. It is very important in the work of budding that the stock and scion be in as perfect condition as possible. (See figs. 3 and 4.)

Bud sticks (fig. 5) are cut from well-matured growth, especially such as shows an abundance of active buds. (See fig. 5, *a*, *a*, *a*.) Wood with many blind buds (see fig. 5, *b*, *b*, *b*) should be avoided and care taken not to use such buds in propagating. Some are likely to occur on any stick.

Various methods of budding have been adopted and some forms of grafting have been suggested. The common shield bud (fig. 2) seems to be about as successful as any that have been tried, though the patch bud is also used with a considerable degree of success.

FIG. 2.—Shield bud cut out preparatory to insertion.

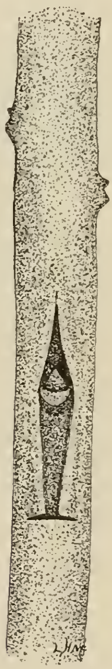

FIG. 3.—Seedling avocado stock with shield bud inserted.

FIG. 4.—Shield bud wrapped with waxed cloth.

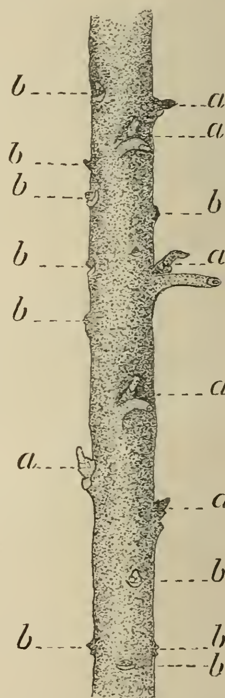

FIG. 5.—Bud stick; *a*, *a*, etc., "live" buds in various stages of development; *b*, *b*, etc., blind buds which should not be used.

GRAFTING.

Baltet[a] recommends four different methods of grafting: (1) Inarching, (2) veneer grafting, (3) cleft grafting, and (4) veneer grafting near the root. In inarching and cleft grafting the top of the stock is figured as having been cut away. In the other two methods the top of the stock is left until the scion has started. Well-matured wood will live for several weeks if kept in a sufficiently moist condition, and will doubtless unite readily with the stock, but it is much more wasteful of scion wood and a more tedious process than budding.

[a] L'Art de Greffer, 7th ed., Paris, 1902, p. 226.

TRANSPLANTING TO THE FIELD.

A great deal of the difficulty that has been experienced in transplanting the avocado is due to the fact that most of the trees have been grown in "fence corners," or possibly they have been permitted to grow under the tree where the seed fell, thus producing tall, slender seedlings, with very few branches and long taproots, but not many fibrous roots. A very different result is obtained from trees grown in a nursery (see Pl. III), where, as previously stated, an abundance of fibrous roots and a good bushy top are produced. A tree of this kind transplants without any greater difficulty than is experienced with other orchard trees.

One hundred budded trees to an acre are sufficient. If the grower proposes to have a seedling orchard the trees should be set closer—160 to 200 per acre. This should be done with a view to cutting out the inferior ones when they come to fruiting. Of the large-growing varieties 80 trees to the acre will be found sufficient. If the variety is tall and spindle shaped instead of bushy, a larger number may be planted.

In the Antillean region trees grow during the entire year, so there is no sensible gradation into winter or anything that corresponds to a dormant season, strictly speaking. While fruit trees are usually in a more or less quiescent state during January and February, this condition is brought about by a diminution in rainfall rather than as the result of a reduction in temperature.

The time to transplant avocados is determined, as in the case of the nursery, by the presence of sufficient moisture, and a suitable moist period will usually occur in Florida during June, July, or August. As the expense of watering during a dry season is much greater than the cost of the tree it is cheaper to set the tree out during a rainy season.

A tree should not be transplanted until it has attained a height of about 3 feet in the nursery (see Pl. III).

In taking up these trees as many of the smaller roots should be secured as possible. The roots should be kept moist and the tree well watered when set out. The top should be cut back to some extent, but enough foliage left to shade the stem. If the tree is not sufficiently provided with leaves an artificial shade can be made by the use of palmetto fans.

TOP-WORKING TREES.

Bearing trees may be top-worked (see Pl. II, fig. 2), but it is necessary to insert buds on vigorously-growing sprouts to succeed. If there are no sprouts with bright green bark, they may be induced to grow by cutting back the branches and thus stimulating some of the latent buds, or by cutting the trees off near the ground and then waiting for sprouts to start from the crown. Several of these sprouts are then budded and the most vigorous of those that have taken are permitted to grow (see Pl. II, fig. 1).

CULTIVATION.

When the trees are set in the field a considerable quantity of mulch should be placed about them; this prevents the soil from becoming hot about the roots and from drying out.

In Florida it is better to plant some field crops, such as cowpeas or velvet beans, or to sow beggar weed in a young orchard. During the winter, crops of vegetables may be grown in the orchard with advantage to the trees. The "middles" may be planted to pineapples, since the pineapple fertilizer will produce a good growth of avocado; but there is the disadvantage that these plants will dry out the soil severely during a drought. During dry weather cultivation should be frequent and thorough, but not deep; 3 inches of soil mulch is sufficient to conserve capillary moisture. During the rainy season cultivation may be suspended entirely and the middles planted to some cover crop, as indicated above.

FERTILIZERS.

In selecting fertilizers a formula should be chosen in which the ammonia is from an organic source, such as dried blood or cottonseed meal, in preference to sulphate of ammonia or nitrate of soda. Sulphate of potash will be a safe form to employ as a source of potash. It should be used in liberal quantities to insure good firm leaves and wood, and also to prevent the dropping of the fruit. Phosphoric acid, so far as experiments teach, may be supplied from any source that is ordinarily used. If the trees be planted about poultry yards, or fowls are allowed to roost in the trees, potash will be all the fertilizer needed, but this should be used liberally to keep the trees healthy and free from insect attacks. Such trees when not fertilized with potash are usually attacked by insect pests, but as a rule are exempt from Glœosporium.

When commercial fertilizers are to be applied, the ordinary "fruit and vine" fertilizer, with the ammonia from an organic source, may be used. The quantity required will vary according to the concentration of the particular brand, the character of the soil in which the trees are growing, and the age of the trees. Fifteen pounds per tree per year of fertilizer prepared according to the following formula will be found good for growing trees four or five years old: Ammonia, 5 per cent; potash, 6 per cent; phosphoric acid, 6 per cent.

As the trees grow older and begin to fruit heavily, increase the percentage of potash and phosphoric acid. Apply the fertilizer in two or three doses during the growing season. The time of applying must be determined by the particular orchard under consideration; ordinarily an application should not be made during December or January, as it would be likely to force an early spring growth or even cause a vigorous winter growth, which should be avoided.

If the trees be put into a dormant or semidormant condition during December and January, they will make a strong spring growth and produce a heavy crop of bloom. If the bloom is retarded as long as possible the blooming period will be shortened, and consequently the fruit will mature more nearly at one time, thus doing away with the necessity of making several pickings from the same tree.

Trees that have been neglected do not prove productive unless they happen to be standing on some place where a large quantity of organic matter has accumulated. Trees on abandoned homesteads located in the piney woods soon become unproductive and require two or three years' nursing to bring them back to good growth and bearing. It usually pays better to start in with good, fresh trees from the nursery than to attempt to " bring out " an abandoned orchard.

SUPERIORITY OF BUDDED TREES.

The earlier productiveness of orchards composed of budded and grafted trees has been repeatedly demonstrated with most of the tree fruits that are grown under cultivation. While occasional seedling trees of most species bear at as early an age as the ordinary budded or grafted tree of the same species, the trees in a seedling orchard usually vary greatly in this particular, and on the average come into bearing much later than budded or grafted orchards of varieties of the same types of fruits grown under similar conditions. While many factors are concerned in producing this result, the greatest advantage of budding and grafting is that varieties of known precocity and productiveness, as well as other desirable characteristics, can be perpetuated with little variation, while the seedling orchard contains individuals differing widely in some or all of these important particulars

Seedling avocados usually do not fruit until they are four or more years old, and they are usually six years old before bearing a crop. There are exceptions to this, but the number of seedlings that bear a good crop before they are six years old will not amount to 10 per cent.

VARIATION OF FRUIT FROM SEEDLING TREES.

The systematic work of propagating and cultivating avocados is just beginning. The fruit being of American origin, it has come into cultivation rather recently, and has not had the benefit of centuries of selection and propagation, as is the case with many other orchard fruits. Throughout Central America and the West Indies it grows in a native state, and only half-hearted attempts are made to put it into cultivation. So far as the writer is aware, no orchard of any considerable size exists outside of Florida. In Cuba, Jamaica, Porto Rico, and the Bahamas a few seedling trees are growing around nearly every settler's place. The owner plants the seed and takes his chances as to the character and fruitfulness of the tree. Under these conditions a considerable quantity of fruit is being grown and marketed, but the product is of an exceedingly variable nature. The two following illustrations prove the truth of this statement.

DESCRIPTION OF VARIATIONS.

Mr. G. L. Macdonald, of Cocoanutgrove, Fla., related his experience to the writer. In preparing for his orchard Mr. Macdonald selected the seed from a tree that bore fruit of exceptionally fine quality and in large quantity. At the time the selection was made it was generally believed that avocados came true to seed. The parent tree produces pear-shaped avocados of large size, fine flavor, and purple color, ripening late. The seedling orchard from this tree has now come into bearing and produces fruit of variable size and shape; good, bad, and indifferent flavor; the color varying from green through yellow to purple; and the fruits ripening at different times in the season.

The following census, taken near Buenavista, Fla., in an orchard of about an acre in extent, shows how little foundation there is for the belief that the avocado trees are unusually fruitful and that the tree comes "true to seed." The impression that the tree is unusually fruitful doubtless originated from the fact that occasional trees bear a heavy crop (see Pl. III), causing the observer to overlook the dozens of trees that have less than ten fruits each or possibly none at all. The unfruitfulness and the variability of the product is not more than should be expected from an orchard of seedlings.

This orchard contains 160 trees, 110 of which are five or more years of age and of a size to permit the smallest to bear 50 fruits, weighing from a pound to one and one-half pounds each. This number of trees produced 1,161 fruits in 1903, a year during which the avocado crop was unusually heavy. This gave an average of approximately 10 fruits to the tree. Forty-seven trees bore no fruit at all; 41 trees bore from 1 to 12 fruits; 22 bore a crop of more than 12 fruits, 9 of these latter trees bearing 595 fruits, or slightly over half the crop. The four most prolific trees bore 385 fruits—that is, one-twelfth of the trees produced one-third of the fruit, or, stating the matter in percentages, 43 per cent of the trees produced no fruit; 37 per cent produced 1 to 12 fruits each; 20 per cent produced over 12 fruits each.

Considering only the prolific trees, we find that 8 per cent of the trees produced 66 per cent and that 3 per cent produced 33 per cent of the fruit.

The nine trees that produced at least a fair crop were of medium size, while the largest and most vigorous trees in every instance bore less than a fair crop.

The trees referred to above were from specially selected seed, so that it may safely be assumed that they were up to the standard for seedling orchards of the same type that have received fair attention and are of the same age. Some of the trees that were without fruit this year had a fair crop last year, indicating a tendency on the part of the avocado to fruit in alternate years. The most fruitful trees are only moderately vigorous and of a bushy growth.

Of the 63 trees that have fruited in the orchard mentioned there are only 2 which combine good qualities in such a way as to be of special merit. Some trees that bear fine fruits are not prolific; others ripen their fruit at an inopportune time of the year, while still others bear a fair crop at the right time but the fruit is inferior in quality. (See figs. 6, 7, A; 8, and 9.)

If a census of all the seedling orchards were taken, it is not probable that the general results would be very different, but this is just what should be expected in propagating from seed a species that is so variable as the avocado.

MARKETING.

PICKING.

The time of ripening of the avocado extends in Florida from the middle of July to December. As now grown, the fruits of a tree do not as a rule mature uniformly, so that in most cases two or more pickings have to be made. The variation in this respect is so much an individual characteristic that the peculiarities of each tree in the case of a seedling orchard, and of each variety if budded, will have to be ascertained by test. The fruit must be removed from the tree while it is still very firm if it is to be shipped to a distant market. For local consumption the crop may be permitted to remain on the tree until a few fruits have fallen.

In picking, the avocado should be broken off so as to leave a portion of the stem attached to the fruit. If a particular variety does not break properly, an orange clipper or the ordinary pruning shears may be used. If the stem be pulled out of the fruit, as occurs in "drops," there is a strong probability that some of the fruit will be lost from ripe rot in transit, or by softening in the hands of the dealer.

GRADING AND SIZING.

With the avocado, as with all other fancy fruits, it is necessary to exercise care to have all the specimens in a crate of uniform shape and

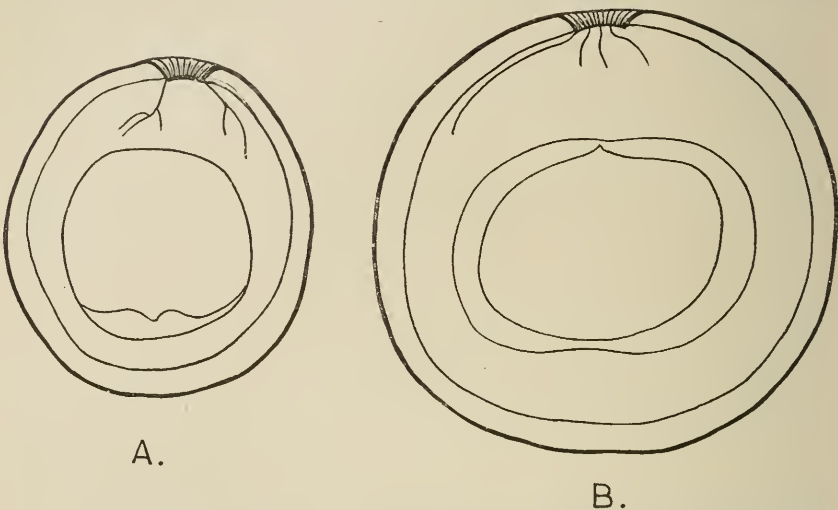

Fig. 6.—Longitudinal sections of round avocados, West Indian-South American varieties (about one-half natural diameter): A, seed filling the cavity; B, fruit from another tree of better quality, but seed loose in the cavity.

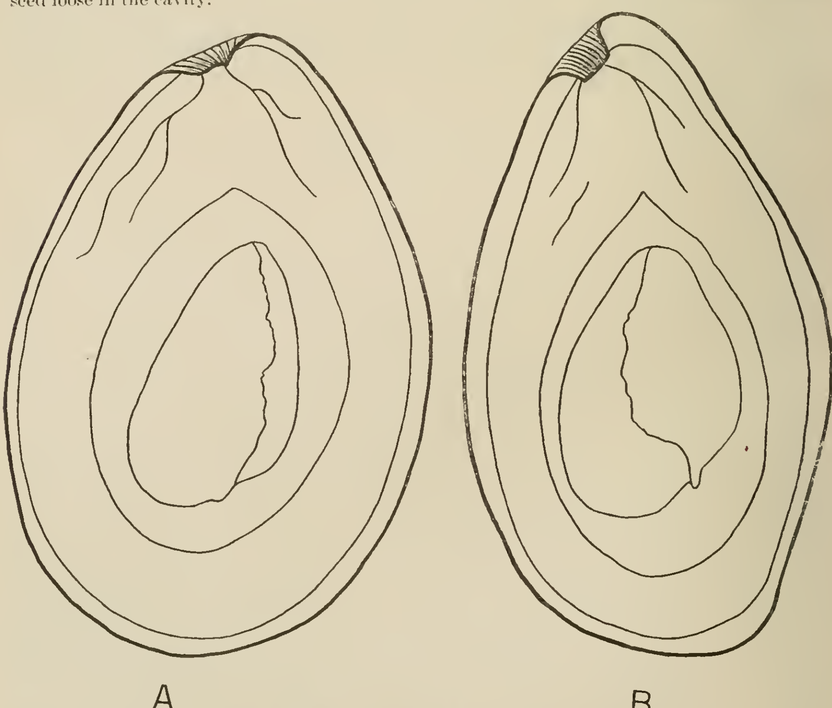

Fig. 7.—Longitudinal sections of oblong avocados, West Indian-South American varieties (about one-half natural diameter): A, small seed, loose in large cavity; B, large seed, loose in the cavity.

size. (See figs. 6, 7, 8, and 9.) A few small ones in a crate of otherwise large fruits will cause a greater loss to the seller than would have been occasioned by rejecting the small ones. Fruits that average more than fifty to a tomato crate are not desirable for sending to distant markets. While the demand has been so strong that almost any avocado in sound condition would sell, too great emphasis can not be placed upon the necessity for packing each crate with fruit of uniform size, shape, and color.

While the market has no pronounced demand for any particular form, those of a decided pear shape (see fig. 8), of even size, and of which about three dozen can be packed in a tomato crate, bring the highest price.

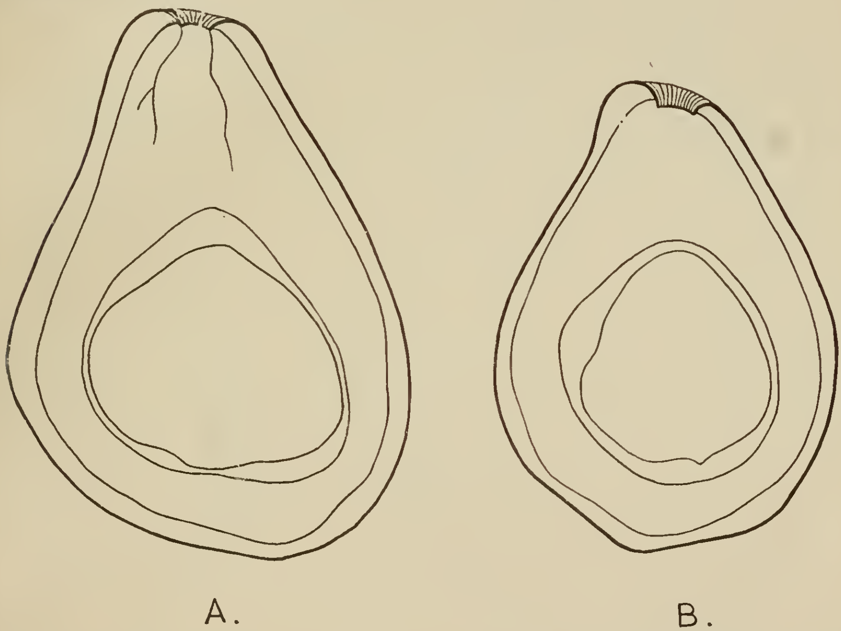

FIG. 8.—Longitudinal sections of pear-shaped avocados, West Indian-South American varieties (about one-half natural diameter): A, very large seed, loose in the cavity; B, large seed, loose in the cavity.

PACKING.

For shipping purposes the market at present demands a tomato crate or an eggplant crate. In the course of a few years a standard package of dimensions best adapted to this particular fruit will, no doubt, be adopted. Neither the tomato crate nor the eggplant crate is perfect from the growers' point of view. The larger package brings such a quantity of fruit into one compartment that some of the lower ones are likely to be bruised in transit. If some of the avocados happen to become soft on the way, the appearance of the remainder will be much injured and the selling value of the entire crate will be greatly reduced. The tomato crate is much better in these respects, but it is not entirely satisfactory, because only the round fruits pack well in it.

When the ideal crate shall be adopted it will probably be similar in shape to the boxes used for California pears.

Before packing, the individual avocado should be wrapped in some substantial and attractive paper. This will add materially to the carrying quality and to the selling price of the fruit. Enough fruit should be put into the crate so that it will be packed firmly, to prevent any possibility of shaking on the way to market. It is not always

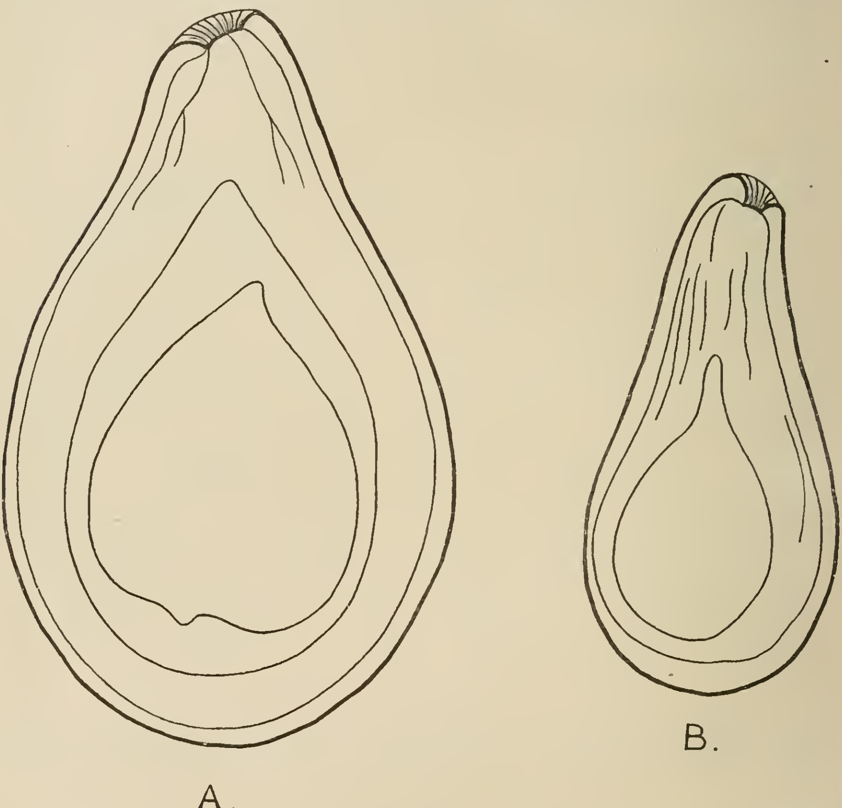

FIG. 9.—Longitudinal sections of bottle-necked avocados (about one-half natural diameter): A, West Indian-South American variety, with very large cavity; B, Mexican variety, with seed filling cavity.

possible to properly fill the crates now used, and it sometimes becomes necessary to fill up the vacant space with excelsior. In large crates and with well-matured fruit a considerable quantity of excelsior must be used to make sure that the fruit will not be bruised. The production of avocados in the United States is so limited and the demand thus far is so much greater than the supply that comparatively little care has been necessary to secure good prices, provided the fruit reached the market in sound condition.

THE FRUIT.

The avocado varies greatly as to size, shape, color, texture, and composition, while the trees also present distinct differences. In size, the fruits vary from those no larger than a hen's egg to specimens which weigh 3 pounds. (See fig. 7, A, and fig. 9, B.) As to shape, there are four recognized types, although all possible gradations occur. The so-called round fruit (see fig. 6) is not strictly spherical, being flattened at the distal end or at both ends. The oblong fruit (see fig. 7) may be of various lengths, but the diameter is always greatest from the stem to the distal end. The pear-shaped (see fig. 8) and bottle-necked varieties (see fig. 9) are sufficiently described by their names.

The color of a ripe avocado varies from a dark purple, like that of a ripe eggplant, to scarlet, yellow, and grass-green. As a rule, the fruit is not of one color over all of its surface; the purple or scarlet fruits are usually lighter and the green fruit tinged with yellow at the distal end. All combinations of the sizes, colors, and shapes mentioned are found.

THE EDIBLE PORTION.

The edible portion of the fruit, called the meat, in desirable varieties is a smooth, rich substance, with the texture of cream cheese. Some inferior fruits are decidedly watery and oily in appearance, while others are comparatively dry.

The following analyses were made by Charles D. Woods and L. D. Merrill.[a] The pulp of three fruits was taken for an analysis.

	Grams.	Per cent.
Edible portion	762.2	71.09
Seeds	201.1	19.71
Skins	94.0	9.20
Total	[a]1,021.6	100.00

[a] Thirty-six ounces.

It was found that 1 pound of the edible portion contained the following weights of nutrients:

	Pound.
Water	0.811
Protein	.010
Fat	.102
Carbohydrates	.068
Ash	.009

The fuel value is estimated at 1,758 calories per pound of edible portion.

[a] Maine Agr. Exp. Sta. Bul. 75, July, 1901, p. 111.

In color of meat the fruits of different varieties vary. Immediately under the epidermis it is green, sometimes for only a fraction of an inch; in other varieties it may be green three-quarters of the way through the meat, the remainder being either whitish or yellowish, or the green color may extend almost to the seed. Some of the finest varieties have a cream-colored meat. In texture some avocados have rather watery meat, with a number of strings running through it, and are decidedly inferior to fruit with firm meat and no strings.

SEED AND SEED CAVITY.

The variations in the seed cavity are of importance from a commercial standpoint. In some fruits the seed is lodged firmly in the meat; in others it occupies only a fraction of the cavity (compare figs. 6, 7, 8, and 9), and variations occur anywhere between these extremes. Obviously, the best shipping fruit is that with a seed cavity so small that the seed can not be shaken about, since in handling the fruit in transit the seed in a large cavity so bruises the meat as to cause rapid deterioration. This point should be borne in mind in selecting varieties for propagation.

In the shape and size of the seed marked variation occurs. The shape does not necessarily conform to that of the fruit, while the size may vary from one-half the bulk of the fruit down to one-tenth or even less. (Compare figs. 6, 7, 8, and 9.) One tree that bears seedless fruit has been discovered in Florida. Since the formation of seeds is the greatest tax on the energies of the plant, it is important for the grower to produce fruits with as small seeds as possible; these the buyer will also prefer, as to him the seed is of no value.

SHAPE OF THE TREE.

The manner of growth of avocado trees differs exceedingly. Some trees grow with a slender shape, like the Lombardy poplar; others spread out in the form of an American elm, while the greater number take on the compact shape of a fruit-bearing tree, making an outline somewhat similar to that of a haycock. (Compare Pls. I, II, and III.) This last mentioned form is, of course, the most desirable of the different shapes. It gives the tree a chance to withstand gales, and permits the fruit to sway on slender branches, thus keeping it from being blown off during storms.

FORMS AND VARIETIES.

The species *Persea gratissima* Gärtn., or what is popularly known as avocado, is well defined from the other species of the genus, but inside of the species as at present understood it is exceedingly variable. Some attempt has been made to separate this species into varieties, but so little has yet been done in the way of perpetuating particular sorts by bud propagation that varieties in the pomological sense have not yet found a place in literature. La Sagra[a] gives the following classification, based upon the characters of the fruit:

The aguacate is, without doubt, one of the most valuable fruit trees of South America. The fruit is in form of a large pear, without any depression at the head. The skin is a yellowish green or a pale violet color, and smooth. The substance of the fruit, when well matured, is nearly white and has a soft, oily consistency and a slightly sweet taste, somewhat sugary. It is eaten in its natural state and also seasoned in various manners, nearly always with a little salt. The animals devour it eagerly.

The tree blossoms in April and the fruit matures in July and August. The varieties which are cultivated in Cuba are—

1. The violet color, which is nearly round in shape.
2. The large green, round, with the inside yellowish and having the consistency of bread.
3. The large yellow, similar to a large pear.
4. The long green.

The maturity of the fruit is known when the seed which it contains becomes loosened from the substance of the fruit and rattles when it is shaken.[b]

In order to obtain good trees one must sow the seed in the place where it will remain permanent, in holes of 3 feet in dimension in every direction, which are filled with good soil.

These trees ordinarily bear fruit from the fifth year and live to about their eightieth year. They are planted in form of beautiful groves and walks about the dwellings of the inhabitants, and as their growth is very vigorous they soon take strength from neighboring trees. Their flowers yield a very agreeable perfume.

Compare the description of plates, page 36, and figs. 6, 7, 8, and 9 with the above description.

Meissner[c] recognizes several botanical varieties based upon the shape and size of the leaves. *Vulgaris* has leaves "3–4 poll" by "$1\frac{1}{2}$ poll;" *Oblonga*, "4–9 poll" by "$\frac{3}{4}$–2 poll;" *Macrophylla*, "6–9 poll" by "$3\frac{1}{2}$–$4\frac{1}{2}$ poll."

THE MEXICAN AVOCADO.

There is a small-fruited form of avocado which was introduced in 1893 from Mexico (see fig. 9, B) in the form of seeds by the Division of Pomology of the Department of Agriculture, to which no reference is made in the literature examined, and no specimens of this form were found in the herbaria visited. It is regarded in Mexico as more frost resistant than the common form found in Florida and the West Indies, but is not considered as valuable as the larger fruited varieties where the latter may be grown successfully. Its fruit is pear-shaped, or bottle-necked, about the size of a hen's egg, usually of a dull blackish or bluish color. The skin of the fruit is thin and leathery. The seed is small, conical, usually about an inch in diameter.

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[a] Translation from Historia Fisica de Cuba (1845), Vol. XI, p. 186.

[b] Correct for some varieties only.—P. H. R.

[c] Martius, Flora Brasiliensis, Vol. V, pt. 2, fasc. 41, p. 159.

The tree is a less vigorous grower, and the branches are inclined to be slender. The leaves are borne on a slender petiole about half as long as the blade, which is thin and elliptical in shape. The flowers are borne in an open panicle on long slender pedicels and the fruit ripens earlier than the West Indian–South American form.

Another striking peculiarity of this form is that the first pair of scale-like leaves produced have, while those of the West Indian–South American form do not have, a distinct petiole and blade. (See fig. 1.) This form has been grown successfully in California, where it is becoming popular. Figure 9, B, is from a specimen kindly furnished by Mr. W. Chappelow, Monrovia, Cal., from a tree grown from seed of the first importation from Mexico by the Department of Agriculture.

THE WEST INDIAN–SOUTH AMERICAN AVOCADO.

The fruit of the West Indian–South American avocado is large, varying in weight from a quarter of a pound to 3 pounds. The shape is as variable as the size, varying from oblate spheroidal to almost banana shaped. (See figs. 6, 7, 8, and fig. 9, A.) The color of the fruit is purple, scarlet, yellow, and green. The rind is usually thick and brittle. The seed is often very large, sometimes making up one-half the weight of the fruit; the shape of the fruit variable—spheroidal to conical. The tree is of vigorous growth, reaching a height of 20 to 30 feet, and sometimes is even taller; the branches are thick and brittle. The leaves are borne on a short, thick petiole, less than one-fourth the length of the blade, which is thick, elliptical, and from 4 to 10 inches long. The lower surface of young leaves is covered with a pubescence. Flowers in open panicle are borne on a short peduncle. The fruit is borne on a thick pedicel, and ripens from the middle of July to December. A few trees retain their fruits until January, and even up to March.

In the native habitats the species seem to run to distinct forms, as is indicated from the botanical literature and botanical specimens named by authorities on the subject. These forms do not come true to seed when brought into cultivation, owing probably to the fact that the trees are put under special new conditions, and that trees from a large number of varieties are planted near to each other, making cross-pollination almost certain. It is not surprising, therefore, that we find large-fruited and small-fruited trees; yellow, green, scarlet, and purple colored fruit; small, medium-sized, and large leaves; good, bad, and indifferent qualities, all coming from selected fruits from a single tree, as indicated from observations cited on a former page. It is really only what should be expected when viewed from a plant breeder's standpoint.

THE IDEAL AVOCADO.

The tree should be of small or medium size. So long as the supply is limited and the fruit brings fancy prices, the cost of gathering from the tall-growing trees is no serious obstacle, but much fruit is lost from a tall tree as a result of high winds, which are common in the Antillean region during the ripening season.

The fruit should weigh about a pound to a pound and a half. This is large enough for persons with an ordinary liking for this fruit, while those who are extraordinarily fond of it can call for two fruits. Pear-shaped (see fig. 8) or oblong varieties (see fig. 7) should be preferred, as they can be packed readily and transported without much danger of being bruised in transit. The seed should not be loose in the cavity, as the shaking of it in transit pounds the meat into an unsightly mush. The color of the fruit should be either yellow or scarlet. The fruits that ripen green are considered by the novice as having been picked when too immature, and those that ripen brown or purple look as if they were in the first stages of decay. A very late variety would undoubtedly be the most desirable, since it would ripen at a time when all the West Indian and Mexican avocados were gone, and most of the northern fruits were out of the market.

USES OF THE FRUIT.

According to Patrick Brown,[a] horses, cows, cats, dogs, as well as all sorts of birds, feed on this fruit.

Much has been written regarding the manner of serving this salad fruit, but only one or two essential additions have been made in the last two hundred years. No matter how daintily it may be prepared one can scarcely relish it more than when, tramping through the forests, he happens upon a tree with a few fruits fully matured. The traveler is likely to be seated at once, enjoy his fruit without salt, sugar, or other condiments, and forever after he will remember the deliciousness of that particular fruit, which if eaten with any or all condiments at the most carefully appointed table would not have made as strong an impression on his memory.

An avocado should not be used until the meat cuts smoothly with a teaspoon and is about the consistency of well-frozen ice cream. No one should attempt to eat the fruit after it has softened; a rancid avocado may well be compared to rancid butter.

The simplest way of using this fruit is as already stated. One merely halves the fruit, removes the seed, and dips out the meat with a teaspoon, or to the plain fruit a bit of salt may be added. Some people use pepper in addition. The number of ways in which the

[a] Civil and Natural History of Jamaica, London, 1789, p. 214.

avocado may be served is as varied as the possible salad combinations. One should not, however, deluge this rich fruit with oil nor overpower with condiments its mild, nutty flavor. Salt, pepper, and vinegar are often used; if to this enough sugar be added to take off the sharpness of the vinegar, it will be an improvement. Lime juice or lemon juice may be substituted for the vinegar with advantage. The avocado is sometimes served as a dessert with sugar and sherry.

Another distinct method of using this fruit is to remove the meat from the skin, add the condiments desired, and then stir the whole into the form of a salad and serve either alone or on lettuce leaves. Some chefs cut the meat into small cubes of about a half or one-third of an inch in size and serve it with condiments, as in minced salad.

The use of the avocado as an ingredient of lobster or other shellfish salad is said to have become quite general in localities where the fruit can be obtained, as it gives the salad a pleasing nutty after flavor not otherwise secured.

Another use is in mixed pickles. For this purpose the fruit should be selected before it has become soft, yet after it is no longer hard and brittle. The fruit is pared, the seed taken out, and the meat cut into pieces not over a half inch thick. This is then prepared in the usual manner for cucumber pickles, etc.

DISEASES.

LEAF DISEASE.

While the avocado has recently been introduced into cultivation, it has some severe diseases, which, however, can be handled without much difficulty if taken in time. One of the most prominent and common diseases noticed is due to a *Glœosporium*, probably an undescribed species. This almost invariably attacks the leaf at the tip, and gradually works back from this point into the blade. By the time the leaf has become two-thirds or three-quarters diseased, it usually falls off, and in this way the fungus may defoliate the entire tree.

Remedy.—Spraying with Bordeaux mixture[a] should be begun on the first appearance of the trouble. If spraying is delayed until the tree has been partially defoliated, success will be attained with much greater difficulty.

[a] Bordeaux mixture may be prepared by dissolving 6 pounds of bluestone in 25 gallons of water. This may be done readily by placing the bluestone in a feed sack and suspending it near the surface of the water. Slake 6 pounds of lime with just enough water to cover it. When this has been thoroughly slaked, dilute with 25 gallons of water. Strain the slaked lime into the tank of the spraying machine through coarse sacking, to remove all particles which might clog the spraying machine. Pour the dissolved bluestone into the lime water, stirring vigorously for two or three minutes. Apply at once.

FRUIT DISEASE.

Apparently the same fungus which causes the disease of the leaves attacks the fruit in various stages of development. If the disease becomes prevalent while the fruit is small, it will shed off until the tree is quite fruitless. If the disease attacks the more mature fruit, it is liable to remain on the tree until nearly ripe, but the fungus produces a brown spot, and finally the skin cracks.

Remedy.—The same remedy should be used as for the leaf fungus.

SUMMARY.

Avocados do not come true to seed.

Orchards of seedling trees can not be relied upon to produce good crops.

Budding is practicable and it is the most desirable way of propagating.

Crown-working is preferable to top-working.

Budded trees grown in a nursery should be used in planting an orchard.

All the fruit shipped to market in a crate should be of the same size, of the same shape, and of one color.

Preferences for color are as follows: Yellow, scarlet, green, brown.

Pear-shaped fruits and oblong shapes are preferred. Round are less desirable than bottle-necked fruits.

The varieties which ripen during December, or later, sell for the highest prices.

The large percentage of fat contained in this fruit makes it especially desirable, since it is much more agreeable to some people than the fat obtained from an animal source.

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PLATES.

DESCRIPTION OF PLATES.

Plate I. *Frontispiece.*—West Indian–South American avocado tree, about 35 years old, growing on a coral breccia reef. Produces fruits of fine quality. Ripens purple.

Plate II. Fig. 1.—Crown-worked avocado tree eighteen months after insertion of bud. The bud was placed in a sprout that had started from a stump of a tree the summer before. West Indian–South American variety. About 8 feet tall. Fig. 2.—Top-worked tree eighteen months after insertion of bud, which was placed in a green sprout. The tree was approximately of the same age and vigor as the one shown in Plate II, figure 1. Mexican variety. About 12 feet tall. Compare the general mode of growth, arrangement of leaves, etc., with the tree shown in Plate II, figure 1.

Plate III. Nursery tree two years old, transplanted from seed bed, West Indian–South American variety. A good, vigorous stock for budding. About 4 feet tall.

Plate IV. Fruiting branch of West Indian–South American variety, showing the manner in which the fruit is borne upon the branches. The photograph from which this illustration was made was taken from the inside of the tree to bring out the peculiar mode of attachment. This branch may be considered as carrying a very heavy crop. Fruits about one-tenth natural diameter, ripening green.

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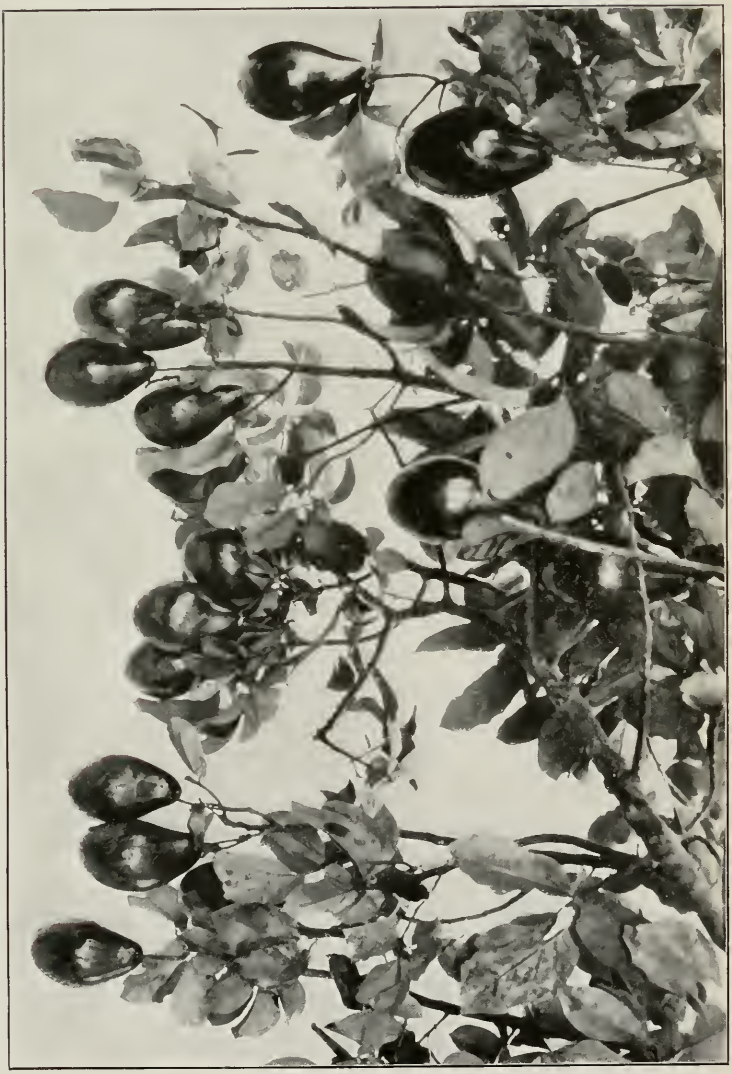
FIG. 1.—CROWN-WORKED WEST INDIAN-SOUTH AMERICAN AVOCADO TREE, EIGHTEEN MONTHS AFTER INSERTION OF BUD.

FIG. 2.—TOP-WORKED MEXICAN AVOCADO TREE, EIGHTEEN MONTHS AFTER INSERTION OF BUD.

WEST INDIAN-SOUTH AMERICAN AVOCADO TREE IN NURSERY, 2 YEARS OLD, 4 FEET



FRUITING BRANCH OF WEST INDIAN-SOUTH AMERICAN AVOCADO TREE. (ONE-TENTH NATURAL SIZE.)

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN No. 62.

B. T. GALLOWAY, *Chief of Bureau.*

NOTES

ON

EGYPTIAN AGRICULTURE.

BY

GEORGE P. FOADEN, B. Sc.,

SECRETARY OF THE KHEDIVIAL AGRICULTURAL SOCIETY,
CAIRO, EGYPT.

VEGETABLE PATHOLOGICAL AND PHYSIOLOGICAL INVESTIGATIONS.

ISSUED JULY 9, 1904.

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1904.

BULLETINS OF THE BUREAU OF PLANT INDUSTRY.

The Bureau of Plant Industry, which was organized July 1, 1901, includes Vegetable Pathological and Physiological Investigations, Botanical Investigations and Experiments, Grass and Forage Plant Investigations, Pomological Investigations, and Experimental Gardens and Grounds, all of which were formerly separate Divisions, and also Seed and Plant Introduction and Distribution, the Arlington Experimental Farm, Tea Culture Investigations, and Domestic Sugar Investigations.

Beginning with the date of organization of the Bureau, the several series of bulletins of the various Divisions were discontinued, and all are now published as one series of the Bureau. A list of the Bulletins issued in the present series follows.

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21. List of American Varieties of Vegetables. 1903. Price, 35 cents.
22. Injurious Effects of Premature Pollination. 1902. Price, 10 cents.
23. Berseem: The Great Forage and Soiling Crop of the Nile Valley. 1902. Price, 15 cents.
24. The Manufacture and Preservation of Unfermented Grape Must. 1902. Price, 10 cents.
25. Miscellaneous Papers: I. The Seeds of Rescue Grass and Chess. II. Saragolla Wheat. III. Plant Introduction Notes from South Africa. IV. Congressional Seed and Plant Distribution Circulars, 1902–1903. 1903. Price, 15 cents.
26. Spanish Almonds. 1902. Price, 15 cents.

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FIG. 1.—TYPE OF EGYPTIAN BULL.

FIG. 2.—ANOTHER TYPE OF EGYPTIAN BULL.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN No. 62.

B. T. GALLOWAY, *Chief of Bureau.*

NOTES

ON

EGYPTIAN AGRICULTURE.

BY

GEORGE P. FOADEN, B. Sc.,

SECRETARY OF THE KHEDIVIAL AGRICULTURAL SOCIETY, CAIRO, EGYPT.

VEGETABLE PATHOLOGICAL AND PHYSIOLOGICAL INVESTIGATIONS.

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[a] Detailed to the Bureau of Forestry.
[b] Detailed to Botanical Investigations and Experiments.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., April 20, 1904.

SIR: I have the honor to transmit herewith, and to recommend for publication as Bulletin 62 of the series of this Bureau, a paper entitled "Notes on Egyptian Agriculture," prepared by Prof. George P. Foaden, Secretary of the Khedivial Agricultural Society, Cairo, Egypt.

The experiments which this Department is conducting in the introduction of Egyptian cotton, berseem, and other Egyptian crops into this country make it highly important to have a knowledge of the methods employed in the cultivation of these crops in Egypt.

The six plates accompanying the paper are considered essential to a full understanding of the text.

Respectfully,

B. T. GALLOWAY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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INTRODUCTION.

Nature may be truly said to smile in the Valley of the Nile, and ancient Eastern writers were never weary of sounding the praises of Egypt. From early times her antiquities have excited imagination and curiosity, yet her system of agriculture is of still more ancient date.

Though the total area of Egypt proper is about 400,000 square miles, only some 12,000 square miles are cultivated and settled. Agriculturally, the country consists of the Nile Valley itself, a comparatively narrow strip of land on each side of the river, together with that part known as the Delta, of which Cairo may be taken as the apex. The width of the Nile Valley is variable; in some districts the desert impinges on the river bank itself, while in others the valley may attain a width of 10 or 12 miles. Its length is about 550 miles, and the number of acres under cultivation and in process of reclamation is about 2,320,000. This, roughly speaking, is the region where basin irrigation is practiced, while the Delta proper is under a system of perennial irrigation. The number of acres under cultivation and in process of reclamation in the Delta is 3,430,000, thus making a total of 5,750,000 acres for the whole country.

Basin irrigation, which has been typical of the country from earliest times, is now being gradually replaced by perennial irrigation, a change which entirely alters the system of agriculture. It is needless to say that at one time the whole of the country was under the basin system, but about the year 1820 the Khedive, by excavating a number of deep perennial canals capable of discharging water during the period of low water in the Nile, began that change which resulted in a complete revolution of the irrigation system of lower Egypt. As long, however, as the canals merely drew their water from the Nile the supply naturally diminished as the summer advanced and the Nile fell.

In the year 1842 the Nile Barrage, which is situated about 12 miles downstream from Cairo, was commenced. Here the Nile bifurcates. Across the two branches two immense masonry bridges were built, provided with sluice gates, by closing which the stream is dammed. The level is thus raised to such an extent that 12 feet of water are held up, over and above the natural level of the river, and the amount of water discharged into the various distributing canals is enormously increased. The bed of the river below the Barrage is to all intents and purposes dry. This provision of water during the summer months permitted the cultivation of cotton, which from this date gradually increased. At the present time the whole of lower Egypt is under a perennial system of irrigation, while upper Egypt, though largely under basin irrigation, is in a transition stage.

The ancient system of basin irrigation, whereby the land received annually a deposit of rich mud, will soon be, comparatively speaking, a thing of the past. It is unnecessary here to enter into any details regarding this ancient type of irrigation, but merely to state that under this system the land is divided by means of banks into basins (of which there are 212), whose areas range from as few as 500 to as many as 75,000 acres. For convenience in the regulation of the flood water, these basins are divided into various sections, 11 of which are on the left bank of the river, while 13 are on the right. During flood time, when these basins are filled, the water is charged with suspended matter, which during its sojourn in the basin is to a great extent deposited on the land. The filling of the basins generally begins about mid-August and is completed in the southern basins by the end of September. The escapes are opened and the water discharged into the river by the middle of October. The more northerly basins are filled and emptied later, the last basin north of the Delta Barrage not becoming dry until the end of November.

When the time for emptying the basins has arrived, the escapes are opened and the water discharged. In some years, when the flood is low and the basins are not full, the upper series of basins are drawn upon to complete the operation; the water passes, that is to say, through the lower series and is then discharged. The water remains in the basins for a period of about sixty days.

The water of the Nile at the time of flood contains from 150 to 200 parts per 100,000 of suspended matter. If 170 parts are assumed to be an average, about 130 parts are actually deposited in the basins, while the remaining 40 parts are returned to the river in the water of discharge. These figures can only be regarded as approximations, the amount of mud deposited on any given area depending to a certain extent on the position of that area in the basin. Again, the water entering all the basins is not equally rich in sediment. Further, water is continually passing through the basins, even though they are full, and consequently the actual quantity which passes through them and deposits its mud is not equivalent to the capacity of the basin itself. The nature of the sediment also varies, being more valuable, relatively speaking, in a low flood, and more sandy and consequently less valuable during a high flood. It is calculated that when the basins are full they contain on an average between 3 and 4 feet of water and the deposit is equal to between 14,000 and 15,000 pounds of sediment per acre, or between 6 and 7 tons. The soil thus receives annually this coating of mud, the chemical nature of which has given rise to very divergent views on the part of chemists, chiefly owing, it is believed, to the manner in which samples for analysis have been taken. The analyses made by Doctor Mackenzie at the School of Agriculture are considered the most reliable obtainable and are the average of many determinations.

COMPOSITION OF NILE MUD DURING FLOOD.

The addition of 15,000 pounds per acre per annum of sediment consisting of nitrogen, 0.12 per cent, phosphoric acid, 0.21 per cent, and potash, 0.68 per cent, would give to the soil 18 pounds of nitrogen, 31½ pounds of phosphoric acid, and 102 pounds of potash. These quantities, when compared with the general composition of Egyptian soils and with the results which have been obtained by actual manurial experiments, are quite consistent. Egyptian clover, as is well known, is very extensively grown in Egypt, and the deficiency of Nile mud in nitrogen has, no doubt, to a very great extent been compensated for in this manner. Roughly speaking, cultivation in the basins means one crop yearly, the flood providing sufficient water and manure for the raising of this crop under a system of rotation. In the basins, where the chief crops are cereals, beans, and clover, this is true as regards the matter of manure supply, but when irrigation is practiced by means of wells or from the Nile the need for manure at once becomes pressing. In fact, this interdependence of manure and water is always most prominently brought out in any irrigated country.

An examination of the manurial ingredients added to the soil during the inundation of the basins will at once indicate that while sufficient phosphoric acid and potash are added to grow an ordinary crop of wheat or barley, this is not true as regards nitrogen, and were it not for the alternation of clover and beans with the cereal crops the growth of the latter without nitrogenous manures would be impossible. The fact that it is found impossible to grow two wheat crops satisfactorily in succession is an indication that so far as nitrogen is concerned the Nile mud does not supply a sufficient quantity. A bean crop, which removes more phosphoric acid and more potash, but which obtains its nitrogen largely from the air, is successfully alternated with it.

IRRIGATION AND FERTILIZERS.

As the crops in the basins are generally grown without irrigation, manures, as already mentioned, are but seldom used. The wheat crop under such circumstances will average some 30 or 35 bushels per acre, and often grows to the height of a man's shoulder. The bean crop is a most important one in Upper Egypt, providing, as it does, the staple food during the summer and flood months, not only for Upper Egypt, but to a considerable extent also for Lower Egypt, while the export trade assumes considerable proportions. Beans are extremely luxuriant, and they produce on an average 35 or 40 bushels per acre on good land.

It is quite unnecessary to state that the cultivation of basin lands is extremely primitive. The seed is merely broadcasted on the silt left by the Nile, covered in by hand-hoeing or scraping, and left until harvest time. The cost of sowing does not exceed 40 cents per acre. Harvest is in the spring, and the land is then generally left bare for the few months which elapse until the Nile again rises, when, in place of fields of waving corn, we have, as it were, inland lakes of red silt-laden water. Though the net return per acre from basin irrigated lands is not as great as on perennially irrigated lands, yet they return to the cultivator a large margin of profit, as the cost of cultivation is reduced to an absolute minimum.

Upper Egypt is thickly populated, in some provinces amounting to as many as two persons per acre. This has led to the cultivation of some of the basin lands during the interval which elapses between the removal of the ordinary winter crop and the arrival of the Nile flood. Such crops have to be irrigated, and this is usually accomplished by means of primitive water wheels lifting the water as much as 15 or 20 feet. This cultivation is generally carried on where a supply of manure is available, an application of which is imperative. The soil is capable of raising only the ordinary winter crop without manure, and the summer crop, which is generally millet, is heavily fertilized. Scattered throughout the country and in use throughout the whole of Egypt are large mounds, sites of antiquity, which are drawn upon to supply manure to grow these summer crops. They contain a nitrogen equivalent of about 2 or 3 per cent of nitrate of soda. As would naturally be expected, however, the best supplies are being exhausted, and many of the poorer ones which remain scarcely pay for transport. The summer crop, when grown in the basins by irrigation, is therefore practically always manured, and this, together with the watering, entails a considerable outlay on the part of the cultivator, though a good margin of profit remains. In some districts corn is grown on basin land which, lying high or being protected by small embankments, does not become inundated until later in the season, when the crop has become sufficiently advanced to stand a certain amount of flooding. It may be mentioned that in the southern provinces, where the basin land is poor, it is often found more profitable to irrigate the winter crop of wheat and barley instead of trusting to the moisture in the soil after the flood. In this case the crop is always manured.

Such, then, is an outline of the system of agriculture practiced in the basins of Upper Egypt, and some idea of its primitive nature can thus be obtained. Nearly 1,750,000 acres of land are under this system of irrigation, a system which will now, to a great extent, disappear and give way to perennial irrigation, whereby two crops at least will be annually raised.

Although basin irrigation is characteristic of Upper Egypt, yet there is a belt of high land between the river and the basins protected from flooding by the dike running along the river bank. This belt could be inundated only in years of exceptionally high flood. The Nile Valley slopes away from the river, not toward it, the river bed thus extending, as it were, along a ridge and not along a depression. The breadth of this high land varies greatly. In some places the basin reaches practically up to the river bank, while in others the high inclosed land possesses a width of a few miles, its area having been increased by the construction of banks, which shut off the flood waters from its farther side. This land, not being flooded, can be cultivated either during summer or during flood, or both; in fact, in intensity of culture it is comparable to that of the Delta proper. The greatest width of this inclosed and artificially irrigated land is found in the provinces of Beni-Suef and Minieh, which are, with the exception of Gizeh, nearest the apex of the Delta. It is on this land in these two provinces and in the province of Fayum (which is an oasis) that the bulk of the cotton known as "Ashmouni" is cultivated. These high lands have, therefore, to be artificially irrigated, and cultivation can be carried on the whole year round.

One great difference, as already pointed out, between the cultivation of these lands and the basin lands is the necessity for manure, large quantities of which are employed. Barnyard manure is obtainable only in limited quantities, and recourse must be had to the ancient mounds to which reference has already been made. In the southern provinces, where millet is characteristic of this inclosed area during the flood season, millions of tons of a nitrate-bearing clay are found. To the agriculture of this tract and to that of Nubia this is of vital importance; in fact, it is difficult to see how the land could support its present population were it not for the existence of this clay. The basin lands, as mentioned, are of poor quality and are often irrigated, while the inclosed area is large; consequently large quantities of manure are required. As soon as the winter crops are removed, the whole population is occupied in the transport of this nitrate-bearing clay. When the material is near it is transported by the owner's own camels and donkeys, but when far away it is brought to the river banks and sold to cultivators who come in boats for it. It is a common sight in summer to see the river bank lined with heaps of this fertilizer, while hundreds of camels and donkeys may be seen wending their way to and from the river.

As already mentioned, the fertilizer is a mixture of clay and nitrate of soda, the percentage of the latter reaching in exceptional cases to as much as 20 per cent and in others dwindling to as little as 2 or 3 per cent. The richest material is found on the surface, and, generally speaking, it would be difficult by quarrying in bulk to obtain material containing as much as 5 per cent of nitrate. Of one fact, however, there can be no doubt, viz, that it forms a most valuable manure for a large tract of land, permitting better crops to be grown in the basins and the raising of a profitable crop of millet, which without it would practically be an impossibility.

Farther north, on this inclosed land, the whole of the sugar crop of Egypt is grown, and, including the Fayum, the Ashmouni cotton crop. Nearly 600,000 acres of land are thus perennially irrigated, chiefly by means of a large canal (Ibrahimia) taking its water direct from the Nile. A branch of this canal waters the Fayum, a deep depression in the desert which lies outside the Nile Valley, and is divided from the river by a range of low hills. Through a break in these the Nile water is admitted. The Fayum is the only oasis in Egypt in direct communication with the river, and is surrounded by desert on all sides. The canal which conveys water to the Fayum is split up on entering the province into a number of radiating canals, like the fingers of an outspread hand.

The Ibrahimia Canal, completed in the year 1873, is the only perennial canal in Upper Egypt which takes its water direct from the Nile. It has a length of about 170 miles, and not only supplies summer water to a large tract, but also water during flood to the basins. In perennially irrigated tracts the seasons are divided, as in the Delta, into summer, flood, and winter.

The chief summer crops are sugar cane, cotton, and summer sorghum, which occupy along the Ibrahimia Canal tract about one-half the area. About 40 per cent of the land is under flood crops, which are chiefly flood sorghum, rice, and corn, while the winter crops (about 60 per cent) are clover, wheat, barley, beans, etc. The cultivation of these crops will be dealt with in detail subsequently, the few remarks which have been made being merely intended to convey an idea of the general system of agriculture in vogue in Upper Egypt. The completion of the new reservoirs will bring large tracts of land under perennial irrigation, and from what has preceded it will be gathered how, under such a system, a much more intensive system of agriculture is practiced. These reservoirs allow a great increase in the area planted to such crops as cotton and sugar cane, while Lower Egypt will also receive its share of water to supplement the summer supply, which is taxed to its utmost to irrigate the gradually extending cotton area.

In Lower Egypt, or the Delta, as already mentioned, perennial irrigation is practiced, by which is meant that the land is irrigated by canals which supply water during the whole year. Under this system, Egypt, favored with an excellent climate and a soil of great natural fertility, may be reckoned upon to produce on an average as much per acre as is possible in any quarter of the globe. When to these conditions a plentiful supply of cheap labor is added, there exists everything necessary for the carrying on of an extensive and profitable system of agriculture. The vast improvements which have been made during recent years in the irrigation system of the country have been the means of greatly increasing the amount of water available during the summer months of low supply, and thus not only have made possible a considerable extension in the area of summer crops (chiefly cotton), but will in the future provide a supply of water for carrying on the reclamation (washing) of large tracts of land in the lower part of the Delta.

Drainage, which is an all-important problem, has received at the hands of the government its due share of attention, and enormous sums of money have been expended in making a complete network of drains throughout the country. Increased supplies of water necessarily involve more complete drainage schemes, and to Egypt, with its practically level soil lying but little above the level of the Mediterranean Sea, it is a question of first importance. In fact, increased supplies of irrigation water without better drainage and a more plentiful supply of manure are of doubtful benefit.

It would be beyond the province of the writer and beyond the object of the present bulletin to deal in any way with the irrigation system of the Delta, and attention will be entirely confined to those matters which are of purely agricultural interest.

SOILS.

Unfortunately, no soil survey of Egypt has ever been made, nor has any series of extensive inquiries been made into the general mechanical composition or chemical nature of the soils of the Delta.

It is needless to say that the soils are all alluvial in origin, and, generally speaking, are of a clayey nature, differing only in the density of the clay. A heavy, dense black clay, extending to a depth of 18 or 20 feet or more, is perhaps the typical soil. This soil is very difficult to work, but is fertile, yielding good crops of cotton. It is not easily injured by infiltration and saturation, on account of the difficulty with which water penetrates it. It can be understood that when canals are running with water practically throughout the whole year, there is always danger of saturation and infiltration, especially so when the water is at a higher level than the surrounding country.

It is feared that this class of soil often receives a greater quantity of water than is necessary, as, on account of the difficulty of percolation, it becomes more or less stagnant and sours the land. There is also insufficient care given to the question of cultivating the land when in the right condition. It is often plowed when more or less wet, the result being that it dries up into a brick-like condition, quite unsuited for a seed bed.

A second class of soil is also clayey to the depth of a few feet, but is underlaid by soil of a more or less light nature. This soil is more free to work than that already mentioned. A third class of soil may be described as a sandy loam, while in some districts there are soils which may be described as almost pure sand.

As regards the chemical nature of the ordinary clay soil of the Nile Valley, it would be rash to reproduce any figures which could be taken as representing in any way their general composition. No systematic attempt has been made to analyze representative samples of every province, only the results of a few isolated analyses being available. It may be stated, however, that the soil is more deficient in nitrogen than in any other ingredient, and nitrogenous manures are found to exercise a most marked effect upon growth.

The manures in common use in the country, in addition to barnyard manure and pigeon manure, are what is known as "coufri," or the remains of ancient villages and ruins, and the nitrate-bearing clay found in Upper Egypt, to which reference has already been made. These latter two fertilizers are valuable chiefly on account of the soluble nitrogen they contain. The soils are almost invariably rich in potash, while in phosphoric acid they are neither poor nor exceptionally rich. For some crops, such as cotton and sugar cane, the use of phosphatic manures is attended with great benefit, while other crops do not, as a rule, repay the cost of the fertilizer.

LABOR.

In Egypt there is a plentiful supply of cheap labor. The labor, from a European point of view, would be described as inefficient, but with the crude systems of cultivation in force it meets all requirements. Owing to its cheapness, a great deal of the labor which would be performed in Europe and in the United States by one or other of the various farm implements is in Egypt done by hand. Practically the only large implements used in the cultivation of the land are the primitive native plows, kassabiehs, or scoops for leveling the land, and planks of wood which, when drawn over the land, serve as harrows. The fass, or hoe, is the essential hand tool, and is the fellah's stock in trade.

The land was formerly held by large proprietors, and though this is true to-day a division into smaller farms is gradually taking place. This subdivision of land is reducing the supply of labor available on large farms, and at certain times of the year it is somewhat difficult to find sufficient labor. The commercial developments of Egypt and the numberless improvements which are being effected attract a considerable amount of labor which would otherwise be employed in agriculture, and a rise in the price of labor has taken place during recent years which is likely to continue in the future. As, however, labor is obtainable for 15 cents a day, it will be seen that there is no cause for complaint—at least from a western standpoint.

The fellah is an extremely clever cultivator and a hard worker. He works sometimes for a daily wage, but in the majority of cases is engaged under one of many bases of contract, receiving a certain area of land for the whole year in lieu of a part of his wages, or it may be a certain area for the growth of corn. In other cases he receives a share of certain crops, etc.; in fact, it would be impossible in a short treatise to deal with the almost innumerable arrangements which are made between employers and employed.

VALUE OF LAND.

Land has increased enormously in value during recent years and to attempt to estimate the increase would be a difficult matter. The best land in the Delta can not be purchased for less than $500 to $600 an acre, while there are many cases where as much as $800 have been paid for land possessing no value, present or prospective, except from an agricultural point of view. Good average land costs from $300 to to $400 per acre, while it would be difficult to find any land under a state of cultivation which could be purchased for less than $150 per acre. Even at these prices land well cultivated will return 6 or 7 per cent on the capital invested, the sheet-anchor of the cultivator being his cotton crop.

ANIMAL LABOR.

Practically the whole of the animal labor on the farm is done by bullocks, a race whose history is somewhat doubtful. The cattle of Upper Egypt are somewhat smaller than those of Lower Egypt, of which the accompanying illustrations (Pl. I, figs. 1 and 2) may be taken as good types.

A certain number of mules and donkeys (see Pl. II, figs. 1 and 2) for transport work are kept on the farm, and from eight to ten bullocks are considered necessary to work 100 acres, generally the smaller number.

The value of these animals has very considerably increased during recent years, and at the present time $100 would have to be paid for a good average working bullock, while anything above the ordinary costs up to $135. During the winter, spring, and early summer months—say, from December to June—they are fed on clover, chiefly grazed in the field, the animals being tethered. About three-fourths of an acre are allowed for each animal. From June to early December they are fed on beans and chopped straw, about 12 or 13 pounds of the former and 22 pounds of the latter being a common ration.

The fellahs are the cattle raisers of Egypt, and large cultivators supply their needs by purchasing from them; in consequence, the small cultivator, raising cattle as he does and keeping buffaloes for the supply of milk for his family and for sale, has a much greater quantity of manure in proportion at his disposal than has the large proprietor.

It may be mentioned incidentally that sheep in Egypt are of a very poor standard. There are several breeds or divisions of breeds known by local names, but the accompanying illustration (Pl. III, fig. 1) will give an idea of the type of animal found in the country. The sheep live on anything they can procure, and are allowed to run over the clover after the cattle have been tethered on it. A fair sheep weighs about 100 pounds live weight, though the better class fed by some cultivators weigh more.

SEASONS.

Agriculturally three seasons are, as already mentioned, recognized in Egypt, viz, winter, summer, and Nili. During the former, extending from November or December to March, wheat, barley, beans, clover, etc., are sown in Lower Egypt, and also flax, lentils, onions, vetches, etc., in Upper Egypt. The summer crops are cotton, sugar cane (chiefly in Upper Egypt), rice, and summer sorghum (Upper Egypt), while during the Nili season corn and rice, together with flood sorghum in Upper Egypt, are the principal crops.

COTTON.

Of all crops cotton is preeminently the most important; it, in fact, in great part constitutes the agricultural wealth of Egypt. Its cultivation commenced about the year 1820, being simultaneous with the introduction of perennial irrigation in the Delta of the Nile. From this time the areas under cotton gradually increased, a great stimulus having been given to its cultivation at the time of the civil war in the United States and the consequent cotton famine throughout the world. When more or less normal conditions were reestablished Egypt did not, like many other countries, cease to show an increase in its cotton area, but on the other hand continued to progress. Recent developments and improvements in the system of irrigation, as well as the expenditure of large sums of money on drainage, have given still greater facilities for cotton cultivation, until there seems to be a growing tendency on the part of cultivators to place too great a reliance on the "one crop," such as existed formerly and is still often found in many cotton districts of the United States.

The cotton area seems to increase annually, though in the absence of a statistical bureau it is impossible to state what the area actually is or what increase takes place yearly. It has been generally accepted by the irrigation department that one-third of the land of the Delta was occupied by cotton, though there can be no doubt whatever that it is more correct now to assume that one-half of the land is planted to this crop. The present area under cotton in Egypt amounts probably to between 1,500,000 and 1,750,000 acres, though the finance department of the Egyptian Government gives as the area under cotton in the year 1901–2, 1,275,676 acres, of which 1,169,106 acres were

FIG. 1.—TYPE OF MULE USED IN EGYPT.

FIG. 2.—ANOTHER TYPE OF MULE USED IN EGYPT.

FIG. 1.—A MERAISE SHEEP, THE BEST EGYPTIAN BREED.

FIG. 2.—FIELD OF MIT AFIFI COTTON.

in the Delta and 106,570 in Upper Egypt. In any case we may state that 90 per cent of the total cotton of Egypt is grown in the Delta proper, and for the purposes of this bulletin, when dealing with the various branches of cotton culture, the writer's observations will refer to this region.

Theoretically a three-year rotation of crops is practiced, though this is in a great majority of cases reduced to a two-year course. Originally on good land the rotation was as follows:

Three-year rotation of crops formerly practiced in Egypt.

Year.	Winter.	Summer.	Nili.
First year	Clover	Cotton	
Second year	Beans or clover		Corn.
Third year	Wheat		Corn.

At present, however, it is more common to find the following system:

Two-year rotation of crops at present practiced in Egypt.

Year.	Winter	Summer.	Nili.
First year	Clover	Cotton	
Second year	Beans or wheat		Corn or fallow.

On poor land clover is grown more frequently and rice is introduced instead of corn, or the land may be fallowed. The cotton crop then generally follows clover or maize or a fallow. If it follows maize, the land is left fallow from the time of cutting the maize in October or November until cotton planting in March; or again, in some cases, the land may be fallowed from the time of the removal of the cereal crop in June until the following spring. If the land is to be fallowed after the cereal crop, a heavy flooding is given with the red water of the Nile, and when sufficiently dry it is plowed and left exposed to the action of the sun and other atmospheric agencies until the winter months, when the preparation of the land for cotton is continued. If it follows maize, the land is plowed as soon as possible after the crop is removed from the ground, while if after clover, the land is generally left until about a fortnight before cotton planting begins, when the soil is broken up and hurriedly prepared.

Small cultivators who can not afford to leave their land fallow occupy the land every moment, as it were. They scatter the clover seeds among their standing maize before it is cut, and thus obtain two crops of clover previous to cotton sowing. Owners of large estates, however, adopt the fallow system—either a long fallow after a cereal crop, a short fallow after a maize crop, or both. It would be impossible for them to prepare a large area of land in time for cotton after berseem, while again they would be unable to dispose of such a quantity of clover were it grown. The small cultivator is, as already mentioned, the raiser of cattle, and can always dispose of his clover crop to advantage.

Large administrations in Egypt are now using steam plows, and by means of them the land is thoroughly plowed for cotton during the autumn months to a depth of 12 inches. With this exception, however, the cotton area of Egypt is prepared by means of the ordinary native plow drawn by two bullocks. (See fig. 1.) As a general rule, four plowings are given in preparation for cotton, each being at right angles to the previous one.

The plow is somewhat comparable to the "scooter" employed in the United States for laying off the cotton rows. The beam, which is

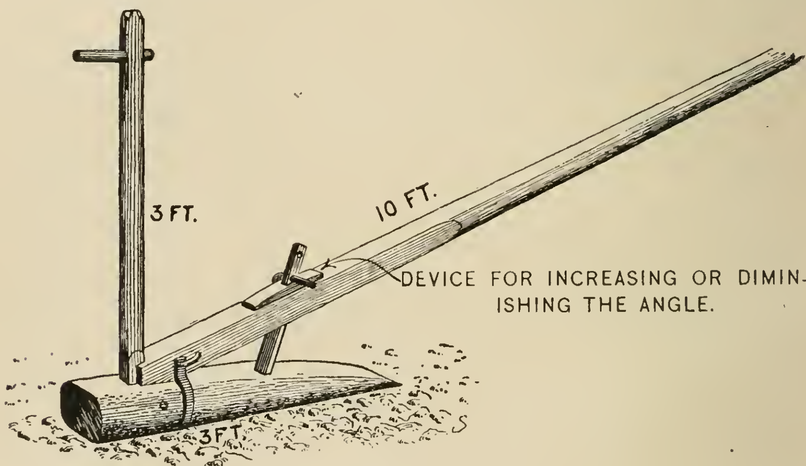

FIG. 1.—Ordinary native plow.

made of wood, is about 10 feet long, while the part which projects from it at an angle of about 25° is also made of wood, but shod with iron, the weight of the whole being about 60 pounds or more. This is the plow in almost universal use in Egypt, though on some areas cultivated by Europeans a few modern plows, provided with moldboards which turn a furrow, are used. The nature of the plow does not admit of the soil being inverted, but merely stirs it. The angle between the draft pole and the sole of the plow can be increased or diminished by adjustment.

It is laid down as an axiom by the best cotton growers that cotton land should be plowed early and left exposed for some time. In a practically rainless climate there is nothing to fear from the leaching effects of rain, while it is universally accepted that cotton sown on such land germinates better and grows more regularly. Growers are fully alive to the necessity of deep and thorough cultivation, and some careful farmers plow their land even more than four times. It must be confessed, on the other hand, that many are less enlightened; but this often arises from the fact that when the cotton follows clover the latter crop occupies the land until the last moment, so that the greatest amount may be obtained from it. Whether this is good practice or not will be dealt with subsequently.

The land, having been thoroughly plowed, is made into ridges (Pl. IV.), and this is done by cheap labor, in a primitive, though effective manner. The angle of the ordinary plow is filled with dried leaves, sacking, or some other material, so that when drawn through the soil it throws the earth to the right and left; this being repeated during the return journey of the plow, a ridge is made. When the land has been thrown into rough ridges at the required distance apart, they are shaped by men working with a fass (hoe), who at the same time break down any large clods of soil. The land is then ready for sowing. Each plow with a pair of bullocks will ridge in this manner about 2½ acres per day, while three men per day are required for completing the ridges on an acre.

The cost of preparing the land for cotton may be estimated thus: It is generally accepted that the labor of a man and a pair of bullocks per day amounts to about $1, making allowance for depreciation in the value of the bullocks, mortality, idle days, etc. The amount of work that can be accomplished per day varies according to the condition of the land. If breaking up clover land less than half an acre may be allowed, while subsequent plowings may result in nearly an acre being accomplished per day on free-working soils, though less on stiff clays. It is approximately correct, therefore, to say that on an average each plowing will cost about $1.25, or the four plowings a total of $5 or $6. The making of the ridges will cost about 40 or 50 cents for animal labor and about 50 cents for manual labor, or approximately $1, making thus a total of about $6 or $7 per acre.

The best cultivators are now, however, adopting an even more intensive preparation of the land and follow the ordinary plowing by another native plow working in the furrow left by the former and thus acting as a subsoil stirrer. The cost of preparing the land in this case is proportionately increased.

Such, then, is the general system adopted, but the depth of plowing usually attained is not sufficient to give the best results. The native plow, as a rule, does not stir to a greater depth than about 6 inches, unless followed, as described above, by a second plow. For cotton, with its deep taproot, this is not sufficient, and there is ample evidence in Egypt of the benefits to be derived by a deeper stirring of the soil. The deeper the stirring the better are the plants enabled to resist periods of drought, provided the surface soil is kept continually broken up, and the deeper can the roots descend in search of nourishment. In the United States the bulk of the work of preparing the soil for cotton seems to be put into the ridges or beds, as it were, and but little or none into the general field. In Egypt it is quite the reverse, and the ridges are not, generally speaking, as well made as they should be. When cotton follows a fallow of greater or less duration, and the land is consequently plowed early, a suitable tilth can be obtained, but when following clover, and a more or less hurried preparation of the soil results, the tilth leaves a great deal to be desired. In such case the cotton is sown in very lumpy ridges, and germination is consequently often very uneven and irregular.

That the well-known Egyptian clover has been the mainstay of Egyptian agriculture there can be no doubt, and without it the fertility of the Delta could not have been kept up except at an enormous expenditure for manure. Both in theory and in practice a crop of clover is an excellent preparation for a cotton crop; but on rich land, when the soil is plowed up just before cotton planting, the unfavorable seed bed obtained seems to more than counterbalance the effects of the decomposing vegetable matter; hence a better crop of cotton is obtained by leaving the land fallow. On the other hand, on poorer land the effects of the clover growth are marked, and a better crop is obtained after the clover than when following a fallow. The sprouting of the cotton is, as a rule, more regular after a fallow, and the greatest amount of replanting is necessary when following a clover crop. If clover immediately precedes cotton it is necessary, in order to obtain the best results, that the soil be broken up some time before planting; the roots then have time to undergo a certain amount of decay and the soil to become dry. To sow cotton in a soil which is plowed up more or less wet, as is the clover land in Egypt, is not conducive to the preparation of a good seed bed and regular germination. The soil should be quite dry when cotton is planted, though a watering is given immediately afterwards.

DISTANCE BETWEEN THE COTTON BEDS.

As Egyptian cotton is raised by means of irrigation, the beds have to be arranged in such a manner as to facilitate watering. (Pl. IV.) The land is divided into sections by ridges running at right angles to the ordinary beds, and the beds are thus not more than about 36 feet long. In some cases where the land is very level they are made longer than this, while small cultivators, whose land is as a rule very uneven, make them of less length. The land is thus divided into sections and from six to seven furrows are irrigated at a time. The arrangement will be made perfectly clear by the accompanying diagram (fig. 2).

The distance at which the furrows are made, as well as the distance allowed between the plants, is at the present time receiving considerable attention in Egypt. The writer, who recently visited the American cotton-growing districts, was particularly struck with the great difference in this respect between the United States and Egypt. It is

FIG. 1.—FIELD OF COTTON RECEIVING FIRST WATERING IN APRIL, ABOUT THIRTY-FIVE DAYS AFTER PLANTING.

FIG. 2.—FIELD OF COTTON SHOWN IN FIG. 1, HAVING BEEN HOED AFTER FIRST WATERING.

very rare in Egypt to find even as great a distance as 35 inches between the beds, while on average land, producing a bale of cotton (500 pounds) or even a bale and a half, about 30 inches or even less may be looked upon as an average. On land which produces less than a bale of cotton, less than 30 inches are left between the rows. This in comparison with the 4 feet in common use in America, together with the fact that Egyptian cotton produces a larger growth, constitutes a sufficiently striking difference in practice. Though there is a tendency among the most enlightened Egyptian planters to increase somewhat the distance between the beds, yet it is quite certain that they will never reach the distances employed in America. There can be no doubt that on certain areas of land in Egypt, where the plants grow particularly large, ridges could with advantage be made 40

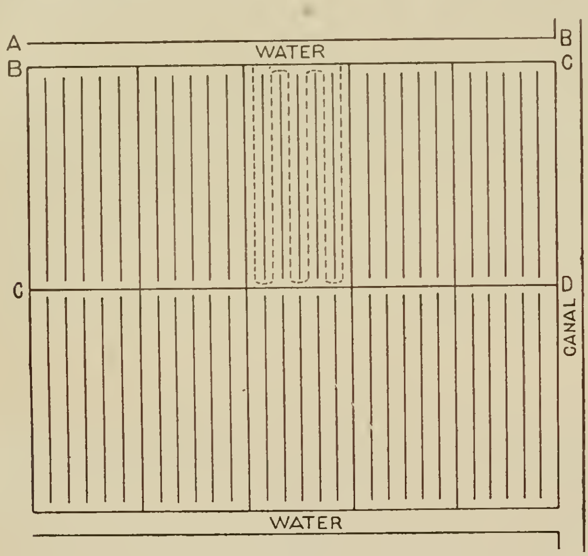

FIG. 2.—Arrangement of ridges for irrigating cotton.

inches apart, but it is at least doubtful whether it would be profitable to extend them farther. That, generally speaking, throughout Egypt cotton is planted too closely there can be no doubt whatever.

The whole of the cultivation subsequent to planting is accomplished by hand labor in Egypt, and it may be that the employment of animal labor in the United States necessitates a greater width between the rows. Whatever the reason, it can be said with safety that practically no cotton is grown in Egypt in beds as far apart as 40 inches, while from 30 to 32 inches may be given as an average on good medium soils and less on poor lands.

As regards the distance between the plants in the row, it is rare to find even on the best lands as much as 19 or 20 inches; the average is about 15 or 16 inches. It must not be forgotten, also, that 2 plants are always left standing together. On an average there are about 13,000 holes, as it were, per acre, each with 2 plants, making thus a total of 26,000 plants, while there are often many more on poorer lands. General experience seems to indicate that if too wide planting is adopted there is a reduction in yield, and it would be impossible to find an Egyptian planter who on any class of soil whatever would bed his land more than 34 or 35 inches, and extremely few at that. It is again very rare to find plants as far apart as 19 or 20 inches in the row. The Egyptian cultivator is a believer in close planting, but there is every reason to think that many have gone too far in this direction.

Beds, then, are much closer than is common in the United States, while on an average the plants are a little farther apart in the row, eliminating the fact that in Egypt 2 plants are left together. The excessive shade and dampness induced by too close planting militates against the production of the finest quality of fiber and encourages at the same time various fungous and insect attacks. Yet it appears to the writer that to adopt such wide distances between the beds as are common in the United States would by loss of plants mean probably a diminished yield.

It is true that the complete control which the Egyptian cultivator has of his water supply enables him to regulate to a certain extent the development of his plants, but in only too many cases this advantage is not employed to the greatest extent, as will be shown subsequently.

DATE OF PLANTING COTTON.

Planting commences as early as the second half of February, though March is essentially the month of cotton planting. In the northern part of the Delta it is delayed until April. There are in Egypt no late killing frosts to contend with, but merely short periods of cold and windy weather in early spring, which do considerable harm to the very young cotton plant. There has been, during recent years, a distinct tendency toward early planting, it being contended that during a series of years the largest yields, as well as the best qualities, are produced by early planters.

Early planted cotton grows more regularly and evenly and does not tend to produce such coarse growth (weed) as that planted late. It also branches better from the bottom. In view of the rainfall to which the American cotton crop is subjected, it is interesting to notice the ill effects of rain in the case of Egyptian cotton. Though it may be said that the crop is grown without rainfall, yet during the very early stages of growth, and especially in the case of early sown cotton, a shower of rain occasionally falls which does considerable harm to the newly sown cotton, especially if the plants have just appeared above the surface of the ground. If they are well established the damage is slight, but in the very young stage a shower generally necessitates a considerable amount of replanting.

SOWING COTTON.

The seed is not planted on the top of the bed, but two-thirds of the distance up the slope of the bed—that is to say, two-thirds of the distance up from the bottom of the furrow to the top of the bed. The quantity of seed used is about $1\frac{1}{4}$ bushels per acre. Holes are made, generally by boys, by means of a stick or a small wooden scoop, at the required distance apart and at the height mentioned, and from eight to ten seeds are deposited in each hole at a depth of 2 or 3 inches. A watering is then given, the water entering between the beds as already described (Pl. IV). In about ten or twelve days the seeds germinate, though this may be a little more or less, depending on the time of sowing and the weather prevailing.

It is soon seen that some seeds fail to germinate and blanks are evident. In some seasons this is much more than in others, but in any case resowing is at once done. Seeds are soaked in water over night and the next day sown in the blank places in a similar manner to the general sowing. The soil has now become somewhat dry, and the object of soaking the seed is to aid germination. If replanting is general and forms a very large proportion of the total, it may be necessary to water the land. In this case the seed is sown dry; the young plants existing suffer, however.

WATERING COTTON.

As soon as the plants are fairly well established a hoeing is given to destroy weeds and break up the surface. (Pl. IV, fig. 2.) This is practiced by all good cultivators, though neglected by others. Three or four men are necessary to hoe an acre per day, stirring not only the soil between the plants, but disturbing also the tops of the beds. Occasionally a second hoeing is given before the first watering, which takes place some thirty-five days after planting. This period is a variable one, depending on the nature of the soil and the prevailing weather conditions. On a clay soil, well hoed, it may be longer, while on a sandy soil it may be less. Before this watering is given the crop should be thinned, the two strongest plants being left standing, while the others are removed. This early thinning is advisable, and to water the crop before thinning is not considered good practice, if it can be avoided.

It is generally accepted that as long an interval as is consistent with the health of the plant should elapse before the first watering is given; otherwise the plant is not encouraged to root well, but tends to grow too rapidly. Too frequent waterings during the early growing period prevent the proper branching of the plants from the bottom. They grow up rapidly, producing their forms at the top rather than from the bottom, and are spindling. After the first watering, which should be a light one, the water not reaching up to the plants, but being allowed to ascend a little by capillarity to reach them, the land is allowed to dry, and when sufficiently dried, another hoeing is given. Some do not thin their cotton until after this hoeing. There are cases (when the first watering is given at a short interval after planting) where this may be advisable, but, generally speaking, it is considered better practice, as already mentioned, to thin before the first watering.

The second watering is given about twenty-five or thirty days after the first, and when the land is sufficiently dry another hoeing (this being generally the third) is given. At each hoeing the soil is removed from the top on the opposite bed and drawn up to the plants. As the plants are planted on the side of the bed, the crest of the ridge is above them. This crest is gradually brought over by the hoe to the opposite bed, so that after the third hoeing the plants will be practically on the tops of the beds. (Pl. V.)

The third watering is given about twenty days after the second—the end of May or beginning of June. This may be followed by another hoeing, and generally speaking on good land the cotton, if sown early, is now sufficiently far advanced to make any further intercultural operations difficult.

Waterings are now given more frequently, if possible, and during the months of June, July, and August the crop requires approximately two waterings during each month, but especially in the two latter months. During the summer months of low Nile supply, however, there exist what are known in Egypt as rotations of canals—that is to say, a restriction is placed by the irrigation department on the frequency of watering; otherwise the quantity of water available would not be sufficient for the whole of the cotton crop. The watering of fallow land is also prohibited by governmental decree until the Nile has again risen sufficiently high to place the safety of the cotton crop beyond question, and in some years of low supply the cultivation of summer rice has also been prohibited.

In the simplest form the rotation is as follows: A canal is divided into three divisions, A, B, and C—A being the first section at the canal head, B the middle section, while C is the section at the tail of the canal. Each section was, for example, in the year 1901, allowed a week's supply when it had first claim on the water. If, however, there was any excess passing section A during its week of supply, when it entered section B the latter was allowed to make use of it during the last three days of A's period, but it must be understood that B had no claim or right to the water. The same arrangement holds good for sections B and C during B's week, and for C and A during C's week. No difficulty can be experienced by this arrangement during A's week and B's week, but great caution has to be exercised in giving section A permission to pump during C's week, as A,

FIG. 1.—FIELD OF COTTON SHOWN IN PLATE IV ON MAY 6.

FIG. 2.—FIELD OF COTTON SHOWN ABOVE AND IN PLATE IV ON MAY 20.

being higher up the canal, has first pull on the water. When water becomes scarce, however, at the end of June, there is no surplus, and no section will get more than its seven days' supply. In bad years there may not be sufficient water to permit the whole of the cotton in any section, even during the seven days of its supply, to be watered, but any unirrigated areas are, if possible, watered during the following section's week.

Under such an arrangement as that described the cotton obtains a watering every twenty-one days. During the season of 1903 the rotation was reduced to one of eighteen days, the completion of the Assuan Dam permitting the quantity of water during low Nile to be supplemented by the opening of the dam and the addition thus of a certain quantity of water to the natural supply. From the middle of June to the middle of July the difficulties in the distribution of water are very great, and as the cotton is then in flower and the temperature high the plants are greatly in need of water. It is seen, therefore, that though cotton may be benefited by a watering every fifteen days during the summer months of June and July, this is not possible owing to the rotations in force. During July, August, and September the cotton crop requires no labor, with the exception of that involved in watering, and in the southern part of the Delta cotton picking begins in the first half of September, and in Upper Egypt earlier.

The actual number of waterings which the cotton crop should receive from the time of planting to the first picking is about nine or ten. There can be no doubt that a great tendency exists toward the too free use of water, and though rotations are not in favor with cultivators, yet, provided they are not severe, it is very questionable whether it is not to their interest to have some kind of control in this way over the water supply. Some crops do not show the ill effects of excessive waterings to the extent that cotton does, but very heavy waterings given to the latter cause considerable damage. It is not only that there is a tendency to apply water too frequently, but too heavy applications are given, and it is extremely likely that a flooding does more harm than lighter applications even at more frequent intervals. When severe rotations were at first put in force great alarm was felt for the safety of the crop, but results showed that cotton was enabled to resist longer periods of drought than had been previously imagined. Land which had been well prepared and kept thoroughly hoed suffered least, and early sown cotton less than that planted later.

It may be interesting to state the quantity of water required to raise a cotton crop. Each watering is supposed to be equivalent to about 350 tons of water per acre, and, as already mentioned, some nine or ten applications of water are given up to the first picking, or a total of from 3,150 to 3,500 tons of water. This is approximately equivalent to a rainfall of from 31 to 35 inches. The "duty" of water in the Delta is annually calculated by the irrigation department, the period chosen being from the date when the rotations are applied to the date of their removal—that is, when the Nile has risen sufficiently high to warrant this step being taken.

This period extends approximately from May to the middle of July, and as the result of observations it is accepted that each acre of cotton consumes about 25 tons of water per day. It is assumed that in the months of May, June, and July a cotton crop can be successfully raised on this basis. The actual "duty" of course varies from year to year, according to the state of the summer supply of the Nile. In a year of good summer discharge the "duty" of water is always low, while in a bad year when severe rotations are employed the "duty" is high. In May and June a canal discharging 25 tons of water per day for each acre of cotton to be irrigated is generally, therefore, accepted as sufficient, though cultivators would use more were it available.

MANURING COTTON.

The question of manures and manuring is assuming greater importance in Egypt than formerly. When the Delta was under a basin system of irrigation and receiving annually the life-giving deposit of the Nile, and when consequently the cultivation of a summer crop, such as cotton, was impossible, there was not that need for manure which exists to-day. The introduction of perennial irrigation and the more intensive cultivation which follows in its train have, however, brought about a great change, and the idea that the soils of the Nile Valley are inexhaustible is a myth which is being rapidly dispelled. True, in the basin lands of Upper Egypt the ancient conditions still prevail, but this section is in a state of transition; and that system which has been typical of the country for so many thousands of years is now giving place to perennial irrigation and the consequent abolition of the one-crop system in favor of a more intensive culture.

The interdependence of water and manure has already been referred to, and whenever land is artificially irrigated the need for manure at once arises. The two questions of water and manure are really intimately connected, and the supply of one should always be considered with reference to that of the other. Where land is artificially irrigated in Upper Egypt the demand for manure, as already mentioned, is very great, and even in the basins themselves, when watering by means of wells is practiced, manure is employed.

In the Delta the supply of manure is considered especially in its relation to the cotton and corn crops, but at present we shall confine ourselves to the question of cotton. It is generally laid down that from 8 to 10 working bullocks per 100 acres are required in Egypt, and in addition there are mules for transport, as well as cows, buffaloes, etc., kept both for milk purposes and for breeding. If it is assumed that about one-half of the area of each farm is under cotton, so far as work animals themselves are concerned there are from

8 to 10, say, to every 50 acres of cotton, and in addition to this manure has to be provided for other crops. It is seen, therefore, that in comparison with the conditions prevailing in the cotton-growing States of America there is a much greater quantity of natural fertilizer at the disposal of the cultivators, though, unfortunately, far from sufficient. Earth is in universal use as litter, and the heaps of manure which one sees surrounding every village are evidence of the great value which even small cultivators attach to the fertilizer question.

It is accepted as beyond question by every Egyptian cultivator that cotton requires manuring, and in many cases the cotton area has been governed by the amount of manure available. Manure and water, in fact, tend to control the area under cotton. At one time it was thought that maximum crops could be raised by ordinary stable manure alone, but during the past five years a great change of opinion has made itself felt. The introduction of chemical fertilizers has not only resulted in increased returns, but has made possible the manuring of a greater area. Instead of applying stable manure, as previously, to a portion of the cotton area and leaving of necessity a part unmanured, it is now accepted that the best practice consists in spreading the stable manure over the whole area and supplementing it by chemical fertilizers.

The question of cotton manuring is not an easy one where not only has the yield to be considered, but (and especially is this the case in Egypt) also the quality. It is unnecessary to state that as a cotton-growing country Egypt is noted for the quantity of its product, and consequently, while endeavoring to obtain the greatest product possible from a given area, the question of quality is one which is ever brought home to the cultivator.

It may be laid down as an axiom that the basis of cotton manuring in Egypt must be organic manures. These must form, as it were, the foundation on which to build up the system of manuring. Unfortunately, in Egypt, as in India, organic matter is at a premium. The absence of wood as fuel necessitates the poorer classes employing every form of organic matter for this purpose, and were it not for the growth of clover it is certain that the soils would speedily become deficient in humus. It is true that by means of chemical manures alone full crops of cotton may be obtained, but in this case if a cereal crop follows the cotton the result is not so satisfactory as when the cotton receives stable manure, while the cost of raising the cotton is increased.

Stable manure is almost invariably spread broadcast over the land before the last plowing is given in the preparation of the land. The amount applied varies from 10 or 15 tons per acre to as much as 30 tons. It is not, however, possible on a farm of any extent to find a sufficient quantity of manure to treat the whole cotton area as liberally as 30 tons or even 20 tons per acre. In fact, it is rarely that large growers can find sufficient manure to apply as much as 15 tons per acre, especially so as a greater proportion of the land is now under cotton. It may be assumed, however, that under the ordinary circumstances of successful agriculture 15 tons per acre are employed.

The manure is certainly not covered as deeply as in America, the use of the native plow after its distribution over the land resulting in its being buried to a trifling depth only. The irrigation water employed tends to wash the valuable ingredients of the manure down into the soil; furthermore, in Egypt great importance is attached to the feeding of the cotton plant during the early stages of growth, and opinion would be rather opposed to burying the manure as deeply as is practiced in the cotton States of America. It is again laid down as a rule that the manure should be old; that is, should have been in the heap for some time. The use of fresh stable manure causes rank growth, late maturity, and an inferior fiber.

Though great importance is attached to the use of stable manure, the best results are not, as a rule, obtained when large quantities are used without the application of chemical manures. The basis of the mixture of chemical manures employed is superphosphate. About 400 pounds per acre of this substance are applied, the quality in common use being that which contains 16 to 18 per cent of soluble phosphoric acid. It is found that this substance exercises a most beneficial effect on the crop. It checks the tendency to coarse growth, and thus encourages ripening, while it greatly improves the quality of the fiber. It is generally considered that the best results are obtained when this manure is applied previous to the sowing of the crop. The use of basic slag as a substitute for superphosphate has not been attended with satisfactory results, the more soluble forms of phosphoric acid being preferred.

While phosphoric acid is the basis of the mixture of manure employed, it is universally conceded that the application of soluble nitrogenous manures during the early stages of growth is most beneficial. It is found that the cotton plants require pushing when young, and that though there may be theoretically quite sufficient nitrogen in the stable manure applied, it does not act as early as is advisable; in fact, when large quantities are applied it causes growth at too late a period, and consequent harm. Some few years since, when the idea gained ground that the question of the manuring of cotton merited more attention than had been given to it in the past, some excellent cultivators, by the addition of large quantities of organic manures produced cotton of poorer quality than they had grown previously with a less liberal application.

The question whether nitrate of soda or sulphate of ammonia is the most suitable substance to employ as the basis of nitrogenous manuring, or whether a mixture of the two is advisable, has been made the subject of many experiments. There were those who maintained that the former would be almost entirely washed away by the irrigation water employed. The results which have been obtained indicate that when barnyard manure is applied there is little need for any nitrogenous fertilizers which do not supply nitrogen in the very early stages of growth. When considerable quantities of sulphate of ammonia are applied, there is a tendency to cause excessive growth late in the season, and on account of a failure to ripen there is often a considerable diminution in the yield. On the other hand, when nitrate of soda predominates, the plant receives a supply of nitrogen just when it is wanted at the early stages, and this gives the plant that good start which is so essential in cotton culture. That there is a loss of a part of the nitrogen is probable, but the effects of its application are always most pronounced and profitable. The benefit derived from the part which is not lost is more than sufficient on ordinary soils to pay for its cost.

It is generally considered that in addition to an application of 10 or 15 tons of stable manure it is profitable to employ as much as 150 or 200 pounds of soluble nitrogenous manure, and two-thirds nitrate of soda and one-third sulphate of ammonia give excellent results. Experiments have clearly proved that better results are obtained when the amount of nitrate of soda predominates than when the greater part consists of sulphate of ammonia, assuming that an organic manure has been applied, which should always be the case when possible.

The employment of cotton seed or cotton-seed meal is out of the question in Egypt, the seed being considered too expensive. It is more costly than in the United States, and practically the whole of it is exported. The economy of the use of cotton seed and cotton-seed meal as such as sources of nitrogen for the cotton crop seems to the writer to be very questionable. In passing through the body of an animal comparatively little of the valuable fertilizing ingredients of the meal are retained, but are found in the resulting manure. It seems, therefore, more practical to employ stable manure or green manures as the basis of manuring in Egypt and to supplement these by the use of such substances as superphosphate, nitrate of soda, and potash manures to supply the deficiency.

Soluble nitrogen gives size to the plant, and up to a certain point a larger and more vigorous plant means an increased yield. It is often argued that the production of large plants reduces the yield, and this may be true to a certain extent; but this arises generally from the plant being stimulated too late. Excessive growth is produced by manures containing nitrogen which act too late in the season. This objection is not felt in the case of manures which supply their nitrogen early, but with those which continue to push the plant too late.

The employment of potash manures in Egypt has not, generally speaking, been attended with satisfactory results except in the case of light soils. The alluvial soils of Egypt are as a rule very rich in potash, and, though potash manures may have a beneficial effect on the quality of the fiber, as far as yield is concerned they exercise practically no effect. Sulphate of potash is the substance generally employed.

As a general rule a mixture of 400 pounds of superphospate, 125 pounds of nitrate of soda, 50 pounds of sulphate of ammonia, and, provided it is thought necessary, about 80 or 90 pounds of sulphate of potash, gives the best results. This mixture is employed in addition to stable manure. Discretion must be exercised as to the quantity of soluble nitrogenous manures to employ. On many soils which naturally produce very strong growth the amounts given may be excessive, but even with the relatively large growth of Egyptian plants there are very few soils where nitrogenous manures may not be used with advantage.

Stable manure contains on an average about 0.25 per cent nitrogen, 0.2 per cent phosphoric acid, and 1.25 per cent potash, so that each ton contains about 5½ pounds of nitrogen, nearly 5 pounds of phosphoric acid, and about 28 pounds of potash. If it is assumed that over the cotton area 10 or 15 tons on an average are applied per acre, it is equivalent to at least 55 pounds of nitrogen, 50 pounds of phosphoric acid, and 280 pounds of potash. A great part of these ingredients is derived from the soil itself, which was used as litter, and the availability of the various elements must be very low. It is generally thought that in addition to this about 30 pounds of nitrogen and 60 pounds of phosphoric acid in available forms are necessary to produce a good crop on land which grows from a bale to a bale and a quarter of cotton per acre. Numerous experiments have shown that these quantities can be applied with advantage to the great bulk of the cotton area.

As already mentioned, the barnyard manure is applied broadcast before the last plowing, and the phosphoric acid is also generally applied before sowing. The nitrate of soda and the sulphate of ammonia, however, are mixed together and applied after the cotton has received its first watering. The plants, generally speaking, are thinned before this watering, and after the second hoeing has been given the nitrogenous manure, mixed with a little earth, is applied at the base of the plants, hoed in, and the second watering given. This occurs in the month of April, and the effects of the manure are seen almost immediately after the watering. Spells of fresh weather often somewhat retard growth during the early months, and the advantages to be obtained by tiding the plant over this period and keeping it steadily growing are very marked.

It may be of interest to give some of the results of experiments which have been made in Egypt during the past three or four years on the subject of cotton manuring. This question was first systematically investigated by the Khedivial Agricultural Society, and as the results of experiments which have been conducted on their experimental farms the matter has assumed great importance, since it is being recognized to a greater extent year by year that by the employment of suitable mixtures of manures profitable increases in yield, as well as an improvement in quality, can be obtained. During the seasons of 1901 and 1902 experiments conducted on somewhat poor land at the society's farm at Mit el Diba showed that when, in addition to stable manure, a suitable mixture of commercial fertilizers consisting of 400 pounds of superphosphate, 125 pounds of nitrate of soda, 50 pounds of sulphate of ammonia, and 80 pounds of sulphate of potash was employed the yield of seed cotton was increased from 880 pounds on unmanured land to 1,595 pounds. The yield obtained by the use of stable manure alone was 1,135 pounds, or 460 pounds less than when commercial fertilizers were employed in conjunction with it. By the use of mineral manures alone, in addition to stable manure, the yield obtained was 1,340 pounds of seed cotton, whereas an increase of 260 pounds, or a total of 1,600 pounds of seed cotton, was obtained when supplemented by nitrate of soda.

As already mentioned, the use of potash salts is attended with practically no increase in yield on the ordinary alluvial soil of the Delta, though when the soils are light the case may be different. This fact has been brought out in many experiments, though whether the use of these salts exercises any effect on the length, strength, or fineness of the staple is a matter for further determination.

The influence of the growth of Egyptian clover preceding cotton is most marked on poor land. On the Khedivial Agricultural Society's farm, in the province of Gharbieh, an experiment was conducted during the season of 1902 on land of similar quality. In one case, series of fertilizer trials were conducted on land where the cotton crop had been preceded by wheat and in the other case by clover. The results obtained in pounds of seed cotton per acre are given below in a tabulated form:

Effect of chemical fertilizers on cotton in Egypt.

Kind of fertilizer.	After wheat.	After clover.
	Pounds.	*Pounds.*
Without manure	800	880
With stable manure only	1,032	1,135
With superphosphate and potash salts	1,005	1,340
With superphosphate, potash salts, and soluble nitrogenous manure	1,105	1,595

It will be seen that the greatest difference is brought out when a mixture of fertilizers is employed and is least when the crop is grown without manure. It may be stated conclusively, therefore, that the use of chemical fertilizers in conjunction with stable manures exercises a very beneficial effect and gives a profitable return. The proportion of nitrogen employed is greater than seems to be the case usually in the United States, and a dressing of soluble nitrogenous fertilizer can be applied in Egypt with advantage, even though barnyard manure is employed, or when following a crop of clover, except on the very best land. The extent of land which is not benefited is very limited, even in Egypt. It may be that, theoretically speaking, sufficient total nitrogen is found in either of the two (i. e., barnyard manure and clover), but they push the plant a little too late in the season and do not enable it to grow so rapidly in the younger stages as is the case under the influence of a more quickly acting source of nitrogen.

The use of soluble nitrogenous manures must not be carried beyond a certain point or there is a great tendency to late maturity. The influence of phosphoric acid in hastening maturity is most marked, and when employed in sufficient quantities in conjunction with soluble nitrogenous manure it checks any tendency of the latter to prolong growth. The use of phosphoric acid without soluble nitrogen gives an earlier crop, but a diminished yield in comparison with that obtained by a combination of the two. Again, soluble nitrogen without phosphoric acid gives also a diminished yield and a late crop. A mixture of the two gives an increased yield and intermediate conditions as regards ripening. This will be made clear from the following table, obtained in an experiment where these manures were employed, the figures referring to pounds of seed cotton per acre on poor land:

Effect of a mixture of phosphoric acid and soluble nitrogen on cotton in Egypt.

Manuring.	First picking.	Second picking.	Third picking.	Total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Phosphoric acid only	835	420	400	1,655
Soluble nitrogen only	138	455	900	1,493
Phosphoric acid, together with soluble nitrogen	435	935	870	2,240

There can be no doubt that organic manures must form the foundation of the Egyptian system of manuring, but it is rare, unfortunately, that a sufficient supply can be obtained by the farmer, and this is more especially the case in view of the tendency to put an increased area under cotton. In Egypt there is no substitute for barnyard manure in any quantity to fall back upon, though poudrette and similar substances give excellent results when so employed.

As regards quality, samples of soil from experimental areas have been repeatedly submitted to experts, and when a suitable mixture of chemical fertilizers has been employed there has always been an improvement in comparison with the employment of large quantities of barnyard manure only.

SUMMARY.

Summarizing, the following statements may be made:

(1) The cotton crop is almost invariably manured and responds freely to the application of manures.

(2) Barnyard manure or some manure of a similar nature should form the basis of manuring in Egypt.

(3) Leguminous forage crops form an excellent preparation for a good cotton crop, but to obtain the best results the soil should be plowed up some time before cotton planting takes place.

(4) The fullest advantage of the use of these manures, as well as of any chemical fertilizer that may be employed, can only be obtained when the soil is well prepared, deeply cultivated, and the crop judiciously watered during growth. Frequent hoeings also keep the crop in a gradually progressive condition.

(5) In addition to the use of barnyard manure at the rate of 10 or 15 tons per acre, applications of chemical fertilizers are attended with profit.

(6) Phosphoric acid at the rate of 400 pounds per acre applied in the form of soluble phosphate gives excellent results. It tends to check excessive growth, increases the yield, improves the staple, and hastens maturity.

(7) A subsequent dressing of soluble nitrogenous manure is attended with excellent results. A good mixture in Egypt consists of about 125 pounds of nitrate of soda and about 50 pounds of sulphate of ammonia. Where larger quantities of barnyard manure are employed it may be advisable to omit the latter. The soluble nitrogenous manure is best employed in two applications.

(8) Potash manures in Egypt have not given any increase in yield, and their value is problematical. Their effect on the quality of the fiber has not been accurately determined.

VARIETIES OF COTTON GROWN IN EGYPT.

The origin of Egyptian varieties of cotton is lost in obscurity. Previous to the year 1820 an indigenous cotton existed in Egypt, but, as already stated, its cultivation was practically unknown. In that year a variety of ordinary white cotton was brought to Egypt by a Frenchman, M. Jumel, and even its origin is somewhat uncertain. It was, however, probably brought from the upper Nile regions. In the growth of this cotton the Khedive took a great interest, and he compelled cultivators to grow it in several districts. At that time the irrigation of Lower Egypt was greatly modified by the making of deep canals capable of carrying the low summer water of the Nile, and the cultivation of cotton began to assume greater importance. From the year 1825 to 1839 it is said that Sea Island cotton was grown regularly in Egypt; and though it is unknown now, old natives occasionally speak of a variety whose name certainly appears to be a corruption of the words "sea island." Again, it is stated by some that Peruvian cotton was introduced and grown.

All that can be asserted with safety is that out of the varieties existing in the country "Ashmouni" cotton was evolved, and of the varieties at present cultivated in Egypt this is the oldest.

ASHMOUNI.

Ashmouni cotton, although at first discovered in the Delta, where its cultivation was at one time general, is now practically confined to Upper Egypt, in the provinces of Beni-Suef, Fayum, and Minieh, being watered by the Ibrahimia Canal. The area exceeds 100,000 acres, though, as already stated, the absence of a statistical department renders any figures somewhat approximate.

The production in the year 1901–2 was 432,000 cantars, made up as follows: Beni-Suef, 174,000 cantars; Minieh, 128,000 cantars; Fayum, 130,000 cantars; total, 432,000 cantars.

The Egyptian bale is equivalent to about 750 pounds of cotton. Expressed in American bales of 500 pounds, the production of Ashmouni cotton would be thus 86,400 bales. Assuming the acreage given to be correct, the average yield is about 1,300 pounds of seed cotton per acre.

This variety is now replaced in Lower Egypt by "Afifi." Practically the whole of the Ashmouni cotton is ginned at various establishments in Upper Egypt, and the fiber is sent to Alexandria for sale and shipment. A small proportion is ginned in Lower Egypt, chiefly at Kafr Zayat. Ashmouni plants are smaller in habit of growth than Afifi and ripen early, owing to the hotter climate of Upper Egypt. When grown under the same climatic conditions Ashmouni does not ripen appreciably earlier than Afifi. The fiber of Ashmouni is brown, though less so than Afifi, and is shorter, being about $1\frac{1}{8}$ to $1\frac{1}{4}$ inches in length. In strength it is fair, but it is neither so lustrous nor so fine as lower Egypt cottons. Though inferior to Afifi, it seems to do better in Upper Egypt than the latter. Afifi not only gives a smaller yield, but soon deteriorates. There seems to be no reason, however, why the latter should not be acclimatized there or a successful cross obtained between the two varieties.

The yield of Ashmouni in ginning is unsatisfactory, being until quite recently only about 95 pounds of fiber per cantar, or about 30 per cent. During the past few years the output has reached 98 to 104 pounds, probably owing to mixture with Afifi. Its value is about $1 per cantar less than that of Afifi for classes up to "good." Ashmouni gives no fine or extra-fine qualities like Afifi. The seed differs from other Egyptian varieties in being "clean"—that is, possessing no adhering fiber. It is very much mixed at the present time, but for the season of 1903 it seemed a little cleaner than usual. The seed is sold early in the season for the same price as Lower Egypt varieties.

The general cultivation of this variety in Upper Egypt has not received as much attention as the Lower Egypt cottons, and as a rule it is not so well cultivated. The fiber is exported chiefly to the Continent of Europe and to Russia, though quantities are sent to England and the United States.

LOWER EGYPT COTTONS.

MIT AFIFI.

Undoubtedly the chief variety of cotton in Egypt is Mit Afifi (Pls. III, fig. 2, and VI, fig. 1), so called from a village in Galiubieh Province, where it was first grown about 1883. It constitutes a very high percentage of the total production of the country, and the price at which its fiber is sold forms a basis for that of other varieties. The plant is normal in size and not so large, generally speaking, as Jannovitch. It is average as regards the time at which it ripens. Ashmouni, grown in upper Egypt, comes into the market first. Abbasi is probably a little earlier, and Jannovitch a little later than Afifi. As regards sowing, quantity of seed used, watering, picking, etc., the particulars given in another part of this bulletin refer to this variety. The fiber of Mit Afifi is brown in color, long, lustrous, generally very strong, and fine to the touch. It attains an average length of $1\frac{3}{8}$ to $1\frac{1}{2}$ inches. There is a great demand for it; in fact, it leads the market. The total production per acre is good, being on an average higher than that of any other variety. It is true that in certain favored districts Abbasi may rival and even surpass it in this respect, but no other variety appears under all circumstances to yield 500 or 600 pounds per acre of lint on good average soil. The bolls are pointed and rather small, but the cotton is easily picked. Ginning is easy, and from 105 to 109 pounds of fiber are obtained per cantar, i. e., from 33 to 35 per cent. Afifi cotton does not show great differences in quality in late pickings as do the other Lower Egypt cottons; that is to say, the difference between the first and second pickings is less marked than with others.

The origin of Afifi cotton is very doubtful. Some years ago there existed in Egypt a considerable number of varieties which were short lived, such as Hamouli, Gallini, Hindi, etc. Pure white cotton also existed, but its cultivation was abandoned after the appearance of Afifi. A variety known as "Bahmia" was also somewhat extensively grown for several years and gave good results on good quality land. It was also replaced by Afifi. A variety known as "Hariri" was first cultivated in the Goddaba district (Garbieh province). This was finer even than the variety known as "Jannovitch" which is cultivated at the present time. The output in ginning, however, was very poor (60 to 70 pounds of fiber per 315 pounds of raw cotton), and its cultivation was abandoned because growers found it unprofitable. Gallini was also first known in the Goddaba district when this region was badly drained and the land consequently salty. Since that time, however, the quality has greatly deteriorated, and as the output in ginning was poor it also was replaced by Afifi. It was commonly reported that this variety, which was itself said to be of Sea Island origin, gave rise to our present Afifi. Each cantar of Gallini cotton (315 pounds) gave only from 85 to 88 pounds of lint.

What is known as "Hindi" cotton is really the old native variety and is now unfortunately found in almost every quality of cotton to a greater or less extent. This, of course, causes deterioration in the staple and also reduces the output in ginning.

The silky nature of Egyptian cottons and the fact that they possess a brown color probably indicate that they are really of Sea Island origin, but there is no evidence to show whence their deeper coloration than Sea Island arose unless it was by means of a cross with some highly colored variety, such as Peruvian. It has often been suggested in the United States that the peculiar soil conditions of Egypt, the Nile mud, etc., may account for this; but there exists in Egypt a pure white variety (Abbasi), which has now been grown for many years, and there has been no tendency whatever toward the development of any brown coloration, which seems to preclude this idea. Again, previous to the appearance of Afifi, the common white cotton was grown. This possessed a short staple and when in quantity sold for less than Ashmouni. It is doubtful also whether a cross with highly colored Peruvian cotton would have resulted in such good quality as Egyptian cottons possess.

The majority of the varieties are probably "sports." When a new variety has appeared, its origin has always been kept a profound secret owing to the very high prices asked at the commencement for seed, and any inquiries made always led to widely differing replies.

The seeds of the different varieties of Lower Egypt cottons can not readily be distinguished from each other. They are black, with small tufts of green fiber at the ends. Their market values are the same.

ABBASI.

This is the only white cotton now grown in Egypt. It made its appearance about 1891–92. At first it was grown only on large estates, but it gradually increased in favor, though at the present time its cultivation is diminishing. Afifi is the general cultivators' cotton, as it were; it is more suited to all conditions, requires less care in picking, and the market is always certain. All other varieties may be called "special," requiring more careful treatment, and the demand for them is not so universal. Abbasi, owing to its color, requires more care in picking. It is said to be more hardy than Afifi, resisting periods of drought and adverse climatic changes more successfully. In the late summer and early autumn, fogs which do a great deal of harm are experienced in Egypt, and it is said that Abbasi cotton suffers less than any other variety, and is also less affected by cold spells. It produces in certain districts a heavier crop than Afifi, and is perhaps a little earlier. In general management and cultivation it resembles the latter.

The first picking of Abbasi is very superior and sells well; the later gatherings deteriorate, and there is small demand for them. The fiber of the first picking is as fine as Afifi and a little longer. As a general rule the second picking is much weaker than the first, and the lower qualities sell for less in proportion than lower grade Afifi. Abbasi is rather more difficult to gin, having a tendency to break the knives. The fiber clings to the roller and often comes to the knives again. Care must be taken not to injure the long fiber; therefore the gins are run at a slower speed. The longer stapled cottons, such as Abbasi, Gallini, and Jannovitch, require a little different regulation of the gins in order to avoid damaging the staple. The output of seed per cantar of Abbasi is about the same as Afifi; there is more "scarto," however. The price of the best qualities ranges from $1 to $1.50 per cantar of 315 pounds more than Afifi.

Abbasi was first put on the market by a Greek planter near Birket-el-Sab in the Garbieh province, and it is almost needless to state that the name given to it is derived from that of the present Khedive. The best qualities are exported to England, and the poorer qualities to all parts of the Continent—a little to Russia.

JANNOVITCH.

This variety, which has been cultivated for about seven years, is the most silky and fine of all Egyptian cottons. It possesses good length—$1\frac{1}{2}$ to $1\frac{5}{8}$ inches—is very fine, and stronger than the best qualities of Afifi. As a rule its cultivation is in the hands of large growers, the fellah confining himself chiefly to Afifi.

The plant is of somewhat coarser growth than the other Egyptian varieties, and is a little later in coming to maturity. The best qualities are grown in the northern part of the Delta, near the sea, and where the land generally contains a certain amount of salt. The output in ginning is inferior to both Afifi and Abbasi, the average being about 97 to 100 pounds per cantar, but in some districts it gives 100 to 102 pounds of lint per cantar, or 315 pounds, of seed cotton. It is chiefly exported to England, but also to America, the north of France, and Switzerland; other countries take very little. The price is generally $2 to $2.50 per cantar above Afifi, and this in spite of the fact that the yield in ginning is from 5 to 8 pounds of lint per cantar less.

It is suposed that this variety originated from a cross of good quality Gallini (of which very little existed at the time in the district) and Afifi. Gallini gave in ginning only from 80 to 88 pounds of fiber per cantar, while Jannovitch when it was subsequently grown gave from 97 to 100 pounds, and Afifi similarly yielded from 106 to 108 pounds. In this respect, therefore, the new variety was intermediate between its parents. At first the originator of this variety planted a few seeds in a garden, but in February, 1898, about 8 or 10 ardebs of seed were bought at $40 per ardeb (5.4 bushels), while subsequently as much as

$100 per ardeb was paid for about 11 ardebs. The following year seed was sold for from $20 to $30 per ardeb.

It may be mentioned that Sea Island cotton when grown in Egypt produces good quality the first year. The staple is longer even than that grown, on an average, in America, but is more irregular in length and not so strong. During the second and third years there is a general deterioration. It ripens late and being in consequence exposed to cold weather and fogs, both yield and quality suffer. The yield in any case is inferior to native Egyptian varieties. The output is only from 70 to 80 pounds of fiber per cantar, according to the quality of the lands. The best qualities are grown on salty lands. On rich soils the quality deteriorates.

SEED SELECTION.

The question of the selection of seed for sowing is occupying considerable attention in Egypt, as Afifi cotton, which is the mainstay of the crop, is greatly deteriorating. Owing to the great similarity not only of the plants of the different varieties grown in the country but also of their seeds, the matter is a somewhat difficult one. At the present time the question of seed is entirely in the hands of the cotton merchants. When the best qualities of cotton of the first picking are being ginned, the factory owner places on one side the resulting seed for disposal to his clients the following season. This is excellent as far as it goes, but where two or three varieties are being dealt with in a factory, even though the proprietor may clean his gins, his riddles, etc., after each ginning a certain admixture must take place. The seedsman class is quite wanting in Egypt, and until recently most of the cultivators were not sufficiently alive to the question of good seed. At the present time, however, the Khedivial Agricultural Society is paying special attention to this most important subject, while individual cultivators appreciate more the necessity of employing good and pure seed.

Small cultivators in the past obtained their seed to a great extent through the village money lender, who supplied them with ordinary commercial seed quite unsuited for sowing purposes. The Khedivial Agricultural Society now distributes seed of first-picking cotton to small growers at cost price. The value of the seed, plus a moderate rate of interest, is collected by the Government agents when the ordinary taxes are collected. The seed is not paid for until the resulting cotton crop is picked. The benefits are two-fold—not only is the fellah provided with better seed than he would obtain elsewhere, but he is to a certain extent kept out of the hands of the usurer.

Afifi seed at present is mixed and contains Hindi seed. This, as already stated, is the old white variety, and its presence greatly detracts from the value of any sample. There are also a great many seeds present in samples which, while differing in shape from good, true Afifi seed are yet Afifi, but seem to be in a state of deterioration. The question of the establishment of seed areas is now under consideration.

PICKING COTTON.

The picking of cotton commences in Upper Egypt, where Ashmouni is grown, during the latter part of August, but in the Delta, generally speaking, toward the middle of September. Cotton is usually picked by small children, who are paid a sum of 18 or 20 cents per hundred pounds of seed cotton (Pl. VI, fig. 2). The previous watering of the crop is so arranged that the land is dry when picking commences to avoid poaching of the land. The operation of picking is more difficult than that of ordinary Upland cotton, though not as much so as that of Sea Island. The average quantity picked per day is about 30 or 40 pounds. After the first gathering the land is watered, and during the month of October a second picking takes place. These two pickings give the best quality of fiber. They are never mixed with each other nor with the third, or last, picking. The latter is taken in November, and as it is small in amount compared with the others a superior sum is generally paid for picking it, generally 25 or 30 cents per hundred pounds.

After picking, the cotton is generally placed in large stores and subsequently put into sacks which hold about 420 pounds, or it may be put directly into sacks.

MARKETING COTTON.

Cotton is almost invariably sold at the farm. There are distributed throughout the country a number of large ginning establishments (as well as a number of minor ones) owned by large exporting houses. Agents are sent into the country to buy cotton, and the grower can obtain many offers from competing houses. The cotton is sold as seed cotton, weighed at the store in the presence of the buyer's agent and the seller, and is then taken charge of by the former for removal to the nearest railway station or is delivered by the seller, according to agreement. In the case of large lots of cotton the grower, provided with samples, sometimes visits the factories,[a] and after a considerable amount of competition and bargaining disposes of his crop.

Cotton is quoted on the bourse at Alexandria per cantar of 100 pounds of lint for "fully good fair" cotton. To this amount the value of the seed is added and a certain sum per cantar (of 315 pounds of seed cotton) is offered to cultivators, depending on the quality of the cotton in question. Ginning is carried on, as already mentioned, at various centers, and the resulting fiber and seed are forwarded to Alexandria for shipment. The factories are generally situated so that

[a] Known as ginneries or gins in the United States.

transportation is easy both by rail and by water. The season is from September to May, and during its height the factories work night and day.

The gin almost invariably used in Egypt is that known as Macarthy's patent self-feeding single action. It is particularly suited to long-stapled cotton, and separates the seeds without crushing, while the fiber is as a rule uninjured. The 40-inch gin so commonly used costs, when complete with roller, shafting, etc., about $150. The gin alone costs $90. It is said to require only 1½ indicated horsepower to drive it, but in practice from 3 to 4 horsepower are allowed. The quantity of cotton turned out per hour varies according to the speed at which the gin runs. It is supposed to give a hundredweight of clean cotton per hour, but from 90 to 100 pounds is considered a good average. Running at 900 or 1,000 revolutions per minute, 100 pounds of fiber per hour will be ginned, or, say from 900 to 1,100 pounds per day of ten hours. The driving pulleys being now provided with balance weights, the gin can run at an increased speed with but little increase in vibration. The gin is not large, the floor space it occupies being less than 17 square feet, while the net weight is less than 700 pounds. In Egyptian factories from 50 to 100 of such machines are generally found.

Regarding the cost of working, it may be taken as a general average that 30 cents will gin a cantar of cotton, i. e., 315 pounds of the seed and fiber, giving approximately 100 pounds of clean cotton. According to the reports of the State Domains the net cost of ginning is 26½ cents per cantar, and thus an acre of good cotton yielding 6 cantars would cost a little over $1.50 for ginning (actual cost).

The gins are generally arranged in two rows, with a trolley line down the middle for the removal of the cotton. The latter is taken to the press room, which is situated at the end of the ginning room. Both hydraulic and steam presses are used. In the small factories, the former only are found and the bales are steam pressed at Alexandria. In the large factories the good qualities are pressed twice. After removal from the gins the fiber is spread out and sprinkled with water by means of a fine syringe and then put into hydraulic bales. After remaining a day the cotton is steam pressed, and the three bands which are used in the former case are replaced by eleven in the steam bale. The seed after removal from the gin is elevated to riddles, which allow those possessing no adhering lint to pass through, while the rest is carried on to the "scarto" gin, which removes short fiber.

One or two of such gins, each requiring 5 horsepower, are sufficient for 100 ordinary gins and turn out about 4 bales of "scarto" cotton per day. The seed is subsequently put into bags containing an ardeb (5.4 bushels), the weight being about 270 pounds, and is sent to Alex-

FIG. 1.—FIELD OF MIT AFIFI COTTON BEFORE GATHERING.

FIG. 2.—EGYPTIAN METHOD OF PICKING AND CARRYING COTTON.

andria for export. Sometimes cotton is ginned for clients at about 30 cents per cantar, the owner selling the resulting seed to the factory, while the cotton is sent in hydraulic bales for his account to Alexandria. If steam pressed, a charge of 15 cents per cantar (100 pounds) of lint is made, plus the cost of bagging required for the bales. The sacking used for bales in Egypt consists of old cotton sacks. The latter after being used two seasons for packing cotton are cut up for this purpose.

The first, second, and third pickings of cotton are always ginned separately. That of the third picking is generally put in hydraulic bales only and forwarded as such to Alexandria.

During the past few years two cotton mills have been erected, one at Alexandria and one at Cairo. The local consumption of cotton, however, is not great. A certain amount is consumed in the villages by being woven into coarse goods, but this is generally the very last cotton gathered from the plants and is of very low quality. The consumption during the past season by local mills amounted to 27,000 cantars, or an equivalent of 5,400 American bales.

Practically the whole of the Egyptian cotton seed is exported. A certain amount is, however, consumed by soap and oil mills in the country. This latter consumption amounts to 420,000 ardebs, or an equivalent of 2,320,000 bushels. The seed is rich in oil, the average content being about 25 per cent. The cotton cake resulting is exported to England, and, as is well known, is "undecorticated cotton cake," the seed not being decorticated.

The following table shows the production of seed cotton in Egypt from the year 1864 to 1903, the season being from September 1 to August 31:

Total crops of seed cotton (interior gross weight).

Season.	Cantars.	Season.	Cantars.	Season.	Cantars.
1864-65	2,139,716	1877-78	2,593,670	1890-91	4,072,500
1865-66	864,581	1878-79	1,683,749	1891-92	4,672,520
1866-67	1,127,895	1879-80	3,198,800	1892-93	5,118,150
1867-68	1,207,402	1880-81	2,776,400	1893-94	4,933,666
1868-69	1,303,156	1881-82	2,912,073	1894-95	4,615,270
1869-70	1,362,514	1882-83	2,284,250	1895-96	5,275,383
1870-71	1,970,717	1883-84	2,694,000	1896-97	5,879,750
1871-72	2,044,254	1884-85	3,615,750	1897-98	6,543,128
1872-73	2,298,942	1885-86	2,923,450	1898-99	5,589,314
1873-74	2,538,351	1886-87	2,931,691	1899-1900	6,510,050
1874-75	2,106,699	1887-88	2,937,000	1900-1901	5,427,338
1875-76	2,928,498	1888-89	2,723,000	1901-2	6,371,643
1876-77	2,773,258	1889-90	3,183,000	1902-3	5,838,090

It is impossible, owing to the absence of a statistical bureau, to state the exact average yield of cotton per acre in Egypt, but it is probably about 1,300 pounds of seed cotton. Very good land gives 2,500 pounds, and in exceptional cases more.

COTTON AND COTTON-SEED EXPORTS.

The statistics of cotton and cotton-seed exports furnished by the customs administration are calculated from January 1 to December 31. In the year 1901 cotton constituted 75.2 per cent of the total exports of Egypt and in 1902 similarly 78.8 per cent.

Distribution of cotton and cotton seed for the years 1902 and 1903.

Countries to which exported.	1902.	1903.
Exports from Alexandria to—	*Bales.*	*Bales.*
Germany	19,126	19,422
England	322,514	351,745
Belgium	9,604	12,670
Spain	31,781	24,910
United States	106,565	84,819
France	78,875	70,608
India	2,443	836
Italy	63,068	60,728
Japan	11,322	9,498
Russia	121,343	55,424
Austria	92,249	75,989
The Netherlands	327	
Greece, Turkey, and other countries	3,753	1,798
Exported from Port Said and Suez	700	[a]5,445
	863,670	773,892
Total in cantars	6,526,407	5,860,023

[a] Estimate.

COTTON SEED (IN ARDEBS OF 5.4 BUSHELS).

	1902.	1903.
To England	3,146,660	2,732,366
To Marseille	182,925	137,018
To various Continental ports	153,585	104,290
Total	3,483,170	2,973,737
Local consumption	310,978	420,000

SUGAR CANE.

Sugar cane is grown in Upper Egypt. The climate of the Delta proper is unsuited to it and results in a low content of sugar. Cane is characteristic of the tract watered by the Ibrahimia Canal already referred to, but it is also grown farther south, being watered by pumps direct from the river. The area varies from year to year, an increase in the cotton area being practically equivalent to a diminution in that devoted to sugar cane. Generally speaking, during the past few years there has been a tendency toward a diminution.

In the year 1902 the area under cane in Upper Egypt amounted to 84,664 acres, of which 58,765 were on the Ibrahimia Canal, while the remainder was grown farther south. Cane occupies the land for nearly a year, and requires water during the whole period, while for the production of maximum crops the soil has to be in a high state of fertility.

The Daira Sanieh Administration, whose lands have now been sold to individual cultivators, owned until quite recently the greater part of the sugar-growing lands and possessed several factories. The land under this administration was cultivated chiefly through tenants.

Considerable areas were leased to large cultivators who grew cane under an agreement to sell the produce to the administration at a fixed price (generally about 15 cents per hundred pounds of canes). The leases for cane cultivation were for three years and bound the tenant to one year's fallow, during which it was plowed by the administration at a fixed rate. This was followed by cane for two years. This again was followed by a three years' lease for minor crop cultivation, after which cane was grown again. The growth of summer crops was prohibited during the intermediate years, but corn was cultivated during the flood season, this being heavily manured. The growth of clover was practiced during the winter, and thus the land was brought into condition for cane again. Small owner proprietors, however, crop their land more intensively. They manure their cane heavily (while this was prohibited on the Daira lands) and only take one cane crop; that is to say, they do not take a rattoon crop. This is followed by two or three years' ordinary cropping with grain crops and clover, when cane is grown again. Though a large yield per acre is obtained in this way, yet by applying heavy quantities of manure the sugar content is considerably reduced.

The factories of the Daira Sanieh have been sold to a private company, and the sugar industry of Egypt is now practically a monopoly in the hands of a French company known as the Société Générale des Sucreries et de la Raffinerie d'Egypte. This company owns the majority of the factories and may be said to crush practically the whole of the crop, except that employed for the manufacture of molasses in small mills owned by natives and Syrians.

The rotation employed is either one of four or five years. In the former case cane is grown for two years, followed the next year by a flood and a winter crop, and this again during the fourth year by a fallow in preparation for the next year's cane crop. Since the introduction of the growing of beets into Egypt a modification in the rotation has been introduced in some places by growing a crop of beets before the fallow, thus making the rotation a five years' course.

Steam plows and cultivators, which do most effective work, are employed by the company; but on ordinary plantations the native plow is used, and four plowings and even more are given with this implement in preparation for the sowing of the crop. The land is thrown into ridges or beds about 40 inches apart; but native cultivators allow a less distance than this, generally about 30 inches. The ridges are made north and south and should have a depth of 15 inches measured from the top of the ridge to the bottom of the furrow. The soil at the bottom of the furrow should be well pulverized, and this is accomplished by attaching a sort of rake to the ridging machine where this is employed. Native cultivators make their ridges in the manner described in the chapter on cotton.

Planting takes place early in spring, in February, though experiments which have been conducted recently seem to indicate an advantage in sowing as early as October. Too little care is given to the question of the choice of canes for planting instead of employing only the best. Generally speaking, the whole of the cane is used. The company to which reference has been made adopted the following plan: If planting takes place before the factories are at work, the whole of the cane is employed, while if the factories are crushing, the top third only (which gives the best results) is kept for planting, the remainder being sent to the factory. No greater quantity is cut and stripped per day than is necessary for that day's planting. The canes are laid along the furrows, covered lightly with earth, and then watered, the same day preferably.

The cultivation of this crop is comparatively simple, and from twelve to fifteen waterings are given. Several hoeings are necessary, and these are performed with the hoe as described under cotton.

It is very doubtful whether Egypt can be regarded as a very suitable country for the production of sugar cane, for neither in yield nor in richness in sugar can it compare with many other countries. The average yield of cane for the first year may be taken as about 26 tons, though in some cases more than 30 tons are obtained. During the second year the yield on an average does not exceed 50 per cent of that obtained during the first.

The average sugar content does not exceed 14 per cent; indeed this would be considered an extremely good result. During the season of 1902, 11,148,491 cantars (of 100 pounds each) of cane were crushed in Upper Egypt, yielding 1,028,105 cantars of sugar of first quality, equivalent to 9.2 per cent of No. 1 sugar.

Only one refinery exists in Egypt. A great portion of the sugar produced is consumed locally or exported to India and other countries without being refined.

The following tables show the quantities of cane crushed during the past five years, together with the yield of No. 1 sugar:

Quantity of cane crushed and yield of sugar during the past five years.

[Cantars of 100 pounds.]

Season.	Cane crushed.	No. 1 sugar produced.	
			Per cent.
1898-1899	13,680,944	1,253,525	9.2
1899-1900	14,515,565	1,369,953	9.4
1900-1901	11,850,485	1,161,471	9.0
1901-1902	12,442,452	1,240,843	10.01
1902-1903	11,148,491	1,028,105	9.2

The following table indicates the export trade in Egyptian pounds:[a]

Country to which exported.	1900.	1901.	1902.
England	33,049	32,747	22,235
English possessions in the Mediterranean		67	70
English possessions in the extreme East	21,029	46,042	31,611
Germany			449
United States	462,454	410,031	257,404
France and Algeria	4,381	1,061	1,270
Italy	1,698	1,211	699
Turkey	39,766	41,593	37,378
Other countries	13,132	9,493	7,777
Total	575,509	542,245	361,973

From these figures it will be seen that the United States is by far the best customer for Egyptian sugar. Of the total production of sugar, 63½ per cent is refined. Of the unrefined sugar 35 per cent is consumed locally and 1½ per cent exported. Of the refined product 84½ per cent is consumed locally and 15 per cent exported.

The crop is heavily manured by natives. Ordinary stable manure is employed, and large quantities of the material known as "coufri," which has already been referred to, are used. Experiments which have been made clearly indicate that an employment of superphosphate with soluble nitrogenous manures gives excellent results for cane.

In an extensive series of experiments made by Mr. Tieman, details of which are given in a recent work, entitled "The Sugar Cane in Egypt," the author recommends the employment of nitrate of soda in preference to any other form of available nitrogen for sugar cane, while as a phosphoric manure the use of basic slag is advocated. The manuring of cane has not, however, received as much attention as has been given to cotton.

Three varieties of cane are cultivated in Egypt: Red, yellow, and striped. The last named seems to give a slightly heavier yield, though in richness of sugar no difference is perceptible.

BEETS.

Though a very minor crop, it may be advisable to refer to beets in close proximity to sugar cane. Some few years since a first attempt was made to cultivate this crop, but up to the present it has not been very successful. The land of Egypt, as is well known, is of good quality, and, generally speaking, such crops as beets, which have a wide range of cultivation, can not be grown in competition with European countries which possess a poorer soil.

Again, the rich soils of the Nile Valley do not give comparatively heavy yields of roots, and 15 tons per acre may be considered a full

[a] An Egyptian pound equals about £1 0s. 6d., which is equivalent to about $4.94.

average. Perhaps, however, the one fact which has militated against the success of the crop has been the severe attacks to which it has been subjected by worms. The most favorable time for the planting is in summer, and attacks by worms are at that time very common; in fact, the beet crop has never escaped. Moreover, summer crops in Egypt exhaust the land, and especially those which require much irrigation. In spite of the fact that the green leaves are turned under after the removal of the crop, and that the land is in good condition after the numerous hoeings, etc., received, a crop of cotton following beets (in the Delta) always suffers and gives a poor yield. This has been repeatedly brought out in experiments which have been made in Lower Egypt.

All the beets grown at present in Egypt are grown by the sugar company in the upper division of the country and amount to about 1,200 acres. The crop occupies the land about six months and is practically always manured with nitrate of soda, which greatly increases the yield. The sugar content is high.

BERSEEM, OR EGYPTIAN CLOVER.

Berseem is the great leguminous forage crop of Egypt, and for luxuriance and rapidity of growth is probably unequaled and certainly not surpassed by any crop in the world. What Egypt would have been or would be without this crop is difficult to conjecture. It is certainly impossible to overestimate its importance. The growth of such heavy crops of cotton, for example, with, comparatively speaking (and especially so until recently), small quantities of manure, has only been possible through the renovating influences of berseem. It has, in fact, only been by the extensive growth of this crop that the maintenance of the fertility of Egyptian soils has been possible. To state the area of land under berseem is extremely difficult, as it not only takes its place in the ordinary rotation, but is also used as a catch crop, one cutting, or it may be two, being taken before the sowing of cotton in the spring.

Berseem constitutes the sole food of working animals, cows and buffaloes; in fact all farm animals during the months of its growth, that is to say, from a period extending from December to early in June. During the rest of the year, as already mentioned, there is almost a complete absence of green fodder and a dry ration, composed of chopped straw, beans, barley, etc., has to be resorted to. The want of a summer forage crop which will grow without repeated applications of water is very much felt in the country. During the winter months no other forage crop is grown; indeed, it is difficult to see how any crop could compete with it in universal use in the country.

There are three recognized varieties grown in the country, viz, the Muscowi, Fachl, and Saidi. The former is that grown on the perennially irrigated lands of Lower Egypt, and the following remarks apply to this variety.

Berseem is generally sown in the months of October and November, following, as a rule, the corn or cotton crop, the date of sowing consequently being dependent on the removal of these crops. As the weather is now daily becoming cooler, the earlier the berseem is sown the shorter the period which elapses before the first cutting or grazing is obtained, and the earlier this is obtained the better, as it diminishes the period during which animals have to be fed on dry food. The first grazing when early can be sold for a considerable sum, as much as $15 per acre in favored districts. When sown after a corn or a cotton crop, the seed is often sown among the standing crop eight or ten days before the corn crop is removed. A heavy watering is given and the seed is then broadcasted immediately. It may be sown in a similar manner among the standing cotton plants. By these means there is a gain of several days and the young clover will be established before the grain or fiber crop is removed. It is becoming more common now, however, to plow the land after the removal of the corn or cotton crop. The cotton ridges or beds are split down the middle with one passage of the plow, the land heavily watered, and the berseem seed broadcasted immediately. The soil is not allowed to become dry, but the seed is scattered over the surface while the water is still on the land, when, owing to its weight, it at once sinks. The amount of seed used varies from 70 to 80 pounds per acre. Germination takes place in two or three days, and if the weather is warm the plants make rapid growth.

Three waterings are generally given previous to the first cutting or grazing, which is obtained from fifty to seventy-five days after sowing, depending to a great extent on the date of the latter. The number and frequency of waterings depend on soil and climate to a certain extent, but two waterings are given between the first two cuttings, and generally two between the second and third and the third and fourth—a total of eight or nine or even ten waterings. On an average three good cuttings or grazings are obtained, while a fourth may or may not be obtained, depending on the date of sowing. In any case it is little in comparison with previous ones. The fourth cutting is generally the one left for seed. Of the latter, 6 or 7 bushels are obtained on good average land. The first and second crops will yield about 8 tons of green fodder; subsequent ones, less. If sown late in October, the first crop will be ready at the end of December, the second early in March, the third from the middle to end of April, and a light fourth crop, either for feeding or for seed, at the end of May or early in June. Hay is frequently made from berseem, about 5 tons of the latter giving 1 ton.

Berseem is fed by tethering animals on the ground by the fore feet, the pegs being moved on as they have eaten those plants within their immediate reach. The luxuriance is sometimes so great that the long lines of bullocks seem to be feeding against a solid wall of forage which reaches almost up to their briskets. A few days are allowed to elapse after grazing before the land is watered again, and the new crop then makes rapid growth. The forage is very succulent, containing as much as 85 or 86 per cent of water in the earlier grazings, and a little care has to be exercised in feeding it to animals in the early morning during the winter when dew is on it to prevent "tympanitis." Animals in Egypt are never in as good condition as when fed on berseem, and during this period no other food is allowed them, though the pressure of work is very severe at cotton planting. From the moment of planting, the crop requires no labor except that involved in watering. No manure of any kind is ever applied.

The root system of berseem is not an extensive one, but it is most abundantly supplied with nodules. In the latter connection and as exemplifying its renovating effect on the soil it may be interesting to quote the results of analyses made last year by Doctor Mackenzie, director of the School of Agriculture. Berseem was sown in October on two adjacent areas, A and B. On B the crop was allowed to remain for two grazings and then plowed up in March in preparation for a cotton crop, while on area A the crop was allowed to remain for its full period of growth until June, and four crops were taken. Previous to the experiment the nitrogen content of each area was determined and also after each crop was grazed. The results were as follows:

	Area A.	Area B.
	Per cent.	*Per cent.*
Nitrogen before sowing	0.099	0.101
Nitrogen after first crop	.110	.116
Nitrogen after second crop	.113	.111
Nitrogen after third crop	.105	
Nitrogen after fourth crop	.099	

On area B, after removing two crops, each containing 100 pounds of nitrogen, the soil was enriched to the extent of practically 300 pounds of nitrogen, or, in other words, the percentage of nitrogen was increased from 0.101 to 0.110 per cent.

When, however, as on area A, the crop is allowed to run the whole course of its existence there is no increase in the total soil nitrogen or it is so minute as to show no difference in the percentage of soil nitrogen present. During the latter stages of growth, therefore, it is clear that the nitrogen contained in the nodules must be drawn upon by the plant for its growth. By comparing the amount of nitrogen added to the soil by the growing of two cuttings of berseem, viz, 300 pounds, with that accepted as the increase in Europe by the growth of an ordinary clover crop, viz, 60 or 70 pounds, it is seen how valuable this forage crop is in this respect.

The rôle played by berseem in the reclamation of salt land in Egypt is worthy of mention. The fact as to whether a stand of this crop can be obtained or not is regarded as an indication of the ability of the soil to grow other crops. There can be no doubt that it will grow on soils so salt that the majority of ordinary crops would fail. Its shallow-rooted habit and the fact that the frequent waterings which it receives tend to keep the salt down no doubt account for this rather than its power to withstand salt. As soon as sufficient salt has been removed by washing, in the process of reclamation, to enable a crop of berseem to be sown, this is done, and is repeated until a successful crop is obtained, when ordinary culture may be followed with the exercise of that discretion necessary for the management of such lands.

In addition to the variety of berseem known as "Muscowi," grown in Lower Egypt, a kind known as "Fachl" is largely grown on basin lands. The seed is broadcasted on the mud as the water recedes, and as this variety is grown without irrigation one main crop only is obtained, which is usually a heavy one. It is less watery than the ordinary Muscowi sort and is generally used in making hay.

The variety known as "Saidi" is less luxuriant than Fachl. It is somewhat of a trailing nature, and is sometimes mixed with the latter sort. It requires but little water, and is generally cut twice, though sometimes a third time. It is grown chiefly on basin lands, and is smaller in growth and less succulent than the Muscowi variety.

LUCERN (ALFALFA).

Lucern is not grown to any extent in Egypt, as during the winter and spring months it can not compete with berseem in luxuriance. It yields very frequent grazings or cuttings during summer, but requires frequent waterings in order to give the best results, and, as already explained, there are too many demands on the supply of summer water to permit this. During these months it becomes, unfortunately, the home of myriads of worms, which are attracted by it and spread to adjoining crops, often doing considerable damage. The scarcity of summer water already mentioned is also a great impediment to its cultivation. Again, land is usually too valuable to make it profitable to leave it under a forage crop for three or four years. The limited area grown is generally cultivated to supply a little green forage to sick animals, or to a few milch cows or horses.

CORN.

The corn crop is of great importance, as it forms the staple food of the lower classes. It is the characteristic Nili crop. The summer-season ends about the last of July, when this, the great flood crop, is sown. As already mentioned, during the summer months a system of rotation of canals is adopted to insure a sufficient supply of water for the cotton crop, and during this period the watering of fallow lands is severely prohibited. The cereal crops, wheat and barley, as

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well as beans, berseem, etc., are all off the land by June, and it is on these lands that the corn crop is sown. The latter, however, can not of course be planted without water, and every cultivator awaits the removal of the decree which has prohibited the flooding of such lands.

As soon after the first week in July as water can be obtained, the irrigation of the land for corn sowing begins. If the Nili is a favorable and early one, this may be permitted as early as July 10, while if the reverse be true it is only toward the end of the month that this is possible. The earlier the corn crop is sown the better, and there is consequently a great rush for water, as not only has the corn area to be watered, but cotton, rice, and sugar cane also require water, while the land to be left fallow is also flooded. The water for flood irrigation is obtained from separate flood canals, in addition to the ordinary perennial canals, and during this period is "flush." The flood canals run from the month of August to November.

It will be seen that for flood irrigation, the earlier the Nile rises the better it is for the farmer. The earlier the corn is sown the better, and an early removal of this crop enables the berseem, which often follows it, to be sown in good time.

As already mentioned, it may be assumed that about 50 per cent of the area of Lower Egypt is under summer crops (chiefly cotton), while the flood crops occupy about 30 per cent. The area of land in Lower Egypt under corn during the year 1902 was 1,128,254 acres, while in Upper Egypt also a certain area is grown.

It is seen, therefore, that during flood the whole of the country requires water and the demand is unlimited; thus, the more the canals can carry the better. The watering given in preparation for the corn crop is a very heavy one, and if water is flush at this period may amount to as much as 600 tons per acre, but less if pumped. This, the first watering of the land to be put under flood irrigation, is thus a very heavy one, but as soon as the land is put under crop the subsequent waterings are about the same as the ordinary summer waterings, viz, about 350 tons.

The land after being watered is allowed to remain some days until it is sufficiently dry to admit the plow. As the latter is drawn through the soil by the usual pair of bullocks, its effect, as already explained, being somewhat similar to the scooter or a one-tined scarifier, it is followed by a boy who deposits seed behind it, which will be covered by the plow on its return journey. The land is subsequently harrowed by drawing a plank of wood over it. No attempt is made to deposit the seed in any regular manner in rows, such as is practiced in the United States, and, as would be imagined, the plants are very thickly crowded together. The number of plants found in an acre of corn varies from 13,000 to as many as 20,000, or even more. This, it will be seen, is strikingly different from American practice. The quantity of seed sown per acre is about 1½ bushels. The cultivation is simple, the crop being merely hoed three times during growth and watered six or seven times. The plants are thinned twice, once when very small and once subsequently. Those removed are given to cattle. The time the crop occupies the land varies according to the sort sown. The so-called native varieties may be cut from seventy to ninety days after sowing. They are small in habit of growth and possess small cobs. The large varieties (often known as Americani), which grow to a greater height and produce large cobs, occupy the land from one hundred and ten to one hundred and twenty days. Varieties which take a long time to grow are not in favor because they make the succeeding berseem crop late, while, again, owing to their larger habit of growth, they exhaust the soil more.

The corn crop is universally manured; in fact, it is the heaviest manured of all Egyptian crops. Both barnyard manure and coufri are used, the latter to the greater extent. The former, as a rule, does not give such good results for the corn crop itself, but exercises an effect on wheat, cotton, etc., if following the corn. Coufri (which contains soluble nitrogen) is quicker in its action, and heavy crops of corn are grown by means of it.

Neither phosphoric acid nor potash is used for this crop, but top dressings of nitrate of soda, as well as applications of sulphate of ammonia, give excellent results. Nitrate of soda is practically the only chemical fertilizer employed in Egypt for this crop.

It may be said that only nitrogenous manures seem to exercise any great effect on the corn crop in Egypt. It is true that no very extensive series of experiments have been made as regards phosphoric acid, but up to the present no appreciable benefit has resulted.

After clover the crop does not require such large quantities of manure as when following a cereal, but in any case it is always manured and a sum of at least $5 or $6 an acre is expended. The heavy watering which the land receives before sowing, and especially the fact that water is given during summer when nitrification is active, no doubt partly explains the pronounced effect of purely nitrogenous manures of rapid action.

The average yield of corn on ordinary land is about 30 or 35 bushels; on good land, well manured, 50 or 55 bushels are obtained, while on poor soil 20 to 25 bushels an acre are produced. The price at which it is sold is about 60 to 65 cents per bushel.

WHEAT AND BARLEY.

Wheat and barley are grown over the whole of Egypt, being sown in the basins of Upper Egypt as well as on the perennially irrigated lands of Lower Egypt. On the latter they are sown in the month of November after cotton or, as is very frequently the case, after a crop of corn which may have been grown during the Nili season and heavily manured, or after a fallow. In Upper Egypt the grain crops are sown earlier, after the water of the Nile recedes, by simply broadcasting the seed on the mud. In the Delta also the cultivation is of the simplest description. The land is plowed, then harrowed by drawing a plank of wood over it, the seed is broadcasted and covered by means of the native plow and harrow, and the land is immediately watered.

In other cases the land is watered some days before planting, and when sufficiently dry for plowing the seed is sown and plowed in, no water being given after planting. The use of implements, such as European harrows, for covering the seed instead of the native plow is very restricted. The quantity of seed employed is about 2½ bushels per acre. When the crop has attained a height of about 8 or 9 inches (in January or early in February) it is watered, and no further watering need be given, though it is more usual to irrigate the crop a second time, viz, when the plants are forming into ears (March or early April). This completes the cultivation of the crop.

Cereals are harvested in Upper Egypt in the month of April, and in Lower Egypt in May and June. The crop is either pulled by hand, in the case of barley, or cut by means of small sickles. About five men are sufficient per acre, and this work is often done by contract for about $1 per acre. Harvesting machinery is not employed, as the small ridges made to facilitate watering prevent the successful working of a reaper, the knives of which run into these small ridges and are broken.

Some years since thrashing machines were introduced into Egypt, these being provided with revolving drums for crushing and bruising the straw into what is known as "tibn." The grain is delivered from them similar to the ordinary thrasher, while the bruised straw is blown out at the end of the machine. These are found on some large estates, though the bulk of the grain is still separated by means of the primative "norag," consisting of a number of circular disks on an axle, which revolve as the whole is drawn by two bullocks.

The produce is arranged in a circle and the tread of the bullocks and the cutting and bruising action of the disks chop the straw and knock out the grain. When this is completed the whole is thrown into a heap for the subsequent separation of the grain from the tibn. This is accomplished by throwing it into the air, when the grain, being the heavier, falls directly to the ground, while the tibn is blown by the wind to one side. It will at once be understood that this system is most laborious. Barley is more easy to thrash than wheat, the straw being more brittle. Hand siftings are necessary to clean the grain, though grain-cleaning machines worked by hand are now finding a use in the country.

As regards the employment of manures, barley is practically never manured, though it is grown on poorer lands than wheat; in fact, it is one of the earliest crops cultivated on newly reclaimed salty lands, as it succeeds where wheat would fail.

Stable manure is sometimes used on wheat, though it is very questionable whether this is economical. It is now thought better to reserve the whole of this manure for the cotton crop. Coufri is also extensively used. During recent years the practice of top dressing wheat with nitrate of soda has become common, and most striking results are obtained. The yield both of grain and straw is increased, and a net profit of fully $5 an acre is obtained by its use.

It may be interesting to note that Egypt is practically free from "rust." The native varieties grow so rapidly that they seem to outstrip it. On the other hand, foreign varieties, when grown, are occasionally entirely destroyed by it, as happened, for example, with American seed introduced by the writer some years since.

The weight of wheat per bushel is about 60 pounds. The standard measure is the ardeb of 5.4 bushels, which weighs about 325 pounds, and is sold on an average for about $4.75 to $5. There are no well-defined varieties grown, different names being given to the same variety in different provinces.

As regards yield, on very good lands from 40 to 45 bushels of grain and 1½ tons of straw are obtained per acre. The average of the country, however, is about 20 to 22 bushels.

Egyptian wheats are poor, being very mixed and deficient in gluten. It is quite exceptional to find a good sample, either white or red, and for the making of bread by Europeans an admixture of foreign flour is almost invariably employed. The wheats in Lower Egypt are almost invariably called white, while in Upper Egypt a greater portion of so-called red wheat is found. For making bread natives prefer the wheat grown in the basin lands of Upper Egypt to that grown on irrigated land.

Egypt, instead of being an exporter of wheat, as is often thought, actually imports a considerable quantity of flour from France and Russia, though that from the former country is largely of Russian origin, having been ground at Marseille. The following table shows the importation of flour during the past three years, the bulk being wheat flour, though a small portion is that of maize. The figures refer to Egyptian pounds, equivalent to about $4.94 in American money:

Country to which exported.	1900.	1901.	1902.	Country to which exported.	1900.	1901.	1902.
England	42,641	34,094	67,628	Belgium	323	307	1,403
English possessions in the Mediterranean	58	5	....	France and Algeria	234,035	294,045	310,799
English possessions in the extreme East	54	....	91	Greece	60	213	71
Germany	305	204	2,842	Italy	9,506	4,663	5,659
United States	1,549	5,025	6,096	Russia	104,700	112,863	119,153
Austria-Hungary	3,364	1,165	2,612	Turkey	811	1,017	5,767
				Other countries	254	2,257	776
				Total	397,660	455,858	552,897

During the same period the import of wheat (as grain) was as follows:

	Egyptian pounds.
1900	72,669
1901	110,374
1902	67,620

The bulk of this grain is of Turkish and Russian origin.

From a European point of view, the barley is poor, being long and thin. Attempts have been made to grow European barleys for malting purposes, and while a good quality can be produced the yield is slight compared with that obtained from native varieties. Practically the whole of the crop is consumed by horses, mules, etc. A superior class of barley (Mariout barley) is grown in the desert in the neighborhood of Alexandria and is dependent on rainfall. As this latter is a very varying amount, the crop fluctuates greatly from year to year. Even in the case of barley the imports exceed the exports in value, as will be seen from the following table:

Year.	Imports.	Exports.
	Egyptian pounds.	*Egyptian pounds.*
1900	70,820	8,000
1901	57,635	11,200
1902	48,939	33,602

The barleys of Egypt are light and generally weigh less than 50 pounds per bushel. The yields obtained on favorable soils are heavy, amounting to as much as 100 bushels per acre in exceptional cases. The average is from 30 to 35 bushels, and the price at which it is sold may be taken as $2.50 to $2.75 per ardeb of 5.4 bushels. The cultivation of barley is similar to that of wheat.

BEANS.

The bean crop of Egypt is a most important one, as it supplies the staple food of working animals during a great part of the year, while a considerable quantity is exported. It is grown in the basin lands, as well as in Lower Egypt, though the bulk of the crop is raised in Upper Egypt. According to the latest returns there were 471,530 acres of beans in the latter division of the country and 162,306 in Lower Egypt during the year 1902, a total of 633,836 acres.

The cultivation of the crop is simple. On the basin lands seed is sown after the emptying of the basins, and the crop is simply allowed to remain until harvest in the spring.

The crop is luxuriant and yields on an average from 30 to 35 bushels per acre on good land. From 3 to 4 bushels of seed are required per acre in Upper Egypt. In Lower Egypt the crop is sown about the same time as ordinary cereal crops, the grain being deposited in the furrow left by the ordinary native plow, a boy following the latter and depositing the seeds by hand. They are then covered on the return journey of the plow, and the land is subsequently harrowed. The quantity of seed employed is about 2¾ or 3 bushels per acre. The crop may be sown "wet" or "dry," as explained in the chapter on wheat—that is, whether a watering has been given previously or not. It is sometimes raised without any water, though one irrigation is generally given in spring.

The harvesting of the crop is similar to that of an ordinary cereal and takes place in April. It may be thrashed by machine or by the norag. The chopped straw is given to camels, goats, sheep, etc., and it is also used for making bricks, etc. The crop is never manured, and yields from 20 bushels on poor land to as much as 35 or 40 bushels on rich soils.

The value of beans as food for dairy and other cattle is well known in Europe and there is a considerable exportation from Smyrna, Egypt, etc., to Europe. The export from Egypt is not increasing, there being a greater home consumption, as will be seen from the following figures, showing total exports:

Year.	Quantity.	Value.
	Bushels.	*Egyptian pounds.*
1889-1893 (average)	5,614,669	669,377
1894-1898 (average)	4,244,157	457,264
1901 (average)	1,886,071	260,508
1902 (average)	1,346,702	190,526

As already mentioned, about 13 pounds of crushed beans are fed per day to working bullocks during the season of scarcity of green forage and a proportional amount to cows, etc. The animals, of course, do not keep up their condition on this food (mixed with chopped straw) as well as they do on green, succulent food, but the work they accomplish during the hot weather when on this diet is remarkable.

Beans form an article of diet of nearly all classes. They are prepared in several ways. They may be soaked throughout the night in water, which is kept at a high temperature, and eaten in the morning, with liberal quantities of clarified butter, or they may be soaked in cold water until they begin to burst previous to germination, and are then boiled and eaten. Upper Egypt beans are preferred to those of Lower Egypt for human consumption.

RICE.

Rice is grown in Egypt both as a summer and a Nili crop, and largely so as a means of reclaiming land. Thus it is sown both in summer and during flood, the difficulty in connection with the former being the large quantities of water required at a time when the cotton area makes such heavy demands on the available supply. For this reason in seasons of a very low Nile the growth of summer rice has been prohibited by governmental decree. As regards actual quality, summer rice (Sultani) is superior to that grown during flood (Sabeini).

It is almost needless to state that this crop will grow on land heavily impregnated with salt. The large amount of water required and the shallow-rooted nature of the crop tend to make this possible. The salt is washed down into the lower reaches of the soil, where the roots do not penetrate.

Summer rice, of which several varieties are grown, is sown in May and early June and occupies the land for varying periods, according to the variety grown, some remaining in the ground for as long as seven months. Sabeini, or flood rice, is sown as soon as the flood arrives, generally early in August to the first week in September, and occupies the land for about ninety days, according to the date of planting. It is thus harvested about the same time as summer rice. During flood, rice lands get flush irrigation and receive every ton of water that the drains can carry. For summer rice it is generally accepted that at least 40 cubic meters of water per acre per day must be allowed, while during the flood season the land practically receives as much water as the drains can carry off.

The first and most important essential in reclamation and rice cultivation is to make the land perfectly level. Unless this is done disappointment will result. The land is divided into squares equal in size, and around these divisions small dikes are made to retain the irrigation water. After leveling is completed sowing takes place. The seed is soaked in water for about six days. It is then spread out under sheds in the shade for two or three days to sprout. Water to a depth of $3\frac{1}{2}$ or 4 inches is put on the land and the seed is sown broadcast. Three days after sowing the water is removed and the land allowed to dry for twenty-four hours. During fifteen days this operation is twice repeated. Subsequently the water is changed from time to time. When about 7 or 8 inches high thinning is done and seedlings of dineba (barnyard grass) and of weeds which would interfere with the development of the plants are removed. When ripe the crop is cut by hooks and placed in small bundles and is thrashed either by machine or by the norag. For summer rice from 1 to $1\frac{3}{8}$ bushels of seed are sown. For the flood crop more is employed.

Rice is grown in Lower Egypt on low-lying lands and those undergoing reclamation, chiefly in the three provinces of Gharbieh, Dakahlieh, and Behera. During the year 1902, 59,634 acres of summer rice and 56,134 acres during flood were grown in Lower Egypt. In Upper Egypt flood rice is grown in the Fayum, the area last year being 24,963 acres. The accompanying diagram (fig. 3) will give an idea of the arrangement of a crop of flood rice which is found successful in the northern part of Gharbieh.

The plan shows a plat of land 500 meters long by 300 meters in width, or a little over 35 acres. The land is cut up into divisions ("gattas"), each being 150 meters by 100 meters, or a little more than 3½ acres. The main drains are 27 inches deep and the smaller drains, similarly, 23 inches. The drainage, according to these data, requires 1,865 cubic meters of earthwork per acre, which, at the rate paid in Egypt, is equal to an expenditure of \$2.15. It is generally conceded that it is preferable for a landowner to let land to tenants for the growth of flood rice rather than to cultivate it himself. The small banks and water channels are made by the tenant. The former are very necessary, as they prevent the disturbing of the young plants during the first fortnight of growth by the heavy winds which often prevail. The small channels are also necessary; otherwise the plats marked "C" will

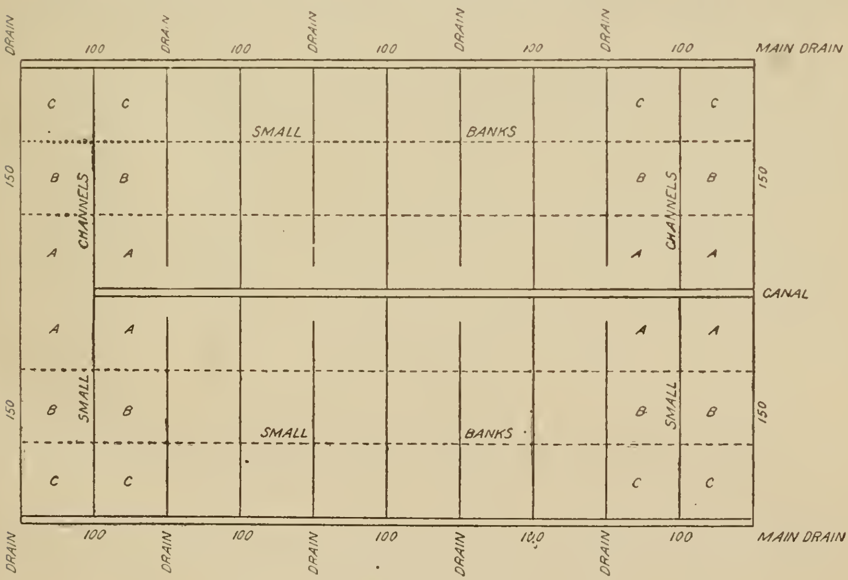

FIG. 3.—Arrangement of a crop of flood rice.

not get fresh water and will be more backward than those marked "A." Fellaheen pay from \$4 to \$5 per acre as rent to grow a crop of flood rice on fairly sweet land. If the land is salt, the tenant gets half the crop for his labor and the owner the other half as rent. The seed is provided by the owner, half of which is returned at harvest.

As soon as the Nile water arrives, the little divisions are filled with water, and the land is again leveled by drawing a plank over it. If the land is not very salt, the seed may be sown after leveling; but if salt, the water must be run off once or twice before sowing. More seed than usual is required on salt lands. The critical period of the crop is the first ten or fifteen days, and if the land has not been properly leveled the high patches die for want of water, or, on the other hand, the low-lying patches are flooded out. On fairly sweet land the water may not be run off for the first six or seven days, and it may be necessary to water every day at the rate of 100 cubic meters per acre under a good system of drainage. After eight or ten days tenants will employ all the water they can get, but this is not necessary and is done at the sacrifice of good drainage.

On salt land more water is necessary than if the soil is fairly sweet, and at first it is necessary to irrigate and run off the water almost daily, which means as much as 150 cubic meters per acre each twenty-four hours. If sown later than the end of August, rice does not grow so well, and any land remaining at that time may be sown with dineba.

To obtain the greatest benefit from the growing of rice it should be followed by berseem. When the heads of the rice begin to curl up, the berseem may be sown; and if rice is sown as late as September, the sowing of the clover is greatly delayed.

The success of the berseem after rice is an indication as to the extent of the removal of salt; and if the clover grows well, it will not be necessary to sow rice again. If otherwise, it may be necessary to resort to rice again. This system of reclamation without summer water is that adopted by a very capable rice grower, to whom the author is indebted for the information.

As regards the yield of rice in Egypt, 40 to 60 bushels per acre may be taken as an average of the summer crop on good land, while of flood rice the product varies from 25 bushels on poor land to 50 or 60 bushels on more forward lands.

ONIONS.

Onions are grown to a considerable extent in Upper Egypt (not less than 15,000 acres), largely on the islands which appear after the fall of the Nile and on the banks of the river. They are also grown on ordinary soils under perennial irrigation. Although two or three varieties are recognized, that known as the Saidi forms the bulk of the export trade. The crop grows to the greatest advantage on deep, loamy soils, inclining to sandy, and possessing a considerable amount of humus.

Seed is sown in a manured seed bed in September. About one-ninth of a bushel of seed sown on 350 square yards of land provides sufficient plants for 1 acre.

The land for onions should be well prepared by two or three plowings, reduced to a friable condition, and made into ridges about 2 feet apart. The seedlings are pushed in the sides of the ridges (both sides) by the fingers and are left about 6 inches apart.

On the islands and river banks the land is not plowed at all, but the seedlings are sown on the flat, either singly in rows about 14 inches apart or in bunches in rows 20 inches apart. In this case the crop is not watered during growth.

The operation of transplanting is done in November and December on the islands and river banks, but later on ordinary lands even up to January and February.

The crop requires careful cultivation to prevent the growth of weeds, and a small hoe is employed to keep the land well stirred. During the first month after transplanting, the crop must be hoed and weeded, and this must be repeated during the second month.

Onions respond to liberal manuring. Barnyard manure is employed, and on the alluvial deposits this is put under the plants at the time of transplanting, but on other land it is applied from one to one and one-half months after transplanting and as a rule before any water is applied. Small quantities of coufri are sometimes used, though barnyard manure is in greatest favor.

On ordinary perennially irrigated lands six or seven waterings are given during the growth of the crop. These should be light and not sufficient in amount to soak the soil.

About five months after transplanting, the bulbs have attained full size and the leaves become yellow. The crop is now ready to lift, and no water should be applied for nearly a month before harvesting; otherwise a second growth commences.

The bulbs are removed and exposed to the sun for two days, the tops being then removed, and another day allowed for drying.

Early in April the onion crop arrives at Alexandria for export, the first arrivals realizing the highest price. The product per acre amounts to 5 or 6 tons, on an average, on good soil.* Care has to be taken in storing. If not thoroughly dried many of the onions will sprout, and those which have been injured or bruised will decay. The average price is from £2 to £3 per ton.

The following figures indicate the export trade:

Year.	Quantity.	Value.
	Tons.	*Egyptian pounds.*
1899	76,568	229,332
1900	76,034	152,873
1901	64,935	129,926
1902	49,933	100,697

The bulk of the crop is sent to England and the rest chiefly to Austria.

MILLETS AND SORGHUMS.

Several varieties of millet possessing either white, yellow, or red grain are grown in Upper Egypt. It is sown both as a summer and as a flood crop, as has previously been mentioned when referring to crops grown in the basins.

Summer sorghum in the basins is sown from about the middle of March to the middle of April, or a little later, the crop being harvested in August. The water for its growth is lifted by hand or animal labor, and it is irrigated on an average about every ten days. It is a very profitable crop, and the area grown in the basins is between 90,000 and 100,000 acres, while it is also sown along the Ibrahimia Canal tract to the extent of between 20,000 and 25,000 acres.

Flood sorghum is sown both in the perennially irrigated tract of Upper Egypt and in the basins. Sowing begins early in August and ends early in September, the crop being harvested in the latter part of November or in December.

Millet is sown either by depositing a few seeds in holes about 14 inches apart, or the seed may be dropped behind the plow similar to corn. It delights in a rich soil and requires large quantities of manure, both coufri and the nitrate-bearing clay being extensively used. The crop is thinned during growth and when grown in holes two plants are left standing together.

The production varies greatly and some very heavy yields are obtained. From good soils 50 to 60 bushels per acre may be taken.

Millet forms the staple food in Upper Egypt, taking to a great extent the place of corn in Lower Egypt. In making bread fenugreek seeds are often mixed with it.

MINOR CROPS.

In a short bulletin such as this it is quite impossible either to treat in detail the most important crops or to deal with those of secondary importance. Of the latter there are many grown in the country, such as lentils, peanuts, chick-peas, lupins, fenugreek, etc. A mere note concerning them will be given.

LENTILS.

Lentils are sown in basin lands as well as those perennially irrigated. On the latter the seed is broadcasted at the rate of about 1¾ bushels per acre. The crop is not manured and requires very little water. From five to six months after sowing, the crop is pulled and thrashed, the yield being about 20 to 25 bushels of seed. The plants are somewhat straggling in habit and grow about 2 feet in height. The seeds possess a high nutritive value and are largely consumed locally. The straw also possesses considerable value. During the year 1902 about 110,000 bushels of seed were exported, valued at approximately 17,000 Egyptian pounds.

EARTH NUTS, OR PEANUTS.

Earth nuts, or peanuts, are grown on light sandy soils in Lower Egypt, being sown in late spring and requiring considerable quantities of water. Their cultivation is similar to that practiced in the United States and calls for no special comment. They occupy the land for about eight months and yield about 55 bushels per acre. They are not generally manured. During the year 1902, peanuts to the value of between 17,000 and 18,000 Egyptian pounds were exported, chiefly to Turkey.

CHICK-PEAS.

Chick-peas are grown to a limited extent both in Upper and Lower Egypt for local consumption. The seeds are eaten either green or roasted, and are also employed in native confectionery. The crop is sown in October and November and harvested from five to six months later, yielding about 23 to 30 bushels of seed per acre. No manure is applied and very little water. During the year 1902 the exports amounted to 7,827 bushels, valued at 1,709 Egyptian pounds.

LUPINES.

Lupines are grown on sandy situations, and, generally speaking, in places where it would be difficult to grow other crops successfully. They are sown in October and November in holes about 15 or 16 inches apart, four or five seeds being dropped in, or the seed may be deposited behind the plow. Lupines are grown either as a green manure crop or for the sake of the seeds, of which about 20 bushels are obtained per acre. The crop is harvested in April. It requires no care, is not manured, receives but little water, and sometimes none at all.

FENUGREEK.

Fenugreek is sown in October or November, the seed at the rate of $1\frac{3}{4}$ bushels per acre being broadcasted after a heavy watering. If grown as a green crop it is cut about sixty or seventy days after sowing and fed, in conjunction with berseem, to camels chiefly and also to cattle. It is not fed alone, as it is too laxative. It is eaten green by natives.

If for grain, the crop is cut about four and one-half to five months after sowing. About 20 to 25 bushels of seed are obtained per acre. The seed is mixed with corn and millet in bread making, and when germinated it is also eaten by natives as a purgative. The seeds are largely used in Europe for the preparation of condiments.

FLAX.

Flax is not so extensively grown as formerly. Seed is sown broadcast from the end of October to the end of November at the rate of $2\frac{1}{3}$ to $2\frac{3}{4}$ bushels per acre. The crop is grown both for fiber and seed. The harvest is in March. The fiber obtained is inferior and calls for no mention. The seed is crushed in native mills and the cake is used for feeding.

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U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY — BULLETIN No. 63.
B. T. GALLOWAY, *Chief of Bureau.*

INVESTIGATIONS OF RUSTS.

BY

MARK ALFRED CARLETON,
CEREALIST IN CHARGE OF CEREAL INVESTIGATIONS.

VEGETABLE PATHOLOGICAL AND PHYSIOLOGICAL INVESTIGATIONS.

ISSUED JULY 12, 1904.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1904.

BULLETINS OF THE BUREAU OF PLANT INDUSTRY.

The Bureau of Plant Industry, which was organized July 1, 1901, includes Vegetable Pathological and Physiological Investigations, Botanical Investigations and Experiments, Grass and Forage Plant Investigations, Pomological Investigations, and Experimental Gardens and Grounds, all of which were formerly separate Divisions, and also Seed and Plant Introduction and Distribution, the Arlington Experimental Farm, Tea Culture Investigations, and Domestic Sugar Investigations.

Beginning with the date of organization of the Bureau, the several series of bulletins of the various Divisions were discontinued, and all are now published as one series of the Bureau. A list of the bulletins issued in the present series follows.

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[Continued on page 3 of cover.]

A PERENNIAL RUST.

(ÆCIDIUM TUBERCULATUM E. & K. ON CALLIRRHOE INVOLUCRATA GR.)

U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY—BULLETIN No. 63.
B. T. GALLOWAY, *Chief of Bureau.*

INVESTIGATIONS OF RUSTS.

BY

MARK ALFRED CARLETON,
CEREALIST IN CHARGE OF CEREAL INVESTIGATIONS.

VEGETABLE PATHOLOGICAL AND PHYSIOLOGICAL INVESTIGATIONS.

ISSUED JULY 12, 1904.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1904.

BUREAU OF PLANT INDUSTRY.

B. T. GALLOWAY, *Chief.*

J. E. ROCKWELL, *Editor.*

VEGETABLE PATHOLOGICAL AND PHYSIOLOGICAL INVESTIGATIONS.

SCIENTIFIC STAFF.

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ERWIN F. SMITH, *Pathologist in Charge of Laboratory of Plant Pathology.*
GEORGE T. MOORE, *Physiologist in Charge of Laboratory of Plant Physiology.*
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[a] Detailed to the Bureau of Forestry.
[b] Detailed to Botanical Investigations and Experiments.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., April 20, 1904.

Sir: I have the honor to transmit herewith the manuscript of a technical paper entitled "Investigations of Rusts," by Mark Alfred Carleton, Cerealist in Charge of Cereal Investigations, Vegetable Pathological and Physiological Investigations, and recommend its publication as Bulletin No. 63 of the series of this Bureau.

The two illustrations accompanying the manuscript are necessary to a complete understanding of the subject-matter of this paper.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

PREFACE.

The experiments and observations on rusts which are the basis of the following notes were begun by Mr. Carleton several years ago, and were continued at intervals until the spring of 1900, when the pressure of other duties prevented further work of this kind up to the present time. The results obtained in many instances are still incomplete, but are of sufficient value to be recorded. Some of the species studied are of much economic importance. The investigation is a continuation of the work reported in Bulletin 16 of the Division of Vegetable Physiology and Pathology, and is concerned chiefly with the segregation of rust forms of economic importance on the common grasses and the completion of the life history of certain species. The work is to be carried on more extensively during 1904.

A. F. Woods,
Pathologist and Physiologist.

Office of Vegetable Pathological and Physiological Investigations,
Washington, D. C., March 26, 1904.

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ILLUSTRATIONS.

INVESTIGATIONS OF RUSTS.

ADDITIONS TO OUR KNOWLEDGE OF LIFE HISTORIES.

In many instances, without any experimental proof, it is inferred that there is a connection between the different forms of rust occurring on the same host plant simply because of their constant association with each other. Sometimes it is afterwards demonstrated that these inferences are wrong, though they are probably correct in a majority of cases. Studies of the following species were made with the view of obtaining a more accurate knowledge of their life history.

EUPHORBIA RUST (*Uromyces euphorbiæ* C. AND P.).

Until the experiments herein described were performed it had not been demonstrated that there is any connection between the æcidial and other stages of this species, although experience naturally leads one to think that there is. They are in very close association on the same plant, the æcidium appearing first, quickly followed by the uredospores. In the spring of 1893 Mr. J. B. S. Norton, now professor of botany at the Maryland Agricultural College, while engaged in experiments in the germination of weeds in the greenhouses of the Agricultural Experiment Station at Manhattan, Kans., called the writer's attention to a very young rusted seedling of *Euphorbia dentata*. In this instance, as is usually the case with the young plants of this host, the pods were first badly affected by æcidia. This fact, taken together with the common observation that the seed pods of this host are usually affected by all stages of the rust, led at once to the thought that it was a case of rust propagation through the medium of the germinating seed of the host, something not before demonstrated for any other species in the entire group of Uredineæ, so far as the writer knows, unless we except the single instance of the experiments of Doctor Eriksson[a] with *Puccinia glumarum*.[b] The seed used by Mr.

[a] Vie latente et plasmatique de certaines Urédinées. Compt. Rend., 1897, pp. 475–477.

[b] T. S. Ralph, in Victorian Naturalist, Vol. VII, p. 18, describes an instance of a rust attacking the seed of *Senecio vulgaris*, stating that "with the microscope we are able to trace the fine yellow sporular matter into the covering of the seed, and into the seed itself;" but apparently it was not determined by further investigation whether or not the rust was able to reproduce itself through the germinating seed.

Norton was examined and the pods were found to be badly affected. Moreover, he stated that the seeds were planted without shelling. But the writer did not know then, as he does now, that this fact would probably make little difference, since the naked seeds are commonly affected, often showing actual peridia.

To test the theory of rust propagation above mentioned, experiments were instituted on April 22 for growing plants from rusted seed under a bell jar. The seed used bore all stages of the rust. The experiments were in five series: (1) Seeds shelled and disinfected by mercuric chlorid; (2) seeds unshelled and disinfected; (3) seeds shelled, but not disinfected; (4) seeds unshelled, not disinfected; (5) like series No. 4, but rusted mainly with æcidium. All were planted in pots in a greenhouse and the pots were kept under bell jars. On May 1 the plants began to come up. After about three months, when the plants had grown to a height of 3 to 5 inches, no rust had appeared on series 1 and 2, and only one spot on one plant of series 3. The plants of series 4 and 5 were much rusted, the æcidium appearing first, followed shortly by uredosori.

On April 25, 1893, it was attempted to germinate teleutospores of rust from the seeds used in these experiments, in water-drop cultures, which resulted in failure. On June 28, 1893, a similar culture of the fresh uredospores failed to germinate in two days.

In 1895 rusted seeds of *Euphorbia dentata*, sent from Kansas, were planted in the greenhouse of the Department of Agriculture, at Washington, D. C. From these three plants grew, which were kept under a bell jar. Soon one of these plants rusted badly, first with the æcidium, then a slight amount of the uredospores, and later the teleutospores. It should be remarked here that Euphorbia rust, so far as reported, occurs only on *E. maculata* in the vicinity of Washington, D. C., and the writer has never yet been able to obtain rusted seeds in that region.

On December 11, 1896, a third series of experiments was started at Washington, D. C. On that date rusted seeds of *Euphorbia dentata* from Kingman and Manhattan, Kans., were planted and kept under a bell jar as before. Eleven plants resulted by December 26. On March 8, 1897, spermogonia appeared in considerable amount on the young leaves of one plant, with a tendency to form a sort of hexenbesen.

On March 29 two more plants were rusted, one with spermogonia only on the young leaves, and the other with æcidia on the fruit. On April 10 still another plant showed spermogonia, making four in all, out of the eleven, that became rusted. (See Pl. II, fig. 1.)

As above stated, the proof that the rust actually penetrates the hulled seed is readily obtained, not only from microscopical demonstration, but also from the fact that the actual peridia may often be seen with the unaided eye in the seed. These experiments, however, further demonstrate the ability of the rust to propagate itself through the medium of the germinating seed of the host, and also make it seem probable that this is even the common method of reproduction in the case of its occurrence on *Euphorbia dentata.*

It will be noted also that the results of these experiments make it almost certain that the Æcidium and Uromyces appearing upon the plants are one and the same species, since in every case all stages resulted from planting the rusted seeds, the æcidium appearing first, then the uredo, and then the teleutospores. If anything was lacking, however, the proof has since been made complete by the experiments of Dr. J. C. Arthur, as reported in the Botanical Gazette,[a] in which the uredospores and teleutospores were obtained on *Euphorbia nutans* from a sowing of æcidiospores from other plants of the same host on June 20, 1899.

As is well known, the Euphorbia rust is widely distributed over the United States, occurring on numerous host species, but it is probably most abundant on *E. dentata* and *E. preslii.* It is a significant fact, bearing upon the ontogeny of the species, that it is also on these two hosts, particularly on *E. dentata*, that the æcidium is most common, and that the rust attacks the seed so severely. The seed pods are also affected considerably in the cases of *E. lata* and *E. marginata.*

On June 12, 1897, æcidiospores of this rust had germinated very well in water-drop culture after three days, and on June 22, after a two days' culture in water of both the æcidium and uredo from *Euphorbia marginata*, the latter germinated sparingly, but the former not at all. In no instance could the teleutospores be germinated, though germination was not attempted very often.

The writer has collected all three stages of this rust on *Euphorbia maculata*, *E. marginata*, *E. dentata*, *E. preslii*, *E. glyptosperma*, and *E. heterophylla.* On *E. petaloidea* and *E. serpyllifolia* only the uredo and teleuto stages were found, and on *E. lata* and what was probably *E. geyeri* even the uredo was rarely seen.

SUNFLOWER RUST (*Puccinia helianthi* SCHW.).

Although Saccardo rightly regards this species of Schweinitz as quite distinct, and includes with it the Æcidium often associated on the same host, in many herbaria the authority of Winter and Burrill is followed in making it a form of *Puccinia tanaceti*, while the Æcidium is commonly referred to *Æcidium compositarum*, a convenient dumping ground for numerous uncertain forms. The writer has always considered this disposition of the species to be without any good reason even on a purely morphological basis, and now the experiments

[a] Arthur, J. C., "Cultures of Uredineæ in 1899," Bot. Gaz., Vol. XXIX, No. 4, pp. 270–271, April, 1900.

here recorded make it rather certain that Schweinitz and Saccardo are correct. So far as this country is concerned, the writer is convinced that *P. tanaceti* either belongs almost entirely to *tanacetum* or does not exist at all. So far it has been utterly impossible, even in a greenhouse, to make transfers of the uredo from one to another of the numerous supposed hosts of that species, except among hosts of the same genus.[a] It is, at any rate, pretty certain that the forms occurring on Vernonia, Helianthus, Actinella, and Aplopappus, which have been referred to *P. tanaceti* at various times, should be considered distinct.

The circumstances connected with the culture experiments with this species were in themselves peculiar. Late in the autumn of 1897 at Manhattan, Kans., it was desired to obtain fresh material of the uredo for inoculating various hosts, but at that date very little else than the teleuto stage could be found. Finally, on October 29 a small amount was found on *Helianthus petiolaris*, mixed among a much larger quantity of teleutospores, and from this material sowings were made on *H. petiolaris* and *H. annuus*. On November 8 there resulted one rust spot on the latter host and three on the former. The spots were of the uredo stage, but the interesting feature accompanying this culture was the appearance first of spermogonia in one of the spots. This fact made it probable that a part of the infection resulted from the teleutospores of the inoculating material, even at this unusual season for the germination of these spores. On March 7, 1898, while stationed at the University of Nebraska, inoculations of *H. petiolaris* were again made with the teleutospores only from other plants of the same host, from which numerous spermogonia appeared in eight days, followed shortly by æcidia, which were fully developed by November 1. By these results the connection of the different stages of the rust is pretty well established. At the same time it is shown that the forms on *H. petiolaris* and *H. annuus* are identical. In all cultures made of this rust both the uredospores and teleutospores have been found to germinate easily and produce infections readily. Reverse cultures with æcidiospores were not made.

These experiments were first reported at the 1900 meeting of the Society for Plant Morphology and Physiology, at Baltimore. Since that time Drs. J. C. Arthur[b] and W. A. Kellerman[c] have made a number of such experiments, confirming these results, but also seeming to indicate a distinction of host forms on different species of sun-

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[a] Dr. M. Voronin at first also obtained negative results in similar experiments in Russia in attempting transfers of the rust on to other hosts. (See Bot. Zeitung, vol. 30, pp. 694–698, Sept. 27, 1872.) Later he obtained infections of *Puccinia tanaceti* from *Tanacetum vulgare* on sunflower, which, however, did not produce such vigorous growth as ordinarily. (Bot. Zeitung, vol. 33, pp. 340, 341, May 14, 1875.)

[b] Botanical Gazette, vol. 35, p. 17, January, 1903; Journal of Mycology, vol. 10, pp. 12–13, January, 1904.

[c] Journal of Mycology, vol. 9, pp. 230–232, December, 1903.

flower. Doctor Voronin, in his experiments above mentioned, also found that rust of cultivated sunflower would not infect *Helianthus tuberosus*. In 1901 Ernst Jacky[a] inoculated the following hosts with teleutospores from *Helianthus annuus: H. annuus, H. cucumerifolius, H. californicus, H. tuberosus, H. maximiliana, H. multiflorus, H. scaberimus*, and *H. rigidus*, with resulting infections of the three first-named species, but no infection of any of the others.

The evidence from all these experiments just quoted and those of the writer shows at least that the rusts of *Helianthus annuus* (including cultivated varieties), *H. petiolaris*, and *H. mollis* are identical, with the probability that a distinct form exists on *H. tuberosus*.

Sunflower rust has been collected by the writer on the following species of Helianthus, including all stages on nearly every species: *H. annuus* (both wild and cultivated), *H. rigidus, H. petiolaris, H. tuberosus, H. hirsutus, H. maximiliana, H. grosse-serratus, H. orgyalis, H. mollis*, and *H. ciliaris*. The æcidium occurs rarely in comparison with the occurrence of other stages, but is to be found on a number of hosts and occasionally in considerable abundance. This rarity of its occurrence, together with the occurrence of spermogonia so often with the uredo, may be accounted for by the fact that the uredo is often produced by direct teleutosporic infection.

CROWN RUST OF OATS (*Puccinia rhamni* [PERS.] WETTST.).

In a mere note in a previous bulletin of this Department[b] it is stated that certain infections had just been made showing the connection of the crown rust of oats on *Phalaris caroliniana* and *Arrhenatherum elatius* with the æcidial form on *Rhamnus lanceolata*. No other demonstration of such a connection of forms had been reported up to that time. During the same season, however, Doctor Arthur obtained infections with the æcidium of *Rhamnus lanceolata* on oats at Lafayette, Ind.[c] The experiments of the writer are here given in detail.

On August 23, 1897, the uredo stage of a rust, supposed to be *Puccinia coronata*, was found in great abundance on *Phalaris caroliniana* at Stillwater, Okla. This host, with the rust, was transferred to a greenhouse of the Agricultural College at Manhattan, Kans., and inoculations were made on oats, wheat, and orchard grass on August 30, 1897, resulting September 7 in a good infection of oats, a poor one of the orchard grass, and no infection at all of wheat. Other inoculations were made September 1 on wheat and rye, with no result. By October 8 the teleutospores had appeared on the original plants of Phalaris

[a] Centralb. Bakt. Parasit. u. Infekt., 2 Abt., Bd. 9, No. 21, pp. 802–804, December, 1902.

[b] Cereal Rusts of the United States, Bul. No. 16, Div. of Veg. Phys. and Path., U. S. Dept. of Agriculture, 1899.

[c] Bul. Lab. Nat. Hist. State Univ. Iowa, Vol. IV, pp. 398–400, December, 1898.

at Stillwater and were of the crown rust type. After this date the experiments were continued at the State University laboratories at Lincoln, Nebr., all host plants then in use being transferred to that place. On November 16 the crown rust was found, in the uredo stage, on *Arrhenatherum elatius* on the State University farm, and a rusted plant was transferred to the greenhouse. On December 11 inoculations with the rust were made on oats and rye, resulting in a good infection of the former in twelve days, but with no result on the latter. Further inoculations of oats with the Phalaris rust on February 16, 1898, resulted again in a good infection in 9 days.

No species of Rhamnus is native near Lincoln, Nebr., but *Rhamnus lanceolata* is rather common at Weeping Water, about 20 miles east of Lincoln, where it is often badly rusted with Æcidium. From that place a large amount of the Æcidium was obtained fresh on June 1, 1898. A water-drop culture of the material, made the next day, gave a profuse germination of the spores in twenty-two hours. Inoculations with the æcidiospores on oats and *Phalaris caroliniana* were made June 1 and June 2, resulting in a successful infection of Phalaris on June 14 and of oats on June 18. The oat inoculations were made simply on detached portions of the plant preserved with their broken ends in water in a damp chamber. As in all other instances, these inoculations were made with the greatest of care to prevent accidental infections. The whole series of experiments proves (1) the connection of the æcidial form of Rhamnus with the crown rust of oats, and (2) the identity of the latter with the forms on *Phalaris caroliniana* and *Arrhenatherum elatius*, besides making it probable that orchard grass may also support this species.

SEGREGATION OF HOST PLANTS.

The most important economic results of the study of rusts are likely to be derived from the investigation of the relationship of the forms on our common grasses. Such work has already been carried on to some extent by the writer and partially reported in the bulletin entitled "Cereal Rusts of the United States." A more detailed account of some of this work will be given here. Because bearing upon the same question, it seems proper to mention also some experiments with the rusts of Salix and Populus. Probably the greatest confusion exists concerning the identity of the different forms on Agropyron and Elymus, though there is much uncertainty also about those occurring on Bromus and other genera.

The experiments here described were conducted at Stillwater, Okla., Manhattan, Kans., Lincoln, Nebr., and Washington, D. C., the host plants being sometimes transferred from one place to another. Of all these rusts the one receiving most attention was the black stem rust of Agropyron and Elymus.

Black Stem Rust of Agropyron and Elymus.

At least three and probably four different rusts occur on the species of these two grass genera, and are often so closely associated that their accurate identification is extremely difficult. Of the herbarium specimens of these rusts throughout the country, probably not one in fifty is identified with any certainty. The writer's experiments with these forms are still incomplete, but a few things at least have been established. When these grasses are brought under cultivation the changed conditions and proximity to other grasses and grains cause them to become much more rusted than is ordinarily the case. In the cultivated grass plats at the experiment stations in Oklahoma, Kansas, and Nebraska the rusts were found in great abundance. It was therefore easy to carry on many culture experiments. These experiments with the uredospores of black stem rust were sufficiently numerous to make it desirable to arrange them in the following table:

Table I.—*Culture experiments with black stem rust of Agropyron and Elymus.*

Date.	Locality.	Origin of inoculating material.	Plant inoculated.	Period of incubation in days.	Result.
Jan. 9, 1897	Washington, D. C.	Wheat	*Elymus virginicus*	10	Success.
Do	do	do	Wheat	10	Do.
Jan. 22, 1897	do	do	*Elymus virginicus*	11	Do.
Do	do	do	*Agropyron richardsoni.*	11	Do.
Do	do	do	Wheat	11	Do.
Do	do	do	*Agropyron occidentale*	11	Failure.
Sept. 13, 1897	Stillwater, Okla	*Agropyron tenerum*	Wheat	6	Success. [a]
Do	do	do	*Agropyron tenerum*	6	Do.
Oct. 5, 1897	Manhattan, Kans	*Agropyron occidentale*	Wheat	12	Failure.
Do	do	Wheat (originally *Agropyron tenerum*).	do	8	Success.
Do	do	do	Barley	8	([b])
Do	do	do	*Agropyron tenerum*	8	Failure. [c]
Oct. 21, 1897	do	do	Wheat	16	Success.
Do	do	do	Barley	16	Do.
Do	do	do	Oats	16	([d])
Do	do	do	Rye	16	Failure.
Do	do	*Agropyron occidentale*	Wheat	18	Do.
Do	do	do	Rye	18	Do.
Do	do	do	Barley	18	Do.
Do	do	do	*Agropyron tenerum*	18	Do.
Nov. 24, 1897	Lincoln, Nebr	do	*Agropyron occidentale*	15	Success.
Jan. 5, 1898	do	*Elymus canadensis glaucifolius.*	Wheat	21	Do. [e]
Do	do	do	Barley	21	Do.
Jan. 21, 1898	do	Wheat (originally *Elymus canadensis glaucifolius*).	Wheat	10	Do.
Do	do	do	Barley	10	Do.
Feb. 11, 1898	do	*Elymus canadensis glaucifolius.*	Wheat	14	Do. [f]
Do	do	do	Barley	14	Do.
Do	do	do	Rye	14	Failure.
Do	do	do	Oats	14	Do.
Do	do	do	*Elymus canadensis glaucifolius.*	14	Success.
Do	do	do	*Elymus virginicus*	14	Failure.
Do	do	do	*Elymus virginicus muticus.*	14	Do.
Do	do	do	*Elymus intermedius*	14	Do.
Do	do	do	*Agropyron tenerum*	14	Do.
Do	do	do	*Agropyron occidentale.*	14	Do.

[a] Pustules differ in color from the original.
[b] 1 pustule only.
[c] Conditions very unfavorable, however.
[d] Apparently 1 pustule formed.
[e] Rust changes color and form of pustule.
[f] Rust changes color.

TABLE I.—*Culture experiments with black stem rust of Agropyron and Elymus*—Continued.

Date.	Locality.	Origin of inoculating material.	Plant inoculation.	Period of incubation in days.	Result.
Feb. 11, 1898	Lincoln, Nebr	*Elymus virginicus*	*Elymus virginicus*	13	Success.
Do	do	do	*Elymus virginicus muticus.*	13	Do.
Do	do	do	*Elymus canadensis glaucifolius.*	13	Do.
Do	do	do	*Agropyron tenerum*	13	Do.
Do	do	do	*Agropyron occidentale.*	13	Failure.
Do	do	do	Rye	13	Do.
Do	do	do	Wheat	13	Do.
Feb. 21, 1898	do	Wheat (originally *Elymus canadensis glaucifolius*).	*Elymus canadensis*	7	Success.[a]
Feb. 25, 1898	do	do	*Hordeum jubatum*	11	Do.
Feb. 28, 1898	do	*Elymus canadensis glaucifolius.*	Wheat	9	Do.[b]

[a] Pustules differ in color from the original. [b] Rust changes in appearance.

The results of these experiments, considered in connection with those recorded in Bulletin No. 16, Division of Vegetable Physiology and Pathology, U. S. Department of Agriculture, appear to establish two things, viz, (1) that the forms of black stem rust on wheat, barley, *Hordeum jubatum*, *Agropyron tenerum*, *A. richardsoni*, *Elymus canadensis*, and *E. canadensis glaucifolius* are identical, with the probability that those on *Elymus virginicus*, *E. virginicus muticus*, and *Holcus lanatus*[a] should be included; (2) that the black stem rust of *Agropyron occidentale*[b] is physiologically distinct from any other.[c]

A very interesting phenomenon in these experiments was the change in color and form of sorus of the rust produced by a transference to another host. In some cases after a transfer the rust was scarcely recognized. The change of color was sometimes from a bright yellow to a deep brown or orange, or the reverse. The uredo of *Agropyron tenerum*, for example, was often very yellow on the leaves, but changed to brown when transferred to wheat. On the species of Elymus the rust has a brown, waxy appearance, and the teleutospores long remain covered by the epidermis of the host.

[a] On January 5, 1900, quite successful infections on wheat were made with the uredospores of black stem rust of this host.

[b] Probably the most correct name of this host, which is known also as *Agropyron spicatum* and *A. glaucum* (See Hitchcock, "Note on Nomenclature," Science, vol. 17, pp. 827–828, May 22, 1903.)

[c] The form on this host was described as a distinct species, named *Puccinia agropyri*, by Ellis and Everhart, in Journal of Mycology, Vol. VII, p. 131, March 10, 1892, a fact not noticed by the writer until after most of these experiments were made. This species includes *Æcidium clematidis* D. C. according to Doctor Dietel, the proof of relationship being the result of culture experiments. (Oesterr. Bot. Zeitschr., No. 8, 1892.)

Orange Leaf Rust of Agropyron and Elymus.

In the following table are summarized the results of inoculations with the uredoform of this rust. They were carried on simultaneously with those of the black stem rust, and the material was taken chiefly from the same individual host plants.

Table II.—*Culture experiments with orange leaf rust of Agropyron and Elymus.*

Date.	Locality.	Origin of inoculating material.	Plant inoculated.	Period of incubation in days.	Result.
Dec. 21, 1896	Washington, D. C.	Rye	*Elymus americanus*	16	Failure.
Do	do	do	Rye	16	Success.
Jan. 7, 1897	do	do	*Elymus virginicus*	12	Failure.
Do	do	do	Rye	12	Success.
Feb. 1, 1897	do	do	*Elymus virginicus*	13	Failure.
Do	do	do	Rye	13	Success.
Feb. 13, 1897	do	Wheat	*Agropyron richardsoni.*	18	Failure.
Do	do	do	Wheat	18	Success.
Do	do	do	Rye	18	Failure.
Feb. 20, 1897	do	Rye	*Agropyron tenerum*	12	Do.
Do	do	do	*Triticum villosum*	12	Do.
Do	do	do	*Elymus canadensis*	12	Do.
Do	do	do	Rye	12	Success.
Mar. 30, 1897	do	do	*Agropyron caninum*	26	Failure.
Do	do	do	Rye	26	Success.
Nov. 3, 1897	Manhattan, Kans.	do	Wheat	9	Failure.
Do	do	do	Barley	9	Do.
Do	do	do	*Agropyron tenerum*	9	Do.
Do	do	do	Rye	9	Success.
Jan. 5, 1898	Lincoln, Nebr	do	do	21	Do.
Do	do	do	*Elymus virginicus*	21	Failure.
Mar. 4, 1898	do	*Elymus virginicus*	Wheat	18	Do.
Do	do	*Elymus canadensis glaucifolius.*	do	18	Do.
Mar. 12, 1898	do	Wheat	do	14	Success.
Do	do	do	*Elymus canadensis*	14	Failure.
Do	do	do	*Elymus canadensis glaucifolius.*	14	Do.
Do	do	do	*Agropyron tenerum*	14	Do.

The chief conclusion to be derived from the results of these cultures is that the orange leaf rust is very sharply limited in its host adaptation and differs widely in this respect from the black stem rust. Similar results are given in Bulletin No. 16 of the Division of Vegetable Physiology and Pathology, U. S. Department of Agriculture, for cultures of the forms on wheat and rye. In fact, it is quite probable that almost every distinct host species bears a distinct form of the rust. One of these forms on *Elymus virginicus* L. has recently been found by Doctor Arthur to be connected with the Æcidium on *Impatiens aurea* Muhl. and is now to be known as *Puccinia impatientis* (Schw.) Arth. [a]

Black Stem Rust of Agrostis alba vulgaris.

Culture experiments with the uredoform of this rust and observations in the field indicate that it is distinct and does not occur on other

[a] Botanical Gazette, vol. 35, pp. 18–19, January, 1903.

hosts.[a] The results of the culture experiments are given in the following table:

TABLE III.—*Culture experiments with black stem rust of Agrostis alba vulgaris.*

Date.	Locality.	Origin of inoculating material.	Plant inoculated.	Period of incubation in days.	Result.
Dec. 23, 1897	Lincoln, Nebr	*Agrostis alba vulgaris.*	*Agrostis alba vulgaris.*	8	Success.
Do	do	do	Wheat	8	Failure.
Do	do	do	Oats	8	Do.
Jan. 24, 1898	do	do	Wheat	12	Do.
Do	do	do	Oats	12	Do.
Feb. 11, 1898	do	*Elymus canadensis glaucifolius.*	*Agrostis alba vulgaris.*	14	Do.

The rust is evidently of the black stem rust group (*Puccinia graminis* of authors), but contains quite a number of abnormal teleutospores, including mesospores. Many measurements of these spores average 27–54 by 16–23μ, mostly 40–46 by 16–18μ.

RUST OF CHLORIS (*Puccinia chloridis* DIET.).

The uredoform of this rust is sometimes very abundant on *Chloris verticillata* in the Great Plains region, occurring in late summer and autumn. The sori are deep brown in color. The uredospores germinate very freely and easily. In a number of experiments made in 1898 it was found that the uredo on *C. verticillata* and *C. elegans* would readily transfer from either host to the other, but not to other grasses, in several cases which were attempted. In a watch-glass culture, made March 18, 1898, of uredospores from *C. elegans*, produced from artificial infection in a greenhouse, not only these spores germinated freely, but a number of newly formed teleutospores at the same time, an occurrence unusual except in the Lepto-uredineæ. Among thousands of cultures made by the writer only one other instance of this kind has occurred. In the summer of 1895 at the Biological Laboratory at Cold Spring Harbor, Long Island, both teleutospores and uredospores taken from the same sorus of a rust on *Luzula campestris* gave good germinations.[b]

RUSTS OF WILLOW AND COTTONWOOD (MELAMPSORA).

Both the uredospores and teleutospores of the rusts of willow and cottonwood germinate readily, the germ tubes of the latter containing always brilliant endochrome. Healthy leaves of either cottonwood or willow placed in a damp chamber have often been infected by the

[a] Arthur describes culture experiments made by his assistant, William Stuart, in July, 1898, in which wheat plants were infected with uredospores from this host, but the spores of the infection sori were larger than those of the original material. (Bul. Lab. Nat. Hist. State Univ. Iowa, vol. 4, No. 4, pp. 396–397, 1898.)

[b] The species was, without much doubt, *Puccinia obscura* Schroet.

writer in nine to twelve days. The incubation period is much shortened by using germinating spores in the inoculations. In the month of October, at Manhattan, Kans., an infection was produced in this way in three days.

It was attempted by numerous inoculations with the uredoform, chiefly at Washington, D. C., to transfer the rust from willow to cottonwood and the reverse, but always without success. An interesting feature of these experiments was the discovery of the fact that the cottonwood most common in Washington, known as South Carolina poplar, could not be infected by the uredoform from the common Western cottonwood, though these two poplars are classed by some as being the same species. Moreover, the rust does not occur in nature on the South Carolina poplar, but is very abundant on the Western cottonwood, and even occurs in Washington on the few individual trees of that type growing in the city.

WINTER RESISTANCE OF THE UREDO.

In another bulletin[a] the writer has given in detail the observations and culture experiments proving the successful wintering of the uredo in the orange leaf rust of both wheat and rye. In this connection it is easy to see a number of closely correlated facts, which may mutually explain each other: (1) As shown under the preceding topic, the uredo of black stem rust may infect a number of different hosts, and therefore has a manifoldly greater chance of propagation with the same number of uredospores than if there were but one possible host; (2) as also shown, the uredo of orange leaf rust is restricted in every case to but one host, or at most to but one genus, and a much greater production of uredospores is therefore necessary for the life of the species in this stage; (3) as a corresponding matter of fact it is well known that the uredo of the latter rust exists usually in very much larger quantity than that of the former; (4) on the other hand, the teleutosporic stage is the prevailing form of the stem rust, which fact makes this rust usually the more damaging of the two, as the teleutospores infest the stem chiefly, thus more directly interfering in plant nutrition; (5) the stem rust is proved to be connected with the barberry rust, thus giving it an additional chance for increased propagation, and this through the medium of the teleuto stage instead of the uredo; (6) finally, the uredo being the prevailing form of the leaf rust, and no æcidial form being known in this country,[b] it would seem necessary that this stage of that rust should be very hardy in order to endure extremes of cold and drought and preserve the life of the species. Previous investigations of the writer and others have amply proved that this is the case. In the meantime it is found that in other species

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[a] Cereal Rusts of the United States, Bul. 16, Div. Veg. Phys. and Path., U. S. Dept. of Agriculture, pp. 21–23, and 44, 45.

[b] Except in the case of the form on *Elymus virginicus* already mentioned.

there exists a similar hardiness of the uredo, of which cases the following will be discussed here:

UREDO OF KENTUCKY BLUEGRASS RUST (*Puccinia poarum* NIELS.).

The writer has known for some time that the uredo stage of the bluegrass rust is able to pass the winter alive and in germinating condition during any season as far north as Lincoln, Nebr., but additional evidence has been obtained from time to time. At the same time it is significant that there is no record that the teleutospores have ever been found, except in one instance, at the above-named place. In fact, few, if any, uredoforms so hardy as this one exist in this country. On February 1, 1893, this uredo was still alive in the vicinity of Manhattan, Kans. Every month of the year it exists alive and growing in great abundance everywhere about Washington, D. C. On March 2, 1898, it was found fresh on green leaves of the host at Lincoln, Nebr. On the same spot of ground it was still growing and spreading rapidly on May 8 of the same year. Host plants were transplanted that day into a greenhouse, where the rust continued to increase rapidly. As would now be supposed, the rust is sharply limited to its one host, Kentucky bluegrass. The results of the following cultures may be given in evidence.

TABLE IV.—*Culture experiments with the uredo of Kentucky bluegrass.*

Date.	Locality.	Origin of inoculating material.	Plant inoculated.	Period of incubation in days.	Result.
Jan. 16, 1893	Manhattan, Kans.	*Poa pratensis*	Wheat	18	Failure.
Do	do	do	Oats	18	Do.
Dec. 21, 1896	Washington, D. C.	Rye (*Uredo rubigo-vera*).	*Poa pratensis*	16	Do.
Jan. 22, 1897	do	Wheat (*Uredo graminis*).	do	11	Do.
Do	do	do	*Poa nemoralis*	11	Do.
Feb. 1, 1897	do	Rye (*Uredo rubigo-vera*).	*Poa pratensis*	13	Do.
Do	do	do	*Poa nemoralis*	13	Do.
Feb. 13, 1897	do	Wheat (*Uredo rubigo-vera*).	*Poa pratensis*	18	Do.
Feb. 25, 1897	do	*Poa pratensis*	do	10	Success.

UREDO OF PUCCINIA MONTANENSIS ELL.

This is, in some respects, one of the most interesting of grass rusts. It is one of the "covered rusts," and is, indeed, so far covered that it is often entirely overlooked by collectors. The uredosori are very uniform in size and are exceedingly small, it being necessary often to examine them, or even find them, with a hand lens. They are elliptical in shape and placed end to end in long, narrow, yellow striæ between the veins of the leaf. The teleuto stage is so far hidden as to be detected only by a faintly darker color beneath the leaf epidermis. The rust is the most nearly like *P. glumarum* Eriks. and

Henn. yet found in this country. The known hosts are *Elymus canadensis* and *E. virginicus*, but it seems to occur on other hosts. Whether the forms on different hosts can be transferred from one to another is not yet fully determined.

The important fact now known, however, is that the uredoform is able to preserve the species over the winter without the intervention of other stages, though it is possible that extensive propagation is aided by other stages. October 28, 1897, fresh uredosori were observed on *Elymus canadensis* at Manhattan, Kans., and again in the same locality on November 2. But as early in the spring as May 26, at Lincoln Nebr., when there was yet but a small beginning of vegetation, the uredo had burst the epidermis of the host in grass plats at the University farm. Previous to this the living uredo had been observed in these plats practically every month of the winter.

In other instances the uredospores of certain species are so very abundant and the teleutospores so rare that there seems a probability that such species are carried over from summer to summer largely through the uredo stage alone, though there is no absolute proof of such a course. Two instances are particularly interesting—those of the uredos of *Puccinia cryptandri* Ell. and Barth., and *Puccinia* on *Panicum autumnale*.[a] The uredospores of these species begin to be conspicuously abundant about midsummer, but continue in considerable abundance until very late in autumn. The uredo of *Panicum autumnale* was found in germinating condition in Kansas up to November 3 in 1897. A water-drop culture of uredospores of this species gave excellent germination in ten hours August 21, 1897, at Perkins, Okla. The uredospores of *Puccinia cryptandri* were found in extreme abundance in Oklahoma until October 11, 1897, but in all cases without any accompanying teleutospores. Often the uredosori had a fresh appearance on portions of leaves that were quite dead.

EMERGENCY ADAPTATIONS.

In connection with some culture experiments conducted at Lincoln, Nebr., in the botanical laboratory of the State University, in February, 1898, a water-drop culture was made (February 3) of uredospores of the above-mentioned *Puccinia cryptandri* which had been collected on October 8, 1897, at Perkins, Okla., and kept to date as herbarium specimens. A fair germination resulted in twenty-four hours. Spores from the same collection were used on February 16 to inoculate seedlings of *Sporobolus airoides*,[b] with the result of the appearance of two rust spots by March 16. These spots may really have appeared much earlier and been overlooked, as they were very small and the host

[a] Perhaps a new species, needing further study.

[b] Apparently this same species of rust had already been collected on *Sporobolus airoides* in the same locality where the collection from *S. cryptandri* was made.

itself is well known to have extremely narrow leaves. Moreover, the spores were not germinated when applied, and, being from dried specimens, the incubation period would naturally be long. Seedlings of *S. cryptandri* were not at the time available. On March 16 a second water-drop culture was made from this dried material, resulting in the germination of a few spores.

Teleutospores from herbarium specimens have often been germinated, but the writer knows of no other instance of the germination of dried uredospores, such spores being able also to infect a different host. These observations and experiments indicate that we have here a second step in the perfection of the uredo stage as a means of propagating the species. The first step, the attainment of sufficien hardiness to continue alive in the green plant over winter, has just been discussed. Even in this case the uredo, although quite active, at least displaces the resting spore, and in a measure performs its part. But as the perennial host becomes more like an annual and the plant dies nearly or quite to the ground, as in this particular case of the Sporobolus (which is quite different in this respect from the evergreen *Poa pratensis*, for example), necessarily, in the absence of teleutospores, the uredospore must be able to infect after a dormant period. The uredospore therefore becomes now practically a resting spore, but retains the appearance and manner of germination of the summer spore. Such a modification in form or function of any stage of a species to correspond with an unusual change of condition of climate or of the host may be considered as an *emergency adaptation*.

It is easily understood how the change of conditions may be so severe as to necessitate still further modification of structure as well as function, simply as a means of protection. Such a development seems to have been actually reached in the species next discussed, which has resulted in the production of a distinct spore form, specialized from the uredo, leaving still, however, a true uredo stage for summer propagation.

Puccinia vexans Farl.

There are probably no other species in all the Uredineæ more interesting than this one, and certainly none that has been more perplexing. In this species there are three distinct spore forms aside from any æcidium or spermogonium that may possibly exist—true uredo and teleuto stages, and a peculiar one-celled form different from either of these. (Pl. II, figs. 2–9.) The species was at first made all the more puzzling by the rarity of the true uredo stage, which was not known to exist, or at least not reported, until 1890, when Dr. H. J. Webber, in the Catalogue of the Flora of Nebraska, reported its occurrence in that State. In certain seasons and localities the teleuto stage also is almost or entirely lacking.

The species was first described by Peck as a Uromyces (*U. brandegei* Pk.)[a] on the basis of material collected by Mr. T. S. Brandege, in which specimens contained only the third spore form. Because of the discovery afterwards of two-celled spores associated with this third spore form, even sometimes in the same sorus, Doctor Farlow described it as a Puccinia (*P. vexans* Farl.) in the Proceedings of the American Academy of Arts and Sciences, Vol. XVIII, pp. 82–83. At that time the true uredo stage had not been discovered.

This third spore form is far more prevalent than either of the others as a rule, but is sometimes entirely absent, leaving only the teleuto stage. It is distinct from either of the other forms in structure and appearance, and yet resembles both in some respects. It is larger than either of them, is strongly papillate, and has a much thicker cell wall, but on the other hand possesses the color and persistence of pedicels of teleutospores and appears to have pores like the uredospores. (Pl. II, fig. 5.) Doctor Farlow, in his description, says:

> A species in which some of the sori contain only two-celled spores must certainly be held to be a Puccinia, and the perplexing question arises, are the one-celled spores a unilocular form of teleutospores similar to what is known in *P. cesatii* Schr., or are they the uredospores of this species? I have not been able to find any other spores which represent the uredo of the species; and never having seen the unicellular spores in germination, there is, so far as we yet know, no reason why they may not be the uredospores. On the other hand, their general appearance and the density of the cell wall would lead one to suppose that they were of a teleutosporic nature. Further conjecture is unnecessary, because, as the species is not at all rare in some localities, botanists who can examine the fungus on the spot ought to be able to ascertain whether the one-celled bodies produce promycelia or not, or else to discover the true uredo of the species.

A full description of all three forms is given by Arthur and Holway in Descriptions of American Uredineæ accompanying Fasicle IV of Uredineæ Exsiccatæ et Icones.[b]

After numerous unsuccessful trials during several years, the writer was finally able to germinate the third spore form, and, as suggested by Doctor Farlow, has in this way been able to determine its nature. In manner of germination it is exactly like the uredospore, the long simple germ-tubes being produced through equatorial pores (Pl. II, figs 7 and 8), but is like the teleutospore in germinating only after a dormant period and exposure to extremes of weather. The uredo and teleuto forms being already present and morphologically different from this form, it must be considered distinct. Because of the dual nature of this spore form, the writer has already proposed for it the name *amphispore* in a paper read before the Baltimore meeting of the Society for Plant Morphology and Physiology in 1900, only an abstract of which was published.[c] The term has since been adopted by Arthur

[a] Bot. Gaz., 4: 127.

[b] Bul. Lab. Nat. Hist. State Univ. Iowa, Vol. V, pp. 329–330.

[c] Science, Vol. XIII, p. 250.

and Holway,[a] and a second instance of the occurrence of this form is described by them for *Puccinia tripsaci* Diet. and Holw. The entire series of observations and experiments with this species made by the writer will now be described.

The first cultures of amphispores were made January 15, 1894, at Manhattan, Kans. Both a water culture and one of a sterilized decoction of manure were employed, with no result, the chief cause of failure being probably that the experiment was too early in the season. Afterwards numerous other trials were made with no better success. In the meantime true uredospores were found on September 25, 1896, at Manhattan, Kans.

Finally a successful culture of the amphispores was made on March 8, 1897, at Washington, D. C. The germination was excellent. An abundance of rather long germ tubes, not promycelia, was produced in forty-two hours, but only one to each spore. These germ tubes, unlike those of most uredospores, are quite colorless and clear. A few teleutospores were present, none of which germinated. The culture was an ordinary water drop, but was made in a new form of culture cell, constructed to special order and similar to the Van Tieghem cell, except that the glass ring is quite thin and drawn out into an open tube on each of two opposite sides, with the opening plugged with cotton wool, thus admitting sterilized air. This construction may or may not have increased the chances for germination. The extreme weather conditions at the time, to which the specimens were first exposed, probably contributed most to the success of the culture. They were fastened to the roof of a near-by shed, and after several days of warm sunshine were thoroughly soaked with rain, which was followed by snow and then a severe freeze, soon after which the culture was made. It is an interesting feature of the experiment that the specimens were received from Dr. David Griffiths, then at Aberdeen, S. Dak., and had been collected in September, 1896, and kept in the herbarium until sent to Washington. It was unfortunate that seedlings of the host were not available for making inoculations with these perfectly viable spores. Such an experiment is yet to be made.

At Manhattan, Kans., in 1897, the uredo was present in considerable abundance from June until late in October in grass plats on the Experiment Station farm. On July 8 inoculations were made with the uredospores of this species and with *Æcidium cephalanthi* and *Æ. xanthoxyli* on seedlings of *Bouteloua racemosa* without result. Further inoculations with uredospores on October 4 were successful, rust spots appearing in twelve days (Pl. II, fig. 9), followed in nine more days with one sorus of amphispores. The uredosori are yellowish-brown and rather inconspicuous. On December 31 uredospores could not be found in the grass plats at Manhattan.

[a] Bul. Lab. Nat. Hist., State Univ. Iowa, Vol. V, p. 175.

At Lincoln, Nebr., a water-drop culture was made of *Puccinia vexans* on March 15, 1898, resulting in a few germinations of the teleutospores in three days. Long promycelia were produced, but no sporidiola. None of the numerous amphispores present germinated.

On September 29, 1899, all three spore forms were again found in the grass plats at Manhattan. Living host plants were transferred to Washington, D. C., and seedlings were started for further experiments, when other duties intervened and the work could not be continued.

Certain facts concerning the relative abundance of the amphispores and teleutospores in different seasons and localities seem to harmonize quite well with the idea already expressed as to the function of the former. If it is the work of the amphispore to carry the species through unusually severe cold or drought, then this spore form should be relatively more abundant in dry periods and relatively more common to the westward and northward in the Great Plains. These conditions are just what exist. The amphispore prevails almost entirely in the Dakotas and in western Kansas, western Nebraska, and eastern Colorado, and appears to have been more common in eastern Kansas during a dry period of several years than during a wet period. At the same time westward toward the mountains there is less chance for an Æcidium to connect with the teleuto stage.

EXPERIMENTS WITH LEPTO-UREDINEÆ.

It is generally supposed that teleutospores which are followed by an æcidium germinate only after a considerable period of rest, usually in early spring. As already mentioned under the discussion of sunflower rust, the writer germinated teleutospores of this species readily in the autumn, and afterwards at different times during the winter. This readiness of germination, apparently at almost any date, is an indication in itself of an alliance to the lepto species. But, more than this, the autumn inoculations with material in which no uredospores could positively be detected nevertheless were, in some cases at least, followed first by spermogonia and then by the uredo! Of course occasional uredospores that may have been overlooked could have produced those few spots in which the presence of spermogonia was not certain. Here, then, is further evidence of the lepto tendency of the species. In addition, it is well known that the æcidium is rare and appears to have no fixed time of occurrence. Now, only the omission of the uredo is needed to make the rust a real lepto species. As it is, its position is more nearly that of a Hemi-puccinia than of an autœcious species. Experiments of this kind, united with critical field observations, thus throw much light upon classification as to group position, as well as enabling us to connect stages.

On the other hand, certain lepto species will be found to closely approach other groups, and, indeed, after further experiment, may have to be placed in some other group. The following species have given interesting results in culture experiments.

RUST OF COCKLEBUR (*Puccinia xanthii* SCHW.).

Observations and culture experiments of the writer show that the rust of cocklebur is probably limited to one host and is distinct from the species on Ambrosia, and also justify the suspicion that it lies very near the border of the Lepto-uredineæ, and may belong to another group.

On March 1, 1897, the first water-drop culture made gave an excellent germination in forty-eight hours. Long promycelia were produced, but no sporidiola. On February 13, 1897, at Washington, D. C., inoculations were made on seedlings of cocklebur and *Ambrosia trifida*, resulting in an infection of the former in eighteen days, but not of the latter. On March 12 a second experiment resulted in a large number of infections of cocklebur seedlings in fourteen days. In all these cases spermogonia preceded the teleutospores in the infected spots. On October 8 of the same year an æcidium was found on cocklebur in considerable abundance, associated with the teleutosori, at Perkins, Okla. An inoculation on cocklebur seedlings, made at Lincoln, Nebr., on February 16, 1898, resulted in the production of spermogonia in ten days. The inoculating material had been collected in October, 1897. An æcidium on cocklebur was again found in abundance at Las Cruces, N. Mex., on July 11, 1899. Attempts should be made to infect the cocklebur with this æcidium. Doctor Farlow says an æcidium on Xanthium in Massachusetts is frequently followed by *Puccinia xanthii*.[a]

The ease with which artificial infections are made with this rust is at first surprising. So long as there is warmth and moisture, germination occurs under almost any condition and at any time.

RUST OF VELVET LEAF (*Puccinia heterospora* B. AND C.).

In the last-mentioned experiments the inoculating material was taken each time from dead leaves. The same was true in one experiment with the rust of velvet leaf, November 14, 1896, at Manhattan, Kans., in which seedlings of the host were infected in twelve days. For all these experiments the average time of incubation was about twelve days. In December, 1896, the infected plants of the last experiment were transferred from Manhattan to Washington, D. C., and material from these was used to inoculate new seedlings, which resulted in an infection in nine days. It appears, therefore, that the

[a] Proc. Amer. Acad. Arts and Sci., Vol. XVIII, p. 75.

incubation period is shorter if inoculating material is taken from living plants, and during the summer it is probably about the same as that of infections from uredospores.

Numerous experiments were also made with other lepto species, including *Puccinia grindeliæ*, Pk., *P. variolans*, Hark., *P. lygodesmiæ*, E. and E., and *P. sherardiana*, Körn, with results similar to those above mentioned. The writer has already called attention to the phenomenon of the formation of catenulate sporidiola in two of these species, *P. grindeliæ* and *P. variolans*.[a]

PERENNIAL SPECIES.

The chance for the continued existence of a rust through winter resistance of the uredo without the intervention of another stage has been discussed. Though such a condition can only exist on a perennial host, or at least one that lives over winter, it must not be supposed that the fungus itself is necessarily or even usually perennial. As fast as the leaves of the host die the spores simply drop on to the next lower and younger leaves and produce reinfection, the mycelium not extending through the base of the infected leaf into the next leaves. If, however, the mycelium is found within the rootstock and after a dormant period during midwinter follows the new shoots upward in early spring and again produces sori at the surface of the plant, the rust is a true perennial. This condition appears to exist in the following species.

ÆCIDIUM TUBERCULATUM E. AND K.

It is now usually supposed that all æcidial forms will likely be found to be connected with other stages, though there are probably more of these forms whose connections are at present undetermined than there are of Lepto-uredineæ. If any Æcidium is more likely than another to be an independent species, certainly the probabilities are largely in favor of this species, which occurs on *Callirrhoe involucrata*,[b] for there is no need of another stage to perpetuate it, though another host might give it a wider distribution.

The striking orange-yellow color, large and otherwise conspicuous sori, and its complete attack of every portion of the host make this an unusually unique and attractive species (Pl. I, frontispiece). A note concerning the hardiness of this species was published by the writer several years ago.[c] The words are here quoted: "*Æcidium tuberculatum*

[a] Bot. Gaz., Vol. XVIII, pp. 455–456.

[b] Though not previously reported, this rust was found also on *Callirrhoe alcæoides* at Salina, Kans., in May, 1893.

[c] Bot. Gaz., Vol. XVIII, p. 453.

E. and K. is still producing æcidiospores on *Callirrhoe involucrata* outdoors here at Manhattan at the time of this writing (October 15, 1893), and Mr. E. Bartholomew, of Rooks County, Kans., tells me that he has seen in December æcidiospores on specimens of this host growing close by a large snowdrift. In the spring æcidiospores of this species begin forming about the first day of April." On December 20, 1893, after the above was transmitted for publication, the rust was found still alive although it had been under 4 inches of snow. In a water-drop culture of some of the material four spores germinated in twenty-four hours. Since that time, at later dates in the winter the living rust has been found, but close within the rootstock, with a faint color still, but producing no spores. The peculiar manner of growth of the rust, permeating the entire host and producing scattering sori all along the stems to their bases, as well as on the leaves, and the difficulty of germinating the spores harmonize also with the idea of a propagation by perennial mycelium. Besides the above instance other cultures of the spores were made as follows: At Manhattan, Kans., May 20, 1893, spores from *Callirrhoe alcæoides*, only a few germinations in forty-eight hours; at Manhattan, June 9, 1893, spores from *C. involucrata* germinated sparingly in twenty-five hours; at Manhattan, January 30, 1894, spores from *C. involucrata* growing in greenhouse, fair germination in sixty hours.

In the winter of 1896–97 infected plants of *C. involucrata* were obtained from Kansas and grown in a greenhouse at Washington, D. C., and on March 17, 1897, inoculations of seedlings of the following grasses with spores from these plants failed to produce infections: *Agropyron occidentale*, *A. richardsoni*, *Sitanion elymoides*, *Elymus canadensis*, and *Bouteloua racemosa*.

Rust of Peucedanum Fœniculaceum.

An Æcidium occurs on this host in Kansas and Nebraska which has been reported as *Æ. anisotomes* Reich., but the identity of which is not yet determined[a] satisfactorily to the writer. At certain places a Puccinia follows the Æcidium so closely that their connection is very probable. Both forms are particularly abundant at Manhattan, Kans. On April 25, 1893, at that place, it was determined by the study of many cross sections of the host plant that the mycelium of the Æcidium extends into the rootstock. It is one of the earliest rusts in the spring to appear in that locality. These facts make it probable that this rust is also perennial. On the other hand, it is possible that the teleutospores of the Puccinia may produce a very early infection at the base of the young shoots, resulting in the Æcidium, although in some localities no Puccinia has yet been found following the Æcidium.

[a] The species is probably *Puccinia jonesii* Pk., with the æcidial stage present.

At Lincoln, Nebr., on March 24, 1898, teleutospores of this same Puccinia germinated in a water-drop culture in twenty-four hours.

It should be noted that it is possible for a perennial rust to exist in an annual host, the mycelium of the rust being carried over winter in the seed of the host. Such an instance is practically certain in the Euphorbia rust already discussed. Granting that Doctor Eriksson's experiments were accurate, there would be another example in *Puccinia glumarum* Eriks. and Henn. on wheat.

PLATES.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN No. 64.

B. T. GALLOWAY, *Chief of Bureau.*

A METHOD OF DESTROYING OR PREVENTING THE GROWTH OF ALGÆ AND CERTAIN PATHOGENIC BACTERIA IN WATER SUPPLIES.

BY

GEORGE T. MOORE,

Physiologist and Algologist in Charge of Laboratory of Plant Physiology,

AND

KARL F. KELLERMAN,

Assistant in Physiology.

VEGETABLE PATHOLOGICAL AND PHYSIOLOGICAL INVESTIGATIONS.

Issued May 7, 1904.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1904.

BULLETINS OF THE BUREAU OF PLANT INDUSTRY.

The Bureau of Plant Industry, which was organized July 1, 1901, includes Vegetable Pathological and Physiological Investigations, Botanical Investigations and Experiments, Grass and Forage Plant Investigations, Pomological Investigations, and Experimental Gardens and Grounds, all of which were formerly separate Divisions, and also Seed and Plant Introduction and Distribution, the Arlington Experimental Farm, Tea-Culture Investigations, and Domestic Sugar Investigations.

Beginning with the date of organization of the Bureau, the several series of bulletins of the various Divisions were discontinued, and all are now published as one series of the Bureau. A list of the bulletins issued in the present series follows.

Attention is directed to the fact that "the serial, scientific, and technical publications of the United States Department of Agriculture are not for general distribution. All copies not required for official use are by law turned over to the Superintendent of Documents, who is empowered to sell them at cost." All applications for such publications should, therefore, be made to the Superintendent of Documents, Government Printing Office, Washington, D. C.

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[Continued on p. 3 of cover.]

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN No. 64.

B. T. GALLOWAY, *Chief of Bureau.*

A METHOD OF DESTROYING OR PREVENTING THE GROWTH OF ALGÆ AND CERTAIN PATHOGENIC BACTERIA IN WATER SUPPLIES.

BY

GEORGE T. MOORE,

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AND

KARL F. KELLERMAN,

ASSISTANT IN PHYSIOLOGY.

VEGETABLE PATHOLOGICAL AND PHYSIOLOGICAL INVESTIGATIONS.

ISSUED MAY 7, 1904.

WASHINGTON:

GOVERNMENT PRINTING OFFICE

1904.

BUREAU OF PLANT INDUSTRY.

B. T. Galloway, *Chief.*
J. E. Rockwell, *Editor.*

VEGETABLE PATHOLOGICAL AND PHYSIOLOGICAL INVESTIGATIONS.

SCIENTIFIC STAFF.

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Erwin F. Smith, *Pathologist in Charge of Laboratory of Plant Pathology.*
George T. Moore, *Physiologist in Charge of Laboratory of Plant Physiology.*
Herbert J Webber, *Physiologist in Charge of Laboratory of Plant Breeding.*
Walter T. Swingle, *Physiologist in Charge of Laboratory of Plant Life History.*
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T. Ralph Robinson, *Scientific Assistant, Plant Physiology.*
Florence Hedges, *Scientific Assistant, Bacteriology.*
Charles J. Brand, *Scientific Assistant in Physiology, Plant Life History.*

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[a] Detailed to the Bureau of Forestry.
[b] Detailed to Botanical Investigations and Experiments.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., April 30, 1904.

Sir: I have the honor to transmit herewith a paper entitled "A Method of Destroying or Preventing the Growth of Algæ and Certain Pathogenic Bacteria in Water Supplies," and to recommend that it be published as Bulletin No. 64 of the series of this Bureau.

The paper was prepared by George T. Moore, in charge of Laboratory of Plant Physiology, and Karl F. Kellerman, Assistant in Physiology, in the Office of Vegetable Pathological and Physiological Investigations, and was submitted by the Pathologist and Physiologist with a view to publication. The subject discussed in this bulletin will be of interest and value to all who have to deal with the problem of preventing algal and other contamination of water supplies.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

PREFACE.

The necessity of finding some cheap and practical method of preventing or removing algal contamination of cress beds first led this Office to undertake the investigations described in this bulletin. The success of the first experiments in 1901 was so marked that it seemed wise to extend the work, and authority was, therefore, granted by Congress "to study and find methods for preventing the algal and other contaminations of water supplies."

The progress of the investigation has been noted from time to time in the annual reports of the Bureau. Though the work is not yet completed, we have been urged to publish the results already obtained for the consideration of boards of health and officers in charge of public water supplies.

Doctor Moore and Mr. Kellerman have shown that it is entirely practicable to cheaply and quickly destroy objectionable algæ in small lakes, ponds, storage reservoirs, and other similar bodies of water by the use of extremely dilute solutions of copper sulphate or of metallic copper. The fact that an extremely dilute solution (one to one hundred thousand) will also destroy the most virulent typhoid and cholera bacteria at ordinary temperatures in three hours is of great importance and significance. Solutions of copper as dilute as this are not considered injurious to man or other animals. The value of copper, especially colloidal, in preventing or treating typhoid and other related diseases should be carefully investigated by competent pathologists.

We desire it distinctly understood that, so far as bacterial contamination of water is concerned, the methods here proposed are not to take the place of, but are simply to supplement the standard methods of filtration; neither can too much stress be laid upon the importance of the consumer boiling water to be used for drinking purposes when taken from a contaminated source.

Upon application to the Department by proper authorities, information and assistance will be furnished in determining the organisms causing the trouble in cases of algal pollution, and the proper treatment will be recommended. It is earnestly hoped that no test of the method described here will be made without first consulting the Department.

As stated in the text of the bulletin—

> The treatment of water supplies for the destruction of pathogenic bacteria, or any application of the copper sulphate method, which has to do with the public health is not contemplated or indeed possible by this Department. The requests of private individuals or of unauthorized bodies for information or assistance can not be granted. When State or local boards of health consider that the disinfection of a water supply is desirable and wish information upon the subject, it will be supplied as fully and freely as possible. All experiments of this kind, however, must be conducted by boards of health, and the Department can serve only in the capacity of an adviser.

We are under obligation to Dr. H. P. Wolcott and Mr. X. H. Goodnough, of the Massachusetts State Board of Health, for facilities in securing material and a temporary laboratory in the Boston State House; to the United States Bureau of Fisheries for fish used in experiments; to Dr. J. J. Kinyoun for typhoid cultures; to Dr. M. J. Rosenau for Asiatic cholera cultures, and to the Bureau of Animal Industry for cultures of typhoid and facilities for carrying on preliminary experiments.

Albert F. Woods,
Pathologist and Physiologist.

Office of Vegetable Pathological
and Physiological Investigations,
Washington, D. C., April 30, 1904.

CONTENTS.

A METHOD OF DESTROYING OR PREVENTING THE GROWTH OF ALGÆ AND CERTAIN PATHOGENIC BACTERIA IN WATER SUPPLIES.

INTRODUCTION.

The necessity and importance of maintaining by every possible means the purity and wholesomeness of public water supplies have caused those in authority to welcome a method which would in any way serve as an additional safeguard against the pollution of reservoirs or would prevent the bad effects produced by the growth of algæ and similar organisms. Although scientific men have been investigating the various problems involved for a considerable length of time, it is feared that the public has not always been in sympathy with these methods, and that, owing to the uncertainty of and disagreement among eminent authorities, the whole question of water analysis, both chemical and bacteriological, has come somewhat into disrepute.

MICROSCOPICAL EXAMINATION OF DRINKING WATER.

While the best known cases of water pollution are those due to the presence of typhoid and other germs which have given rise to serious epidemics, there are a vastly greater number of water supplies which are rendered unfit for use, not because they are dangerous to public health, but on account of the very offensive odor and taste produced in them by plants other than bacteria. For this reason, in recent years, the question of whether or not a water was fit to drink has been submitted to the biologists as well as to the chemists and bacteriologists, a biological examination being generally understood to mean the determination of the character and quantity of the microscopical plants and animals the water may contain as distinct from the bacteria.

The history of this method of examining drinking water is really confined to the last quarter of the nineteenth century, but only within ten or fifteen years have we had any accurate knowledge of the effect of these minute plants upon the water in which they live. It is probable that Dr. Hassall, of London, was the first to publish any adequate account of a thorough microscopical examination of any water supply, and this work, which appeared in 1850, was practically the only thing upon the subject for twenty-five years, when "MacDonald's Guide to the Examination of Drinking Water" was published. In the meantime various Germans had carried on investigations relating to the biology of water supplies, notably Professor Cohn, of Breslau, who, in a paper entitled the "Microscopical Analysis of Well Waters," anticipated much that has since been ascertained in regard to the effect of environment upon the character and quantity of the organism found in the water. About the time of the appearance of MacDonald's book, interest in the effect of algæ in drinking water first began to be aroused in this country, and papers by Farlow[a] and others called attention to the fact that these plants were responsible for many of the disagreeable odors and tastes in water reservoirs. By the year 1878 there was on record a list of over 60 cities and towns in the United States which had had serious trouble because of the presence of certain forms of vegetation in their reservoirs, but since then thousands of water supplies throughout the country have been rendered unfit for use by this cause alone. Early in the year 1891 the special report upon the examination and purification of water by the Massachusetts State Board of Health was published, this being the most complete treatment of the subject which had appeared up to that time. This report has been supplemented by further investigations and experiments, and the work accomplished by this board in perfecting methods for insuring a pure water supply has established the standard both in this country and abroad for similar lines of investigation.

WIDE DISTRIBUTION OF TROUBLE CAUSED BY ALGÆ IN WATER SUPPLIES.

In order to demonstrate the very wide distribution of the trouble caused by algæ in water supplies throughout the United States, a circular letter was sent to about five hundred of the leading engineers and superintendents of water companies, asking for information in regard to the deleterious effects produced by plants other than bacteria in water supplies with which they were familiar. Many instructive replies were received, indicating that those in authority were extremely anxious to be provided with some efficient remedy for preventing the bad odors and tastes in drinking water, and that they considered the

[a] FARLOW. Reports on Peculiar Condition of the Water Supplied to the City of Boston. Report of the Cochituate Water Board, 1876.

——— Reports on Matters connected with the Boston Water Supply. Bulletin of Bussey Inst., Jan., 1877.

——— Remarks on Some Algæ found in the Water Supplies of the City of Boston, 1877.

——— On Some Impurities of Drinking Water Caused by Vegetable Growths. Supplement to 1st Ann. Rept. Mass. State Board of Health. Boston, 1880.

——— Relations of Certain Forms of Algæ to Disagreeable Tastes and Odors. Science, II, 333, 1883.

subject worthy of most careful investigation. Quotations from some of the letters received are given, but, because there might be some objection to the naming of towns, only the State in which the trouble occurred is indicated. This is sufficient, however, to show that the difficulty is not confined to any one part of the country, and that it is the algæ alone which are responsible for most of the bad odors and tastes reported.

California:

Any efforts in the direction of preventing the growth of algæ will be gratefully acknowledged. So long as the growth is healthy it is a benefit, but as soon as the algæ break up then trouble begins.

Colorado:

We have a reservoir of water that has recently become affected through the presence of micro-organisms of the algæ type that impart to the water a disagreeable fishy odor and render its use objectionable.

Delaware:

A fishy taste and odor.

Illinois:

The water tasted and smelled like rotten wood.

Trouble serious enough to cause general complaint by consumers on account of odor and taste.

People declared that the water was musty. The appearance of the growth is yellowish-brown, and as nearly as I can describe it the smell is musty. I certainly think the subject worthy of the best thought and work the Government can give it.

Indiana:

The growth increased to such an extent that we were compelled to cement the bottom and 5 feet up the sides. It was as dense as a field of clover in June.

Taste was said by the people to be woody or fishy, like rotten wood or decayed fish. At one time the report got out that the body of a missing man had been found in the reservoir.

Iowa:

After certain stages in the alga's growth it seemed to die and become decomposed, thus impregnating the water, giving it a most unpleasant odor and taste.

Kentucky:

Fishy odor and taste, rather musty.

The odor was so strong that we had to discontinue sprinkling the streets and lawns.

Urgency in this case is great, indeed almost imperative, since the condition of the water during the past two or three summers has culminated in formal action by the authorities.

Maine:

Trouble to such an extent as to lead us to consider, without taking definite action, whether or not the water should be filtered before being distributed. Odor is reported as exceedingly disagreeable, so that many customers avoid the use of it as far as possible and believe it injurious to health.

Massachusetts:

Trouble very serious; some years water is unfit to drink. Present year odor and taste are not so strong as last year, when it was almost impossible to drink it.

The odor was so bad that it would be almost impossible to take it as far as the mouth to taste it. Horses refused it at the street watering troughs and dogs fled from it.

MINNESOTA:

Water at times a fishy odor or taste due to decomposed vegetable matter. Experts claim it is entirely harmless.

NEW JERSEY:

Dark green gelatinous substance in water, causing a stench almost unbearable.

Have seen Uroglena so abundant that an odor could be plainly detected one-third of a mile away.

NEW YORK:

Water had a very fishy taste and smell.

So very offensive as to alarm all water takers.

It caused such a prejudice that the supply was rejected, although the pollution was of short duration.

Strong fishy odor and taste; also odor of "smartweed." Popular complaint was dead fish in water mains.

Odor and taste were fishy, popularly attributed to dead fish; but this is absurd, as the odor is that of live fish.

Odor pondy and fishy; bad water; publicly condemned. Board of health interfered, yet analysis showed that water was not unhealthful.

Very rank, water smelled bad, particularly when warmed. Tasted bad, but not injurious to health. Looked better than tasted or smelled.

Water became unfit for use, musty or cucumber taste and smell, odor very strong in hot water; water became slimy, making it exceedingly hard to filter. Odor and taste at times decidedly fishy. A bright green powder seemed to have been sprinkled on surface.

I am much interested to know that you are taking up an investigation of algæ and organisms, and I very much hope you will favor me with all circulars and information which you may issue relating to the same. I have not attempted to fill out the circular on the back of your letter, but so many cases of trouble of this kind have come to my attention that any listing of them would be very difficult.

I am devoutly thankful that science in this particular instance has got beyond the pursuit of science for recreation's sake and is doing good and endeavoring again directly to be of much use to mankind. I believe your work is the first done in line of either cure or prevention from algæ conducted in a rational manner, or so far as I know even attempted, and I have been connected with or well informed on public water supplies and their management all my professional life of some thirty-five years. The worst case I know of is at the ——— reservoir. A special commission is at this moment charged with the duty of advising whether or not property worth some two million dollars is to be abandoned on account of annual trouble from algæ.

OHIO:

Complaint from customers of a fishy taste in water like the slime from fresh-water fish.

Water had a fishy taste, causing a general kick; consumers laid it to the fish in the reservoir.

All water drawn from house bibbs had an objectionable and strong odor, the popular idea being that it was due to dead fish.

The towns A— and B— both have vile water, A— all the year round, B— for six or eight weeks in the hottest part of the summer. A—'s water has a vile odor, offensively musty. All vegetables, cereals, coffee, and such edibles and drinks made with the water are scarcely endurable to the visitor.

PENNSYLVANIA:

Water had a disagreeable fishy odor.

Water smelled and tasted as if dead fish were in it.

PENNSYLVANIA—Continued.

The growth affected the taste of the water on boiling, but was not regarded as dangerous to health.

A very fishy taste and smell. I have been unable to locate, but had an idea it came from vegetation.

The water during the autumn is so foul in taste and odor that it was necessary to shut off the supply. The odor is similar to that of decayed fish.

The first season of using reservoir the water became so fishy that it was almost unfit for use. Since that, owing to our care of reservoir, we have had no trouble whatever.

TEXAS:

At this time of the year algæ are fierce; some days we are on top and some days the algæ are on top. Costs us an average of $25 a month for cleaning out algæ from two reservoirs.

WISCONSIN:

Universal complaint, caused by the odor and taste due to algæ.

METHODS IN USE FOR PREVENTING BAD EFFECTS DUE TO ALGÆ.

In order to prevent the odors and tastes above described, engineers and those in charge of water supplies have tried various remedies, none of which has been perfectly satisfactory. Since few of the algæ can develop without sunlight, the most frequent recommendation has been to cover the reservoir, and this method has proved successful in a few instances. However, the expense involved is so great as to make the remedy prohibitive in most cases, and other methods have had to be resorted to. One precaution which is now almost universally recommended as a means of preventing the growth of algæ is to remove all the organic matter possible from the reservoir and to keep the source of supply as free as can be from dead and decaying animal and vegetable matter. In one notable instance millions of dollars have been spent in the removal of earth and the substitution of gravel at the bottom of an immense new reservoir. It remains to be seen, however, whether this will be sufficient to insure permanent freedom from these troublesome plants. It is certain that attempts of this kind will delay the appearance of algæ in quantity, and, wherever it is possible to do so, every effort should be made not only to clean up the reservoir at the time of its construction, but to keep it as free as possible from organic matter after it is filled. In addition to cleanliness a direct pumping system with duplicate, in case of breakdown or repairs, has often been recommended for use with ground water, which usually produces a more luxuriant growth of algæ and similar organisms than surface water. Where it has been necessary to store such water, it has been advisable to limit the capacity of the reservoir, and frequently this storage is only intended to be used in case of fire. Even so, the cleansing of the reservoir and the frequent flushing of the water mains has been considered necessary. In storing surface water subdividing the reservoir is occasionally resorted to, and means of obtaining frequent agitation are introduced wherever possible. The pumping of air into water or aerating it by means of a spraying apparatus is often of considerable value in removing foul gases which may be in solution, but the effect of aeration upon the growth of algæ in a reservoir has been very much overestimated, in some cases the quantity being actually increased by this means.

The filtration of water, both mechanically and by sand, which has proved so effective for the removal of pathogenic bacteria, has been recommended as a means of removing the odors and tastes caused by algæ, but the results obtained have not given promise of success. Perhaps the most careful experiments to determine this point have been conducted by those in charge of the Ludlow reservoir at Springfield, Mass. Here the annual trouble from algæ for the past fifteen years has been so great that every possible means has been used which offered any relief from the effects produced by these plants. On page 4 of the "Special Report on the Improvement of the Present Water Supply and an Alternative New, Independent Supply," made by the board of water commissioners to the city council of the city of Springfield, Mass., April 14, 1902, the following statement is made:

> We find, as the results of the experiments of filtration, made with the sanction of your honorable body during the last fifteen months, that to purify the waters of this source by filtration would be not only doubtful as to the degree of purification, but so expensive in the cost of construction and perpetual maintenance thereafter as to make it inexpedient to attempt improvement by such a method. Your board has given constant and personal attention to the experimental work, and is convinced that the excessive growths of obnoxious fresh-water organisms, notably the Anabaena, impart to the reservoir such rank and persistent tastes and odors as to make uncertain entire removal by any method of filtration except that of the expensive kind, applicable only to the filtering of extremely small quantities of water, and requiring constant attention and adjustment.

The State board of health, in a special report (p. 84) submitted at the same time, say that the results of the experiments indicate, in the opinion of the board, that by double filtration it will be possible to purify the Ludlow reservoir; hence there seem to be differences of opinion as to the value of this treatment for the removal of odors and tastes, but on account of the expense involved there is not likely to be any very extensive use of this method.

DESIRABILITY OF OTHER METHODS.

While each of the above-mentioned methods has been used with some success, it is generally conceded by engineers that there is no known remedy which is universally applicable. It is the practice of some of the highest authorities to recommend that reservoirs frequently polluted by algæ be abandoned, and steps taken to provide an entirely new system of supply. This is, of course, the last resort, as in all such cases a large loss of money is involved. One fact is certain.

If any known method of preventing the growth of algæ was considered truly effective, it would under all circumstances be recommended.

Because of the unsatisfactory results or the prohibitive expense of the present methods recommended for ridding reservoirs of algæ, it seemed advisable that the problem be taken up from an entirely new standpoint, one that would take into consideration the biological aspect of the question and perhaps furnish a solution, through a study of the physiology of the organisms under laboratory conditions. A series of investigations were therefore undertaken to discover, if possible, some substance which, because of its extreme toxic effect upon the algæ involved, would absolutely prevent their growth in water supplies.

DETERMINATION OF A PHYSIOLOGICAL METHOD.

In determining such a physiological method of dealing with reservoirs contaminated by algæ, two conditions had to be considered: The remedy should not only be readily available and cheap enough for practical use in the largest reservoirs and by the poorest communities, but under the conditions used it must also be absolutely harmless to man; the maximum amount necessary to kill the algæ being far below the amount which could in any way affect the consumer of the water. Of the large number of substances experimented with, few gave encouraging results. Free chlorine at a dilution of 1 to 10,000, and sulphur dioxide in saturated aqueous solution at 16° C., diluted 1 to 1,000 and to 10,000, will destroy many of the common forms of algæ, but sulphur dioxide and chlorine are likewise very injurious to animal life. Silver has a very high toxicity, and were not the expense prohibitive, would undoubtedly warrant extended tests. Mercury and lead are, of course, out of the question, and zinc requires too high a concentration to be practically considered. The ordinary sodium, potassium, and ammonium salts are innocuous,[a] as are most of the acids. Loew[b] finds that magnesium sulphate is toxic in pure solution at 0.4 per cent, and that oxalates are slightly more toxic; of the acids, 0.0001 per cent oxalic kills most of the cells of *Spirogyra majuscula* in five days. Migula[c] notes the effect of many of the organic acids, but the use of these substances in the amounts requisite for treating a contaminated water supply is entirely impracticable.

EFFECT OF COPPER SULPHATE.

Reviewing the experiments carried on in the Laboratory of Plant Physiology, as well as the results obtained by other investigators, it

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[a] Cf. Richter, Flora, **75**: 4.

[b] Loew, Flora, **75**: 368.

[c] Migula, Ueber den Einfluss stark verduenter Sauren auf Algenzellen, Breslau, 1888 (Original not consulted.)

seems that copper sulphate is the substance best adapted to the work in question. This salt has a very high toxicity for algæ, and experiments with a number of the forms usually found in reservoirs, and the source of much trouble, have shown that inconceivably small amounts of copper are poisonous in a high degree. These experiments demonstrated, however, that all algæ and protozoa are not equally sensitive. Among the latter *Paramæcium* is killed in three hours by a 1 to 1,000,000 solution, while *Amœba*, *Difflugia*, and *Spirostomum* die within two hours. Crustacea are more resistant, some—*Cypris* and *Daphnia* especially—requiring as much as 1 part copper sulphate to 10,000 of water to kill them. Mosquito larvæ die at a concentration varying from 10,000 to 200,000.

Quoting the results of other experimenters, Devaux[a] found that both phænogams and cryptogams were poisoned by solutions of copper diluted to the ten-millionth part or less; Coupin[b] that 1 part copper sulphate to 700,000,000 of water was sufficient to affect the growth of seedlings when applied to their roots and that this is the most injurious of the heavy metal salts tested by him; Deherain and De Moussy[c] that the development of the roots of seedlings was arrested in distilled water containing the slightest trace of copper, and they conclude from this that higher plants during germination, as well as fungi and algæ, are extremely sensitive to copper; Bain's experiments[d] indicated that 1 part of metallic copper to 25,000,000 of water was fatal to apple seedlings in one day; on the other hand, according to Raulin,[e] copper chloride does not injure *Sterigmatocystis* until a concentration of 1 to 240 is reached, although silver nitrate is toxic at 1 to 1,600,000.

In dealing with algæ, the toxic concentration varies greatly for different genera, even for different species in the same genus. Nägeli[f] demonstrated the extreme sensitiveness of *Spirogyra nitida* and *S. dubia* to the presence of copper coins in the water. *Oscillatoria*, *Cladophora*, *Œdogonium*, and the diatoms succumb in six hours to a copper sulphate solution of 1 to 20,000, and in two days to 1 to 50,000, according to Bokorny.[g] Galeotti[h] finds that a concentration between 1 to 6,300,000 and 1 to 12,600,000 is sufficient to kill *Spirogyra nitida* in two days, and that the so-called colloidal solutions at 1 to 6,300,000 are fatal in the same length of time; while in the experi-

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[a] Devaux, Compt. Rend., **132**: 717.

[b] Coupin, Compt. Rend., **132**: 645.

[c] Deherain and De Moussy, Compt. Rend., **132**: 523.

[d] Bain, Bull. Agr. Exp. Sta. Tenn., April, 1902.

[e] Raulin, Ann. des Sc. Nat. Bot., 5e Ser., II: 93.

[f] Nägeli, Ueber oligodynamische Erscheinungen in lebenden Zellen. Neue Denkschr. d. schweizerischen Gesellsch. für die gesammten Naturwiss., **33**: 51.

[g] Bokorny, Arch. f. d. ges. Phys. d. Mensch. u. Thiere, **64**: 262.

[h] Galeotti, Biol. Centralbl., **21**: 321.

ments of Israel and Klingman[a] the presence of 60 sq. cm. of copper foil in 300 cc. of water for twenty-four hours produced plasmal cutting in *S. laxa* after one and one-fourth hours, in *S. crassa* after fifteen minutes, and in *S. majuscula* after thirty minutes. The work of Rumm[b] shows 1 to 10,000,000 solution still toxic to a few more susceptible cells of *S. longata*. According to Ono,[c] weak solutions of the salts of most of the metals encourage the growth of algæ and fungi. Mercury and copper, however, at 0.00005 per cent and 0.00001 per cent, respectively, distinctly inhibit growth. This was the case with *Stigeoclonium*, *Chroococcum*, and *Protococcus*.

In the experiments conducted in this laboratory it has not been possible as yet to include all of the organisms known to pollute water supplies. It is believed, however, that, pending the completion of more extensive work, the data at hand will be of considerable benefit to those who have to deal with contaminated reservoirs. The method of procedure in studying this question was to determine roughly the death points of the forms under consideration, using Van Tieghem cells. Accurate solutions were then made, with distilled water, and 200 cc. of each solution was pipetted into an Erlenmyer flask. The algæ, if filamentous forms, were rinsed; if free-swimming, they were concentrated by the Sedgwick-Rafter[d] method from 500 cc. to 5 cc. volume, and this 5 cc. was added to the treated water. The inaccuracy due to the addition of the 5 cc. of untreated water to the 200 cc. of treated water was disregarded. Whenever possible, a test of these concentrations, determined experimentally, was made under natural conditions by treating the pool from which the species under consideration was taken. If this was impracticable, an additional series was carried through in aquaria of 15 liters capacity, in which were kept goldfish, frogs, minnows, crustacea, and rotifers. Since in no case was there an appreciable difference in the effect of a concentration upon a particular organism under either natural or artificial conditions, no special record is made of these gross experiments.

The different species tested may, for convenience, be grouped as (1) those with death points at higher concentrations than 1 part copper sulphate to 1,000,000 parts of water; (2) those with death points between 1 to 1,000,000 and 1 to 5,000,000; and (3) those with death points at greater dilutions than 1 to 5,000,000.

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[a] Israel and Klingman, Virchow's Archiv., **147**: 293.

[b] Rumm, Beitrage zur Wissenschaftliche Botanik, **1**: 97.

[c] Ono, Journ. of College of Sc., Imp. Univ. Tokyo, **13**: 141.

[d] Whipple, The Microscopy of Drinking Water, New York, 1899, p. 15.

Effect of various concentrations of copper sulphate upon different forms of algæ.

[d=dead; vfa=very few alive; vfd=very few dead; g=in good condition.]

GROUP 1.

CHLAMYDOMONAS PIRIFORMIS Dill.

Date.	One part copper sulphate to water, parts—						Check.
	2,000	5,000	10,000	20,000	200,000	1,000,000	
October 19–21	$\frac{1}{2}$d	g	g	g	g	g	g
October 21–24	$\frac{1}{10}$d	vfd	g	g	g	g	g
October 24–27	$\frac{1}{4}$d	vfd	g	g	g	g	g

RAPHIDIUM POLYMORPHUM Fres.

Date.	One part copper sulphate to water, parts—						Check.
	25,000	50,000	75,000	100,000	500,000	1,000,000	
October 19–29	d	d	$\frac{1}{2}$d	$\frac{1}{10}$d	g	g	g
November 2–6	d	$\frac{3}{4}$d	$\frac{1}{2}$d	$\frac{1}{10}$d	g	g	g
November 16–20	d	vfa	$\frac{1}{2}$d	vfd	g	g	g

DESMIDIUM SWARTZII Ag.

Date.	One part copper sulphate to water, parts—						Check.
	50,000	75,000	100,000	150,000	200,000	1,000,000	
December 2–5	d	d	$\frac{1}{2}$d	vfd	g	g	g
January 4–7	d	d	$\frac{3}{4}$d	vfd	g	g	g

STIGEOCLONIUM TENUE (Ag.) Rabenh.

Date.	One part copper sulphate to water, parts—						Check.
	50,000	100,000	300,000	500,000	1,000,000	2,000,000	
December 21–24	$\frac{1}{2}$d	$\frac{1}{2}$d	$\frac{1}{2}$d	$\frac{1}{2}$d	vfd	g	g
January 2–5	$\frac{1}{2}$d	$\frac{1}{2}$d	$\frac{1}{2}$d	$\frac{1}{2}$d	vfd	g	g
January 7–11	$\frac{1}{2}$d	$\frac{1}{2}$d	$\frac{1}{2}$d	$\frac{1}{3}$d	vfd	g	g

DRAPARNALDIA GLOMERATA (Vauch.) Ag.

Date.	One part copper sulphate to water, parts—						Check.
	50,000	100,000	300,000	500,000	1,000,000	2,000,000	
December 1–8	$\frac{1}{2}$d	$\frac{1}{2}$d	$\frac{1}{4}$d	$\frac{1}{4}$d	vfd	g	g

NAVICULA Sp.

Date.	One part copper sulphate to water, parts—						Check.
	100,000	200,000	300,000	400,000	500,000	1,000,000	
October 20–25	d	d	$\frac{1}{2}$d	vfd	vfd	g	$\frac{1}{2}$d
January 4–9	d	vfa	$\frac{1}{2}$d	vfd	vfd	g	g

Effect of various concentrations of copper sulphate upon different forms of algæ—Cont'd.

GROUP 1—Continued.

SCENEDESMUS QUADRICAUDA (Turp.) Breb.

Date.	One part copper sulphate to water, parts—						Check.
	100,000	200,000	300,000	400,000	500,000	1,000,000	
September 14–18	d	d	vfa	½d	g	g	g
December 7–12	d	vfa	vfa	¼d	g	g	g
January 11–15	vfa	vfa	vfa	¼d	g	g	g

EUGLENA VIRIDIS Ehrb.

Date.	One part copper sulphate to water, parts—						Check.
	100,000	200,000	300,000	400,000	450,000	500,000	
September 21–25	d	vfa	vfa	⅔d	½d	g	g
October 26–30	vfa	vfa	vfa	¾d	½d	g	g
December 31–January 2	vfa	vfa	vfa	½d	½d	g	g

SPIROGYRA STRICTA (E. Bot.) Wille.

Date.	One part copper sulphate to water, parts—						Check.
	50,000	75,000	100,000	200,000	500,000	1,000,000	
December 26–30	d	vfa	¾d	g	g	g	g

GROUP 2.

CONFERVA BOMBYCINUM Ag.

Date.	One part copper sulphate to water, parts—						Check.
	50,000	100,000	300,000	500,000	1,000,000	2,000,000	
October 1–4	d	d	d	d	d	g	g
October 8–11	d	d	d	vfa	vfa	g	g
October 13–17	d	d	d	vfa	vfa	g	g

CLOSTERIUM MONILIFERUM (Bory) Ehrb.

Date.	One part copper sulphate to water, parts—					Check.
	25,000	100,000	500,000	1,000,000	2,000,000	
December 14–18	d 12hrs	d 24hrs	d	d	½d	g

SYNURA UVELLA Ehrb.

Date.	One part copper sulphate to water, parts—						Check.
	250,000	500,000	666,666	750,000	1,000,000	2,500,000	
March 14	d 5–25min	d 15–30min	d 15–45min	d 15–60min	d 28–60min	g at 1hr	g at 1hr
March 18	d 5–25min	d 15–30min	d 15–45min	d 15–60min	d 28–60min	g at 1hr	g at 1hr

Effect of various concentrations of copper sulphate upon different forms of algæ—Cont'd.

GROUP 2—Continued.

ANABÆNA CIRCINALIS Raben.

Date.	One part copper sulphate to water, parts—						Check.
	50,000	100,000	500,000	1,000,000	3,000,000	5,000,000	
December 26–29	d	d	d	d	½d	vfd	g
January 4–7	d	d	d	d	¼d	vfd	g

ANABÆNA FLOS-AQUÆ Breb.

Date.	One part copper sulphate to water, parts—						Check.
	50,000	100,000	500,000	1,000,000	3,000,000	5,000,000	
July 12–14	d 12hrs	d 24hrs	d 24hrs	d 36hrs	d 72hrs	½d	g
August 27–29	d 12hrs	d 24hrs	d 24hrs	d 36hrs	d 72hrs	½d	g

GROUP 3.

UROGLENA AMERICANA Calk.

Date.	One part copper sulphate to water, parts—				Check.
	1,000,000	2,500,000	5,000,000	10,000,000	
March 19, 1903	d 3–5min	d 16hrs	vfa 16hrs	vfa 16hrs	g

The foregoing tables clearly demonstrate the effectiveness of copper sulphate as an agent for the destruction of algæ, and as the cost for an amount of this salt necessary to make the strongest solution required will not exceed from 50 to 60 cents per million gallons, but one condition remains to be satisfied—that it shall be absolutely harmless to man, domestic animals, and fish under the conditions used.

In general, animal life is less susceptible to injury by copper than is plant life, though most of the higher plants, some of the fungi, and, as the preceding tables show, certain algæ will live in concentrations of copper sulphate that would be fatal in a few hours to fish and frogs. The critical concentration for game fish is higher than that for such fish as carp and catfish. Black bass in good condition have endured concentrations of 1 to 50,000 for many weeks with no apparent discomfort, while 1 to 100,000 was sufficient to kill German and mirror carp in a few hours, and 1 to 500,000 killed the most susceptible in a few days. Mud catfish are affected at practically the same concentration; goldfish at slightly greater, while yellow perch are perhaps less susceptible than goldfish. This agrees with the results of Perry and Adams,[a] who state that minnows and goldfish live indefinitely in a 1 to 200,000 solution.

[a] Perry & Adams, 4th Rept. River Polnt. Conn., 2: 377–391.

The effects of copper upon the higher animals have been studied by a large number of investigators, and the following results may be appropriately cited:

Metallic copper and its oxides, mixed with sugar, albuminoids, and fats, had no noticeable effect upon dogs; even 8 grams of fine powder (4 grams each of copper monoxide and dioxide) caused only a slight sickness. Verdigris in small amounts produced none of the violent results it is supposed to cause in man. Soluble salts of copper can be given in quantities up to 1 gram daily, but more than this has a fatal effect.[a]

Dogs that had eaten half a gram of copper acetate per day for 24 days suffered but slightly; one dog was unaffected by doses as high as 5 grams at a time.[b] Similar results were obtained by Du Moulin,[c] who gave dogs and rabbits as much as 3 to 5 grams, causing sickness but in no case death, and Hippolyte Kuborn[d] states that a dog can take 4 grams of copper sulphate with but slight effect.

Ellenberger and Hofmeister[e] experimented with sheep, giving them from 18 to 182½ grams of copper in quantities sometimes as large as 2 grams per day, with fatal results. Tschirsch[f] deduced from this that the nontoxicity of weak solutions of copper does not hold for ruminants, but this seems hardly warranted. Two grams per day can scarcely be considered a small amount, yet one sheep lived 53 days and the other 128.

Ever since copper compounds have come into general use as fungicides, the question as to their effect upon the human system has received more or less attention.[g] At times there have been vague and misleading statements in the public press, calculated to alarm those who are in the habit of using vegetables and fruits which have been subjected to treatment with Bordeaux mixture. The popular belief seems to be that copper is a poison, but it is found upon examination that the very best authorities are by no means agreed upon this point. It is true that after the question had been discussed for seven months before the Belgian Royal Academy of Medicine, in 1885, it was finally decided that copper compounds in foods were harmful, but it should be remembered that in the whole discussion, where every effort was made by one side to show that copper was an actual poison, not a

[a] Burcq & Ducom, Journal de Pharmacie et Chimie, **25**: 546, 1877.

[b] Galippe, Journal de Pharmacie et Chimie, **23**: 298.

[c] Du Moulin, Journal de Pharmacie et Chimie, **5**: 189.

[d] Hippolyte Kuborn, Congrès Internationale d'Hygiène, **2**: 216, 1878.

[e] Ellenberger and Hofmeister, Archiv für wissench. u. prakt. Thierheilkunde, **9**: 325, 1883.

[f] Tschirsch, Das Kupfer vom Standpunkte der gerichtlichen Chemie, Toxicologie und Hygiene, Stuttgart, 1893.

[g] Spraying Fruits for Insect Pests and Fungous Diseases, with a Special Consideration of the Subject in Its Relation to the Public Health. U. S. Department of Agriculture, Farmers' Bulletin No. 7, 1892. See also Bull. No. 6, Div. Veg. Path., U. S. Dept. Agric.

single instance was given of injury to health resulting from the daily absorption of a small quantity of copper. On the other hand, many instances were cited where foods containing copper in considerable amounts were used without producing any harmful effect whatever. It should be noted also that the law prohibiting the use of copper in regreening fruits was repealed by the French authorities after the discussion before the Belgian Academy.

According to Thiemann-Gartner,[a] chronic copper poisoning has never been proved. The supposed copper colic was discussed by Burcq[b] before the Congrès Internationale d'Hygiène in 1878, and declared by him to have no existence; he even went so far as to assert an immunity against cholera for the workers in copper during various epidemics at Paris, Toulon, Marseilles, and elsewhere, but this statement he afterwards modified with reference to the epidemic of 1832. The good health of copper workers is also noted by Houlès and Pietra-Santa,[c] though they do not claim for them immunity from typhoid and cholera. Gautier[d] states that persons working in dye factories, where the hands, faces, and even hair were colored green by copper, were physically unaffected, which is true also of copper turners, who remain apparently in the best of health although constantly in an atmosphere highly charged with copper dust.

A considerable number of experiments have been made to determine the effect of copper upon man when taken into the intestinal tract. For fourteen months Galippe[e] and his family used food cooked and cooled in copper vessels, the amount of copper present in the food being sufficient to be easily determined. Kobert's experiments[f] show that a 60-kg. man can take 1 gram of copper per day with perfect safety. From his own results Lehmann[g] considers that copper to the amount of 0.1 gram in vegetables may produce bad taste, nausea, possibly colic and diarrhea, but nothing more serious. He has himself found peas containing as much as 630 mg. of copper per kilogram not distasteful, and 200 mg. consumed at a single meal was without effect. A very careful and thorough series of tests have shown that some individuals, at least, can take copper even to the amount of 400 to 500 mg. daily for weeks without detriment to their health.

Tschirsch[h] finds that 0.01 to 0.02 of copper (0.039 to 0.078 of copper sulphate) in dilute form have no effect; 0.05 to 0.2 causes only vomiting and diarrhea.

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[a] Thiemann-Gartner, Handbuch und Beurtheilung der Untersuchung der Wasser, Braunschweig, 1895.

[b] Burcq, Congrès Internationale d'Hygiène, **1**: 529, 1878.

[c] Houlès and Pietra-Santa, Journal de Pharmacie et Chimie, 5th Ser., **9**: 303.

[d] Gautier, Le Cuivre et le Plomb, Paris. 1883.

[e] Galippe, Compt. Rend., **84**: 718.

[f] Kobert, Lehrbuch der Intoxicationen. (Original not consulted.)

[g] Lehmann, Münch. Med. Wochensch., **38**: 603.

[h] Tschirsch, l. c.

The process of regreening legumes is described by Bouchardat and Gautier,[a] showing the amount of copper thus introduced into the vegetables to be too small to produce any injurious effect. The maximum amount of this metal in regreened peas as given by Gautier[b] is 125 mg. per kilogram, in connection with which he notes that Chatin and Personne have given it as 270 mg. According to Gautier, the amount of copper ordinarily consumed in a full meal is 95 mg.

Lafar[c] attributes the green color of Lodisan and Parmesan cheese to the presence of copper, giving the maximum amount for Lodiśan cheese as 215 mg. per kilogram. Chocolate[d] contains 0.005 to 0.125 gram per kilogram, cafe bourbon[e] 8 mg. per kilogram, and beef 1 mg. per kilogram. There is 0.01 gram of copper sulphate in 1½ pounds of bread,[f] 0.1 gram of copper oxide has been found in 1 kilogram of preserves, and similar amounts are normally present in a large number of commodities used for food.

Medicinal uses of copper compounds are cited by Du Moulin.[g] He has prescribed 12 to 15 cg. for scrofulous children, for cases of ophthalmia, etc., and found no ill effects. Copper sulphate in doses of 40 to 50 cg. for four or five days has proved beneficial to children with diphtheria.

Summarizing from a large number of experiments, Bernatzik[h] concludes as follows: After entering the stomach only small quantities of copper are absorbed by the blood, and toxic action occurs only when the necessary amount can accumulate in the circulation. Silver, copper, and zinc have almost the same medicinal properties, the difference being of degree rather than kind. They differ markedly from other heavy metals, having no harmful effects upon the tissues, and producing no fatal functional injuries; hence they are not poisons in the same sense as are lead, mercury, arsenic, antimony, and phosphorus. Moreover, in the case of copper, after suspension of the dose the injured functions return to the normal.

It is evident that there is still a considerable difference of opinion among eminent authorities as to the exact amount of copper which may be injurious, but as a very conservative limit we may accept 0.02 gram as the amount that may with safety be absorbed daily. According to Merck's Index, the National Dispensatory, and the United States Dispensatory, the dose of copper sulphate for tonic and astrin-

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[a] Bouchardat and Gautier, Congres Internationale d'Hygiene, **5**: 486.

[b] Gautier, l. c.

[c] Lafar, Technical Mycology, 159.

[d] Duclaux, Bull. de la Soc. Chim. de Paris, **16**: 35.

[e] Sargeau, Jour. de Pharm., **18**: 219, 654; **16**: 507.

[f] Tschirsch, l. c.

[g] Du Moulin, Journal de Pharmacie et Chimie, **13**: 189.

[h] Bernatzik, Encyclop. d. ges. Medicin., **11**: 429; Encyclop. d. ges. Heilkunde, **11**: 429.

gent purposes is one-fourth grain, or 0.016 gram; as an emetic, a dose of five grains, or 0.33 gram. Thus it is seen that even if the maximum concentration of copper sulphate necessary to destroy algæ in reservoirs were maintained indefinitely, the total absorption from daily use would be very far below an amount that could produce the least unpleasant effect. Taking a dilution of one to one million, which in all cases would be sufficient to prevent the growth of a polluting algal form, it would be necessary to drink something over twenty quarts of water a day before an amount which is universally recognized as harmless would be introduced into the system, while more than fifty quarts would have to be consumed before there would be danger of producing an unpleasant or undesirable effect. As will be seen from the preceding tables the use of copper sulphate at this maximum strength of one to one million would need to be resorted to only in extreme cases, and for a very short length of time, for, the reservoir once entirely free from the organisms, a very much weaker solution would be sufficient should any further application be necessary.

Perhaps the strongest argument in favor of using a chemical treatment of this kind is that even though enough copper should be added to a reservoir to make a one-millionth solution, nothing like this amount would appear in the water distributed. A very large percentage of the copper is combined with the algæ and precipitated in other ways, so that practically none would remain in solution after the first few hours.[a] Samples of water taken from a reservoir treated with sufficient copper sulphate to make a solution of one to one million, failed to show any reaction for copper after twenty-four hours, although all the algæ were killed. It is believed that the process used of evaporating down the original quantity and testing by the delicate potassium ferro-cyanide method would certainly have detected copper had it been present in the proportion of one to fifty million. Other tests were made by different chemists, but always with negative results.

In addition to the use of copper sulphate in reservoirs containing water to be used for domestic purposes, there are possibilities of its application in treating irrigation reservoirs, small pleasure lakes, fish ponds, oyster beds, etc. Here it may often be desirable to exceed the strength of solution that would represent the maximum required in a municipal water supply. This would be done not only to kill all the algæ, but to destroy or drive away reptiles and other pests, leaving the water perfectly clear and clean. The use of some such method for the destruction of mosquito larvæ also seems worthy of attention. The mere removal of the great mass of algal growths in stagnant pools undoubtedly reduces the number of larvæ by destroying this source

[a] Adsorption, according to True and Ogilvie (Science, N. S., 19: 421), would materially reduce the quantity of copper in solution. See also Bull. No. 9, Veg. Phys. and Path., U. S. Dept. Agric.

of their food and depriving them of protection from fish and other enemies. This is probably the explanation of the reported[a] decrease in the number of mosquito larvæ after spraying a lily pond with Bordeaux mixture, although it is possible that the strength of the solution used may have been partly responsible for their death. It is believed that it will not be impracticable to use the amounts of copper sulphate necessary to actually destroy such larvæ. Certainly this method if effective offers considerable advantages over any now in use, and it should be thoroughly tested. Cooperative experiments are now under way with the Bureau of Entomology to determine the strength of solution necessary to kill larvæ of different species and ages under various conditions.

METHOD OF APPLYING THE COPPER SULPHATE.

The method of introducing the copper sulphate into a water supply is extremely simple. Though any plan will suffice which distributes the copper thoroughly, the one recommended and used by the Department of Agriculture is as follows: Place the required number of pounds of copper sulphate in a coarse bag—gunny-sack or some equally loose mesh—and, attaching this to the stern of a rowboat near the surface of the water, row slowly back and forth over the reservoir, on each trip keeping the boat within 10 to 20 feet of the previous path. In this manner about 100 pounds of copper sulphate can be distributed in one hour. By increasing the number of boats, and, in the case of very deep reservoirs, hanging two or three bags to each boat, the treatment of even a large reservoir may be accomplished in from four to six hours. It is necessary, of course, to reduce as much as possible the time required for applying the copper, so that for immense supplies with a capacity of several billion gallons it would probably be desirable to use a launch, carrying long projecting spars to which could be attached bags each containing several hundred pounds of copper sulphate.

In waters that have a comparatively high percentage of organic acid it is sometimes advisable to add a sufficient amount of lime or some alkali hydrate to precipitate the copper. The necessity for this will never occur in a limestone region, as in this case there will always be enough calcium hydrate or carbonate to cause the desired precipitation. The precipitation of copper does not mean the destruction of its toxicity, for experiments conducted in this laboratory have confirmed Rumm's[b] results that the insoluble salts of copper, such as the hydrate, carbonate, and phosphate, are toxic only if they are in contact with the cell, but are highly toxic in that case. In this connection it should be mentioned that Hedrick[a] has described a method for con-

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[a] Hedrick, Gardening, **11**: 295. [b] Rumm, l. c.

trolling the growth of algal scum in lily ponds by the use of Bordeaux mixture which seems to have been temporarily effective. However, the impracticability of using such a mixture is apparent for the destruction of microscopic algæ distributed through a reservoir or a lake containing millions of gallons.

PRACTICAL TESTS OF THE METHOD.

WATER-CRESS BEDS.

The first practical test of the treatment of water for the purpose of killing out extensive growths of algæ was made in the fall of 1901 near Ben, Va., in connection with the cultivation of water cress for market. Water cress is grown there, as well as in other parts of the country, in large quantities during the winter, it being a valuable crop at that season of the year. The cress is confined in beds made by constructing dams across a small stream, which maintains a water level not too high for the growth of the plants and yet permits flooding when there is danger of a freeze. In the locality where the experiments were carried on the water was obtained from a thermal spring with a temperature the year around of about 70° F. Such a temperature was particularly favorable to the development of *Spirogyra* and similar filamentous algæ, so that when the cress was freshly cut they frequently increased to such an extent as to completely smother out a large part of the young and tender plants. The only known remedy under such conditions was to rake out the water cress and algæ and reset the entire bed. This was an expensive method, however, besides being successful only about half the time. Consequently, it was very desirable to devise some means of preventing the growth of the algæ without injuring the water cress, and the treatment by means of copper suggested itself. At first a strong solution of copper sulphate was used, spraying it on the algal covered surface of the beds, but this only destroyed the few filaments with which the copper came in contact, the large mass of algæ being practically unaffected. The method of applying the copper by means of dissolving it directly in the beds was next tried, and the success of the treatment was almost immediately evident. In this case the amount of copper added was about equal to a strength of 1 to 50,000,000 parts of water, but it is probable that by the time it reached most of the *Spirogyra* it was considerably weakened, as it was impossible to prevent a slight current of fresh water from passing through the beds at all times.

The success of the copper treatment for eradicating algæ from cress beds has been thoroughly demonstrated, and there is no reason why growers should have trouble from this cause in the future. The strength of the solution used for killing the algæ is so very much weaker than that which might affect the cress that there is no possible danger of injuring the latter if the solution is used by anyone capable of observing ordinary care. The question of how long a treatment is effective must, of course, depend upon conditions, but it is believed that the application of the proper amount of copper once or twice a year will in most cases be sufficient to keep down any algal pest. The manager of the Virginia Cress Company writes, under date of April 12, 1904:

> The "moss" has given me no trouble at all this winter. In fact I have for six months only had to resort to the copper sulphate once. * * * All the conditions were favorable last fall and early winter for a riot of "moss," but it did not appear at all until just a few days ago, and then yielded to treatment much more readily than it did when I first began to use the copper.

WATER RESERVOIRS.

The successful elimination of algæ from the cress beds of the South, under conditions which were particularly favorable to the growth of these pests, made it desirable that experiments be inaugurated calculated to demonstrate the possibility of ridding water reservoirs of the disagreeable odors and tastes caused by similar organisms. While it was realized that the popular prejudice against any chemical treatment of drinking water was strong, it was believed that the very weak solution, together with the very rapid disappearance of the salt added, would not render it a prohibitive method when applied under the direction of the proper authorities. It was also found that consumers of a water which possessed a disgusting odor and taste were not so prejudiced against the use of even a chemical method of extermination, provided it could be proved that no bodily harm would result.

In the spring of 1903 there was brought to the notice of the Department the supply of a water company in Kentucky, which promised to furnish a most satisfactory test. Ever since the construction of their reservoir it had given off an unpleasant odor. For the first two seasons this was supposed to be due to decaying vegetation, but later years demonstrated the well-known "pigpen" odor due to algæ, and this increased from year to year until it was almost unbearable.

In July, 1903, when the trial was begun, the microscopical examination demonstrated an average of—

Anabæna	per cc..	7,400
Clathrocystis	do....	1,100
Eudorina	do....	200

There were about 25,000,000 gallons of water in the reservoir at the time of the experiment, and on account of the great number of blue-green algæ present it was decided to apply the copper at a strength of 1 to 4,000,000. About 50 pounds of copper sulphate was accordingly placed in a coarse sack and this, attached to a boat, was dragged over the surface of the reservoir, giving especial attention to the region which seemed to contain the greatest number of *Anabæna* filaments.

The decrease in the number of organisms as the result of this treatment during the next twenty-four hours was very decided. In two days the surface was clear and the water had lost its blue-green color, becoming brown, due to the dead organisms held in suspension. There was a slight increase in odor during the first two days after treatment, but this was followed by a gradual subsidence until it had entirely disappeared, not to appear again that season. The following list of counts made from surface examinations at one station illustrates what went on throughout the reservoir, and shows the almost immediate effect of a 1 to 4,000,000 solution of copper sulphate upon the number of filaments of *Anabæna flos-aquæ*. The treatment was made July 9.

	Filaments per cubic centimeter.
July 6	3,400
July 10	54
July 11	8
July 13	0
July 15	0
July 20	0

It remains to be seen what the condition will be during the coming summer, but it is believed it can never be any worse than at the time of treatment, and it is reasonable to suppose that there will be considerably fewer organisms this year than last. Even though an annual treatment of the reservoir prove necessary, involving a cost of from $25 to $50, the already great improvement in the quality of the water will certainly make it justifiable.

Other experiments of a similar character were carried on in different parts of the country with reservoirs of a capacity of from 10,000,000 to 600,000,000 gallons. While the results were all favorable, it is deemed best not to publish any detailed account until the effect of the treatment can be followed through another season. The summer of 1903 was cold and wet, and in some cases the decrease in the number of organisms may have been due to these factors. However, the several instances of the very sudden and rapid disappearance of forms which were present in tremendous quantity, without any reappearance, indicated that the treatment was most effective. Those in charge of these water supplies reported that they were well satisfied with the result.

EFFECT OF COPPER UPON PATHOGENIC BACTERIA.

TYPHOID.

The value of copper sulphate as an agent for the destruction of algæ polluting reservoirs suggests its use in cases where the organism is pathogenic. Since this salt is fatal to the algal growths, it seemed probable that it would also destroy bacteria, and that cholera germs and typhoid germs might succumb to its action.

The sterilization of public water supplies by chemical means has so far seemed an impossibility. Nearly every known substance has been tested, but the high concentrations required to produce the desired effect, the extreme toxicity of the agents, their cost, or the difficulty of application, have eliminated all but copper sulphate as a possibility for the present purpose. According to Semmer and Krajewski,[a] a 1 to 160 solution of this salt will inhibit action in infected blood, and septic bacteria can be destroyed with a 10 per cent solution. Bolton[b] says that 1 to 500 is toxic, but 1 to 1,000 permits the growth of cholera; 1 to 200 and 1 to 500, respectively, produce the same results with typhoid, and some of the spore-bearing forms are unaffected at 2 per cent. Green[c] gives 2½ per cent as the amount necessary to kill typhoid in two to twenty-four hours, and finds cholera only slightly less sensitive. Israel and Klingman,[d] however, find that almost infinitesimal amounts of copper in colloidal solution are fatal to typhoid, cholera, and *Bacillus coli*. There is considerable literature upon the use of copper sulphate as a disinfectant for clothing, bedding, cesspools, etc., but it is not necessary to review it at this place. Sternberg[e] found that its germicide power was decidedly superior to the corresponding salt of iron and zinc, and demonstrated that it destroyed micrococci from the pus of an acute abscess in the proportion of 1 to 200. He says, "This agent (cupric sulphate), then, is a valuable germicide and may be safely recommended for the disinfection of material not containing spores."

The high percentage of copper sulphate given by most of these authorities seems to preclude the idea of its practical use for the purpose desired. It should be remembered, however, that these investigators were working for a very different end, namely, to find concentrations destructive to bacteria in the presence of large quantities of albuminoid and fatty matter. Experiments conducted under similar circumstances have confirmed the above results, but the conditions obtaining in public water supplies are widely different. Here the amount of albuminoid matter is so small that the death point of the typhoid or cholera organism is lowered tremendously and very dilute solutions of copper are shown to be toxic. The tabulated results on the succeeding pages demonstrate this fact.

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[a] Semmer and Krajewski, Arch. f. exp. Path. u. Pharmakol., **14**: 139.

[b] Bolton, Rep. of Com. on Disinfectants, Am. Pub. Health Assn., 1888, p. 153.

[c] Green, Zeit. für Hyg., **13**: 495.

[d] Israel and Klingman, Virchow's Archiv., **147**: 293.

[e] Sternberg, Rep. Com. Disinfection, Am. Pub. Health Assn., 1888, p. 38. See also Infection and Immunity, New York and London, 1903.

Effect of copper sulphate upon Bacillus typhi at different temperatures.[a]

[Determination made in tubes of bouillon. + indicates growth after 48 hours' incubation; – indicates no growth.]

Duration of exposure to action of copper sulphate.	Temperature.	Check.	1 part copper sulphate to 100,000 parts of water.	1 part copper sulphate to 200,000 parts of water.	1 part copper sulphate to 500,000 parts of water.
	° C.				
2 hours	38	+	–	+	+
	28	+	+	+	+
	23.5	+	+	+	+
	14	+	+	+	+
	4	+	+	+	+
4 hours	38	+	–	+	+
	28	+	–	+	+
	23.5	+	(?)	+	+
	14	+	+	+	+
	4	+	+	+	+
6 hours	38	+	–	–	+
	28	+	–	+	+
	23.5	+	–	+	+
	14	+	+	+	+
	4	+	+	+	+
12 hours	38	+	–	–	+
	28	+	–	+	+
	23.5	+	–	+	+
	14	+	–	+	+
	4	+	(?)	+	+

[a] Experiment conducted in test tubes, each containing 5 cc. of sterilized water, portions of which had been previously treated with the desired amounts of copper sulphate. All tubes inoculated with a 3 mm. loop of a 24-hour culture of *B. typhi.*

Effect of copper sulphate upon Bacillus typhi cultures of various ages.[a]

[Determination made in tubes of bouillon. + indicates growth after 48 hours' incubation; – indicates no growth.]

Duration of exposure to action of solution of 1 part copper sulphate to 100,000 parts of water.	Culture 36 hours old.	Culture 24 hours old.	Culture 18 hours old.	Culture 12 hours old.	Culture 6 hours old.	Culture 3 hours old.
3 hours	+	+	+	+	–	–
6 hours	(?)	–	–	–	–	–
9 hours	–	–	–	–	–	–

[a] Experiment conducted in test tubes each containing 5 cc. of sterilized water, portions of which had been previously treated with the desired amount of copper sulphate. All tubes inoculated with a 3 mm. loop of a culture of *B. typhi* of the proper age.

Effect of copper sulphate on Bacillus typhi at different temperatures.[a]

[Determination made in Petri dishes.]

Duration of exposure to action of copper sulphate.	Temperature.	Check.	One part copper sulphate to 100,000 parts of water.	One part copper sulphate to 200,000 parts of water.	One part copper sulphate to 500,000 parts of water.
	° C.	*Colonies.*	*Colonies.*	*Colonies.*	*Colonies.*
2 hours	5	720	315	1,440	894
2 hours	38	1,260	0	312	917
5 hours	5	155	115	495	278
5 hours	38	37	0	9	21

[a] Experiment conducted in test tubes each containing 5 cc. of sterilized water, portions of which had been previously treated with the proper amounts of copper sulphate. All tubes inoculated with a 3 mm. loop of an 18-hour culture of *B. typhi.*

Effect of copper sulphate upon Bacillus typhi at room temperature.[a]

[Determination made in Petri dishes.]

Duration of exposure to action of copper sulphate.	Check.	One part copper sulphate to— 100,000 parts water.	200,000 parts water.	500,000 parts water.	1,000,000 parts water.	5,000,000 parts water.
		Colonies.	*Colonies.*	*Colonies.*	*Colonies.*	*Colonies.*
½ hour	1,650	5,481	2,376	2,751	2,646	3,645
1 hour	1,836	918	2,106	2,403	1,377	1,755
1½ hours	1,566	1,026	1,242	1,323	2,673	2,808
2 hours	1,485	864	1,296	2,835	2,430	3,024
2½ hours	999	243	1,620	1,185	2,727	2,106
3 hours	1,134	180	1,161	1,620	1,782	756
3½ hours	1,080	156	783	918	2,079	1,242
4 hours	783	108	972	1,998	1,836	1,458
8 hours	270	0	72	165	324	459
12 hours	297	0	14	12	213	105

[a] Experiment conducted in test tubes each containing 5 cc. of sterilized water, portions of which had been previously treated with the desired amounts of copper sulphate. All tubes inoculated with a 3 mm. loop of an 18-hour culture of *B. typhi*.

Effect of copper sulphate upon Bacillus typhi at room temperature.[a]

[Determination made in Petri dishes.]

Duration of exposure to action of copper sulphate.	No. 1. Check.			No. 2. One part copper sulphate to 200,000 parts water.			No. 3. One part copper sulphate to 100,000 parts water.			No. 4. One part copper sulphate to 50,000 parts water.			No. 5. One part copper sulphate to 100,000 parts water.		
	Colonies.			Colonies.			Colonies.			Colonies.			Colonies.		
	Bacillus typhi.	Molds.	Saprophytic bacteria.	Bacillus typhi.	Molds.	Saprophytic bacteria.	Bacillus typhi.	Molds.	Saprophytic bacteria.	Bacillus typhi.	Molds.	Saprophytic bacteria.	Bacillus typhi.	Molds.	Saprophytic bacteria.
0 hour	144	4	5	108	2	7	3	1	4	3,672	0	0	234	0	5
	792	2	4	90	1	4	198	1	5	5,742	1	1	306	0	0
3 hours	14,624	2	7	11	0	5	72	3	4	0	0	0	6	0	0
	16,212	0	0	126	0	2	6	0	0	4	0	1	4	1	0
4 hours	954	0	2	0	0	1	0	0	0	0	0	0	0	2	0
	558	3	31	0	0	0	0	0	0	0	0	3	0	0	0
6 hours	24,300	2	8	0	1	1	0	0	1	0	0	0	0	0	0
	19,400	0	0	0	1	5	0	0	0	0	0	3	0	1	1
8 hours	20,484	0	0	0	0	2	0	0	1	0	0	0	0	0	0
	19,674	0	0	0	0	0	0	0	3	0	0	2	0	1	0
12 hours	6,156	0	33	0	0	0	0	0	0	0	0	0	0	0	0
	21,600	0	0	0	0	0	0	0	0	0	0	0	0	0	0

[a] Experiment conducted in 12-liter aquaria. No. 1 was untreated; copper sulphate was added to Nos. 2, 3, 4, and 5. Three cubic centimeters of a mixture of cultures of *B. typhi* were added to each jar 18 hours before treating. All small nonliquifying colonies counted as typhoid.

Effect of copper sulphate upon Bacillus typhi at low temperature.[a]

[Determination made in Petri dishes.]

Duration of exposure to action of copper sulphate.	Temperature.	Check.	One part copper to 100,000 parts water.
	° C.	*Colonies.*	*Colonies.*
3 hours	5	2,187	1,944
6 hours	5	2,646	881
9 hours	5	1,026	702
12 hours	5	351	98
24 hours	5	37	0

[a] Experiment conducted in test tubes each containing 5 cc. of sterilized water, part of which had been previously treated with the desired amount of copper sulphate. All tubes inoculated with a 3 mm. loop of a culture of *B. typhi* of the proper age.

Effect of copper sulphate upon Bacillus coli cultures of various ages.[a]

[Determination made in tubes of bouillon. + indicates growth after 48 hours' incubation; — indicates no growth.]

Duration of exposure to action of solution of 1 part copper sulphate to 100,000 parts water.	Culture 36 hours old.	Culture 24 hours old.	Culture 18 hours old.	Culture 12 hours old.	Culture 6 hours old.	Culture 3 hours old.
3 hours	+	+	+	+	+	—
6 hours	—	—	+	—	—	—
9 hours	—	—	+	—	—	—

[a] Experiment conducted in test tubes each containing 5 cc. of sterilized water, part of which had been previously treated with the desired amount of copper sulphate. All tubes inoculated with a 3 mm. loop of a culture of *B. coli* of the proper age.

Effect of copper sulphate upon Bacillus coli at different temperatures.[a]

[Determination made in tubes of bouillon. + indicates growth after 48 hours' incubation; — indicates no growth.]

Duration of exposure to action of copper sulphate.	Temperature.	Check.	One part copper sulphate to— 100,000 parts water.	200,000 parts water.	500,000 parts water.
	° C.				
	38	+	+	+	+
	28	+	+	+	+
2 hours	23.5	+	+	+	+
	14	+	+	+	+
	4	+	+	+	+
	38	+	—	+	+
	28	+	+	+	+
4 hours	23.5	+	+	+	+
	14	+	+	+	+
	4	+	+	+	+
	38	+	—	+	+
	28	+	+	+	+
6 hours	23.5	+	+	+	+
	14	+	+	+	+
	4	+	+	+	+

[a] Experiment conducted in test tubes each containing 5 cc. sterilized water, portions of which had been previously treated with the desired amounts of copper sulphate. All tubes inoculated with a 3-mm. loop of a 24-hour culture of *B. coli*.

Effect of copper sulphate upon Bacillus coli at room temperature. [a]

[Determination made in Petri dishes.]

Duration of exposure to action of copper sulphate.	Check.	1 part copper sulphate to—				
		100,000 parts of water.	200,000 parts of water.	500,000 parts of water.	1,000,000 parts of water.	5,000,000 parts of water.
	Colonies.	*Colonies.*	*Colonies.*	*Colonies.*	*Colonies.*	*Colonies.*
½ hour	3,888	5,697	4,155	8,937	5,190	6,426
1 hour	3,456	2,295	1,755	2,700	3,483	2,160
1½ hours	2,592	2,565	1,755	2,403	1,377	1,873
2 hours	2,079	1,971	3,429	1,890	3,267	3,912
2½ hours	3,969	2,835	2,295	3,456	2,214	2,319
3 hours	2,457	1,701	1,242	3,834	2,106	3,078
3½ hours	1,566	1,404	2,295	1,431	2,025	3,240
4 hours	1,323	675	1,593	2,403	1,674	1,836
8 hours	1,107	96	459	1,026	513	1,728
12 hours	297	5	43	366	513	891

[a] Experiment conducted in test tubes, each containing 5 cc. of sterilized water, portions of which had been previously treated with the desired amounts of copper sulphate. All tubes inoculated with a 3 mm. loop of an 18-hour culture of *B. coli*.

Effect of copper sulphate upon Bacillus coli at low temperature. [a]

[Determination made in Petri dishes.]

Duration of exposure to action of copper sulphate.	Temperature.	Check.	1 part copper to 100,000 parts water.
	° C.	*Colonies.*	*Colonies.*
3 hours	5	2,700	2,673
6 hours	5	3,591	1,620
9 hours	5	2,403	1,215
12 hours	5	2,106	1,431

[a] Experiment conducted in test tubes each containing 5 cc. of sterilized water, part of which had been previously treated with the desired amount of copper sulphate. All tubes inoculated with a 3 mm. loop of a culture of *B. coli* of the proper age.

Effect of copper sulphate upon paracolon cultures of various ages. [a]

[Determination made in tubes of bouillon. + indicates growth after 48 hours' incubation; — indicates no growth.]

Duration of exposure to action of solution of 1 part copper sulphate to 100,000 parts of water.	Culture 36 hours old.	Culture 24 hours old.	Culture 18 hours old.	Culture 12 hours old.	Culture 6 hours old.	Culture 3 hours old.
3 hours	+	—	?	—	—	—
6 hours	—	—	—	—	?	—
9 hours	—	—	—	—	—	—

[a] Experiment conducted in test tubes each containing 5 cc. of sterilized water, part of which had been previously treated with the desired amount of copper sulphate. All tubes inoculated with a 3 mm. loop of a culture of paracolon of the proper age.

These tables show that *Bacillus typhi* is more sensitive to copper sulphate than is *coli*, that the para group are about equally sensitive, and that temperature has a very important bearing on the toxicity of the copper in solution. At room temperature, which is near the temperature of a reservoir in summer, a dilution of 1 to 100,000 is fatal to *typhi* in three to five hours; at 5° it requires twenty-four hours for complete destruction.

The results obtained were checked in three ways:

(1) Five cubic centimeters of each of the solutions to be tested, made up with filtered hydrant water and check tubes of the same water, were sterilized in test tubes. To each of these was transferred one 3-mm. loop of a bouillon culture of the bacillus. After the proper exposure, a 3-mm. loop of the inoculated water from each tube was transferred to a sterile bouillon tube with a corresponding number. These bouillon tubes were then incubated forty-six hours at 38°, the time and concentration of the agent required to prevent growth being noted.

(2) Instead of transferring to bouillon tubes from the inoculated water, the transfer was made to gelatine tubes, and plates were poured in 10-cm. Petri dishes, thus making it possible to estimate the reduction in the number of bacteria in concentrations not sufficient to prevent growth.

(3) Five 12-liter aquaria, two of which contained a high percentage of organic matter, also a large quantity of algæ and other aquatic plants, were inoculated, each with 3 cubic centimeters of cultures of *Bacillus typhi* of different ages, and allowed to stand eighteen hours, and two poured plates were made from each aquarium, the 3-mm. loop being used in all cases. To these aquaria were then added a 1 per cent solution of copper sulphate in sufficient quantity to produce the desired concentration. After the proper time had elapsed, another series of plates was made, this being repeated every two hours for a period of twelve hours.

The tests were made upon four distinct cultures of *Bacillus typhi*, designated respectively Wasserman, Stokes, Say, and Longcope, and except in the case of the aquaria series, upon *Bacillus coli* and some of the para forms. These organisms were obtained from the laboratory of H. K. Mulford & Co.

ASIATIC CHOLERA.

The method of procedure in determining the toxic concentration for *Microspira comma* (*Spirillum choleræ*) was identical to that employed in the case of *Bacillus typhi*. The tables on the next page show that the toxic limits of these two pathogenic organisms are very similar and that *Microspira comma* is slightly more sensitive to copper sulphate than is *Bacillus typhi*. To destroy the cholera germ requires about three hours in a 1 to 100,000 solution at a temperature above 20°. A longer exposure or a higher concentration is necessary to produce this result at lower temperatures.

Effect of copper sulphate upon Microspira comma at different temperatures.[a]

[Determination made in Petri dishes.]

Duration of exposure to action of copper sulphate.	Temperature.	Check.	One part copper sulphate to— 100,000 parts water.	200,000 parts water.	500,000 parts water.
	° C.	*Colonies.*	*Colonies.*	*Colonies.*	*Colonies.*
2 hours	5	1,866	1,100	566	3,366
	15	2,500	533	1,100	1,000
	26	3,500	3	100	733
	30.5	4,556	7	66	1,433
4 hours	5	1,533	133	13	766
	15	1,033	21	72	95
	26.5	1,033	0	6	11
	30.5	1,466	0	0	12
6 hours	5	2,000	32	9	700
	15	3,033	9	20	81
	26.5	3,600	0	166	533
	30.5	1,066	0	0	90

[a] Experiments conducted in test tubes, each containing 5 cc. of sterilized water, portions of which had been previously treated with the desired amounts of copper sulphate. All tubes inoculated with a 3 mm. loop of a 14-hour culture of *M. comma*.

Effect of copper sulphate upon Microspira comma at different temperatures.[a]

[Determinations made in bouillon tubes. + indicates growth after 48 hours' incubation; — indicates no growth.]

Duration of exposure to action of copper sulphate.	Temperature.	Check.	1 part of copper sulphate to— 100,000 parts water.	200,000 parts water.	500,000 parts water.
	° C.				
2 hours	17	+	+	+	+
	24.4	+	+	+	+
	30.5	+	—	—	+
4 hours	17	+	+	+	+
	24.4	+	—	+	+
	30.5	+	—	—	+
6 hours	17	+	—	+	+
	24.4	+	—	+	—
	30.5	+	—	—	—

[a] Experiment conducted in test tubes each containing 5 cc. of sterilized water, part of which had been previously treated with the desired amount of copper sulphate. All tubes inoculated with a 3 mm. loop of a 16-hour culture of *M. comma*.

It will be seen that the concentration of copper required is considerably greater than the maximum necessary for the destruction of algæ, and would, of course, be injurious to the aquatic animals normally present in a reservoir if it were allowed to act for any great length of time. Experiments in this laboratory have demonstrated, however, that the time necessary to remove *Bacillus typhi* is from three to four hours in summer, twenty-four hours in the coldest weather, and that under such conditions the solution does not injure fish and frogs or the common aquatic plants such as *Elodea*, *Myriophyllum*, and *Lemna*. To remove the copper at the desired time the method suggested in the preceding section in the case of acid and soft waters may be employed—that is, precipitate the copper by some soluble hydroxide or carbonate. This somewhat complicates the treatment, as it will be necessary to determine from the character of the water the amount of copper necessary to produce a solution of 1 to 100,000, as well as to estimate how much of the hydroxide or carbonate should be added. That such work be conducted under the constant and direct supervision of competent authorities is even more important than when treating for algal contamination.

COMPARISON OF EFFECT OF OTHER DISINFECTANTS.

A comparison of the effect of copper sulphate with certain other substances commonly used as disinfectants is instructive, and gives some idea of the great toxicity of this metal. Mercuric chloride (corrosive sublimate) is slightly more fatal to typhoid and cholera than copper sulphate acting at a lower temperature and in a shorter length of time. Carbolic acid, one hundred times as strong as the dilution found to be effective for copper sulphate, and acting eight times as long, failed to kill. The same is true of formalin used between fifteen and twenty times the strength of a 1 to 100,000 solution. Using one thousand times the amount of citric acid that would be used of copper sulphate produces death. Thymol is effective in six hours when used in a solution of 1 to 5,000, and naphthalene is five times weaker.

COLLOIDAL SOLUTIONS.

The preceding experiments have dealt with copper in solution as the salt of some acid. The effect upon water of metallic copper surfaces, producing the so-called colloidal solution of copper, deserves especial mention. As Nägeli, Galeotti, and Israel and Klingman have abundantly demonstrated, the slight amounts of copper thus brought into solution are highly toxic to many forms of algæ and bacteria.

The experiments carried on in this laboratory show that it is undoubtedly possible to exterminate *Uroglena* and some forms of *Spirogyra* by suspending in the water copper foil sufficient to give an area of about 1 sq. cm. to each 100 cc. of water. This would not be a practicable method of treating a reservoir, but it suggests the possibility of sheet copper being used as a preventive of pollution. By suspending large sheets of this metal at the intake of a reservoir, it is probable that conditions would be rendered sufficiently antagonistic to algal growth to maintain the sterility of a reservoir after it had once been thoroughly cleansed of polluting forms. It would, of course, be necessary to keep such copper sheets clean in order to prevent a reduction of the toxic action due to the formation of an insoluble or slimy coating on its surface. It is possible that some electrical method may be perfected for rapidly obtaining a strong colloidal solution, which will furnish a more convenient means of application than that of the crude salt.

In regard to the bacteria causing cholera and typhoid, the importance of the specific toxic effect of colloidal copper is probably much greater than with algæ. The following tables show the proportions of the area of copper to the quantity of water and to the time and the temperature necessary to produce the complete sterilization of water containing these pathogenic germs:

Effect upon Bacillus typhi of exposure to colloidal solution of copper at room temperature.[a]

[Determination made in tubes of bouillon. + indicates growth after 18 hours' inoculation; − indicates no growth.]

Duration of exposure to action of copper.	Check.	15 sq. mm. copper foil in 10 cc. of water.	100 sq. mm. copper foil in 10 cc. of water.	225 sq. mm. copper foil in 10 cc. of water.
10 hours	+	−	−	+
16 hours	+	+	−	−
20 hours	+	+	−	−
50 hours	−	+	−	−

[a] Experiment conducted in test tubes containing 10 cc. each of sterilized water. The copper foil was sterilized and added immediately before inoculating the tubes with the usual 3 mm. loop of a 24-hour culture of *B. typhi*. This experiment was duplicated with three separate strains of typhoid with identical results.

Effect upon Bacillus typhi of exposure to colloidal solution of copper at room temperature.[a]

[Determination made in Petri dishes.]

Duration of exposure to action of copper.	Check.	1 sq. cm. copper foil to 5 cc. of water.	4 sq. cm. copper foil to 5 cc. of water.
	Colonies.	*Colonies.*	*Colonies.*
½ hour	1,650	2,241	2,025
1 hour	1,836	1,944	2,349
1½ hours	1,566	1,620	1,188
2 hours	1,485	1,674	1,188
2½ hours	999	675	1,053
3 hours	1,134	972	918
3½ hours	1,080	1,242	621
4 hours	783	837	360
8 hours	270	216	0
12 hours	297	24	0

[a] Experiment conducted in test tubes, each containing 5 cc. of sterilized water. The copper foil was sterilized, and added immediately before inoculating the tubes with the usual 3 mm. loop of a 24 hour culture of *B. typhi*.

Effect upon Bacillus coli of exposure to colloidal solution of copper at room temperature.[a]

[Determination made in tubes of bouillon. + indicates growth after 48 hours' inoculation; — indicates no growth.]

Duration of exposure to action of copper.	Check.	15 sq. mm. copper foil in 10 cc. of water.	100 sq. mm. copper foil in 10 cc. of water.	225 sq. mm. copper foil in 10 cc. of water.
10 hours	+	+	+	+
16 hours	+	+	+	—
20 hours	+	+	+	—
50 hours	+	+	+	—

[a] Experiment conducted in test tubes containing 10 cc. each of sterilized water. The copper foil was sterilized and added immediately before inoculating the tubes with the usual 3 mm. loop of a 24-hour culture of *B. coli.*

Effect upon Bacillus coli of exposure to colloidal solution of copper at room temperature.[a]

[Determination made in Petri dishes.]

Duration of exposure to action of copper.	Check.	1 sq. cm. copper foil to 5 cc. of water.	4 sq. cm. copper foil to 5 cc. of water.
	Colonies.	*Colonies.*	*Colonies.*
½ hour	3,888	2,241	3,024
1 hour	3,456	1,971	2,025
1½ hours	2,592	1,512	2,754
2 hours	2,079	1,188	1,846
2½ hours	3,969	1,242	999
3 hours	2,457	1,242	1,593
3½ hours	1,566	1,026	2,727
4 hours	1,323	1,323	810
8 hours	1,107	702	69
12 hours	297	348	0

[a] Experiment conducted in test tubes, each containing 5 cc. of sterilized water. The copper foil was sterilized and added immediately before inoculating the tubes with the usual 3-mm. loop of a 24-hour culture of *B. coli.*

Effect upon paracolon of exposure to collodial solution of copper at room temperature.[a]

[Determination made in tubes of bouillon. + indicates growth after 48 hours' inoculation; — indicates no growth.]

Duration of exposure to action of copper.	Check.	15 sq. mm. copper foil in 10 cc. of water.	100 sq. mm. copper foil in 10 cc. of water.	225 sq. mm. copper foil in 10 cc. of water.
5 hours	+	+	+	+
10 hours	+	+	+	—
16 hours	+	+	+	—
20 hours	+	+	—	—
50 hours	+	+	—	—

[a] Experiment conducted in test tubes containing 10 cc. each of sterilized water. The copper foil was sterilized and added immediately before inoculating the tubes with the usual 3 mm. loop of a 24-hour culture of paracolon. This experiment was duplicated upon another form of paracolon with exactly the same results.

Effect upon paratyphoid of exposure to colloidal solution of copper at room temperature. [a]

[Determination made in tubes of bouillon. + indicates growth after 18 hours' inoculation; – indicates no growth.]

Duration of exposure to action of copper.	Check.	15 sq. mm. copper foil in 10 cc. of water.	100 sq. mm. copper foil in 10 cc. of water.	225 sq. mm. copper foil in 10 cc. of water.
10 hours	+	+	+	+
16 hours	+	+	+	–
20 hours	+	+	–	–
50 hours	+	+	–	–

[a] Experiment conducted in test tubes containing 10 cc. each of sterilized water. The copper foil was sterilized and added immediately before inoculating the tubes with the usual 3 mm. loop of a 24-hour culture of paratyphoid.

Effect upon Microspira comma of colloidal solution of copper at various temperatures. [a]

[Determination made in Petri dishes.]

Duration of exposure to action of copper.	Temperature.	Check.	½ sq. cm. copper foil to 5 cc. water.	2 sq. cm. copper foil to 5 cc. water.
	° C.	*Colonies.*	*Colonies.*	*Colonies.*
2 hours	5	1,866	833	2,500
	15	2,500	733	2,433
	26.5	3,500	4,600	333
	30.5	4,556	1,666	533
4 hours	5	1,533	52	29
	15	1,033	633	366
	26.5	1,033	200	0
	30.5	1,466	8	30
6 hours	5	2,000	700	10
	15	3,033	45	17
	26.5	3,600	300	0
	30.5	1,066	4	8

[a] Experiments conducted in test tubes, each containing 5 cc. of sterilized water, portions of which had been previously treated with the desired amounts of copper sulphate. All tubes inoculated with a 3 mm. loop of a 14-hour culture of *M. comma*.

It is evident that the amount of surface exposed in any ordinary copper tank would far exceed the amount demanded for the above results, and it is likewise certain that after standing from 6 to 8 hours at room temperature in a *clean* copper vessel water becomes safe to drink even though it may have contained cholera and typhoid germs. It remains to be seen whether or not the application of these facts to conditions in the Tropics, where cholera is abundant, will be of any value. It would seem that the construction of canteens and other water vessels from copper might serve as an additional safeguard, if not an actual preventive of this disease, and would prove of considerable value where distillation or efficient filtration apparatus is not at hand.

CONCLUSIONS.

It is believed that the foregoing experiments demonstrate the possibility of the use of copper sulphate for the destruction or prevention of growths of algæ in water supplies, and that when used under the direction of a competent authority, it is the only practicable remedy for this trouble capable of universal application which has ever been proposed. It is, of course, probable that with the experience which must come from a wider opportunity for testing this salt, many improvements will be made in the practical application of the treatment to large bodies of water. However, it is hoped that the results already obtained, together with trials now under way, will make it possible to begin using this method within a short time upon a large scale throughout the country.

NECESSITY OF KNOWLEDGE OF ORGANISM AND CONDITION IN RESERVOIR.

It can not be too strongly emphasized, however, that harmless as the method undoubtedly is under proper control, it must always require a certain amount of definite knowledge in regard to the condition of the reservoir before any treatment can be made, even by those thoroughly able to conduct such an experiment. This is regarded as a fortunate requisite, since it will tend to prevent the irresponsible or careless dosing of reservoirs by incompetents, who are occasionally in charge of water supplies.

Before the amount of copper to be added can possibly be known, it is absolutely necessary to ascertain the exact character of the organism causing the trouble. This will make a microscopical examination of the first importance. Also, the sooner such an examination reveals the presence of the polluting form, the more effective will be the treatment. If examinations are made at short intervals during the entire year, it is possible to detect the troublesome forms at their first appearance and by prompt treatment to destroy the algæ before the consumer is aware of any difficulty. The early detection of the algæ will also make a considerable difference in the expense of the treatment, as it may require fifteen or twenty times as much copper to clean a reservoir after the bad odor and taste are evident than it would could the application have been made before the organism began to rapidly multiply. In all cases the use of copper as a preventive rather than a cure is advocated, and this can not be intelligently applied unless the microscopical examinations are thorough and frequent at the time of year the trouble is to be anticipated.

On account of the necessity of determining the nature of the organism and the time of its appearance as nearly as possible, it will become as imperative for water companies to employ some one competent to make these examinations as it now is to have a chemist or bacteriologist. In fact, in regions where the difficulty from algæ is great, the microscopical examination must take precedence of everything else as a means of keeping the water palatable and satisfactory to the consumer.

In addition to the character of the organisms and the earliest possible determination of their appearance, it has already been pointed out that the chemical constitution, the temperature, and other special conditions of the water are factors in determining the line of treatment. No specific instructions are given in this bulletin for the amount of copper sulphate which is to be used for each species of algæ which is known to affect water supplies, because it is impossible to make a definite statement without a knowledge of the conditions already mentioned. *Each reservoir must be regarded as an individual case, requiring special knowledge and a particular prescription.* It is believed that the public water supplies of this country are worthy of such special care, and it would be a matter of regret if the method proposed here should ever be regarded as a universal panacea to be used by everyone, regardless of the organism to be eradicated and the condition of the water.

APPLICATION OF METHOD FOR DESTRUCTION OF PATHOGENIC BACTERIA NOT DESIGNED TO REPLACE EFFICIENT MEANS OF FILTRATION ALREADY IN USE.

The use of copper sulphate in clearing polluted reservoirs of pathogenic bacteria, such as typhoid and cholera, is regarded as incidental to the main purpose of the investigation. There already exists a most efficient means of preventing the appearance of these organisms in water supplies, and under no circumstances can it be considered that the method as described is expected to replace or supersede slow sand or any other efficient filtration. There are conditions, however, which sometimes make it desirable to thoroughly sterilize a reservoir, and under those circumstances the use of copper sulphate is believed to offer a new and adequate way of dealing with the difficulty. Experience has demonstrated the impossibility of compelling consumers of what may be an infected water to boil it, or observe other precautionary measures, and the absence of proper filtration plants in a very great number of cities and towns in this country makes it necessary that some efficient method for destroying disease germs in water be employed until the danger from pollution be past. Up to this time no satisfactory and yet harmless method has been known that would become effective in the course of a very few hours and the cost of which was in the reach of every community. It is believed that the results of the experiments upon typhoid and cholera germs described in this bulletin indicate that it will be possible under competent direction to employ copper sulphate with perfect safety in any municipal water reservoir which may have become infected with some nonspore-forming disease germ. Its application to barnyard tanks and pools as a preventive of hog cholera may also prove to be of value. Since the selective toxicity of this salt renders it fatal to pathogenic forms peculiar to water, while the common saprophytic or beneficial bacteria are unaffected, the method is particularly well adapted for this purpose.

MEDICINAL USE.

While it is not within the province of this bulletin to discuss or recommend any line of medical treatment, reference should be made to the fact that certain eminent practitioners, after reviewing the results here published, are of the opinion that the use of copper in cases of typhoid fever and related diseases should be more thoroughly investigated than it has been heretofore. It was the testimony of several that other intestinal troubles, more recently presumed to be due to the presence of certain disease germs in drinking water and milk, had responded most favorably to copper in one form or another.

CONDITIONS UNDER WHICH THE DEPARTMENT OF AGRICULTURE CAN FURNISH INFORMATION AND ASSISTANCE IN APPLYING THIS METHOD.

The problem of destroying or preventing the growth of algæ by the method devised in the laboratory of plant physiology in water reservoirs, lakes, ponds, water-cress beds, and wherever these plants have become a pest, is one which distinctly comes within the province of the Department of Agriculture. Definite instructions as to the treatment to be followed will at all times be furnished to the proper authorities who may desire assistance, and in so far as the limited facilities of the laboratory permit, determination will be made of the organisms causing the trouble. It is earnestly hoped that no tests of the method described here will be made without first consulting with the Department. Those most intimately connected with this work are constantly gaining information and experience, and this may prove of considerable value, besides a saving of expense, to those who have occasion to exterminate algal pests.

The treatment of water supplies for the destruction of pathogenic bacteria, or any application of the copper-sulphate method which has to do with public health, is not contemplated or indeed possible by this Department. The requests of private individuals or unauthorized bodies for information or assistance can not be granted. When State or local boards of health consider that the disinfection of a water supply is desirable and wish information upon the subject it will be supplied as fully and freely as possible. All experiments of this kind, however, must be conducted by the board of health, and the Department can serve only in the capacity of an adviser.

COST.

No definite estimate of the cost of the treatment of a reservoir can be given, because of the special conditions governing each case. It is evident, however, that the maximum cost of material for exterminating algæ can not exceed 50 to 60 cents per million gallons, and will often be less than half this amount. The cost for the copper-sulphate destruction of bacteria will be from $5 to $6 per million gallons, and where lime or some soluble hydrate is used in addition the cost would be increased about one-third. The cost of labor necessary to introduce these substances will be slight, since two men can usually treat from 10,000,000 to 20,000,000 gallons in less than three hours.

SUMMARY.

The importance of maintaining all public water supplies at the highest degree of purity and wholesomeness is too well recognized to require any discussion.

The disagreeable odors and tastes so often present in drinking water are due almost exclusively to algæ, although the economic importance of studying these plants has not been recognized until recent years.

These algal forms are widely distributed, and reservoirs in many States have been rendered unfit for use by their presence.

The methods now known for preventing or removing the odors and tastes caused by algæ have proved unsatisfactory, either because of prohibitive expense or failure to accomplish result.

It is therefore desirable that some new, cheap, harmless, and effective method be devised for ridding reservoirs of these pests.

It has been found that copper sulphate in a dilution so great as to be colorless, tasteless, and harmless to man, is sufficiently toxic to the algæ to destroy or prevent their appearance.

The mode of application makes this method applicable to reservoirs of all kinds, pleasure ponds and lakes, fish ponds, oyster beds, water-cress beds, etc. It is also probable that the method can be used for the destruction of mosquito larvæ.

At ordinary temperatures 1 part of copper sulphate to 100,000 parts of water destroys typhoid and cholera germs in from three to four hours. The ease with which the sulphate can then be eliminated from the water seems to offer a practical method of sterilizing large bodies of water, when this becomes necessary.

The use of copper sulphate for the prevention of disease is regarded as incidental and is not designed in any way to supplant efficient preventive measures now in use. It is believed, however, that up to this time no such satisfactory means of thoroughly, rapidly, and cheaply sterilizing a reservoir has been known. Since the selective toxicity of copper sulphate renders it fatal to pathogenic forms peculiar to water, while the saprophytic or beneficial bacteria are unaffected, the method is particularly well adapted for this purpose.

Definite knowledge in regard to what organisms are present, the constitution of the water, its temperature, and other important facts are necessary before it is possible to determine the proper amount of copper sulphate to be added. A microscopical examination thus becomes as important as a bacteriological or chemical analysis.

No rule for determining the amount of copper sulphate to be added can be given. Each body of water must be treated in the light of its special conditions.

The cost of material for exterminating algæ will not exceed 50 to 60 cents per million gallons and will usually be less. The destruction of pathogenic bacteria requires an expenditure of from $5 to $8 per million gallons, not including the cost of labor.

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U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY— BULLETIN NO. 65.
B. T. GALLOWAY, *Chief of Bureau.*

RECLAMATION

OF

CAPE COD SAND DUNES.

BY

J. M. WESTGATE,
ASSISTANT IN SAND-BINDING WORK.

GRASS AND FORAGE PLANT INVESTIGATIONS.

ISSUED JUNE 30, 1904.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1904.

BULLETINS OF THE BUREAU OF PLANT INDUSTRY.

The Bureau of Plant Industry, which was organized July 1, 1901, includes Vegetable Pathological and Physiological Investigations, Botanical Investigations and Experiments, Grass and Forage Plant Investigations, Pomological Investigations, and Experimental Gardens and Grounds, all of which were formerly separate Divisions, and also Seed and Plant Introduction and Distribution, the Arlington Experimental Farm, Tea Culture Investigations, and Domestic Sugar Investigations.

Beginning with the date of organization of the Bureau, the several series of bulletins of the various Divisions were discontinued, and all are now published as one series of the Bureau. A list of the bulletins issued in the present series follows.

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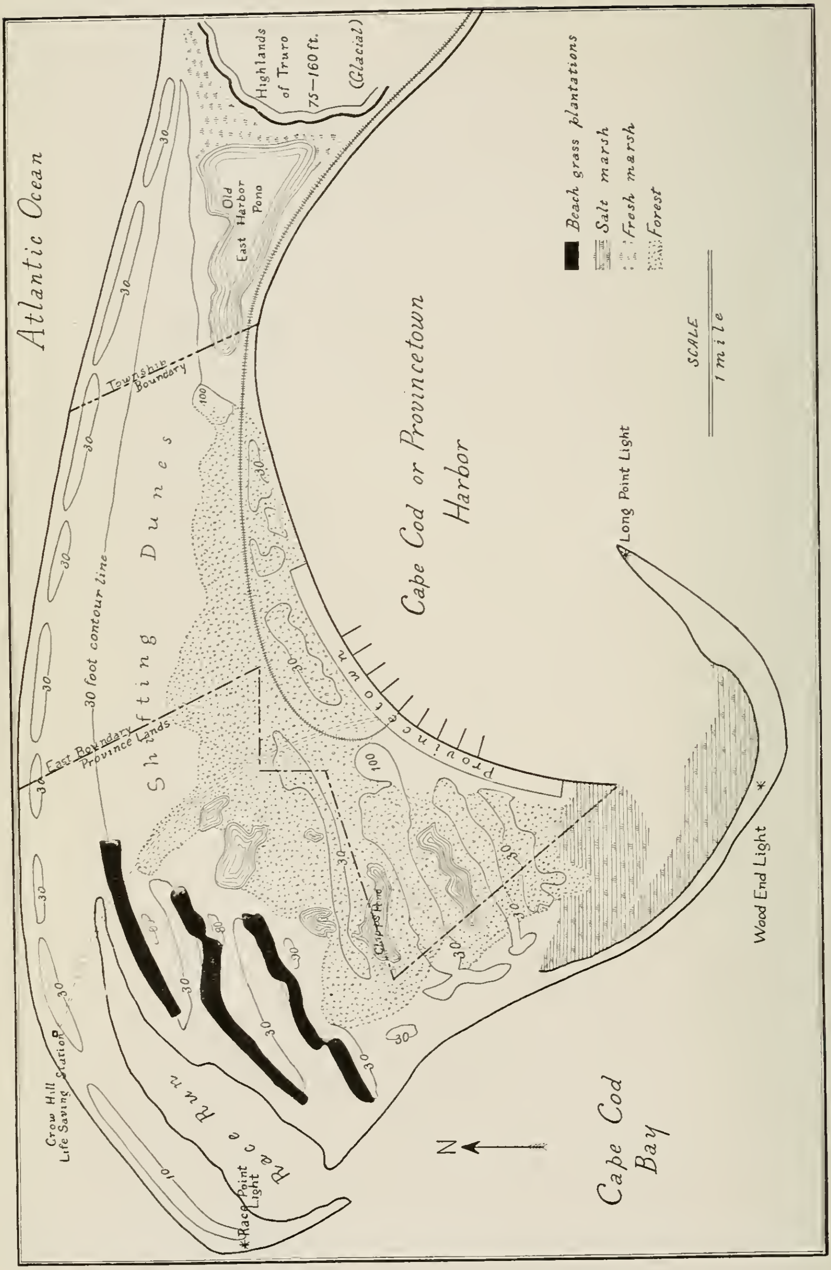
[Continued on page 3 of cover.]



MAP OF THE SAND AREAS INCLOSING CAPE COD HARBOR.

U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY—BULLETIN NO. 65.
B. T. GALLOWAY, *Chief of Bureau.*

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1904.

BUREAU OF PLANT INDUSTRY.

Beverly T. Galloway, *Chief.*

J. E. Rockwell, *Editor.*

GRASS AND FORAGE PLANT INVESTIGATIONS.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., May 10, 1904.

Sir: I have the honor to transmit herewith a paper on "Reclamation of Cape Cod Sand Dunes," and respectfully recommend that it be published as Bulletin No. 65 of the series of this Bureau.

This paper was prepared by Mr. J. M. Westgate, Assistant in Sand-Binding Work, Grass and Forage Plant Investigations, and has been submitted by the Agrostologist with a view to publication.

The six plates accompanying the paper are necessary to properly illustrate the text.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

PREFACE.

The extensive areas of sand dunes which surround Cape Cod Harbor furnish the best example that this country affords of the extensive utilization of beach grass for the binding of shifting sand which would otherwise cause great damage by its encroachment on valuable property. The harbor and city alike are endangered by the shifting dunes which have been encroaching upon them since the original devastation of the forests which formerly held the sands in check.

For a century and a half beach grass has been utilized for sand-binding work upon the cape by the Commonwealth of Massachusetts and by the General Government for the purpose of protecting Cape Cod Harbor, but it was not until 1893 that the State of Massachusetts put in operation the present extensive system of reclamation, which has proved so successful. The Province lands, upon which these plantings have been made, are owned by the State, and the work itself is under the immediate supervision of Mr. James A. Small.

Since these operations are proving so successful and the methods developed there are applicable in a large measure to other similar areas in this country, Mr. J. M. Westgate, Assistant in Sand-Binding Work, was authorized to visit Cape Cod for the purpose of investigating the details of the work now in progress, and to determine, as far as possible, the causes which led to the devastation, and also the measures which have at various times been taken looking to the reclamation of the shifting dunes. The results of the investigation are presented in this bulletin.

Acknowledgments are due the authorities having the reclamation work in charge for the courtesy shown to Mr. Westgate in providing every means to facilitate his investigations.

W. J. Spillman,
Agrostologist.

Office of the Agrostologist,
Washington, D. C., May 11, 1904.

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ILLUSTRATIONS.

RECLAMATION OF CAPE COD SAND DUNES.

INTRODUCTION.

The sand areas at the extremity of Cape Cod comprise approximately 6,000 acres, less than half of which is under the protection of forest covering. The city of Provincetown, with its extensive fishing and shipping interests, is built along a narrow strip of reclaimed land lying in the lee of the inner range of fixed dunes bordering the harbor. The peculiar shape and position of the city bring it into immediate peril should any destructive force be brought to bear upon the adjacent dune areas, or in case of the encroachment of the shifting dunes farther back but in line with the winter winds, which are by far the most efficient in sand movement. The harbor around a portion of which the city is built is even more endangered, as it is surrounded by the sand accumulations which have been washed around the head of the Cape, and the entire border on three sides is threatened with the possibilities of sand encroachment. Many houses now stand where a century ago small boats found convenient anchorage. In fact, certain areas have been filled in several hundred feet during the last half century. The value of the harbor thus endangered can hardly be overestimated. It is the home port of a large fleet of fishing vessels, while as a harbor of refuge its position, capacity, depth, excellent anchorage, and land-locked condition combine to render it one of the most important on the Atlantic coast. As many as 1,000 vessels are said to have been counted at one time in the harbor during the heavy gales which occasionally occur along the coast. The entire portion originally known as "East Harbor" has been rendered worthless by the encroaching sands, a fresh-water marsh marking its original site. Not only is the harbor of great commercial value, but in event of war its position is such as to render it of great strategic importance. During the civil war a portion of the extreme end of the Cape was ceded to the Government. Batteries were established and war vessels were at times stationed in the harbor.

The greater portion of the sand areas inclosing the harbor is owned by the State and designated "Province lands" (Pl. I). This enables the authorities to exercise a more effective surveillance than would be possible were the areas under private ownership.

The problem of controlling the drifting sands of the Cape has concerned the municipal, State, and National authorities for two hundred years, and the extensive planting of beach grass as a means of protection dates back for more than a century.

The physiographic and botanical phases of the subject presented are based upon the writer's personal observations and collections. The bibliography indicates the source of the historical features. Many of the details were derived from an examination of the statutes and town records, together with what could be deduced from local testimony and personal observation. The details of the early work of dune control were obtained from the records on file in the War Department, all the work of harbor protection on the part of the General Government having been under the supervision of that Department.

ECOLOGICAL RELATIONS OF THE VEGETATION.

Ecological Factors.

The ecological factors which are of the most importance in the consideration of the sand-dune areas are light and heat, wind, soil, and moisture. The low specific heat of the sand causes it to respond very quickly to any change of temperature in the surrounding medium. The sand becomes excessively hot on the side of the dune exposed to the direct rays of the sun and for the same reason the cooling process at night is quite as marked. The extremes of temperature incident to this condition are severe upon any form of vegetation and probably constitute the chief reason for the absence of many species which might otherwise be present. The oceanic location of the area tends to produce an equable climate. The thermometer rarely registers temperatures below 2° F. in winter or above 85° F. in summer, except immediately upon the bare sand areas, where the conditions are much less equable.

The wind is an important factor for several reasons. Its effect upon transpiration, especially when augmented by the high temperatures incident to the heated layers of air at the surface of the sand, is very marked. The distortions of the trees so often noticeable along the coast are not present, as the rejuvenescence of extensive forested dunes has destroyed the woody vegetation to beyond the limits of the injurious effect of the unbroken salt-laden winds. The bombardment by the sand which the wind hurls against the vegetation is especially severe. The presence of sand as large as wheat grains (one-eighth to one-sixth inch in diameter) in great quantities on the dunes testifies to the force of the winter gales which swept it there from the beach below. The force of this bombardment may be realized when walking across a dune area during a strong wind or by examining the effect of the sand blast upon the windward side of the exposed vegetation.

The action of the wind in shifting the sand and thereby either uprooting or burying the vegetation is one of the most obvious points to be noted in a shifting dune area. The heavy winter winds, usually from the northeast or northwest, are the most effective in shifting the sand and in preventing the existence of vegetation. A much more meager vegetative covering is present on the northern than on the southern slopes of the partially established dunes.

The isolated location of the area is such as to subject it to the unbroken force of the winds. The average hourly velocity of the wind for Nantucket, where records are accessible, is 11.7 miles per hour. Gale velocities of from 50 to 60 miles per hour are not infrequent, while velocities as high as 72 miles per hour have been recorded.

The soil of the entire area is largely reassorted glacial sand, at least 95 per cent of which is light-colored quartz.. The other constituents are principally magnetite, limonite, feldspar, schist, and garnet. The vigorous growth of the vegetation in the protected locations indicates that the sand is not as deficient in food salts as is sometimes supposed. The large size and angularity of the grains constitute the characteristic features of the Cape sands. It is noticeable that on the bare wind-swept slopes the dune sand has been swept away, leaving the coarser grains, which remain and act as a protective blanket, thus reducing the movement of the underlying sand by the wind.

The following table indicates the size of the two kinds of sand. No. 1 was taken from the surface of the windward slope of one of the dunes. No. 2 was taken from 8 inches beneath the surface of a typical dune and fairly represents the bulk of the Cape sands.

Diameter.	Sample No. 1.	Sample No. 2.
	Per cent.	*Per cent.*
6–2 mm	61.6	00.0
2–1 mm	27.9	16.8
1–0.5 mm	7.5	77.0
0.5–0.25 mm	0.0	5.2
0.25–0.05 mm	0.0	1.0

The moisture relations of the dune vegetation are unique. Though the upper layers of sand are usually hot and dry during the growing period except when rain is actually falling, the moisture comes to within a few inches of the surface, even during periods of protracted drought. The effect of a heavy rain is not noticeably different from that of a very light one, as in either case a few hours of sunshine suffice to remove all visible traces of the precipitation, most of which percolates at once to the lower layers of sand. For this reason the number of rainy days, which averages 96, is ot greater moment than the actual annual precipitation of 43 inches, which is sufficient under proper soil conditions to produce a luxuriant vegetation. The snows which might afford considerable protection to the vegetation of the sand stretches are blown off and lodged in the lee of the dunes or within areas covered with vegetation. The humidity incident to the oceanic location of the Cape acts in favor of the existing vegetation. The average annual rainfall is 42.58 inches. The accompanying table indicates the normal monthly precipitation as compiled from the normals for neighboring stations.

	Inches.		Inches.
January	3.90	July	2.89
February	3.39	August	3.62
March	3.98	September	2.91
April	3.41	October	4.00
May	3.62	November	4.38
June	2.74	December	3.74

The factor of associated vegetation or the interrelations of individuals and species is of little importance in areas of shifting sands. The conditions do not admit of a closed formation, that is, where the vegetation completely covers the ground, and it is only when this does finally obtain that the factor assumes an important rôle in the plant society.

Mode of Deposition of the Cape Sands.

The arm of the Cape extending around Cape Cod Bay consists of glacial deposits, with the exception of about 10 square miles which is composed entirely of post-Glacial sand which has subsequently washed around the head of the Cape from the south, inclosing the harbor within a sickle-shaped sand hook.

The addition of sand to the extremity of the Cape apparently takes place in the form of successive bars, which are built up off the north shore and added to the Cape by deposition in the neck of the channels lying to the east and south, forming successive "race runs" (Pl. I), which are gradually filled in by tide and wind deposits. The sand cast up by the waves on one of these new beaches is dried and blown inland, forming a beach ridge or foredune and eventually a dune range, which, protected by the succeeding deposits, ultimately becomes covered by the forest and associated vegetation.

The above hypothesis is supported by the following observed facts: (1) Four old dune ranges now forested but badly distorted by the long-continued action of the wind; (2) three dune ranges held only by beach grass and lying north of the first-mentioned ranges, parallel with them and also with the north shore of the Cape; (3) a race run (now nearly filled in) with its flanking beach ridge fast becoming a conspicuous foredune (Pl. I and Pl. II, fig. 1); (4) a bar in present process of formation offshore and to northward of the present shore line but parallel with it; (5) the seven dune ranges indicated constitute the main body of the extremity of the Cape; (6) the presence of shingle or coarse beach deposits underlying the dunes in places, and on the same level with the present beach.

If this be the method of deposition it follows that the necessity for sand fixation will never cease unless the sand supply for the shore drift becomes exhausted. However, the process of sand accumulation is so comparatively slow as to be of little importance when compared with the more serious conditions incident to the extensive areas of only partially reclaimed sand dunes.

Development of the Dune Range.

It is probable that each of the seven dune ranges which constitute the greater portion of the extremity of the Cape was developed in a similar manner, from the successive beach ridges and ensuing foredunes, by the accumulation of the sands blown up from the beaches. The vegetation has been an important factor in their formation, and although the intermediate stages between the foredune and the forested dune range are fragmentary the general sequence of events is evident.

As soon as the sand deposited by the waves is blown up to beyond the action of the tides the beach grass, associated with the typical strand vegetation, spreads rapidly over the surface and retards the movement of the resulting beach ridge. As the sand accumulations continue, the ridge becomes a foredune. The beach grass pushes its way up through the accumulating sand by the formation of new rootstocks, thus keeping the ever-increasing area of sand comparatively well covered, as the gradual addition of sand constitutes one of the essential conditions for the ideal growth of the grass (Pl. II, fig. 1). The foredune continues to rise and other species of plants come in, but ultimately a height is reached where the unbroken winds are of sufficient force to prevent the vegetation from holding the sand. At this stage the long foredune becomes a dune range and begins to move inland, covering the preexistent vegetation in its path (Pl. IV, fig. 1). The movement continues until the dune range is sufficiently removed from the unbroken force of the ocean winds to permit the development of a vegetative covering dense enough to prevent its movement. The forested condition ultimately dominates.

The development of the succeeding beach ridge and foredune may have been rapid enough to afford some protection to the preceding dune range, and thus hasten its fixation by the vegetation which would develop more rapidly under the protection afforded by the new foredune.

This beach ridge is of two possible origins. It may be formed from the normal sand accumulations cast up by the waves along the old beach, after the dune range migrates inland, or it may develop from the sand spit or bar which is added to the mainland as first indicated.

In either case it exerts the same protective influence on the inland vegetation. It may or may not remain stationary long enough for the forest in the lee to reach its farthest possible extension seaward before its rejuvenescence causes it to begin its migration inland.

The movement inland on the part of the newly formed dune range was probably never extensive, as there is little evidence of its having encroached upon the preceding range. However, the contour of each indicates that it was shifting to some extent before its fixation. It is quite probable that the ranges were never entirely bare, as the new accumulations of sand were not so rapid as to prevent the existence of a partial vegetative covering upon the dune range.

The devastating activities within historic times have destroyed any intermediate stages which may have existed between the foredune at present in process of formation on the north shore and the forested dune ranges which lie inland from the three dune ranges which have been devastated by human agencies. It is probable that the forest was never able to develop as far as the beach, owing to the exposure to the severe north winds. However, old forest beds outcropping in places among the unforested dunes demonstrate that the forest originally extended much farther seaward than it does at the present time.

Of the seven dune ranges constituting the body of the extremity of the Cape, only the inner four are at present forested. These are badly distorted, but were probably formed as has just been indicated, as the irregularities are not greater than could be reasonably postulated when the action of the wind during the interval of time which has elapsed since their formation is considered (Pl. I). These ranges are covered with a growth of pine and oak, with an occasional beech in the more favored situations. The outer three ranges are covered with scattering growths of beach grass. The depressions between the ranges are characterized by wild or partially reclaimed cranberry bogs and the associated vegetation. It is probable that all these ranges, with the possible exception of the outer one, were at one time forested, but have been brought to their present unstable condition within historic times.

Natural Reclamation.

The natural reclamation of sand areas may be observed in the study of the series of dunes in the various stages of fixation or establishment by the native vegetation. The forest which ultimately obtains is unable to develop directly upon the bare sand areas. There are certain definite stages that must be passed through before the mesophytic conditions incident to the forest are attained. The vegetation of each stage requires more favorable conditions than did that of its predecessor and at the same time is making the conditions possible for the existence of the vegetation which characterizes the succeeding stage. Even when the forest condition is reached the cycle is not complete, for the presence of the ultimate climax forest species is possible only after the continued existence of other species of trees has gradually rendered the soil, moisture, and protection sufficiently favorable for the development of the climax type. The ultimate forested condition is the same whether the original area be a salt marsh or a shifting dune, and the sand areas under consideration show several types of reclamation which differ in the initial stages.

AREAS RECEIVING GRADUAL ACCUMULATIONS OF SAND.

These areas are confined principally to the depositing beaches and are of less relative importance at the present time than formerly. The strand plants form a zone just above the action of the tides. The sea rocket (*Cakile edentula*), beach pea (*Lathyrus maritimus*), and cocklebur (*Xanthium echinatum*) may be mentioned as typical species. These strand plants are effective in retarding the sand which is blown inland from the beach. They also act as pioneers to the succeeding vegetation which dominates when the original area has become built up sufficiently far beyond the action of the tides to permit the development of another strand or beach formation below the one just indicated. Beach grass (*Ammophila arenaria*) is the dominant species, and extends itself to well within the limit of the wave action during the winter storms (Pl. II, figs. 1 and 2). This is associated with seaside golden-rod (*Solidago sempervirens*) and sand wormwood (*Artemisia caudata*).

The bayberry (*Myrica carolinensis*), wild rose (*Rosa lucida?*), and beach plum (*Prunus maritima*) may be taken as typical of the shrub vegetation which encroaches upon these areas from the wooded stretches lying inland. These, by their presence, increase the humus content of the soil and furnish the necessary protection for the development of the seedlings of the pitch pine (*Pinus rigida*) which soon extend themselves over the partially reclaimed areas. Later the oaks (*Quercus rubra* and *Q. velutina*) become associated with the pine, and in especially favored situations the beech (*Fagus americana*) ultimately dominates. The few areas which have reached this last stage present a somewhat unusual condition. As the beech represents the extreme mesophytic type of forest growth in the northeastern United States and normally grows only in the presence of the most favorable edaphic conditions of soil, moisture, and exposure, the development of the beech formation upon the sand dune is of rare occurrence. The great bulk of the present forest covering consists of the pine and oak, although the white birch (*Betula populifera*), white oak (*Quercus alba*), and red maple (*Acer rubrum*) are to be observed in the lower areas.

The undergrowth within the timbered area consists largely of ink berry (*Ilex glabra*) and huckleberry (*Gaylussacia resinosa*). The wintergreen or checkerberry (*Gaultheria procumbens*) forms an extensive substratum below the two species just mentioned, while the hog cranberry or bearberry (*Arctostaphylos uva-ursi*) forms extensive mats where the undergrowth of shrubs is more open. The two grasses, *Agrostis hyemalis* and *Danthonia spicata*, are abundant, forming scattered clumps throughout the open woodlands. Less important but characteristic species of shrubs and vines occurring in the forests are green brier (*Smilax rotundifolia*), bayberry (*Myrica carolinensis*), service berry (*Amelanchier botryapium*), Virginia creeper (*Parthenocissus quinquefolia*), dwarf blueberry (*Vaccinium pennsylvanicum*), and coast arrowwood (*Viburnum venosum*). Several species of wild rose are to be noted in the more open places in the forest and along its borders.

AREAS NOT RECEIVING GRADUAL ACCUMULATIONS OF SAND.

If, instead of receiving the gradual accumulations of sand, an area is subjected to the eroding action of the wind or at least fails to receive additions of sand, the early stages are quite different from those which characterize the areas just mentioned. The reclamation process at first is very slow, for the heavy winds frequently destroy the work of a whole season and the reduced vigor of the plants incident to the conditions renders the process of humus accumulation extremely slow. The beach grass as before is the pioneer and continues to occupy the area for some time, although not showing a thrifty growth. The poverty grass (*Hudsonia tomentosa*) formation gradually develops and often nearly covers the ground with its procumbent herbaceous stems. This condition continues for some time before there is sufficient humus accumulation for the next members of the cycle. At this stage the bearberry or hog cranberry (*Arctostaphylos uva-ursi*) appears and extends its mat-like evergreen growth over large areas. This is associated with such species as *Polygonella articulata* and *Corema conradii.* These are followed by the bayberry and the beach plum. The ensuing development is substantially that cited for the areas receiving gradual accumulations of sand, as when the formation becomes closed in the two instances there is no further opportunity for either the addition or removal of sand, and hence the initial differences no longer obtain.

As indicated above, the succession of stages from the accumulating beach to the forest was probably the one which characterized the development of the vegetation upon the original sand areas of the Cape. As the deposition of the sand was comparatively slow the vegetation was able to keep pace with the increments, thus preventing the existence of any extensive sand wastes. The devastating influences which have been brought to bear upon the forested dune areas within historic times have resulted in the extensive areas of loosely bound sands which, with the exception of the brows of the shifting dunes, are for the most part subject to wind erosion. This renders the latter system of natural reclamation most important at the present time. It may be doubted if this system of natural reclamation would be able to reforest the extensive wastes of sand were it not for the artificial reclamation processes which have recently been inaugurated.

MARSHES AND BOGS.

The accumulation of sand incident to the formation of the sand hooks or spits has caused considerable areas of salt marshes to be developed (Pl. I). The shifting sands have prevented the establishment of any natural drainage system, and as a result there are extensive areas of ponds and marshes between the dune ranges. These two processes have been the cause of the existence of extensive marsh and bog lands throughout the area. The sand hook which exists at the extreme point of the Cape inclosing the harbor is bordered by an extensive salt marsh. The typical marginal species is saltwort (*Salicornia ambigua*). The characteristic grasses of the salt marsh are the salt reed grass (*Spartina polystachya*) and the salt meadow grass (*Spartina patens*). These grasses constitute the bulk of the salt-marsh hay cut for the local market.

The salt marsh at the head of the old race run at the northwest corner of the sand areas is being gradually filled in by tide and wind deposits. The Salicornia-Juncus-Scirpus formation gives way to extensive areas of cranberry (*Oxycoccus macrocarpus*).

Clapps Pond, one of the fresh-water ponds and marshes lying between the dune ranges, presents over a considerable portion of its surface a sphagnum bog society. Among the characteristic species may be mentioned *Sphagnum acutifolium* (?), pitcher plant (*Sarracenia purpurea*), *Kalmia angustifolia*, and *Xolisma ligustrina*. The margins of the bog are shallow and are rapidly giving way to the encroaching forest. Young pitch pines were noted as extending for a considerable distance into the margin of the bog.

In the low, moist areas between the nonforested dune ranges the cranberry is dominant, occupying large areas to the exclusion of other species. These areas are surrounded by a scattered growth of *Cyperus grayi* and *Carex silicea*. The condition indicated is not permanent, for if undisturbed the woody growth eventually dominates to the exclusion of the above-named species and the forest condition ultimately develops. The improvement and utilization of the cranberry bogs often necessitate the removal of large numbers of bushes which are present as forerunners of the forest. The order of the succession of the woody plants is practically the same as that given for the other classes of sand areas, except that the beach plum is not conspicuous. It is these low areas that constitute the nuclei of the forests, as it is here that they first develop and then gradually extend to the higher areas. This fact, as will be mentioned under the development of cranberry bogs, constitutes the chief reason for the State's objection to the utilization of these areas for this purpose, as it retards the natural development of the forested condition desired by those who have the preservation of the harbor in mind.

While it is not probable that all of these low areas will ever become entirely forested, yet it is evident that this is the stage to which the low areas, as well as the dunes, are slowly trending. The recent reclamation processes will hasten this condition as the encroachment of the dunes has been checked.

Early Accounts.

The early accounts of the New England coast, dating back to the earliest French and English explorers, and possibly even to the Norsemen, essentially agree in their descriptions of the general outlines and forested condition of the Cape. The wooded area appears to have been much more extensive at those dates than at present, although there has always been, at least within historic times, more or less shifting sand exposed to the action of the winds. Champlain in one of his voyages described the Cape and named it Cape Blanc on account of the white color of its sand areas.

The old forest beds, now for the most part covered with sand, but outcropping in places, demonstrate that the wooded areas, at least three times, extended much farther toward the north side of the Cape than they do at present. The tree stumps visible at low tide near Wood End light-house substantiate the local tradition that the forest extended well out on to the extreme point of the Cape a century and a half ago. It is safe to say that at least three-fourths of the non-forested sand areas of to-day were well covered with trees within historic times. However, the devastation is not so marked as it was three-quarters of a century ago, at which time extensive reclamation processes were inaugurated.

DEVASTATION OF THE ESTABLISHED DUNE AREAS.

The principal causes of the rejuvenescence of the sand areas and the incident encroachment upon the forest were the pasturing of stock and the partial destruction of the forest covering. The early statutes show many instances where these practices were forbidden under heavy penalties. Much of the injury has been due to fires, as is evidenced by the charred stumps and charcoal beds which outcrop in places among the devastated dune areas.

The forests close to the harbor were naturally assailed at an early date by the inhabitants and shipmasters, who found the timber a convenient source of certain necessary supplies. The salt factories, which originally constituted an important industry on the Cape, used wood for fuel for evaporation purposes until the beginning of the last century when the more economical method of sun evaporation was introduced. This caused the destruction of large quantities of timber, as did also the extensive production of pitch and turpentine, and the use of the wood on the part of the inhabitants for fuel, fish flakes, ship repairs, and other purposes.

The pasturing of cattle upon the scattered clumps of *Agrostis hyemalis* and *Danthonia spicata* in the more open places in the forested area and upon the beach grass on the outer dune ranges appears to have been a very potent cause of much of the rejuvenescence.

The more recent devastating influences have been much less important. It is still the custom to cut certain areas of beach grass for hay. Until recently it was the practice to cure much of the marsh hay on the adjacent beach ridge which has been artificially built up by the Government as a harbor protection. This process resulted in the killing out of much of the beach grass by smothering it in event of rain, owing to the consequent nonremoval of the marsh hay. The removal of sods for reclamation work within the city limits has caused some concern to the authorities, as has also the utilization of the low areas for the production of cranberries, but, even in the aggregate, these activities are relatively unimportant when compared with the early devastation of the established dune areas.

Early Conditions Incident to the Devastation.

The conditions incident to the devastation of the forested areas appear to have been most severe about a century ago. Many of the houses were constructed on piles to allow the sand to sweep under rather than to accumulate and bury them. Large amounts of sand were artificially removed to prevent the burial of the houses. The sand blast was so severe at times as to completely etch the glass in the windows in a comparatively short space of time. At that time the road led along the beach at low tide and at high tide the travel was through the heavy sands farther up on the beach. The streets were of the same loose sand that everywhere abounded, and it is stated that it was not until the last century that a plank walk was constructed along one side of the principal street of the town.

The committee which was appointed in 1825 to investigate the conditions at Provincetown reported that the trees and beach grass had been cut down and destroyed on the seaward side of the Cape, allowing the sand to become loosened and driven in great quantities toward the harbor. The report also states that—

> The space where a few years since existed some of the highest lands of the cape, covered with trees and bushes, now presents an extensive waste of undulating sand.

The filling up and consequent destruction of that part of the harbor known as East Harbor was the work of the drifting sands to the northward, a fresh-water marsh now marking its original site. As an instance of the effects of the rejuvenated sand areas it may be stated that several once valuable farms situated along Stouts Creek, near Truro, have been covered with sand and to-day there is no trace of even the creek to indicate the location of the original properties.

Restrictive Legislation.

The devastated sand areas at the extremity of the Cape have been the object of State and local concern since the earliest days of its settlement. Accounts state that as early as 1703 local public measures were taken to prohibit the destruction of timber on the "East Harbor lands."[a] In 1714 the devastation incident to the boxing and barking of pine trees for the production of pitch and turpentine had become so extensive upon the sand areas at the extremity of the Cape as to be at that date prohibited by State statute.

It was originally the practice on the part of the inhabitants farther south along the Cape to allow a considerable number of cattle to range over the northern extremity. As the grass growing in the timbered areas was limited, the stock was forced to subsist to some extent upon the beach grass, which then as now covered considerable areas of the Cape sands. An act was passed in 1740 prohibiting this practice and providing for the impounding of the stock found at large upon the lands. In 1745 the destruction of timber within half a mile of the shore was prohibited under penalty. These acts, however, were not as effective as their framers had hoped and were reenforced at intervals.

In 1825 the devastation had become so extensive that commissioners were appointed by the State to investigate the conditions. Their suggestions resulted in an act to prevent the unrestricted pasturage of stock and the destruction of beach grass and woody growth either by pulling or cutting. The enforcement of this measure, together with the reclamation processes inaugurated at this time, materially reduced the devastation which at this period was probably the worst in the history of the Cape.

In 1838 Provincetown was required to elect annually a committee of three persons: (1) To enforce the existing laws regulating the Province lands; (2) to grant permits for the use of portions of these lands by

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[a] Massachusetts House Doc. 339, p. 49.

various inhabitants of the town when such use was not detrimental to the safety of the harbor or the town; (3) to enter any of the Province lands, inclosed or uninclosed, for the purpose of setting out trees or beach grass. The cost of the planting was to be defrayed by the occupant of the lands if the necessity for planting resulted from his actions; otherwise the town was authorized to provide for the expenses incident to the planting operations. This was known as the "beach grass committee," and it continued in existence until 1893, when the reclamation work by the State required the appointment of a superintendent on full time.

In 1854 an act, reenforced in 1869, was passed, appointing an agent to prosecute for the penalties prescribed for the destruction of the vegetation. He was authorized to issue permits for pasturage and the removal of sod and brush where the same would work no injury to the harbor or other property. The beach grass committee was continued with the indicated curtailment of its duties. This act became practically noneffective. With the extensive population so close to the public forests and only one person to defend them, it is not surprising that the removal of timber and sod should have proceeded almost without interruption. In 1891 the agent was paid for only five days' services and he issued but four permits. No attempt was made to prosecute parties for the removal of sod without a permit. This constitutes only another instance of the difficulty of enforcing a law in the face of opposing public sentiment.

In 1893 the inhabitants of Provincetown were ceded the lands lying within and adjacent to the city limits, the State retaining possession of what to-day constitutes the Province lands (Pl. I). A superintendent of the Province lands was appointed to look after the interests of the State and to take charge of the reclamation processes at that time inaugurated.

ARTIFICIAL RECLAMATION OF THE CAPE SANDS.

Early Work of Sand Control.

Although at as early a date as the beginning of the eighteenth century there was considerable local concern for the devastation of the sand dune areas, there does not appear to have been much work, other than legislative, actually performed until after the middle of the same century. It was at this time, when the sea broke through to the cove inlet in the arm of the Cape at East Harbor and threatened to destroy the entire Cape Cod Harbor, that the extensive planting of beach grass was commenced. This grass, used in connection with brush fences, repaired the break, and in the course of a few years caused extensive accumulations of sand. It appears to have been the practice upon the part of the inhabitants of Truro to devote a specified time each year to the planting of beach grass. The aggregate effect of this regular and combined effort was quite marked, although it is always difficult to estimate the results of measures more or less protective in nature. In 1826, as a result of the report of the commission appointed by the State the preceding year to investigate the devastation of the lands surrounding the harbor, the General Government inaugurated an extensive and systematic attempt at the reclamation of the exposed sand areas by the planting of beach grass.

The operations required appropriations extending over a period of twenty-eight years and aggregating the sum of $36,350. Of this amount it is reported that $29,889.06 was spent in planting 1,403 acres of the barren sand areas with beach grass. It was soon found that it was best to first plant the areas lying farthest to the windward, as these constituted the source of the sand and the spreading of the grass by seed over the unplanted areas would be facilitated. The actual planting operations were commenced in 1830, and the bulk of the plantings was made between this date and 1839. The grass was brought from Truro in boats and planted at intervals of from two to three feet, depending upon the exposure to the winds. Most of the grass was set with the aid of a shovel, two men working together, although in the low places a pike provided with a crossbar 15 inches from the point proved an excellent tool, as deeper planting was possible and but one man was necessary. This method was found to be impracticable in dry sand, as the small holes filled with sand before the sets could be inserted. Mr. Asa S. Bowly was the superintendent during the greater portion of the time. Spring planting was the rule, and about two hundred acres were planted each season, requiring a force of fifty laborers.

In 1852 the planting was resumed, this time for the purpose of strengthening the narrow arm of the Cape separating East Harbor from the ocean. At this time there was an abundance of grass within the old plantations available for transplanting, although the grass on certain areas had been buried, while in others it had been uprooted by the wind. As a rule the grass on the higher elevations had suffered the most and it was thought best to confine the plantings to the lower areas. The spreading of the grass was facilitated by prohibiting the pasturing of cattle upon the Province lands.

The General Government has spent to June 30, 1903, the sum of $162,019.86 for the protection of the harbor. Aside from the amount expended for grass planting, this has been used for dikes, bulkheads, and groin fences to catch and hold the sand in place. It has always been the practice to plant beach grass for the purpose of accumulating sand along the dikes and bulkheads, thus increasing the protection afforded by them.

The work of the State was principally confined to legislative acts until the recent work was begun in 1893. It should be stated, however, that in 1868 the sum of $131,770.14 was expended in the construction of a dike across East Harbor for the purpose of protecting the remaining portion of the harbor from the large quantities of sand which were carried out by each ebb tide. This dike greatly facilitates the travel southward from Provincetown and is utilized by the railway and State road. The city of Provincetown was authorized to levy taxes to cover the expenses incurred by its beach-grass committee, but an examination of the general records failed to reveal any considerable expenditures by the committee, which was nominally continued until 1893. The regular annual work on the part of the inhabitants of Truro in the planting of beach grass was probably a potent factor in reducing the evil effects of the shifting sand. The independent work on the part of private citizens was on a very small scale. In one instance a number of cranberry growers combined efforts for the purpose of planting beach grass to protect their bogs from the encroaching sand.

There are not sufficient data at hand to render possible a just opinion concerning the effectiveness of the early work of sand reclamation. The devastation is much less than when reclamation processes were commenced, but it is difficult to state to what extent the natural reclamation processes, unassisted save possibly by the restraining but poorly enforced statutes, are to be credited with the change in the conditions.

The grass plantations along the bulkheads, designed to accumulate sand for the protection of the harbor from the sea, have, without apparent exception, been successful. The plantings to restore the breach caused by the sea breaking over into East Harbor resulted in perhaps the greatest single success of any of the earlier operations. The fact that two-thirds of the nonforested areas were covered with beach grass by the end of the last century indicates that the early plantings were probably more lasting in their effect than has been supposed (Pl. IV, fig. 2).

One criticism made is to the effect that the planting was too much confined to the high hills, where it was without protection and as a result the grass was uprooted and destroyed. The statement concerning uprooting indicates that possibly the plantings were too thin, as the plantations recently made on the same exposed places have as yet shown little tendency to be blown out. Perhaps the most just criticism that can be made of the plan of operation is that the woody plants were not introduced within the grass plantations. The life of the beach grass on the areas not receiving regular accumulations of sand seldom exceeds ten years, a period of time which, however, suffices for the establishment of a self-protecting plantation of bushes and tree seedlings which require but little subsequent attention to render the reclamation permanent.

Recent Work by the State.

PRELIMINARY OPERATIONS.

The artificial reclamation which had been prosecuted with more or less vigor during the first half of the last century apparently received but little attention until 1892, when the trustees of the public reservations were authorized to submit all available information concerning the status of the sand encroachments and control, together with a comprehensive plan for the reclamation of the nonforested sand areas that threatened the harbor. The committee made a careful personal examination of the land and presented, with their general report, a stenographic transcript of the proceedings of a mass meeting of the representative citizens of Provincetown and Truro, who presented such information and suggestions as they were able to give concerning the historic features of the sand areas and the most practical steps to be taken for their reclamation. As a result of the trustees' report the Province lands were placed in charge of a permanently employed superintendent, Mr. James A. Small.

The State at this time relinquished its right to the lands within and immediately adjoining the city of Provincetown, leaving but 3,290 acres under State title. Of this area approximately 2,000 acres were nonforested.

Correspondence with various authorities revealed the fact that the initial operations would have to be more or less experimental, owing to the lack of data concerning the previous reclamation operations upon similar areas. Even the available details of the extensive grass plantations made upon the same areas in the early part of the century were purely matters of local tradition.

There was expended during the ten years ending January 1, 1904, the sum of $31,929.78 for the reclamation of these lands. The following itemized statement has been furnished by the authorities:

Beach grass planting	$10,950.00
Introduction of woody growth	6,011.78
Construction and maintenance of roads	6,250.00
Superintendence	6,000.00
Incidental expenses, including survey	2,718.00
Total	31,929.78

ATTEMPTS WITHOUT BEACH GRASS.

The three great dune ranges which lie between the timbered area and the north shore of the Cape were entirely bare upon their northern slopes, and were encroaching at the rate of 15 feet per year upon the forest and toward the city and harbor from a quarter of a mile to a mile distant (Pl. IV, fig. 1). The less exposed areas were partially covered with beach grass, while the lower places were dominated by native cranberry bogs, surrounded by the characteristic low-growing vegetation. As the bare northern slopes of the dune ranges constituted the source of the sand supply, the initial attempts involved the covering of these areas with vegetation.

Extensive plantings of shrubs and tree seedlings were made upon the outer range of dunes. The result was that the heavy winter gales of the first season buried, uprooted, or killed by the sand blast so great a portion of these plantings that some other method of procedure was considered necessary. The next season the transplanting of beach grass was commenced, as the experience of the preceding season had demonstrated that some protection for the woody plants is necessary until they have made sufficient growth to be self-protecting (Pl. V, figs. 1 and 2). The beach grass was selected for this purpose as it occurs very abundantly in places immediately adjacent to the areas which required planting and had been extensively utilized in the early reclamation attempts.

UTILIZATION OF BEACH GRASS.

Grass planting operations on each range commenced on the west end and were extended eastward with more or less regularity. The following table shows the salient points concerning the various plantings, which aggregate 219 acres. The mortality percentages were calculated from a number of counts in several representative areas within each season's planting. The mortality appears to have been less among the fall plantings.

Year.	Acreage planted.		Mortality of plantings, per cent.	
	Spring.	Fall.	Spring.	Fall.
1895	11	2	50	31
1896	12	4	61	38
1897	20	22	40	35
1898	3	17	22	11
1899	13	22	6	2
1900	4.5	15.5	4	2
1901	4	21	3	2
1902	1	20	1	1
1903	2	25	0	0
Total	70.5	148.5	....	....

RELATIVE MERITS OF SPRING AND FALL PLANTING.

The early plantings on the Province lands and the Cape generally were as a rule made in the spring, although many parties practiced fall planting. The plantings incident to the recent work of reclamation have been made for the greater part in the autumn. It is the consensus of opinion that better results follow fall planting for the following reasons: (1) In the fall the growth of the season is finished and plants are dormant for a considerable period of planting weather. (2) The new rootstocks appear to be more firmly attached than they are in the spring, and are consequently less liable to be broken off during the transplanting process. (3) The days are cooler and the incident evaporation less. (4) It is easier to distinguish prime planting stock, and the rooted nodes lying within a few inches of the surface of the sand may be readily removed by hand pulling; in the spring they are apt to be either buried or exposed by the action of the shifting sands. (5) There is an additional winter of effectual protection to be gained by fall planting, as the dormant sets suffer no deterioration the first winter.

The above table concerning the plantings of the different years and seasons shows a marked difference in favor of fall planting. However, the difference between the two seasons is so slight as to be offset by any practical reason why the spring season should be utilized for planting, as for instance the greater ease in procuring the labor or the necessity of finding nearly permanent employment for the help in order to keep it available when needed. In case the planting is extensive it can rarely be completed in one season, and the planting period is thus practically doubled if the spring as well as the fall season can be utilized.

SELECTING AND TRANSPLANTING THE SETS.

The plants selected for transplanting are vigorous and well rooted. This means in practice 2-year-old stock, as the year-old plants are not mature enough or sufficiently rooted to bear transplanting well, as do the older plants. If more than two years old the vitality is likely to be low. As a rule the 2-year-old plants may be readily pulled with the hand and still retain sufficient rootage to enable them to grow when transplanted (Pl. III, fig. 1). It should be mentioned that the hand pulling is not extensively practiced elsewhere in the country, it being the custom to use a spade or shovel in procuring the planting stock. The results indicate that it is largely a matter of opinion as to which method is the better. The plants are piled in bunches and carted to the place where the planting is in progress. Whenever they are to be exposed to the air for any length of time they are heeled in with a covering of moist sand over the roots.

When setting out the grass it is the custom for two men to work together (Pl. III, fig. 2). The one with a shovel inserts it in the sand as far as the foot can force it. A backward pull of the handle loosens the sand at the bottom of the hole, while a forward thrust produces a sufficient opening between the back of the shovel and the sand to allow the insertion of the plant by the second man, who carries an armful of the sets. The man with the shovel by one pressure of his foot packs the sand around the newly set plant. The shovel is inserted a second time at a distance of about 20 inches from the first, and all is ready for the next set. The planting proceeds quite rapidly, as two men are able to set 600 plants per hour.

COST OF PLANTING.

The cost of planting depends upon the thickness at which the grass must be set. On the more exposed areas requiring thick setting five men procuring sets, two teamsters, and eight planters, working nine hours per day, are able to cover an acre in two days. With wages at $2 per day the cost is approximately $65 per acre. This is with an abundance of planting stock growing within a mile of the areas to be covered. The thickness of the planting is responsible for the great expense of the operation, but the exposure of the northern slopes to the severe winter gales makes it probable that thinner plantings would prove ineffective, at least upon the most exposed areas. The expense is much less on the more protected areas, where thinner planting suffices, and those having the work in charge state that the 219 acres, covered with grass, have been planted at an average cost of $50 per acre.

The plantings of the first two years were made in rows ranging from 12 to 18 inches apart with the plants 12 inches or less in the row, but this method appears to be less desirable than the irregular setting which has since been used, as under the latter method there are no uninterrupted channels through which the wind might sweep. The plants are set approximately 20 inches apart, but there is evidence, however, that it is not necessary to set them so close as this, except on the most exposed areas. The thinner plantings afford more rooting area for the sets, and this helps to maintain the vigor of the transplanted sets. The increase in cost of the thick over the thin planting is not justified unless there is considerable advantage to be derived from the former. It has been the custom to protect the plantings with lateral brush hedges. The large branches are set vertically in the ground at intervals of from 2 to 3 feet and the interstices filled with smaller brush. These hedges catch great quantities of sand or in case of wind erosion prevent the uprooting of the grass (Pl. VI, fig. 1).

In some of the areas the small and isolated elevations have been covered at a considerable expense with grass. This has been thought to be an unnecessary procedure, as the wind reduces these elevations, furnishing a gradual accumulation of sand over the plantings on the associated level areas, which instead of proving a detriment to the plantations increases the vigor and vegetative propagation.

PRESENT STATUS OF THE VARIOUS PLANTINGS.

The table giving the acreage and mortality shows the salient facts concerning the plantings of the different dates and seasons. There is a uniform deterioration from the time the plants are set until they have disappeared. This is shown more clearly in Plate V, figure 2, than in the mortality table, for in the latter no account is taken of the great reduction in size and vigor which the sets have undergone. In the plantations of 1895 beach grass and poverty grass (*Hudsonia tomentosa*) from wind-scattered seed are slowly working in among the old sets. It is possible that this natural reclamation process will continue until the entire area is permanently covered with vegetation, although this same site was covered with grass in 1830 and the force of the winds prevented the natural vegetation from establishing itself among the transplanted beach grass. In the plantations of 1899 there are to be noted areas where the grass has retained its natural vigor, although there is no apparent difference between these and the areas showing a less vigorous growth.

EFFECTIVENESS OF BRUSH LAYING.

It has been the custom to cover certain areas with brush, usually those at the top of the ranges and just above the grass plantations. These areas were more or less subject to the eroding action of the wind, and it was thought that brush would answer the purpose better than beach grass. The brush was at first laid on in squares, but this proved less effective than the method of placing the brush uniformly over the entire surface; hence the latter system has been adopted. The beach grass comes in from naturally sown seed, and since the sand is not accumulating the grass is more or less depauperate; yet it is able to survive and by the time the brush decays has prepared the way for the succeeding vegetation, which, in connection with the grass, is able to hold the sand quite effectively. The laying of brush has been practiced quite extensively for the protection of roadways through the sand. The total area covered has been about 15 acres, at an approximate cost of $25 per acre. The addition of a small amount of soil to the area covered with brush has been found to greatly hasten the formation of the vegetative covering. The application need not be continuous nor at all thick. Brush cut with the leaves attached is best, as the humus content of the sand is increased and a much better protection afforded as long as the leaves remain.

EFFICIENCY OF BEACH GRASS FOR SAND BINDING.

Although many grasses have been tried at various times and places in this and foreign countries, no other has proved so effective as the beach grass. The long, tough, but flexible leaves of the beach grass enable it to endure the action of the wind with little detriment. A bunch of dead grass will withstand two seasons of wind action without becoming entirely destroyed. The statements sometimes made concerning the sand-binding power of the roots of this grass must be taken with some allowance. The principal place where the sand-binding action of the rootstocks may be observed is where an area covered with beach grass becomes rejuvenated. Here, the places most thickly overgrown with the grass are the last to be eroded by the wind. The grass stems and exposed rootstocks hanging loosely over the sides of the eroded hillock protect it to a considerable extent and retard its ultimate reduction. So far as observed the rootstocks seldom form a thick mat-like mass sufficiently near the water's edge to be of material assistance in reducing the eroding action of the waves, except in severe storms, when the wave action extends inland for a considerable distance (Pl. II, fig. 1). The chief value of the grass in this instance is the accumulation of sand induced, which, by its presence, keeps the destruction of the property adjoining the water reduced to a minimum.

Beach grass ordinarily requires a gradual accumulation of sand over its crown to induce a normal vigorous growth. It is for this reason that it is to be noted in great clumps protruding from the crest of small dunes, where it has accumulated a considerable quantity of sand each year, but at the same time not enough to cover it so deeply that the new plants are unable to develop. This is due to the fact that when the grass becomes partially buried the sand is no longer held by the protruding grass leaves and it passes over, and the grass is able to renew its growth the following year with increased vigor, since the accumulated sand is permeated with the roots of the new rootstock sent out by the half-buried clump. A healthy growth of beach grass can thrive where the burial by sand is not over a foot per year.

The areas which usually require planting are generally those from which the sand is being removed by the wind rather than those which are receiving the accumulations so essential to the vigor of the grass. For this reason the most that can be expected of the grass is that this sand removal shall be checked as long as the grass is able to survive under the unfavorable conditions, which allow of no accumulation of sand over the plants. The decrease in vigor of the sets from the time they are set out is a matter of common knowledge to those who have noted the plantations of beach grass under these conditions for a series of years. (See mortality table, p. 25.) It appears that this necessity for sand accumulation lies in the fact that it induces the development of new rootstocks by the old plant and thus occupies an unused portion of the sand which presents such a dearth of food salts that these are soon depleted and the deterioration noted must ensue unless new areas of sand are made tributary. Furthermore, there is no power of downward growth on the part of the rootstocks, and as a set rarely possesses more than two nodes the root system is very limited. The new rootstocks developed in the accumulated layers of sand constitute the only means of bringing new supplies of sand within reach of the grass plants. The old rootstock becomes buried, but continues to support to some extent the new plants until sufficiently established to be able to withstand the rather severe conditions incident to the dune areas. This process continues and the grass is thus continually rejuvenated.

Another reason for the deterioration noted above may be the fact that a single set of grass is not of indefinite existence, and unless it is induced to increase vegetatively it soon loses its vigor. There are areas in the United States where this deterioration subsequent to the transplanting is not manifested. At Grand Haven, Mich., at Coos Bay, Oregon, and at Poplar Branch, N. C., the beach grass has continued to increase in vigor since the plantations were established. This is apparently due to the fact that the plantings were made sufficiently far apart to allow most of the sand to drift through the plantations, thus enabling each set to receive a small amount of sand. This method, however, would be applicable only to limited areas on Cape Cod, as it is the eroding surfaces which require protection. However, these instances indicate that it is possible in certain areas to distribute the sand accumulation and often build up areas that are eroding, and this method should be in mind whenever a plan of attack on the dune areas is under consideration. The great reduction in the cost per acre where this thin planting can be utilized is a decided point in favor of its adoption wherever at all practicable. The cost of the Coos Bay plantations has been only $8 per acre, 64 acres having been planted in a single season with an appropriation of $500. In this place the grass was set 4 feet apart, and rather favorable climatic and edaphic conditions have been to some extent responsible for the success of such thin planting.

Trials of other sand-binding grasses have demonstrated the superiority of beach grass for sand-binding purposes under conditions which characterize the dune areas of Cape Cod. In 1901 experiments were made with the sand sedge (*Carex macrocephala*) and seaside bluegrass (*Poa macrantha*). These are very efficient sand binders upon the Pacific coast, and were obtained through the Division of Agrostology from Clatsop beach, near Fort Stevens, Oregon. Neither the seedlings nor the sets of these species proved successful. The seeds germinated well, but failed to survive the winter, as was also the case with the transplanted sets.

NECESSITY OF ULTIMATE FORESTATION.

The marked deterioration of the beach-grass plantings shows the need of introducing woody growth among the areas at as early a date as possible (Pl. V, figs. 1 and 2). The various native or imported woody plants should be set out among the grass soon after the grass has been planted, as the first years of the protection afforded by the grass are the best and are, in the aggregate, none too long to enable the shrubs and young trees to make sufficient growth and rootage to be self-protecting by the time the grass deteriorates so as to be practically valueless. It seems that it is necessary to start such a shrub or bush as the bayberry. This is not injured by the unfavorable conditions, and seedlings of pines and oaks may with safety be introduced among the bushes. Even the planting of the pine seeds and acorns has with this protection been successful.

Several species of woody plants have been tried with varying success. The following have been found to be unadapted to the conditions: Seaside pine (*Pinus maritima*), tree of heaven (*Ailanthus glandulosa*), ironwood (*Ostrya virginiana*), European birch (*Betula alba*), tamarack (*Tamarix gallica*), poplar (*Populus alba*), larch (*Larix* sp.), willow (*Salix* sp.), and privet (*Ligustrum vulgare*). Too much weight should not be given to the unsuccessful attempts with the willow and poplar, as they have made a vigorous growth on the sand within the city limits, and their behavior elsewhere, under almost as adverse conditions, appears to at least justify a more extended trial.

The successful species are comparatively few in number. Of the pines, pitch pine (*Pinus rigida*), Austrian pine (*P. laricio*), and Scotch pine (*P. sylvestris*) are proved successes. The pitch pine is used most extensively, as it grows naturally in the adjacent forests, and young trees and cones can be obtained in almost unlimited quantities. The black locust (*Robinia pseudacacia*) and the European or black alder (*Alnus glutinosa*), though not occupying extensive areas, have proved thoroughly adapted to the conditions, and it is the plan to increase the plantings of these two species. The Scotch broom (*Cytisus scoparius*) is well adapted to the conditions with the one exception of not being perfectly hardy, as many small areas have been killed by one or two excessively cold winters, though much of the original planting is still alive and vigorous. The plant does not spread readily from seed, as the severe conditions prohibit its existence in the early seedling stage, and furthermore, the seed being large and conspicuous is readily eaten by birds and small animals. The growth is very dense, and even scattered bunches would prevent the sand from shifting, but its semihardiness makes it decidedly inferior to the bayberry, which is locally abundant, perfectly hardy, and easily transplanted. The bayberry has formed the bulk of the pioneer plantings of woody growth, and used in connection with the beach grass appears to be the only necessary forerunner of the pines.

Miscellaneous Operations on the Sand.

Besides the reclamation processes leading to the ultimate reforestation of the dunes, there are a number of other operations which have ameliorated to some extent the adverse conditions incident to the sand dunes. Among these may be mentioned the construction of roads, formation of cranberry bogs, etc., the development of a sod in pastures, cemeteries, and lawns, and the accumulation of sand to form a beach ridge for harbor protection.

ROAD CONSTRUCTION.

The problem of road construction in sandy regions, and, as a rule, districts with sparse population, is a very difficult one, and is frequently not solved until the demand has long been imperative. The road leading from Provincetown south originally followed the beach at low tide, but at high water the travel was through the heavy sand farther up on the beach. The State is at present constructing a macadamized road extending from Provincetown southward, thus connecting it with the main part of the State. Before the road across the sand areas was macadamized, liberal applications of clay had facilitated the travel for many years.

There are several roads across the Province lands, and where they lead through the forested portion they are in good repair. On the shifting sand areas none but the State road has received much attention, although most of the portions where there is danger of gullying by the wind have received a protective covering of brush (Pl. VI, fig. 2).

The building of the State road across the Province lands was commenced in 1894 and completed in 1901. It extends from the city to the Peaked Hill Life-Saving Station and provides an easy means of access to the heart of the dune territory. The road was not constructed across the dunes area until the shifting sands had been brought under control. The roadbed was first graded and then covered with a layer of brush, after which it received a covering of turf sod obtained from the adjacent woods. It is still in good condition and promises with some attention to be fairly permanent, as it is subject to but little heavy teaming. The cost of construction was about 35 cents per running foot.

When the railroad was constructed the cuts were covered with brush and rubbish, which proved sufficient protection until a natural growth of beach grass developed, and no difficulty has since been experienced from gullying by the wind.

RECLAMATION OF SMALL AREAS.

Although the State holds the title to the Province lands and the public in general has had free access to its natural products, there are certain areas of the native cranberry bogs which have been staked off and improved by private parties. This was a common practice and many of the berry growers were assessed either on the land or its product. There seems to have been no serious outcome from this procedure except that it generally involved the removal of considerable brush and bushes, thus preventing the development of the forest in the immediate area. This has been the cause of some conflict of opinion with the State authorities, as it is the idea of those that have the preservation of the harbor in mind that the lands can be controlled with much less expense if the entire area be forested, and it may be said that the present State appropriations for the Cape are to this end. Fires have been started from the careless burning of the brush removed in the process of clearing the bogs. However, it appears that even with State ownership of the land the present prices of cranberries make them a source of little, if any, profit, as the soil is not adapted to producing yields comparable with those farther south along the Cape.

The pasturage of cattle upon the Province lands has long been prohibited by statute, and the pastures in use have been reclaimed from the bog lands near the city. Certain low places have been filled in, and the redtop present forms a close turf and is apparently able to withstand the usual amount of pasturing

The lee side of an established dune adjacent to the city has been terraced for the purpose of growing strawberries. The necessary substratum for the vines was obtained from the humus accumulation on the side of the dune. As there are numerous similar areas in the immediate vicinity, this indicates the possibilities if due care were taken not to rejuvenate the dunes, and there appears to be little danger of this on the lee slopes.

As with all old places, the cemetery is extensive and its uniformly good appearance is worthy of note, especially when the adverse conditions are considered. The soil rendering the bluegrass sod possible was either hauled in wagons from further south along the Cape or brought by boat from across the bay. A recent addition to the cemetery was leveled off and the bare sand protected with brush and sods, most of which came from the land leveled for the addition. The above statements may also be made concerning the lawns about the residences in the city, as the soil for these had to be imported from the same sources.

COMMERCIAL UTILIZATION OF SAND.

The sand, being of varying size, angular, and light colored, is valuable for many purposes, but its exportation appears to have been discontinued. The sand constituting an entire dune was at one time removed to Boston, the ships returning with loads of soil for use on lawns and in the cemetery. A glass factory was once in operation farther south on the Cape, but it, too, has been discontinued. The sand is valuable for polishing and cutting marble and granite, as well as for use in mortar, and in former years "Cape Cod sand" was frequently specified in important contracts for building in cities having navigable water connection with Provincetown. Sand was used in filling in the shallow water at the base of the forested dunes to form building sites for the business houses and dwellings, as originally there was very little building space along the harbor, which was so shallow near the edge as to make landing difficult.

DEVELOPMENT OF THE PROTECTIVE BEACH RIDGE.

The extensive sand flats and marshes associated with the sand hook forming one side of the harbor have always been subject to the inroads of the sea, which threatened the harbor with great incursions of sand. A protective beach ridge has been developed in all of the weaker places on the sand hook. Groin fences, in connection with beach grass, have induced extensive accumulations of sand, which are very effective in protecting the harbor and the bulkheads from the action of the sea during storms. This process of reclamation is in operation at present, the object being to build up a protective beach ridge along the salt marsh near the extreme end of the Cape south and west of Provincetown.

THE PROVINCE LANDS.

State Ownership.

The Province lands, situated at the extremity of Cape Cod, have had a peculiar history. When the provincial government ceased and Massachusetts became a State, all of the unoccupied lands retained the title of "Province lands," as all the land had previously been designated. It was not until 1893 that the State ceded to the inhabitants of Provincetown even their building sites, although previous to that date they had been privileged to give warranty deeds when making real estate transfers. There exist excellent reasons for State ownership of these sand areas which inclose the harbor, as it is only under such ownership that the necessary attention can be given to render the protection of the harbor efficient. The city and harbor are entirely too important to allow the half-established sand areas which endanger them to pass into the hands of private parties and to be subject to possible shortsighted policies leading to immediate profit.

It seems equally desirable that the State should also own what are known as the "Lotted lands," which constitute the sand areas lying between the Province lands and the glacial deposits comprising the original head of the Cape (see Pl. I). The sand of this area is more loosely bound and the shifting dunes are much nearer the harbor than are the sand areas of the Province lands. The "Lotted lands" are of little economic value and title could be obtained for a nominal consideration. At the present time timber and beach-grass hay are being removed by private persons to supply the local demand for these products. In view of the importance of the property thus endangered these practices need no comment.

Value of the Lands.

Agriculturally and horticulturally the lands surrounding the harbor have little value. No field crops are raised, and the redtop pastures are very small, being for the most part reclaimed bogs with an aggregate area of approximately 25 acres. The salt marshes yield about 200 tons of hay per year, and beach-grass hay to the amount of 15 tons is annually obtained from the sand areas lying just outside of the Province lands. The cranberry bogs, while extensive, are not regarded as especially profitable holdings even with the State owning the lands.

The sylvicultural resources of the lands might possibly be turned into account. The growth of the timber is slow, but the climatic contions are favorable, and an intelligent system of forestation under existing prices would materially assist in providing for the expenses incident to the supervision of the lands.

It has been suggested that the lands might be improved and brought into the market as building lots for summer cottages, or, this failing of realization, that a game preserve might be established and a revenue derived from shooting privileges. Neither of the projects appears to have met with much favor. The chief value of the lands is as a harbor former, and all plans should conserve to this end.

The idea of converting the area into a marine park has many points in its favor, and it may be stated that those in charge of the land have this project in mind and are working to that end. The isolation, beauty of natural scenery, and oceanic location, with its 5 miles of heavy surf and an equal frontage on the bay, combine to render the locality probably without an equal on the Atlantic coast. The harbor must be protected from the loose sands on the north side of the Cape, and the forested condition necessary for a marine park is exactly what is required by the proposed plans to render the area a permanent protection to the harbor, and the money spent in reclaiming the lands, if applied along landscape-engineering lines, will ultimately produce an ideal ocean park. The successful development of the Golden Gate Park at San Francisco has demonstrated the possibilities of such sandy tracts when properly reclaimed.

SUMMARY.

The sand areas inclosing Cape Cod Harbor were originally forested, but have been extensively devastated within historic times. Restrictive legislation dating back as far as 1714 has exerted a restraining influence upon the devastating activities. In 1826 extensive reclamation processes were inaugurated, but were unsuccessful owing to the failure to introduce woody plants within the beach-grass plantations. The State in 1893 formulated an extensive plan for the reclamation of these areas. The initial plantings of woody plants were unsuccessful, owing to their having been introduced into the shifting sand areas without the protection of beach grass. Plantations of beach grass aggregating 219 acres have been made and large numbers of bayberry bushes, young pines, etc., have been introduced among the grass, which persists until the bushes and young trees have attained sufficient size to be self-protecting. The State has expended for reclamation purposes during the ten years ending January 1, 1904, $31,929.78, of which $10,950 was for grass planting. The General Government has spent $162,019.86 in its work of harbor protection, and the total amount expended upon the harbor by the State and National Governments is $325,719.78. This includes $131,770.14 expended by the State in 1868 for the construction of a dike across East Harbor.

The sand areas are of vital importance to the harbor and their control necessitates reforestation, which is at present being accomplished, the authorities having in mind the ultimate development of a marine park.

BIBLIOGRAPHY.

Dwight, T. Travels in New England and New York, 1796 and 1797 (1823).

Mass. Sen. Doc. No. 5 (1854).

(Being a report on Cape Cod and East harbors.)

Flint, C. L. Grasses and forage plants (1858).

Thoreau, H. D. Cape Cod (1864).

Mass. House Doc. No. 50.

(Being a report on the condition of Long Point and East Harbor.)

Mass. Sen. Doc. No. 5 (1872).

(Being a report on the construction of the East Harbor dike in 1868.)

Annual reports of the Chief of Engineers, U. S. Army, 1876, pp. 181–190; 1879, pp. 273–275; 1886, pp. 574–577; 1903, pp. 87, 783–784.

Mass. House Doc. No. 339 (1893).

(Being a report on the Province lands authorized under chapter 420 of the acts of 1892.)

Small, James A. Reports of the Superintendent of the Province lands. Annual reports of the Harbor and Land Commissioners, 1893–1903.

Scribner, F. Lamson-. Grasses as sand and soil binders. Reprint from the Yearbook of the U. S. Dept. Agric., 1894, pp. 421–436.

——— Sand-binding grasses. Reprint from the Yearbook of the U. S. Dept. Agric., 1898, pp. 405–420.

Cowles, H. C. Ecological relations of the vegetation on the Lake Michigan sand dunes. Reprint from the Bot. Gaz., **27** : 95 et seq.

Hollick, A. Geological and botanical notes: Cape Cod and Chippaquidick Island, Massachusetts. Bul. N. Y. Bot. Gard., **2** : 381–407.

PLATES.

DESCRIPTION OF PLATES.

Plate I. (Frontispiece.) Map of the sand areas inclosing Cape Cod Harbor. The 30-foot contour lines indicate roughly the topography and general outlines of the seven dune ranges which constitute the larger portion of the sand areas surrounding the harbor. The outer three nonforested dune ranges have been covered with beach grass and are indicated in black.

Plate II. Fig. 1.—Beach grass forming protective beach ridge. The grass is shown to extend to within the limit of wave action during the winter storms. Its peculiar habit of sending out rootstocks when buried enables it to keep the ever-increasing sand deposits well covered. The gradual accumulations of sand incident to these depositing ridges form the ideal conditions for the thrifty growth of this grass. The beach ridge indicated has increased 20 feet in height during the past twenty years. The beach grass has been the chief factor in accumulating the sands necessary for the strengthening of this portion of the sand areas protecting the harbor. Fig. 2.—Beach grass, showing method of vegetative propagation. Beach grass is efficient in the natural reclamation processes owing to the method of rapid vegetative propagation from rootstocks, which enables scattered individuals to soon cover the drifting sands with a sufficient growth to prevent the sand movement.

Plate III. Fig. 1.—Set of beach grass suitable for transplanting. The set shows two nodes of the rootstock with attached rootlets. Two-year-old stock is most desirable for transplanting. The method of hand pulling is practiced throughout these areas. Fig. 2.—Transplanting beach grass. The gently sloping sand areas are covered with beach grass in the manner indicated. The brows of the hills are covered immediately with bayberry transplanted from the adjoining timbered areas. The steeper slopes are often reduced to an angle of 25 degrees or less before the planting is begun.

Plate IV. Fig. 1.—Lee slope of a sand dune showing the manner in which the advancing dune buries forests lying in its path. Fig. 2.—General view of the grass plantations, looking south. Native growth in foreground. In the background the transplanted beach-grass area adjoins the sands not yet covered. Bayberry bushes have been introduced upon the crests of the dunes. Before these areas were covered with the grass, the dunes were encroaching upon the forest and city shown in the distance.

Plate V. Fig. 1.—Bayberry bushes without grass protection. The presence of bushes alone is not sufficient to prevent the shifting of the sand. The large size of the sand grains is indicated in the foreground. Fig. 2.—Bayberry bushes with grass protection. The deterioration of the grass is evident but its duration is sufficient to enable the introduced woody growth to become self-protecting. The grass was planted in 1898 and the bayberry a year subsequently.

Plate VI. Fig. 1.—Wind erosion of nonprotected sand. The brush line in the center marks the eastward extension of the beach grass plantings of 1898. The amount of sand erosion by the wind since the grass was introduced is clearly indicated on the eroded sand areas at the left where it appears that at least 15 feet of sand have been removed. Fig. 2.—Protecting a road through the dunes. The brush lines, logs, and bushes form an efficient protection to the sides of the cut. The roadbed consists of brush overlaid with turf sods obtained from the neighboring forest.

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FIG. 1.—BEACH GRASS FORMING PROTECTIVE BEACH RIDGE.

FIG. 2.—BEACH GRASS, SHOWING METHOD OF VEGETATIVE PROPAGATION.

FIG. 1.—SET OF BEACH GRASS SUITABLE FOR TRANSPLANTING.

FIG. 2.—TRANSPLANTING BEACH GRASS.

FIG. 1.—SAND DUNES BURYING FOREST.

FIG. 2.—BEACH GRASS PLANTATIONS—GENERAL VIEW.

FIG. 1.—BAYBERRY BUSHES WITHOUT GRASS PROTECTION.

FIG. 2.—BAYBERRY BUSHES WITH GRASS PROTECTION.

FIG. 1.—WIND EROSION OF NONPROTECTED SAND.

FIG. 2.—PROTECTING A ROAD THROUGH THE DUNES.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 66.

B. T. GALLOWAY, *Chief of Bureau.*

SEEDS AND PLANTS IMPORTED

DURING THE PERIOD FROM SEPTEMBER, 1900, TO DECEMBER, 1903.

INVENTORY No. 10; Nos. 5501—9896.

SEED AND PLANT INTRODUCTION AND DISTRIBUTION.

Issued February 8, 1905.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1905.

BULLETINS OF THE BUREAU OF PLANT INDUSTRY.

The Bureau of Plant Industry, which was organized July 1, 1901, includes Vegetable Pathological and Physiological Investigations, Botanical Investigations and Experiments, Grass and Forage Plant Investigations, Pomological Investigations, and Experimental Gardens and Grounds, all of which were formerly separate Divisions, and also Seed and Plant Introduction and Distribution, the Arlington Experimental Farm, Tea Culture Investigations, and Domestic Sugar Investigations.

Beginning with the date of organization of the Bureau, the several series of bulletins of the various Divisions were discontinued, and all are now published as one series of the Bureau. A list of the Bulletins issued in the present series follows.

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[Continued on page 3 of cover.]

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 66.

B. T. GALLOWAY, *Chief of Bureau.*

SEEDS AND PLANTS IMPORTED

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INVENTORY No. 10; Nos. 5501—9896.

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ISSUED FEBRUARY 8, 1905.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

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Pathologist and Physiologist, and Chief of Bureau.

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SEED AND PLANT INTRODUCTION AND DISTRIBUTION.

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W. W. TRACY, SR., *Special Agent.*
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JOHN E. W. TRACY, *Expert.*
GEORGE W. OLIVER, *Expert.*

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., May 5, 1904.

Sir: I have the honor to transmit herewith, and to recommend for publication as Bulletin No. 66 of the series of this Bureau, the accompanying manuscript entitled "Seeds and Plants Imported During the Period from September, 1900, to December, 1903."

This manuscript has been submitted by the Botanist in Charge of Seed and Plant Introduction and Distribution with a view to publication.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

PREFACE.

The present inventory, No. 10 of our series, covers a number of introductions almost equal to the entire number included in the previous nine inventories. It is put forth as the first part of the record of the permanent work of this office with these introductions, and shows what seeds and plants have been introduced. The completion of the record requires a report of the disposition made of these seeds and the results obtained from the experimental work done in this country. Such records will appear from time to time as our different introductions are tested and either discarded or found to be valuable additions to the plants cultivated by American farmers and gardeners.

The introductory statement by Mr. Fairchild covers the general information in regard to the sources from which these introductions have been obtained, and I wish in addition to emphasize the fact that the seeds and plants represented by this inventory have all been distributed, and that the inventory is in no sense intended as a check list to enable persons to call for seeds and plants with which they would like to experiment.

A. J. Pieters,
Botanist in Charge.

Office of Seed and Plant
Introduction and Distribution,
Washington, D. C., May 4, 1904.

SEEDS AND PLANTS IMPORTED DURING THE PERIOD FROM SEPTEMBER, 1900, TO DECEMBER, 1903.

INTRODUCTORY STATEMENT.

This inventory of seeds and plants which have been collected by agricultural explorers, or received through other sources by this Office, covers the period from September, 1900, to December, 1903. It includes 4,396 accession inventory numbers. Since the last inventory was published in 1901 the explorers and special agents of this Office have continued their extensive searches after new and promising varieties of plants for introduction into this country. The notes furnished regarding the different introductions vary greatly with regard to their completeness and it is desired to point out clearly that this inventory makes no pretenses to being an embodiment of all the information we possess regarding the various seeds and plants listed. It is merely a collection, largely for use in this Office and by members of the State experiment stations, of the notes which accompanied the various seeds and plants when they were sent in. Their value will in many cases be more historical than explanatory. For some of the most important numbers, separate detailed reports have been issued in the form of bulletins or are being prepared for publication.

It will be noticed that no attempt has been made to follow the latest reforms in nomenclature, the Kew Index having been taken in most cases as a convenient guide in the spelling of the different scientific names.

The quantities of seeds or plants represented by these different numbers are, as a rule, small, and in the vast majority of cases it has been necessary to distribute them as soon as possible after arrival to competent experimenters throughout the country. It will therefore be, in most cases, impossible to furnish seeds or plants described in this inventory. If, however, special reasons can be shown by reputable experimenters why further introductions of certain species or varieties should be made, this Office will be glad to take the matter up, for it is desirous of introducing any new variety which may be called to its attention by plant breeders or others in a position to carry out consecutive and careful plant-introduction experiments.

Of the nearly 4,400 new introductions, a very large number represent work accomplished by the explorations of Mr. Barbour Lathrop, of Chicago, with whom the writer had the pleasure of being associated as Agricultural Explorer. Mr. Lathrop's explorations, which have required about four years of travel abroad, were carried out with the one practical object of making a reconnoissance of the useful plant possibilities of the world, and have successfully covered every continent and touched every important archipelago. Owing to the very out-of-the-way parts of the world visited by Mr. Lathrop, a large number of the seeds and plants secured by him are so rare that they will be exceedingly difficult to replace, and the Office considers itself extremely fortunate to have enlisted the cooperation of such a public-spirited man as Mr. Lathrop, who has conducted these various explorations almost entirely at his own expense, with no other idea than that of benefiting the American public through this branch of the work of the Department of Agriculture. No stronger evidence is needed of the practical value of plant-introduction work than that furnished by Mr. Lathrop's devotion to its study.

The collections of the several Department agricultural explorers which are represented in this inventory have also been gathered from a wide range of the earth's surface. The explorations of Dr. S. A. Knapp, the results of which are represented in the inventory, covered his second voyage to the Orient in 1901–2, and comprised a trip to Hawaii, Japan, China, Manila, the Straits Settlements, and British India in search of information bearing on the rice question of the South. Bavaria, Austria, Dalmatia, Greece, Egypt, Tunis, Algeria, and Spain were explored by the writer for brewing barleys, hops, fruits, and forage crops. Mr. C. S. Scofield made a careful survey of the leguminous fodder and green manure crops of Algeria and incidentally a study of the wheat varieties of France. Mr. M. A. Carleton made a second trip in 1900 through Austria and Roumania, into Russia and Central Asia, and returned through Turkey and Servia in search of cereals and forage crops. Mr. E. R. Lake, a specialist on American prunes, was sent in 1900 on a short trip to the prune-growing regions of France. Dr. J. N. Rose, of the U. S. National Museum, assisted us in 1901 in his botanizing trips in Mexico to secure a collection of desert plants and varieties of other plants of economic importance. Mr. Ernst A. Bessey was sent as agricultural explorer on two expeditions in search of hardy alfalfas and more resistant fruits for the Northwest. The first was through Russia to Turkestan in 1902, and the second to the Caucasus in 1903. Mr. Thomas H. Kearney and Mr. T. H. Means, the latter of the Bureau of Soils, were sent as explorers to the arid regions of Algeria, Tunis, and Egypt in search of better strains of Egyptian cotton and alkali-resistant grains and fodder plants. Mr. P. H. Rolfs, in charge of the Subtropical

Laboratory at Miami, Fla., visited for this Office in 1903 several islands in the West Indies in search of varieties of cassava and other suitable agricultural plants for southern Florida. Mr. G. Onderdonk, of Nursery, Tex., a specialist on stone fruits, made a trip to Mexico for this Office in search of varieties of this class of fruits for the Southern States.

In addition to the seeds and plants which these various exploring trips have brought in, the Office is indebted to correspondents all over the world for numerous interesting things which have been presented to it and for which credit is given in each separate instance under the various numbers.

It is desired to urge strongly in this introductory statement that the numbers which accompany these seeds and plants when they are sent out should be carefully preserved by those who receive them. By means of these inventory numbers the seeds and plants can always be identified. The machinery of the Office is so arranged that a permanent record is kept on file of all seeds and plants sent out, and the addresses of the experimenters to whom they are sent. This feature is considered essential, and unless carefully carried out there will be nothing on record to prevent reintroductions of plants which have proved by extensive trials to be unworthy of a place in American agriculture, and much annoyance and delay will be caused in the handling of those things which are successful.

While it is one of the aims of plant introduction to encourage those who can afford it to try new plants, such an object would not be gained by any attempt to supply those who—misguided, perhaps, by exaggerated newspaper accounts—apply for seeds or plants which they are not in a position to test successfully. All seeds are sent out with the idea that those who receive them are willing to take the pains to reply to queries from this Office regarding the success of their trial and to supply on request reasonable quantities of seeds, scions, or plants produced from the imported material. A failure on the part of an experimenter to respond to repeated inquiries or his refusal to assist in giving new introductions a wide distribution will affect unfavorably his standing in the list of capable experimenters which it is one of the objects of this plant introduction work to create.

David G. Fairchild,
Agricultural Explorer.

Washington, D. C., *April 18, 1904.*

INVENTORY.

5501 to 5512.

From Washington, D. C. Seeds from a number of crab-apple trees growing on the grounds of the Department of Agriculture. These trees were imported from Russia, by Prof. N. E. Hansen, in 1898. The numbers in parentheses are those under which the trees were received from Professor Hansen. They are as follows:

5501. Pyrus prunifolia edulis. (No. 4.)

5502. Pyrus prunifolia purpurea. (No. 5.)

5503. Pyrus prunifolia. (No. 6.)

Transparent.

5504. Pyrus prunifolia. (No. 7.)

Transparent.

5505. Pyrus prunifolia moscowiensis. (No. 8.)

5506. Pyrus prunifolia purpurea. (No. 9.)

5507. Pyrus prunifolia macrocarpa. (Nos. 10 and 11.)

5508. Pyrus prunifolia baccata. (No. 12.)

5509. Pyrus prunifolia baccata. (No. 15.)

5510. Pyrus prunifolia baccata. (No. 16.)

5511. Pyrus prunifolia. (No. 17.)

5512. Pyrus prunifolia. (No. 18.)

5513. Avena sativa. **Oat.**

From Torneå, Finland. Received through Messrs. Lathrop and Fairchild (No. 435), September 27, 1900.

North Finnish Black. "This seed is from the north province of Finland, and being grown at this high latitude should be early ripening. It is not, however, of first quality because the recent crops have been very poor." (*Fairchild.*)

5514. Avena sativa. **Oat.**

From Torneå, Finland. Presented by F. O. U. Nordberg, through Messrs. Lathrop and Fairchild (No. 435a, Aug. 6, 1900). Received September 27, 1900.

North Finnish Black. "One liter of black oats of the 1897 crop, which was so highly prized here that I could only get this small quantity. It should ripen earlier than No. 5513." (*Fairchild.*)

5515. Triticum vulgare. **Wheat.**

From Michaux, Va. Received September 27, 1900.

Banat. Grown in Virginia from seed imported by this Department in 1899.

5516. Passiflora edulis. **Passion flower.**

From New South Wales, Australia. Presented by Dr. N. A. Cobb. Received September 27, 1900.

"This plant grows best in good soil at some distance from the coast, where there is little frost and an annual rainfall of about 50 inches. The plants are usually trellised about 6 feet apart, grow rapidly, and bear fruit the second year." (*Cobb.*) (See No. 1906, Inventory No. 5.)

5517. Glycine hispida. **Soy bean.**

From Macassar, Celebes. Received through Messrs. Lathrop and Fairchild (No. 336, Jan., 1900), October 8, 1900.

Katjang-Koro.

5518. Phaseolus mungo. **Gram.**

From Macassar, Celebes. Received through Messrs. Lathrop and Fairchild (No. 337, Jan., 1900), October 8, 1900.

"A small bean used in soups." (*Fairchild.*)

5519. Dolichos sp. **Ussi bean.**

From Lombok, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 338, Jan., 1900), October 8, 1900.

Katjang Ussi.

5520. Cucurbita sp. **Squash.**

From Amboina, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 339 Jan. 15, 1900), October 8, 1900.

"Native-grown squash, suited to a moist, warm climate. Said to be very sweet when cooked." (*Fairchild.*)

5521. Phaseolus lunatus. **Lima bean.**

From Lombok, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 340, January 7, 1900), October 8, 1900.

"A peculiar white and black striped lima bean." (*Fairchild.*)

5522. Arachis hypogaea. **Peanut.**

From Matarum, Lombok, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 341, January 7, 1900), October 8, 1900.

"A large rough-shelled, three-seeded peanut, having thin shells and a good flavor." (*Fairchild.*)

5523. Oryza sativa. **Rice.**

From Surabaya, Java. Received through Messrs. Lathrop and Fairchild (No. 342, January, 1900), October 8, 1900.

"Short-grained Java rice." (*Fairchild.*) (Injured in transit.)

5524. Capsicum annuum. **Red pepper.**

From Macassar, Celebes. Received through Messrs. Lathrop and Fairchild (No. 343, January 10, 1900), October 8, 1900.

"A small variety of very hot red pepper generally used green in Macassar. Probably the same as that used in Java and other parts of the Dutch East Indies." (*Fairchild.*)

5525. CAPSICUM ANNUUM. **Red pepper.**

From Macassar, Celebes. Received through Messrs. Lathrop and Fairchild (No. 344, January 10, 1900), October 8, 1900.

"A long red pepper of the shape of the so-called Guinea pepper." (*Fairchild.*)

5526. CAPSICUM ANNUUM. **Red pepper.**

From Bali Island, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 345, January 7, 1900), October 8, 1900.

A long red variety.

5527. SOLANUM sp.

From Bali, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 346, January 7, 1900), October 8, 1900.

"A white-fruited species which is used on the *Rijstafel* or rice table of Europeans. Much like an eggplant, of which it may be only a variety." (*Fairchild.*)

5528. MOMORDICA sp.

From Macassar, Celebes. Received through Messrs. Lathrop and Fairchild (No. 347, January 11, 1900), October 8, 1900.

"A fruit called Paparé here. It is eaten raw. When mature it is very showy, with bright-red endocarp. Said by Paillieux and Bois to grow well in France." (*Fairchild.*)

5529. CITRUS LIMETTA. **Lime.**

From Macassar, Celebes. Received through Messrs. Lathrop and Fairchild (No. 348, January 11, 1900), October 8, 1900.

"A very thin-skinned, juicy lime of inferior flavor." (*Fairchild.*)

5530. CAPSICUM ANNUUM. **Red pepper.**

From Macassar, Celebes. Received through Messrs. Lathrop and Fairchild (No. 349, January 11, 1900), October 8, 1900.

A long red variety.

5531. CITRUS LIMONUM. **Lemon.**

From Banda, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 350, February 8, 1900), October 8, 1900.

"*Sauerbier*, a very large, thin-skinned, exceedingly juicy lemon of good flavor, sent through the kindness of Mr. Sauerbier from his own garden. The fruit examined was 3 inches in diameter, with smooth skin, not over one-quarter of an inch thick, and large oil glands. The flesh is composed of large cells which are much elongated in shape and therefore easily broken by pressure. The amount of juice is exceptionally large. Nearly three-fourths of an ordinary glassful was squeezed by hand from a single fruit. Juice of good flavor, somewhat aromatic, but the fruit was too ripe to judge fairly. The tree is said to be small. This is the finest lemon seen by us on the expedition, and its discovery was made by Mr. Lathrop." (*Fairchild.*)

5532. CITRUS LIMONUM. **Lemon.**

From Banda, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 351, February 8, 1900), October 8, 1900.

From the garden of Mr. Sauerbier. "Seeds from the remarkable lemon described in No. 5531. Its seedlings may produce its like." (*Fairchild.*)

5533. CITRUS LIMONUM. **Lemon.**

From Banda, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 352, February 8, 1900), October 8, 1900.

"Seeds from lemon said to have come from the same tree as No. 5531. The fruits from which these seeds were taken were smaller, but still of unusual size and excellence." (*Fairchild.*)

5534. CANARIUM AMBOINENSE. **Amboina almond.**

From Amboina, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 353, February 8, 1900), October 8, 1900.

"This is possibly the stateliest avenue tree in the world and forms in the famous garden of Buitenzorg, Java, the '*Canarium Allée*,' which is noted as the most beautiful avenue in existence. A valuable table oil is made from the kernels of the fruits and these are highly prized by Europeans, being eaten like almonds. If introduced into the Philippines they might be made to pay as a secondary crop." (*Fairchild.*)

5535. SOLANUM MELONGENA. **Eggplant.**

From Amboina, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 354, February 8, 1900), October 8, 1900.

"Fruit long, striped with red, purple, and white." (*Fairchild.*)

5536. CAPSICUM ANNUUM. **Red pepper.**

From Amboina, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 355, February 14, 1900), October 8, 1900.

"An excellent variety of egg-shaped red pepper." (*Fairchild.*)

5537. CAPSICUM ANNUUM. **Red pepper.**

From Singapore. Received through Messrs. Lathrop and Fairchild (No. 356, January 24, 1900), October 8, 1900.

"A long, slender variety of red pepper." (*Fairchild.*)

5538. CAPSICUM ANNUUM. **Red pepper.**

From Macassar, Celebes. Received through Messrs. Lathrop and Fairchild (No. 357, January 11, 1900), October 8, 1900.

"A small red pepper." (*Fairchild.*)

5539. **Forest tree.**

From Boela, Ceram Island, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 358, January 18, 1900), October 8, 1900.

"Seeds from a single fruit of a beautiful orange-red color; borne by a small forest tree with lanceolate dark-green leaves. Fruits borne in pairs, and are pulpy, jelly-like, and almost transparent. One of the showiest fruits I have ever seen. I do not know whether or not it is edible." (*Fairchild.*)

5540. **Forest tree.**

From Boela, Ceram Island, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 359, January 18, 1900), October 8, 1900.

"Fruit oblate spheroid, dark green, several-seeded with hard, smooth exocarp. Flesh brown and spongy. Not known to be edible." (*Fairchild.*)

5541. **Forest tree.**

From Boela, Ceram Island, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 360, January 18, 1900), October 8, 1900.

"One-seeded, purple-fleshed fruit, from clearing in virgin forest. Said to be poisonous." (*Fairchild.*)

5542. VICIA FABA. **Broad bean.**

From Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 361, January 11, 1900), October 8, 1900.

"Sample of a variety of broad bean which is canned and sent from Holland to India, where it is cooked in water and eaten as a great delicacy by Europeans. Most excellent eating." (*Fairchild.*)

5543. **Shade tree.**

From Toeal, Kei Island, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 362, January 20, 1900), October 8, 1900.

"A rapidly growing shade tree resembling *Albizzia lebbek*, but with long cylindrical pods of dark-brown color. Suitable for Florida, Porto Rico, or any tropical region." (*Fairchild.*)

5544. MOMORDICA sp.

From Toeal, Kei Island, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 363, January 20, 1900), October 8, 1900.

"A small-fruited species growing wild in the island. Said to be eaten raw by the natives." (*Fairchild.*)

5545. SOLANUM MELONGENA. **Eggplant.**

From Toeal, Kei Island, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 364, January 20, 1900), October 8, 1900.

"A yellow-fruited species of *Solanum*, cooked and eaten by the natives. May prove valuable for breeding purposes." (*Fairchild.*)

5546. CAPSICUM ANNUUM. **Red pepper.**

From Gisser Island (a typical atoll near Ceram), Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 365, February 3, 1900), October 8, 1900.

"A large oblong variety of red pepper." (*Fairchild.*)

5547. CITRUS DECUMANA. **Pomelo.**

From Sekar, Dutch New Guinea. Received through Messrs. Lathrop and Fairchild (No. 366, February 1, 1900), October 8, 1900.

"Seeds of a large and very sour variety of pomelo or shaddock presented by the Radja of Sekar, a village on the coast of Dutch New Guinea. The shaddock is native of the islands of the Malay Archipelago, being more particularly abundant in the Friendly Isles and Fiji. Introduced into India from Java and into the West Indies by Captain Shaddock, hence the name *Shaddock*. It is cultivated in most tropical countries." (*Fairchild.*)

5548.

From Wetter Island, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 367, January 23, 1900), October 8, 1900.

"Long purple fruit found on the shore of the island of Wetter. The pulp is soft like that of a plum. It is said not to be edible." (*Fairchild.*)

5549. CONVOLVULUS sp. (?)

From Dammer Island, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 368, January 22, 1900), October 8, 1900.

"A large vigorous vine with curious seed pods." (*Fairchild.*)

5550. CONVOLVULUS sp. (?)

From Dammer Island, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 369, January 22, 1900), October 8, 1900.

"Small-fruited vine which covers low trees and shrubs." (*Fairchild.*)

5551.

From Dammer Island, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 370, January 22, 1900), October 8, 1900.

"From vine not in flower, but of luxuriant growth, covering trees and shrubs." (*Fairchild.*)

5552. CUCURBITA sp. (?)

From Dammer Island, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 371, January 22, 1900), October 8, 1900.

"A vigorous cucurbitaceous vine, covering trees and shrubs and bearing large numbers of curious dry fruits resembling *Luffa*." (*Fairchild.*)

5553. CAPSICUM ANNUUM. **Red pepper.**

From Gisser Island, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 372, February 4, 1900), October 8, 1900.

"A cherry-shaped red pepper." (*Fairchild.*)

5554. CITRUS LIMETTA. **Lime.**

From Gisser Island, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 373, February 3, 1900), October 8, 1900.

"Seeds from a lime of very peculiar shape. Long and slender, with a decided beak at the lower end. Flavor inferior." (*Fairchild.*)

5555. CAPSICUM ANNUUM. **Red pepper.**

From Gisser Island, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 374, February 3, 1900), October 8, 1900.

"A small red pepper."

5556. CAPSICUM ANNUUM. **Red pepper.**

From Toeal, Kei Island, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 375, January 31, 1900), October 8, 1900.

"A small cherry-shaped red pepper." (*Fairchild.*)

5557. CONVOLVULUS sp. (?)

From Dobbo, Aru Islands, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 376, January 28, 1900), October 8, 1900.

"Seed from vine growing in the mangrove swamps near the town. Ornamental." (*Fairchild.*)

5558. CONVOLVULUS sp. (?)

From Dobbo, Aru Islands, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 377, January 28, 1900), October 8, 1900.

"Seeds from a plant growing near mangrove swamps on sandy soil." (*Fairchild.*)

5559. CUCURBITA sp. **Squash.**

From Sekar, Dutch New Guinea. Received through Messrs. Lathrop and Fairchild (No. 378, February 2, 1900), October 8, 1900.

"Seeds from a squash presented by the Radja of Sekar, a small village on the coast of New Guinea." (*Fairchild.*)

5560. ZEA MAYS. **Maize.**

From Amboina, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 379, February 7, 1900), October 8, 1900.

"A variety of Indian corn which is of such superior quality that it is shipped from the island of Amboina to many other points in the archipelago. A hard flinty variety, and worthy of trial in Porto Rico, Hawaii, and the Philippines." (*Fairchild.*)

5561. ARACHIS HYPOGAEA. **Peanut.**

From the Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 380, February 7, 1900), October 8, 1900.

"A very large peanut, one of the most delicious we have ever tasted, probably from the island of Ternate." (*Fairchild.*)

5562.

From Letti Island, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 381, January 25, 1900), October 8, 1900.

"Small fruits with lemon-yellow pulp, very sour. Brought on board and sold by natives of Letti." (*Fairchild.*)

5563. Chavica officinarum. **Long pepper.**

From Macassar, Celebes. Received through Messrs. Lathrop and Fairchild (No. 382, January 22, 1900), October 8, 1900.

"A sample of so-called *Tjabeh aroij*, used in the Dutch East Indies as a condiment. It is very hot, and is much used by the natives in their curries. It is also used in medicine." (*Fairchild.*)

5564. Cicca nodiflora.

From Amboina, Dutch East Indies, Received through Messrs. Lathrop and Fairchild (No. 383, February 7, 1900), October 8, 1900.

"Seeds from fruit tree, the sap of which is used for poisoning arrows. The roots are used as a medicine for asthma. Syphilis is treated with a decoction of the leaves, and the sour fruits are used for making preserves. The seeds act as a purgative. The tree grows about 25 feet high." (*Fairchild.*)

5565. Capsicum annuum. **Red pepper.**

From Fack Fack, Dutch New Guinea. Received through Messrs. Lathrop and Fairchild (No. 384, February 1, 1900), October 8, 1900.

"Very small red pepper found growing on a bush 4 feet high." (*Fairchild.*)

5566. Calophyllum sp.

From Saparoea Island, Dutch East Indies. Received through Messrs. Lathrop and Fairchild (No. 385, February 8, 1900), October 8, 1900.

"A giant tree growing in front of the Controlleur's house at Saparoea. One of the most beautiful shade trees I have ever seen." (*Fairchild.*)

5567. Cucumis sativus. **Cucumber.**

From Macassar, Dutch East Indies. Received through Messrs. Lathrop and Fairchild, October 8, 1900.

"An excellent variety of uniform size and shape, especially suited for cultivation in the Tropics." (*Fairchild.*)

5568. Stuartia pentagyna.

From Gage, Tenn. Presented by Mr. J. H. H. Boyd, through Mr. Lyster H. Dewey, of the Division of Botany. Received October 17, 1900.

5569. Humulus lupulus. **Hop.**

From Auscha, Bohemia. Received through Mr. E. R. Lake, October 18, 1900.

Auscha Red.

5570. Humulus lupulus. **Hop.**

From Auscha, Bohemia. Received through Mr. E. R. Lake, October 18, 1900.

Saaz.

5571. Thea viridis. **Tea.**

From Ceylon. Received October 30, 1900.

Highest class "Jat," a wild indigenous tea.

5572 to 5585. **Leguminous forage plants.**

From Algeria. Presented by Doctor Trabut, Government Botanist of Algeria, through Mr. W. T. Swingle. Received November 2, 1900.

"This valuable collection comprises small amounts of the seed of a number of forage plants which are cultivated by Doctor Trabut at the Algerian experiment station at Rouïba. Many of these were introduced into culture by Doctor Trabut, and are now sent out of North Africa for the first time. Some of the plants occur in other parts of the Mediterranean region, but in general the forms of these species found growing in Algeria are more resistant to drought than those obtained elsewhere. This has proved true of the common vetch from Tunis, the narrow-leaved lupine or naturalized form of the Corsican lupine. All of these species are adapted for planting in autumn in the warmer regions of the South and Southwest. Unfortunately, only a small amount of seed of these species could be obtained. It is hoped that enough can be grown in this country to give a fair trial another year. There can be no doubt that all of the native North African forage plants deserve a most careful trial in the arid and semiarid regions on the Pacific slope. All of these are winter crops and should be sown in early autumn, since at that time there is sufficient moisture in the soil to enable the seed to germinate. The climate of North Africa is very mild in winter, and probably most of these species would be injured by severe frosts. They could, however, be grown in spring in Washington State and Oregon, where the winter would probably prove too severe to permit of their being sown in autumn." (*Swingle.*)

5572. VICIA CALCARATA. **Vetch.**

"This vetch is native to the Mediterranean region. The seed of this particular sort was obtained at Boghar in Algeria where the climate is very dry. This is one of the species introduced into culture by Doctor Trabut." (*Swingle.*)

5573. VICIA HIRTA. **Vetch.**

"This plant, which is usually considered to be a hairy form of *Vicia lutea*, occurs very commonly in Algeria and has been introduced into cultivation by Doctor Trabut. It reaches a height of 16 to 18 inches at the experiment station at Rouïba." (*Swingle.*)

5574. VICIA FULGENS. **Scarlet vetch.**

"An Algerian vetch with handsome red flowers. It is an annual and grows with extraordinary vigor, reaching a height of 6 to 8 feet and yielding an abundance of excellent forage. Doctor Trabut, who introduced the species into culture, reports that at the experiment station at Rouïba, near Algiers, it yields 40 tons of green fodder to the acre. The great drawback of this most promising vetch is that the pods when ripe snap open, especially under the influence of hot winds, and scatter the seed, rendering its collection very difficult and the seed in consequence high priced. It is sown in autumn before the first rains in Algeria, either alone or with winter oats. It occasionally produces seed abundantly. It is to be hoped that some region may be found in the United States which has a sufficiently humid atmosphere during the ripening period of the pods to prevent their scattering the seeds. It might be possible to breed varieties which would hold the seed better. This vetch is most likely to succeed in the Southern States and on the Pacific slope." (*Swingle.*) (See Nos. 3825 and 4336, inventory No. 8.)

5575. VICIA SATIVA. **Common vetch.**

"Doctor Trabut has been making comparative tests of all obtainable varieties of the common vetch at the Algerian Experiment Station at Rouïba. The one which proves best adapted to Algerian conditions is the present number, which is from the dry regions of Tunis." (*Swingle.*)

5576. VICIA BENGALENSIS. **Bengal vetch.**

"This name is given by the Kew Index as a synonym of *V. nissoliana.* It is one of the best of the numerous species of vetch grown at the Algerian Experiment Station at Rouïba. It somewhat resembles the scarlet vetch, attaining a considerable height." (*Swingle.*)

5572 to 5585—Continued.

5577. Vicia faba. **Horse bean.**

"This is a dwarf form of horse bean which Doctor Trabut reports as growing wild 25 miles south of Teniat. He considers it to be undoubtedly the wild form of the cultivated broad beans and horse beans. It is utilized by the Arabs, but is probably of little value compared with the improved form, though it may resist drought better, since it comes from a dry region in Algeria." (*Swingle.*)

5578. Melilotus macrostachys. **Melilot.**

"This species of melilot, native to Algeria, differs from most of the sweet clovers in having no pronounced odor. In consequence of this it is readily eaten by cattle. It has succeeded very well at the Experiment Station at Rouïba, where it attains a height of from 3 to 6 feet." (*Swingle.*)

5579. Trigonella corniculata. **Small fenugreek.**

"This species, which has the same strong odor as fenugreek, from which it differs, however, in having very much smaller pods and seeds, grows very vigorously at the Experiment Station at Rouïba, where it attains a height of from 3 to 5 feet. It could not be used for feeding milch cows, as the strong odor would make the milk unsalable. It is, however, used for fattening stock and as a green manure. It is said to resist drought very well." (*Swingle.*)

5580. Trigonella gladiata. **Trigonella.**

"This plant also resembles fenugreek in odor. It has been cultivated with some success at the Experiment Station at Rouïba." (*Swingle.*)

5581. Scorpiurus vermiculata. **Rabbit's ear.**

"This plant is a half-prostrate annual and grows wild all through northern Algeria. It is said to furnish an excellent forage on good land and the Arabs eat the seeds. The pods, which are bent more or less into a circle, are as large as one's finger and lie on the ground. They are eaten greedily by the sheep and constitute one of their important foods on the plains of northern Algeria." (*Swingle.*)

5582. Ononis avellana. **Ononis.**

"This is said by Doctor Trabut to be a good green manure for heavy soils. It is found only in Algeria, where it occurs in few localities on clay hills." (*Swingle.*)

5583. Lupinus angustifolius. **Narrow-leafed lupine.**

"This species is commonly grown by the Kabyles and Arabs, and is used by them as a substitute for coffee. It is the earliest maturing species grown in North Africa and is good for green manure. It is said to dislike an excess of lime in the soil." (*Swingle.*)

5584. Lupinus termis. **Egyptian or Corsican lupine.**

"This is considered by Doctor Trabut to be the best species for culture in North Africa. It is sown at the rate of about 100 pounds to the acre, in autumn, and it grows rapidly, and in February or March can be plowed under. It much resembles the white lupine, but is said to be taller and have larger seeds. It is a very promising species for culture in California." (*Swingle.*)

5585. Lathyrus tingitanus. **Tangier flat pea.**

"This species, which is a native of North Africa, is considered by Doctor Trabut to be one of the best forage plants in Africa. It reaches a height of from 3 to 4 feet and drives out all other plants. Sown in autumn it prevents the growth of all weeds, and on the 16th of May gives a crop of 3½ tons of dry hay to the acre. It is sown at the rate of about 50 pounds of seed per acre and is sometimes sown with one-third the weight of winter oats. It is a beautiful plant, very vigorous, and probably has a great future as a forage plant in the South and Southwest. (*Swingle.*)

5586. NEOWASHINGTONIA sp. **Fan palm.**

From San Diego, Cal. Presented by Mr. T. S. Brandegee; collected in Cajon de Santa Maria, near Calamaguet, on the eastern shore of Lower California.

5587. HUMULUS LUPULUS. **Hop.**

From Spalt, Bavaria, Germany. Received through Mr. D. G. Fairchild (No. 461), November 19, 1900.

Spalt City. "Cuttings or 'Fächser' of the finest Spalt hops grown in the restricted area of Spalt, Bavaria. These Spalt hops are renowned throughout Germany as next to the Saaz and Auscha, the best in the world. They are exported from here in considerable quantities to America where they are used by the large brewers in the manufacture of their finest beers. In planting these cuttings it should be remembered that they have been taken in October and transported to America and may suffer in vigor by this unusual treatment. The cuttings are planted here four or five together in one hill, being placed upright in the ground some 3 inches apart and covered about $1\frac{1}{2}$ to 2 inches with soil. The hills are from 3 to 4 feet apart each way. The soil, which is the most important item of any in hop culture, must be a sandy loam. In Spalt it is a disintegrated red sandstone, similar to the soil in the Bohemian hop region of Saaz. Only in the small region about the little village of Spalt do these famous hops develop their fine aroma and valuable lupulin contents. Before planting, the soil should be carefully worked to a depth of $2\frac{3}{4}$ to 3 feet and the culture should be scrupulously clean during the season. This is not a heavy bearer, one pound per pole being a maximum. Its value lies in its superior quality of aroma. The best grade of hop from which these cuttings are taken brings this year on the Spalt market over 15 cents per pound. Great care should be taken that no male hop plants are grown near these Spalt hops, as their presence induces a heavy seed production and an immediate lowering of the quality of the yield. Harvesting, sulphuring, etc., as usual." (*Fairchild.*)

5588. HUMULUS LUPULUS. **Hop.**

From Spalt, Bavaria, Germany. Received through Mr. D. G. Fairchild (No. 462, October 24, 1900), November 19, 1900.

Seed from the best *Spalt hops*, grown in the village of Massendorf. "This variety of hop produces very few seeds indeed, and these may be of distinct value for breeding purposes and for the selection of a more vigorous strain of superlative quality." (*Fairchild.*)

5589. COCHLEARIA ARMORACIA. **Horse-radish.**

From Biersdorf, Bavaria. Received through Mr. D. G. Fairchild (No. 457, October 19, 1900), November 12, 1900.

"Cuttings of a variety of Bavarian horse-radish which ranks among the best in Europe. It is much milder in flavor than the malin variety, and its method of cultivation is different." (*Fairchild.*) (See S. P. I. Circular No. 21.)

5590. HORDEUM DISTICHUM. **Barley.**

From Kitzing, Bavaria. Received through Mr. D. G. Fairchild (No. 458), November 26, 1900.

Lower Frankish *Kitzing* brewing barley. "The most noted Bavarian variety, and one of the best brewing barleys in the world. It is a heavy, thin-skinned sort containing a large percentage of starch. It was grown on a *heavy clay soil*, and should, according to the growers in Bavaria, be tried on a *light but not too sandy soil*. A change of soil is considered essential." (*Fairchild.*)

5591. HORDEUM DISTICHUM. **Barley.**

From Kitzing, Bavaria. Received through Mr. D. G. Fairchild (No. 459, October 22, 1900), November 26, 1900.

"This is the same as No. 5590, except that it was grown on light soil, and should, therefore, be tried on heavy clay soils in America." (*Fairchild.*)

5592. HORDEUM DISTICHUM. **Barley.**

From Würzburg, Bavaria. Received through Mr. D. G. Fairchild (No. 460, October 22, 1900), November 26, 1900.

Lower Frankish brewing barley. Essentially the same as Nos. 5590 and 5591. Suited to fairly light soils.

5593. HUMULUS LUPULUS. **Hop.**

From Wolnzach, Bavaria. Received through Mr. D. G. Fairchild (No. 462, October 25, 1900), November 19, 1900.

Cuttings from the Wolnzach hops. "These are late-ripening hops of excellent quality, but not so highly prized as those from Saaz or Spalt. Cuttings from 6-year-old stocks, suited to a friable loam; yield from $\frac{1}{4}$ to $\frac{1}{3}$ pound per pole; probably not so susceptible to soil conditions as the Saaz." (*Fairchild.*)

5594. HUMULUS LUPULUS. **Hop.**

From Wolnzach, Bavaria. Received through Mr. D. G. Fairchild (No. 463, October 25, 1900), November 19, 1900.

Seeds from Wolnzach hops.

5595 to 5608.

From the Government Laboratory, Georgetown, Demerara, British Guiana. Received through the Division of Chemistry, October 19, 1900.

A collection of sugar-cane arrows with fertile seeds sent by Mr. J. B. Harrison.

5595.	(J. B. H. 74.)	**5602.**	(J. B. H. 5044.)
5596.	(J. B. H. 116.)	**5603.**	(J. B. H. 5201.)
5597.	(J. B. H. 790.)	**5604.**	(J. B. H. 5443.)
5598.	(J. B. H. 1485.)	**5605.**	(J. B. H. 5444.)
5599.	(J. B. H. 1850.)	**5606.**	(J. B. H. 5454.)
5600.	(J. B. H. 2093.)	**5607.**	(J. B. H. 5717.)
5601.	(J. B. H. 5041.)	**5608.**	(J. B. H. 5774.)

5609. MELINIS MINUTIFLORA. **Molasses grass.**

From São Paulo, Brazil. Presented by the Brazilian minister, the Hon. Dr. J. F. de Assis-Brasil, through the U. S. Consul at São Paulo, September, 1900.

5610. VILLEBRUNEA INTEGRIFOLIA. **Assam rhea.**

From Calcutta, India. Presented by D. Prain, Superintendent of the Royal Botanic Garden, Calcutta. Received November 16, 1900.

(See Agric. Ledg., Calcutta, 1898, No. 15, for description of this fiber plant.)

5611. HUMULUS LUPULUS. **Hop.**

From Wolnzach, Bavaria. Received through Mr. D. G. Fairchild, November 19, 1900.

"A mixture of hop seeds from the drying room of Wolnzach." (*Fairchild.*)

5612. PASSIFLORA EDULIS. **Passion flower.**

From Auckland, New Zealand. Presented by J. P. Carolin, through Mr. George William Hill, Chief of the Division of Publications. Received November 21, 1900.

5613. ATRIPLEX LEPTOCARPA. **Saltbush.**

From Berkeley, Cal. Presented by the California Experiment Station, through Prof. Chas. H. Shinn. Received November 21, 1900.

5614. ATRIPLEX HALIMOIDES. **Saltbush.**

From Berkeley, Cal. Presented by the California Experiment Station, through Prof. Chas. H. Shinn. Received November 21, 1900.

5615. CINNAMOMUM CAMPHORA. **Camphor.**

From Berkeley, Cal. Presented by the California Experiment Station, through Prof. Chas. H. Shinn. Received November 21, 1900.

5616. VITIS VINIFERA. **Grape.**

From Saonara, Italy. Received through Mr. D. G. Fairchild, November 23, 1900, from Fratelli Sgaravatti.

Sultanina rosea.

5617 to 5621.

From Manila, P. I. Received July 1, 1900.

No descriptions furnished.

5617. ERYTHRINA CARNEA. **Dap-dap.**

5618. BIXA ORELLANA. **Achiote.**

5619. SOLANUM MELONGENA. **Eggplant.**

5620. COIX LACHRYMA-JOBI. **Job's tears.**

5621. INGA LANCEOLATA.

5622. HUMULUS LUPULUS. **Hop.**

From Tetschen, Bohemia. Received through Mr. D. G. Fairchild, November 30, 1900.

"Seed from wild hops growing on the grounds of the Experiment Station at Tetschen-Liebwerd." (*Fairchild.*)

5623. CLIANTHUS DAMPIERI.

From Roebourne, West Australia. Presented by Mr. W. F. Cusack. Received December 3, 1900.

"A beautiful garden flower and also good feed for stock. It will grow with 6 inches of rain per annum, or one day good rain in the year. The seed requires scorching or soaking in hot water." (*Cusack.*)

5624.

From Roebourne, West Australia. Presented by Mr. W. F. Cusack. Received December 3, 1900.

"A leguminous shrub 6 feet high. Splendid feed for horses, cattle, and sheep. It is smaller than 5623, erect instead of prostrate. A beautiful garden flower." (*Cusack.*)

5625.

From Roebourne, West Australia. Presented by Mr. W. F. Cusack. Received December 3, 1900.

Mundle bundle. "A good perennial tussock grass. Grows where the annual average rainfall is 14 inches, and the thermometer sometimes shows temperatures up to 127° F. in the shade." (*Cusack.*)

5626. **Pela.**

From Roebourne, West Australia. Presented by Mr. W. F. Cusack. Received December 3, 1900.

"A good annual. It grows on sandy soil very well with small rainfall." (*Cusack.*)

5627. RUBUS NUTKANUS. **Salmon berry.**

From Blaine, Wash. Presented by Mr. C. E. Flint. Received November 6, 1900.

A large red raspberry growing on the Pacific Coast of North America.

5628. TRITICUM VULGARE. **Wheat.**

From Portland, Oreg. Presented by Mr. R. C. Judson. Received December 4, 1900.

Yaroslaf winter wheat. Grown from No. 2792; imported from the Government of St. Petersburg, Russia, in March, 1899, by Mr. M. A. Carleton. Considered objectionable for Oregon because of bearded character.

5629. TRITICUM VULGARE. **Wheat.**

From Portland, Oreg. Presented by Mr. R. C. Judson. Received December 4, 1900.

Banatka winter wheat. Grown from No. 2956; imported by Mr. M. A. Carleton in March, 1899.

5630. TRITICUM VULGARE. **Wheat.**

From Portland, Oreg. Presented by Mr. R. C. Judson. Received December 4, 1900.

Sandomir winter wheat. Grown from No. 2958, imported by Mr. M. A. Carleton in March, 1899.

5631. HUMULUS LUPULUS. **Hop.**

From Schwetzingen, Germany. Received through Mr. D. G. Fairchild (No. 456, Nov. 6, 1900), December 5, 1900.

"Cuttings of the Schwetzingen hop, one of the best early varieties, ripening the middle of August. Not considered by Professor Braungart as so delicate as the 'Saaz' or 'Spalt,' and on this account may thrive better on American soils." (*Fairchild.*)

5632. CAESALPINIA BONDUCELLA.

From Manila, P. I. Received July, 1900.

This genus of leguminosæ contains some 40 species; inhabitants of the Tropics of both hemispheres. Robust, erect trees, shrubs, or woody prickly climbers; leaves large; flowers showy, yellow. In some parts of India it grows at an altitude of 2,500 feet. Oil from the seeds is useful in convulsions and palsy, debility after fever, and other diseases. Is said to soften the skin and remove pimples. The seeds are used instead of quinine, and also as an ointment. In disorders of the liver the leaves are considered very efficacious. The nuts are used for making bracelets and necklaces. The seeds are used by children in place of marbles and in other games. The root is also used for medical purposes.

5633. JUGLANS REGIA. **Walnut.**

From Mettmenstetten, Switzerland. Presented by Hon. A. Lieberknecht, U. S. Consul at Zürich.

5634. GARCINIA MANGOSTANA. **Mangosteen.**

From Ceylon. Received through Mr. D. G. Fairchild, December 7, 1900. Presented by Dr. Valentine Duke, of Newara, Eliya.

Fruits covered with a coating of paraffin to preserve the germinative power of the seeds.

5635. TRITICUM VULGARE. **Wheat.**

From Kurman-Kemelchi, Central Crimea. Received through Mr. M. A. Carleton, December 12, 1900.

Crimean. "A hard red winter wheat, one of the best in the world. Adapted for trial in Kansas, Oklahoma, northern Texas, Missouri, and southern portions of Iowa and Nebraska." (*Carleton.*)

5636. TRITICUM VULGARE. **Wheat.**

From Altonau, near Melitopol, in northern Taurida. Received through Mr. M. A. Carleton, December 12, 1900.

"Similar to No. 5635, but from a rather colder latitude and not ripening quite so early. Adaptation like No. 5635." (*Carleton.*)

5637. TRITICUM VULGARE. **Wheat.**

From Altonau, near Melitopol, in northern Taurida. Received through Mr. M. A. Carleton, December 12, 1900.

Girka winter wheat. "A beardless variety, soft-grained, but very hardy. Adaptation like No. 5635." (*Carleton.*)

5638. TRITICUM VULGARE. **Wheat.**

From Constantinovskol, 40 miles east of Stavropol, in north Caucasus. Received through Mr. M. A. Carleton, December 12, 1900.

Ulta. "A hard, red-grained, bearded, winter variety, very resistant to cold and drought. Adapted for trial as a winter wheat in Iowa, Nebraska, and the southern portions of Wisconsin, Minnesota, and South Dakota, and eastern Colorado. An excellent variety for all of Kansas and northern portions of Missouri and Oklahoma." (*Carleton.*)

5639. TRITICUM DURUM. **Wheat.**

From Uralsk Territory, Russia. Received through Mr. M. A. Carleton, December 12, 1900.

Kubanka. "One of the best macaroni wheats known. Sown in the spring. Admirably adapted for growing in the semiarid regions, between the one hundredth meridian and the Rocky Mountains, and North Dakota to Texas, and also in New Mexico, Arizona, Utah, eastern Oregon, and the Palouse country." (*Carleton.*)

5640. TRITICUM VULGARE. **Wheat.**

From Padi, Saratov, Russia. Received through Mr. M. A. Carleton, December 12, 1900.

Padi. "A beardless, soft, or semihard winter wheat. Adapted to all the northern winter wheat States, from New York to Kansas and southward to the thirty-fifth parallel." (*Carleton.*)

5641. TRITICUM VULGARE. **Wheat.**

From Starobelsk, Kharkof, Russia. Received through Mr. M. A. Carleton, December 12, 1900.

Kharkof. "A bearded, hard, red, winter wheat, similar to No. 5635, but coming from a region much farther north and therefore extremely hardy. Especially resistant to piercing, dry, winter winds, where there is little snowfall. Admirably adapted for trial as a winter wheat in Minnesota, South Dakota, Iowa, northern Nebraska, Wisconsin, and perhaps southern North Dakota." (*Carleton.*)

5642. TRITICUM DURUM. **Wheat.**

From Ambrocievka, 20 miles northeast of Taganrog, in the Don Territory, Russia. Received through Mr. M. A. Carleton, December 12, 1900.

Yellow Gharnorka. "A macaroni wheat similar to No. 5643, but having yellow grains. Sown in the spring. Adapted for trial in the most arid portions of the United States." (*Carleton.*)

5643. TRITICUM DURUM. **Wheat.**

From Ambrocievka, 20 miles northeast of Taganrog, in the Don Territory, Russia. Received through Mr. M. A. Carleton, December 12, 1900.

Gharnorka. "The best macaroni wheat from the vicinity of Taganrog. Sown in the spring. Adapted for trial in the most arid portions of the United States." (*Carleton.*)

5644. TRITICUM DURUM. **Wheat.**

From Ambrocievka, 20 miles northeast of Taganrog, in the Don Territory, Russia. Received through Mr. M. A. Carleton, December 12, 1900.

Velvet Don. "An excellent macaroni wheat with *black beards.* Sown in the spring. Adaptation same as for No. 5643." (*Carleton.*)

5645. TRITICUM DURUM. **Wheat.**

From Ambrocievka, 20 miles northeast of Taganrog, in the Don Territory, Russia. Received through Mr. M. A. Carleton, December 12, 1900.

Black Don. "A *black-chaff* macaroni wheat. Sown in the spring. This wheat and the two preceding numbers, however, might be sown in November or December with good results in Texas, New Mexico, Arizona, and southern California. Adaptation same as for No. 5643." (*Carleton.*)

5646. TRITICUM DURUM. **Wheat.**

From Taganrog, Don Territory, Russia. Received through Mr. M. A. Carleton, December 12, 1900.

Gharnovka. "A spring wheat, but may be sown in late autumn south of the 35th parallel. This and No. 5643 are the best of the Taganrog macaroni wheats. Adaptation same as for three preceding numbers." (*Carleton.*)

5647. PANICUM MILIACEUM. **Proso.**

From Uralsk Territory, Russia. Received through Mr. M. A. Carleton, December 12, 1900.

White Ural. "The best sort for milling and extremely drought resistant. Adapted to growing in all semiarid districts west of the Mississippi River." (*Carleton.*)

5648. PANICUM MILIACEUM. **Proso.**

From Uralsk Territory, Russia. Received through Mr. M. A. Carleton, December 12, 1900.

Yellow Ural. "A variety of excellent quality, yielding heavily, and very resistant to drought. Adaptation same as No. 5647." (*Carleton.*)

5649 to 5686. PRUNUS DOMESTICA. **Prune.**

From France. Received through Mr. E. R. Lake, December 8, 1900. A collection of French grafted stock, as follows:

5649.

Cœur de bœuf. From Salvetat, Carcassonne, France. (Lake No. 1.)

5650.

Chaproni. From Vallerand, Traverny, France. (Lake No. 2.)

5651.

Giant. From Barbier, Orleans, France. (Lake No. 3.)

5652.

Isjum Erik. From Barbier, Orleans, France. (Lake No. 4.)

5653.

Des Béjonniers. From Barbier, Orleans, France. (Lake No. 5.)

5654.

Quetsche sucré. From Barbier, Orleans, France. (Lake No. 6.)

5655.

Mirabelle de Metz. From Barbier, Orleans, France. (Lake No. 7.)

5649 to 5686—Continued.

5656.

Sainte Catherine. From Barbier, Orleans, France. (Lake No. 8.)

5657.

Bleu de Belgique. From Rothberg, Gennevilliers, France. (Lake No. 9.)

5658.

Jaune d'Agen. From Rothberg, Gennevilliers, France. (Lake No. 10.)

5659.

The Czar. From Rothberg, Gennevilliers, France. (Lake No. 11.)

5660.

Grand Duc. From Rothberg, Gennevilliers, France. (Lake No. 12.)

5661.

Altesse. From Rothberg, Gennevilliers, France. (Lake No. 13.)

5662.

Big rose. From Croux et Fils, Paris, France. (Lake No. 14.)

5663.

Quetsche de Letricourt. From Croux et Fils, Paris, France. (Lake No. 15.)

5664.

Belle de Louvrain. From Croux et Fils, Paris, France. (Lake No. 16.)

5665.

Surpasse monsieur. From Croux et Fils, Paris, France. (Lake No. 17.)

5666. (Number not occupied.)

5667.

Tardive musque. From Baltet Frères, Troyes, France. (Lake No. 19.)

5668.

Mirabelle grosse. From Baltet Frères, Troyes, France. (Lake No. 20.)

5669.

Mirabelle petite. From Baltet Frères, Troyes, France. (Lake No. 21.)

5670.

Mirabelle précoce. From Baltet Frères, Troyes, France. (Lake No. 22.)

5671.

Mirabelle tardive. From Baltet Frères, Troyes, France. (Lake No. 23.)

5672.

De Norbet. From Baltet Frères, Troyes, France. (Lake No. 24.)

5673.

Monsieur hâtif. From Baltet Frères, Troyes, France. (Lake No. 25.)

5674.

Précoce de Tours. From Baltet Frères, Troyes, France. (Lake No. 26.)

5675.

Prince Englebert (strain). From Baltet Frères, Troyes, France. (Lake No. 27.)

5649 to 5686—Continued.

5676.
Reine Claude d'Oullins. From Baltet Frères, Troyes, France. (Lake No. 28.)

5677.
Reine Claude d'Althau. From Baltet Frères, Troyes, France. (Lake No. 29.)

5678.
De Montfort. From Baltet Frères, Troyes, France. (Lake No. 30.)

5679.
D'Agen améliorée. From Baltet Frères, Troyes, France. (Lake No. 31.)

5680.
Quetsche de Dorel. From Baltet Frères, Troyes, France. (Lake No. 32.)

5681.
Reine des Mirabelles. From Baltet Frères, Troyes, France. (Lake No. 33.)

5682.
Reine Victoria. From Fleury-Meudon, near Paris, France. (Lake No. 34.)

5683.
Violet prune. From Fleury-Meudon, near Paris, France. (Lake No. 35.)

5684.
Sannois quetsche. From Sannois, France. (Lake No. 36.)

5685.
Reine Claude violette (strain). From Sannois, France. (Lake No. 37.)

5686.
Gloire d'Épinay. From Epinay, France. (Lake No. 38.)

5687. PYRUS MALUS. **Apple.**

From France. Received through Mr. E. R. Lake, December 8, 1900.

Transparente de Croncels. (Lake No. 39.)

5688. PYRUS MALUS. **Apple.**

From France. Received through Mr. E. R. Lake, December 8, 1900.

Transparente de Zurich. (Lake No. 40.)

5689. VITIS VINIFERA. **Grape.**

From France. Received through Mr. E. R. Lake, December 8, 1900.

Gamay. (Lake No. 41.)

5690 to 5744. PYRUS spp. **Apple.**

From France. Received through Mr. E. R. Lake, December 8, 1900. A collection of ornamental apples, as follows:

5690. SEROTINA.
5691. HILLENT ARGENTE.
5692. OBLONGA.
5693. JOHN DOWNIE.
5694. PAUL'S IMPERIAL.
5695. SPECTABILIS IMPERIAL.
5696. PULCHELLA.
5697. SPECIOSA.
5698. SULFUREA.
5699. ATROPURPUREA.
5700. NIVEA POLYPETALA.
5701. FASTIGIATA.
5702. FLAVA.
5703. INTERMEDIA.
5704. TURBINATA.
5705. COERULESCENS.
5706. HALLEANA.
5707. VESPER ROSE.
5708. MARENGO.
5709. TENORII CARNEA PLENA.
5710. AMPLA.
5711. PRUNIFOLIA PENDULA.
5712. MINNESOTA.
5713. SPHAEROCARPA.

5690 to 5744—Continued.

5714. General Grant.
5715. Tardiv d'hiver.
5716. Ringo.
5717. Pulchra.
5718. Kaido.
5719. Magnifica.
5720. Nigra.
5721. Edulis.
5722. Orange.
5723. Lady Elgin.
5724. Translucens.
5725. Montreal Beauty.
5726. Lutescens.
5727. Magnifica.
5728. Flavescens.
5729. Cire.
5730. Longifolia.
5731. Maxima.
5732. À fleur double.
5733. Fastigiata bifera.
5734. Whitney.
5735. À fruit blanc.
5736. Quaker beauty.
5737. Ibric?
5738. Spectabilis Imperial Reveni.
5739. Nikita floribunda.
5740. Van Wyck.
5741. Hyslop.
5742. The Fairy.
5743. Toringo.
5744. Yellow Siberian.

5745. Eucalyptus globulus.

From San Francisco, Cal. Received through Trumbull and Beebe, July 14, 1900.

5746 to 5750. Trifolium pratense. **Red clover.**

From Hamburg, Germany. Received December 14, 1900. A collection of seeds of various European strains, as follows:

5746. English.
5747. Hungarian.
5748. Italian.
5749. Russian.
5750. Silesian.

5751. Andropogon rufus. **Jaragua.**

From Matto Grosso Province, Brazil. Presented by the Brazilian minister, Hon. J. F. de Assis-Brasil, December 1, 1900.

A native fodder grass called by the Portuguese "provisorio." Described by Mr. Assis-Brasil in his book on Brazilian agriculture. (See letter of October, 1899.)

5752. Arctostaphylos sp. **Pendicuas.**

From Celaya, Mexico. Presented by Prof. Felix Foëx. Received December 10, 1900.

"The brown berries of this plant are edible. When fresh they are not disagreeable, having a fresh subacid flavor. When dried they are nearly tasteless, but are used in great quantities medicinally. An infusion is used for catarrh and headaches. The tree which produces them is very ornamental." (*Foëx.*)

5753. Carica heterophylla. **Jarrilla.**

From Celaya, Mexico. Presented by Prof. Felix Foëx. Received December 10, 1900.

"A curious fruit, being *drunk* as one would swallow a raw egg, and not eaten. The name is *Jarrilla* or 'little pitcher,' because it is shaped like a pitcher and is always full of water. The water contained in it is fresh and slightly acid, resembling lemon juice. When the fruit is taken from the plant it acquires in a few days a bitter taste, something like lemon peel, but without its aroma. The plant is a perennial, half climber, and grows wild on the hills around Celaya." (*Foëx.*)

5754. Triticum durum. **Wheat.**

From Matagalpa, Nicaragua. Presented by Hon. Isaac A. Manning, U. S. consular agent. Received December 17, 1900.

Nicaragua. Grown at an elevation of 2,200 feet.

5755. Cucumis melo. **Muskmelon.**

From Erfurt, Germany. Received December 13, 1900.

Coral Reef. This is a cantaloupe of very striking appearance, the rind being studded with warty excrescences. The melon is bright yellow, with reddish markings, small seed cavity, and greenish yellow flesh. If planted in frames in winter it ripens fruit in early summer.

5756. Hordeum distichum. **Barley.**

From Pilsen, Austria. Received through Mr. D. G. Fairchild (No. 466, November 7, 1900), February 9, 1901.

Mixed barley used for brewing the original Pilsen beer; said by the brewing master of the great Pilsen "Urquelle" Brewery to compare favorably with *Hanna* barley.

5757. Humulus lupulus. **Hop.**

From Polepp, Bohemia. Received through Mr. D. G. Fairchild (No. 469, November 14, 1900), December 18, 1900.

Seed from the drier in Polepp of the *Semsch Red* variety.

5758. Humulus lupulus. **Hop.**

From Polepp, Bohemia. Received through Mr. D. G. Fairchild (No. 470), December 18, 1900.

Red Semsch. "This variety originated in the immediate neighborhood of Polepp. It was discovered in 1853 as a sport among the so-called 'Tschims' hops, which were then grown here in Polepp, by Wenzel Semsch, a hop grower then only 20 years of age. This hop is earlier than the Saaz variety and more productive. It is remarkably uniform in time of blooming and ripening, and has been sent all over Bohemia and Alsatia, and thousands of cuttings go every year to Saaz, where they are planted. The largest proportion of Saaz hops comes from these cuttings. The exact locality of the garden from which these cuttings were taken I can not positively affirm further than that it is in the renowned Polepp or Polepp-Platte region, which is famous through its production of a quality of hop which often in good years approaches very closely to that of the best Saaz variety. The important facts are that it is an August-ripening hop of very uniform maturity and possessed of a very fine aroma and 'bitter' (so fine in fact that it is everywhere reported as being used for mixing with Saaz hops as a substitute), and a productiveness which stands to the Saaz hop as 5 to 3 in proportion; 180 poles will yield 110 pounds of hops, while it requires about 300 poles of the Saaz to yield as much. The soil upon which these hops are grown is a dark friable loam with a subsoil of gravel, in strong contrast with the soil of Saaz or Spalt, which is so-called perm or disintegrated red sandstone. The whole Polepp region, which is the largest single stretch of hop country in Bohemia, has this dark, rich, alluvial soil. Formerly the whole valley bottom was a peat bog. Fine sand is often used to lighten the soil. It is strewn along the rows and worked in. For further particulars regarding the origin of this Semsch hop, see No. 5759." (*Fairchild.*)

5759. Humulus lupulus. **Hop.**

From Werbitz, Bohemia. Received through Mr. D. G. Fairchild (No. 471), December 18, 1900.

Semsch red. "Cuttings of the original specimen from the garden of the son of Wenzel Semsch, to whose efforts the production and distribution of this remarkable hop are due." (*Fairchild.*)

5760. HUMULUS LUPULUS. **Hop.**

From Saaz, Bohemia. Received through Mr. D. G. Fairchild (No. 475, November 19, 1900), December 18, 1900.

Saaz. One-year-old plants of the original *Saaz* hop. This variety has without doubt the finest "bitter" and best "aroma" of any known sort, but its small yield makes it an unprofitable kind to raise. It requires often from 300 to 480 plants to produce 110 pounds of hops, while 180 poles of the *Semsch red* will produce the same amount. These plants come from the city region of Saaz, where the soil is a brick-red broken-down sandstone of the Lower Permian formation.

5761. COCHLEARIA ARMORACIA. **Horse-radish.**

From Malin (Kuttenberg), Bohemia. Received through Mr. D. G. Fairchild (No. 479, November 22, 1900), December 18, 1900.

Malin. The finest flavored, sharpest horse-radish in the world, being cultivated in a different way from that generally practiced in America. The marketable shoots are only one season old instead of several. (See Circular No. 1, Section of Seed and Plant Introduction.)

5762. CYDONIA VULGARIS. **Quince.**

From Carlovitz, Slavonia. Presented by Director Hess, of the Agricultural School of Laun, Bohemia, through Mr. D. G. Fairchild (No. 473, November 15, 1900). Received December 18, 1900.

Cuttings from a tree that bore fruit weighing 14 ounces, of excellent shape, and of a deeper yellow than most quinces seen in America. Said to be an indigenous Slavonian variety.

5763. ARACHIS HYPOGAEA. **Peanut.**

From Washington, D. C. Seed of No. 4253, grown during the season of 1900 on the Potomac Flats.

5764 to 5766. GLYCINE HISPIDA. **Soy bean.**

From Washington, D. C. Three varieties of soy beans from Japan, grown during the season of 1900 on the Potomac Flats.

5764. COMMON. (S. P. I., No. 4912.)

5765. BEST WHITE. (S. P. I., No. 4913.)

5766. BEST GREEN. (S. P. I., No. 4914.)

5767. PISTACIA VERA × P. TEREBINTHUS.

From San Francisco, Cal. Presented by Mr. G. P. Rixford, through Mr. W. T. Swingle. Received December, 1900.

"This number comprises the fruits of the terebinth tree ripened near San Francisco. Most of these fruits contain no seed, although they look very plump and have a perfectly developed pit or stone. According to Mr. Rixford, the fruits which are decayed or with dark-purple exteriors are the ones which most often contain seeds. The majority of the fruits vary from wine color to pink and are more or less studded over with white specks. The flesh is very thin, probably only about one thirty-second of an inch." (*Swingle.*)

5768. HUMULUS LUPULUS. **Hop.**

From Tettnang, Bavaria. Received from Mr. J. A. Bueble, through Mr. D. G. Fairchild (No. 464, November 4, 1900), December 26, 1900.

"Sets of the earliest ripening hop variety in Europe, often maturing by the end of July. They occupy a special place on the European hop market, being used by many breweries for brewing their first summer beer." (*Fairchild.*)

5769. BETA VULGARIS. **Sugar beet.**

From Paris, France. Received February, 1900.

Vilmorin's French Very Rich.

5770. BETA VULGARIS. **Sugar beet.**

From Germany. Received February, 1900.

Strandes Kleinwanzleben.

5771. BETA VULGARIS. **Sugar beet.**

From Germany. Received February, 1900.

Hoernings Kleinwanzleben.

5772. BETA VULGARIS. **Sugar beet.**

From Germany. Received February, 1900.

Dippes Kleinwanzleben Elite.

5773. BETA VULGARIS. **Sugar beet.**

From Utah. Received February, 1900.

American-grown seed. From Lehi, Utah.

5774. CUCUMIS MELO. **Winter muskmelon.**

From Arizona. Received December 29, 1900.

Seed grown at Phoenix, Ariz., from No. 149, originally imported from New Bokhara, Turkestan, by Prof. N. E. Hansen, February, 1898.

5775. VACCINIUM VITIS-IDAEA. **Foxberry.**

From Finland. Presented by Dr. Gösta Grotenfeld. Received December 31, 1900.

5776. OXYCOCCUS PALUSTRIS. **Small cranberry.**

From Finland. Presented by Dr. Gösta Grotenfeld. Received December 31, 1900.

5777. QUEBRACHIA LORENTZII. **Quebracho colorado.**

From La Plata, Argentina. Presented by Dr. Carlos Spegazzini. Received January 4, 1900.

"A magnificent slow-growing tree, with a wood like iron, containing much tannic acid. Last year's seeds from Salta Province." (*Spegazzini.*)

5778. MACHAERIUM TIPU. **Tipu.**

From La Plata, Argentina. Presented by Dr. Carlos Spegazzini. Received January 4, 1900.

"Leguminosæ; beautiful tree for gardens and forest, rapid grower, producing excellent wood for building purposes." (*Spegazzini.*)

5779. ELYMUS ANDINUS. **Coiron flor.**

From La Plata, Argentina. Presented by Dr. Carlos Spegazzini. Received January 4, 1901.

5780. LIBOCEDRUS CHILENSIS.

From La Plata, Argentina. Presented by Dr. Carlos Spegazzini. Received January 8, 1901.

Cipres de Patagonia.

5781. ASPIDOSPERMA QUEBRACHO BLANCO. **Quebracho blanco.**

From La Plata, Argentina. Presented by Dr. Carlos Spegazzini. Received January 8, 1901.

"A very rapidly growing tree, with medicinal properties." (*Spegazzini.*)

5781a. GOMPHOCARPUS sp. **Buluba.**

From La Plata, Argentina. Presented by Dr. Carlos Spegazzini. Received December, 1900.

5782. LATHYRUS MAGELLANICUS.

From La Plata, Argentina. Presented by Dr. Carlos Spegazzini. Received January, 1901.

Mixed seeds of this and *Vicia macraei.*

5783. PROSOPIS DENUDANS.

From La Plata, Argentina. Presented by Dr. Carlos Spegazzini. Received January 5, 1901.

Algarroba orozii?

5784. BERBERIS DULCIS.

From La Plata, Argentina. Presented by Dr. Carlos Spegazzini. Received January 5, 1901.

Calafata parra. From Chubut.

5785. PHYSALIS FRANCHETI (?).

From Tokyo, Japan. Presented by Mr. T. Watase, of Tokyo Plant and Seed Co. A variety with very large fine fruits.

5786. GOMPHOCARPUS sp. **Buluba.**

From the Soudan, Africa. Presented by Doctor Trabut, Government Botanist of Algeria, through Mr. Lyster H. Dewey, Assistant Botanist, U. S. Department of Agriculture.

"I have cultivated this species of gomphocarpus for several years under the name 'Buluba.' It attains a large growth, and yields a beautiful fiber closely resembling silk." (*Trabut.*)

5787. HUMULUS LUPULUS. **Hop.**

From Bohemia, Austria-Hungary. Received through Mr. D. G. Fairchild (No. 483), January, 1901.

Semsch. "Cuttings of this noted hop, from the neighborhood of the most famous locality of the Platte, where it is known to yield almost as fine hops as the best Saaz variety and in much larger quantity. It is this variety which the growers of the Saaz variety have imported in large quantities into Saaz to replace the old Bohemian variety, which has so fallen off in yield that its culture no longer pays, unless a fancy price can be secured. These hops possess an aroma that is really fine. Professor Chodounsky, of the Experiment Station for Brewing Industries in Prague, one of the best-known and most careful judges of hop varieties, says of this Semsch hop:

"'This red hop, which gives a much larger yield than the old Bohemian red hop (Saaz variety), is to be reckoned among the very good hops. It has an oval form, a well-shaped spindle, and an agreeable aroma. It is considered as an intermediate type approaching the Rakonitz-Saaz hop, standing next to it as regards worth. This is probably the best yielder of all the really fine European varieties.'

"As these cuttings have been secured with great difficulty, and as it will be more and more difficult to obtain others, they should be given especial attention. In order to propagate them as rapidly as possible, the young shoots should be layered next spring and cut into lengths when rooted. These cuttings have been taken from one of the best hop gardens in the Platte region in Bohemia, but being cut during the winter they are not as thrifty as if taken in the spring. The rule in Bohemia is to place a single cutting in a hill, but if small and weak it might be better to put two together.

"These hops produce the finest aroma when planted on yellow clay soils. The vines are light yellow when grown in sandy or clayey soil, but darker when grown where the soil has more humus, or is of a peaty or swampy character—what the Germans call '*moor Erde.*'" (*Fairchild.*)

5788 to 5792. HORDEUM DISTICHUM. **Barley.**

From Munich, Bavaria. Received through Mr. D. G. Fairchild (No. 467), January 16, 1901.

A collection of prize-winning barleys from the Barley and Hop Exposition, 1900. Forwarded by Hon. James H. Worman, U. S. Consul at Munich, as follows:

5788. (467b.)
5789. (467d.)
5790. (467e.)
5791. (467f.)
5792. (467g.)

5793. HORDEUM DISTICHUM NUTANS. **Barley.**

From Kwassitz, Moravia, Austria. Received through Mr. D. G. Fairchild (No. 481), January 16, 1901.

Moravian or *Hanna.* "The noted *Hanna* brewing barley from the breeder or selecter, Emanuel Ritter von Proskowetz, of Kwassitz. This is unquestionably one of the best brewing barleys in the world and is noted for its qualities of early ripening, unusual heavy yields, and special mealiness, which latter, together with other qualities of kernel, renders it one of the great favorites among German as well as Austrian brewers. Notwithstanding a duty in Bavaria of 22 marks per German ton on brewing barleys and an increased cost of transportation, the best Bavarian breweries import this *Hanna* barley. In the Thirty-ninth Session of the Bavarian House of Deputies (1899) the purchase of these *Hanna* barleys among other foreign sorts by the famous Hofbrauhaus was made the reason of an attack upon the director of this State institution and, although the claim was not sustained that the *Hanna* barley is superior to the *best* Bavarian, the inference which is drawn is that on the average it is more satisfactory and economical from the brewer's standpoint. The former director of the Brauhaus Staubwasser claimed in his defense that the *Hanna* barley, especially that grown in Hungary, was ready for malting earlier than Bavarian varieties, which speaks for the earliness of the variety claimed by the producer. Von Proskowetz claims for the variety a *pedigree* and says that it was selected as a single plant from some barley which he knew to be of very old Moravian origin. Through careful selection he has been able to bring its productivity up to 3,700 kilos per hectare and *shorten its period of growth by over a week.* It is a light straw producer *suited especially to light or sandy loams.* Owing to its early ripening quality it is especially valuable in Hungary, where the hot season occurs the latter part of July, but after the *Hanna* barley has so far matured as to be little influenced by it. Sow in March, or earlier if possible, providing soil is in proper condition. On light soil drill in rows 5 inches apart, on heavier soils 6 to 7 inches. If it can be made to follow a beet root or potato crop so much the better. Owing to its heavy yielding capacity, earliness, and high grade as a brewing grain, this variety is driving out all other sorts in Austria and every year large quantities of seed grain are imported into Hungary. So far as I can ascertain this is the first importation of this variety ever made into America." (*Fairchild.*)

5794. HORDEUM DISTICHUM. **Barley.**

From Leneschitz, Bohemia. Received from Prof. Frantisek Hess, of the Laun Ag. School, through Mr. D. G. Fairchild (No. 472, November 15, 1900), January 16, 1901.

An excellent brewing barley, probably not a pure stock. A part of the same lot which took the first prize in the Austrian section of the Paris Exposition. From the estate of Josef Pisoft.

5795. PHASEOLUS VULGARIS. **Adler bean.**

From Sachsenfeld, Styria, Austria. Received through Mr. D. G. Fairchild (No. 484, December 21, 1900), January 16, 1901.

Adler. A sample. "One of the finest varieties known in Austria. It is indigenous to Styria, where it is considered by connoisseurs an exceptionally fine table bean. I have eaten it and found it unusually good, though the skin is somewhat tough. It is, however, worth a trial by experiment stations." (*Fairchild.*)

5796. PAPAVER SOMNIFERUM. **Poppy.**

From Sachsenfeld, Styria, Austria. Received through Mr. D. G. Fairchild (No. 485, December 20, 1900), January 16, 1901.

A large-podded variety of poppy, grown in Styria exclusively for the production of oil. The pods are collected in autumn, dried, their tops cut off, and the seed shaken out. The seed is then ground and an oil is pressed out of it. This oil is extensively used in cooking and as a table oil. It is said not to grow rancid, and is very highly esteemed by the Styrians. The pods are often 2 inches in diameter." (*Fairchild.*)

5797. COFFEA ARABICA. **Coffee.**

From Macassar, Celebes. Presented by Mr. Karl Auer, U. S. consular agent, Macassar, through Messrs. Lathrop and Fairchild (No. 485*a*, February 11, 1900), January 22, 1901.

Patjoe or *Bonthain* coffee. "A superior local variety from south Celebes, which was formerly exported in large quantities to Europe." (*Fairchild.*)

5798. BROMELIA sp. **Timbiriche.**

From Celaya, Mexico. Presented by Prof. Felix Foëx. Received January 22, 1901.

"Like the Jarilla (No. 5753), it is a fruit to be drunk, not eaten. It is ground or crushed in water. The Mexicans prefer this as a refreshing drink to lemonade made from lemons. It is especially valuable for improving hard water, i. e., calcareous or magnesian waters, because the acid in the fruit precipitates these salts. The fruit does not grow in this vicinity, but in an arid region higher up. The plant is said to resemble the Yucca, but I have not seen it. The fruits sell in the markets here at 1 cent each, while other fruits have no value because of their abundance." (*Foëx.*)

5799. TRITICUM POLONICUM. **Polish wheat.**

From France. Received January 23, 1901.

Polish or *Astrakhan.*

5800. TRITICUM DURUM. **Wheat.**

From Paris, France. Received January 23, 1901.

Belotourka.

5801. LAVANDULA VERA. **Lavender.**

From Paris, France. Received January 23, 1901.

5802. LAVANDULA SPICA. **Spike lavender.**

From Paris, France. Received January 23, 1901.

5803. SESAMUM INDICUM. **Sesame.**

From Paris, France. Received January 23, 1901.

White seeded.

5804. SESAMUM INDICUM. **Sesame.**

From Paris, France. Received January 23, 1901.

Yellow seeded.

5805 to 5809. ANDROPOGON SORGHUM. **Sorghum.**

From Medicine Lodge, Kans. Received February, 1901. Seed of the following varieties:

5805.

Amber.

5806.

Collier.

5807.

Colman.

5808.

Kansas orange.

5809.

Minnesota early amber.

5810 to 5823. PYRUS MALUS. **Apple.**

From Stockholm, Sweden. Presented by Director Axel Pihl, of the Swedish Horticultural Society, Rosendal, through Messrs. Lathrop and Fairchild (Nos. 400–413, July 18, 1900). Received February 4, 1901.

5810.

Astrachan sparreholms (Svensk Pomologi Applen, p. 73). "Originated in 1859. Ripens late in September; not commonly cultivated even in Sweden; as good as any ripening at this time; believed to be a hybrid between White Astrakhan and Rosenhäger." (*Fairchild.*)

5811.

Bjorkvicks (Svensk Pomologi, p. 93). "A fall apple; well known; first described in 1862; original tree in middle Sweden, at Bjorkvicks." (*Fairchild.*)

5812.

Fagerö (Svensk Pomologi, p. 91). "A new sort worthy of trial. Not well known, even in Sweden." (*Fairchild.*)

5813.

Frösåkers. "A fall apple, little known, even in Sweden. Director Pihl says it is a good sort; has been introduced into Finland within the last ten years, and is cultivated there with great success." (*Fairchild.*)

5814.

Gimmersta. "Of unknown origin. Little known, even in Sweden. An excellent early (September) table apple; very hardy; a first-rate market apple." (*Fairchild.*)

5815.

Hampus. "A summer apple of the very first quality; rather small; trees hardy, but of slow growth; probably of Swedish origin; very commonly grown; one of the best known and most extensively grown sorts." (*Fairchild.*)

5816.

Oranie. "A well-known summer or early autumn sort, in color not very attractive, but in flavor next to "Humus," the best in Sweden; very heavy and early bearer; hardy; largely cultivated in Sweden. Director Pihl recommends it heartily for trial." (*Fairchild.*)

5817.

Svensk vinterpostof. "One of the oldest and commonest sorts; late autumn and early winter variety of medium quality; most used as a table apple, but is suitable for kitchen use; does not keep late into winter." (*Fairchild.*)

5810 to 5823—Continued.

5818.

Ringstads. "A showy red-cheeked table apple of excellent quality; a good market sort; largely planted in Sweden and Finland; quite hardy. Highly recommended by Director Pihl." (*Fairchild.*)

5819.

Stenkyrke. "One of the very best Swedish sorts. Excellent keeper. A very good table apple. Originated on the chalky soil of Gottland. It does well on clay soil and is heartily recommended by Director Pihl." (*Fairchild.*)

5820.

Stäringe. "Late summer or early autumn variety. Ripens in September. A table apple of very fine quality. Origin unknown. Ranks very high, though it is not very commonly cultivated." (*Fairchild.*)

5821.

Säfstaholms. "Ripens in September. A most popular sort and one Director Pihl thinks would be very highly prized in America. A table sort made known by the well-known Swedish pomologist, Olof Eneroth. Quite hardy." (*Fairchild.*)

5822.

Åkerö. "This variety is considered, at the present time, to be the best of all the Swedish apples. The tree is one of the hardiest and of uncommonly strong growth. Not liable to disease. A winter table apple of excellent quality. Keeps until spring. A heavy bearer only at advanced age. Grows well in any kind of soil. The original tree is standing at Åkerö, although planted more than one hundred years ago. Much propagated in last twenty-five years." (*Fairchild.*)

5823.

Olands Kungs. "Closely related to *Scharlakansparmän*, but is not the same. A small, very bright red table apple. Sold in very large quantities as a Christmas-tree apple, for which it is especially suited, as it keeps well until Christmas. Hardy and tolerably productive." (*Fairchild.*)

5824. PRUNUS DOMESTICA. **Plum.**

From Stockholm, Sweden. Presented by Director Axel Pihl through Messrs. Lathrop and Fairchild (No. 414, July 18, 1900). Received February 4, 1901.

Allmänna gul. "A very good cooking plum. Extremely hardy, but not a very heavy bearer. Almost always propagated by root division. Grown as far north as any plum." (*Fairchild.*)

5825. CERATONIA SILIQUA. **Carob.**

From Lissa Island, Dalmatia. Received through Mr. D. G. Fairchild (No. 499, January 7, 1901), February 5, 1901.

"Bud sticks of a variety with large sweet pods." (*Fairchild.*)

5826. LATHYRUS PLATYPHYLLUS.

From Stockholm, Sweden. Presented by Prof. V. Wittrock, director of the botanic gardens, Frescati, through Messrs. Lathrop and Fairchild (No. 441, August 11, 1900). Received February 5, 1901.

"A species of Lathyrus named by Retzius *L. platyphyllus.* Its origin is uncertain. In Professor Wittrock's garden, at Frescati, are plants which have been growing for twelve years. One of these is planted against a wall 12 feet or more high, and the plant has spread over a large surface and overtops the wall by several feet. The vigor of this plant is remarkable and the amount of fodder produced apparently great. So far no experiments with the plant have been made in the field. As it is a perennial and makes a comparatively little growth in the first three years, such experiments as have been started do not as yet show results. A few seeds only are obtainable here, as the plant seldom ripens its seeds in this latitude. Director Wittrock thinks it is quite possible that this plant is a different variety from that described by Retzius. So far as I am aware it is quite unknown as a fodder plant outside of southern Sweden, where Professor Wittrock has sent seeds. It deserves careful attention." (*Fairchild.*)

5827. BROMUS INERMIS. **Smooth brome-grass.**

From Stockholm, Sweden. Presented by Prof. V. Wittrock through Messrs. Lathrop and Fairchild (No. 442, August 10, 1900). Received February 5, 1901.

5828. CEPHALARIA TATARICA.

From Stockholm, Sweden. Presented by Prof. V. Wittrock through Messrs. Lathrop and Fairchild (No. 443, August 10, 1900). Received February 5, 1901.

"A new fodder plant of exceptionally vigorous growth. Professor Wittrock thinks it is worthy of extensive trial." (*Fairchild.*)

5829. HEDYSARUM OBSCURUM.

From Stockholm, Sweden. Presented by Prof. V. Wittrock through Messrs. Lathrop and Fairchild (No. 445, August 10, 1900). Received February 5, 1901.

"A high Alpine fodder plant which occurs above the timber line and is especially suited to mountain climates, although growing well in deep soil in the valleys or on the plains. The root system is very long; grows readily from seed if latter has been passed through a 'preparator' or rubbed with sandpaper. Otherwise it will take one to three years to germinate. Has been grown here twelve years on same spot. Yield is good. Highly ornamental. Professor Wittrock says it is the best Alpine fodder plant he knows." (*Fairchild.*)

5830. CALAMAGROSTIS PHRAGMITOIDES.

From Stockholm, Sweden. Presented by Prof. V. Wittrock through Messrs. Lathrop and Fairchild (No. 446, August 11, 1900). Received February 5, 1901.

"An excellent fodder grass for moist localities. It very seldom seeds, but spreads rapidly when once planted. Yields a heavy, nutritious fodder." (*Fairchild.*)

5831. AMMOPHILA ARENARIA. **Beach-grass.**

From Stockholm, Sweden. Presented by Prof. V. Wittrock through Messrs. Lathrop and Fairchild (No. 447, August 11, 1900). Received February 5, 1901.

"An excellent fodder grass for moist localities in high latitudes. The plant has a wandering habit. It dies out in one place after a few years, but spreads from a center in all directions. It yields a large quantity of valuable fodder, according to Professor Wittrock." (*Fairchild.*)

5832. GLYCERIA SPECTABLIS.

From Stockholm, Sweden. Presented by Prof. V. Wittrock through Messrs. Lathrop and Fairchild (No. 448, August 11, 1900). Received February 5, 1901.

"A forage plant grown extensively in some parts of Sweden. Adapted to moist places. Baron von Pijkull Volloesäby, of Knifsta, Sweden, has large cultures of this plant and can supply rhizomes in quantity for trial if desired." (*Fairchild.*)

5833. VERBASCUM SPECIOSUM.

From Stockholm, Sweden. Presented by Prof. V. Wittrock through Messrs. Lathrop and Fairchild (No. 449, August 11, 1900). Received February 5, 1901.

"An East European or West Asiatic biennial that has just been determined by Professor Wittrock. It is quite new, and one of the most gorgeous yellow decorative plants I have ever seen. The immense flower spikes, of which there are many branches, remain covered with blossoms for more than a month. Caution should be taken with it as, like others of the same genus, it may prove a weed. Professor Wittrock says it is very easily rooted out and will probably never be a bad weed." (*Fairchild.*)

5834. TRIFOLIUM PANNONICUM.

From Stockholm, Sweden. Presented by Prof. V. Wittrock. Received February 5, 1901.

5835. FESTUCA ARUNDINACEA.

From Stockholm, Sweden. Presented by Dr. V. Wittrock. Received February 3, 1901.

5836. HUMULUS LUPULUS. **Hop.**

From Polepp, Bohemia. Received through Mr. D. G. Fairchild (No. 470a), 1901.

Red Semsch. Same as No. 5758.

5837. COCHLEARIA ARMORACEA. **Horse-radish.**

From Polepp, Bohemia. Received through Mr. D. G. Fairchild, January, 1901.

5838. ELEUSINE CORACANA. **Ragi millet.**

From Rhodesia, South Africa. Presented by Dr. Wm. L. Thompson, of Oberlin, Ohio.

Upoka or *Ngoza.* "This is the most important food plant of the natives of Rhodesia and its yield of seed is said to be something phenomenal." (*Fairchild.*)

5839. CUCUMIS SATIVUS. **Cucumber.**

From Znaim, Austria. Received through Mr. D. G. Fairchild (No. 480), January 10, 1901.

Znaim. "A variety largely grown for salting and pickling. Said by Mr. W. W. Tracy, sr., to be a mixture of strains probably deriving its name merely from the noted locality where cucumber growing is largely practiced." (*Fairchild.*)

5840. ACTINIDIA.

From Ichang, China. Received through Mr. G. D. Brill (No. 1), December, 1900.

"Large fruited. Chinese name *Yang Tao.*" (*Brill.*)

5841. ASTRAGALUS CICER.

From Stockholm, Sweden. Presented by Dr. V. Wittrock through Messrs. Lathrop and Fairchild (No. 444, August 10, 1900). Received February 6, 1901.

"Considered by Doctor Wittrock to be a very important forage plant. It spreads with great rapidity and should be watched as it may become a weed. Suited to both sandy and clay soils. A true Steppe plant. Better for prairies than for cultivated lands." (*Fairchild.*)

5842. HORDEUM DISTICHUM. **Barley.**

From Binsbach, Bavaria. Received from Mr. D. G. Fairchild, through the kindness of Hon. James H. Worman, United States Consul at Munich, 1901.

Chevalier.

5843. HORDEUM VULGARE. **Barley.**

From Binsbach, Bavaria. Received from Mr. D. G. Fairchild, through the kindness of Hon. James H. Worman, United States Consul at Munich, 1901.

Webs.

5844. HORDEUM VULGARE. **Barley.**

From Binsbach, Bavaria. Received from Mr. D. G. Fairchild, through the kindness of Hon. James H. Worman. United States Consul at Munich, 1901.

Franken.

5845. HORDEUM DISTICHUM. **Barley.**

From Thalham, Bavaria. Received from Mr. D. G. Fairchild, through the kindness of Hon. James H. Worman, United States Consul at Munich, 1901.

Bohemian.

5846. HORDEUM DISTICHUM var. NUTANS. **Barley.**

From Binsbach, near Gonheim, Bavaria. Received through Mr. D. G. Fairchild (No. 478), February, 1901.

"This barley was awarded the gold medal as the best of 680 exhibits of brewing barley at the Bavarian Barley and Hop Exposition, held at Munich, September 29 to October 3, 1900." (*Fairchild.*)

5847 to 5899. HORDEUM DISTICHUM. **Barley.**

From Paris. Received through Mr. D. G. Fairchild, February, 1901. Samples of barley obtained at the exposition, as follows:

5847.

Kitzinger.

5848.

Pilsen.

5849.

Laniger. (No. 573.)

5850.

Kwassitzer.

5851.

Landgerste. (No. 442.)

5852.

Scottish pearl. (No. 159.)

5853.

Chevalier. (No. 47.)

5854.

Fünfstettener. (No. 551.)

5855.

Fünfstettener. (No. 63.)

5856.

Saal or *Kaiser.* (No. 167.)

5857.

Frankish. (No. 608.)

5858.

Common two-rowed. (No. 238.)

5859.

(No. 479.)

5860.

(No. 108.)

5861.

Lower Bavarian. (No. 476.)

5862.

Hanna. (No. 149.)

5863.

Melon. (No. 325.)

5864.

Imperial. (No. 48.)

5865.

Chevalier. (No. 64.)

5866.

Chevalier. (No. 198.)

5867.

Bohemian. (No. 135.)

5868.

Bohemian. (No. 454.)

5869.

Goldthorpe. (No. 1.)

5870.

Frankish. (No. 356.)

5847 to 5899—Continued.

5871.
Frankish. (No. 300.)

5872.
Lower Bavarian. (No. 417.)

5873.
Mittelgerste Thürengen. (No. 599.)

5874.
Christensen's Goldthorpe. (No. 43.)

5875.
Juwel. (No. 324.)

5876.
Bavarian. (No. 567.)

5877.
Hanna. (No. 79.)

5878.
Laninger. (No. 670.)

5879.
(No. 683.)

5880.
Frankish. (No. 220.)

5881.
Hanna. (No. 152.)

5882.
Webbs. (No. 191.)

5883.
Lower Bavarian. (No. 107.)

5884.
Tauber. (No. 310.)

5885.
(No. 3.)

5886.
Bohemian. (A).

5887.
Poppenheim.

5888.
(Probably not a pure variety.)

5889.
(No. 2.)

5890.
Poppenheim.

5891.
Hanna.

5892.
Kitzingen.

5893. (Number not used.)

5894.
Hanna.

5895.
Bohemian.

5896.
Bohemian.

5897.
I Schwarzenberg.

5898.
II Schwarzenberg.

5899.
III Schwarzenberg.

5900. CUCUMIS SATIVUS. **Cucumber.**

From Auburn, N. Y. Received through Mr. G. W. Boynton, February 6, 1901.

Aksel dwarf, grown from No. 8, Inventory No. 1.

5901. RAPHANUS SATIVUS. **Radish.**

From Amite City, La. Received through Mr. W. O. Posey, February 6, 1901.

Seed grown from No. 1189, Inventory No. 2.

5902. CAPSICUM ANNUUM. **Sweet pepper.**

From Anna Maria Key, Fla. Received through Mr. W. C. Berg, February 9, 1901.

Seed grown from No. 3976, Inventory No. 8.

5903. HORDEUM DISTICHUM. **Barley.**

From Saaz, Bohemia. Received through Mr. D. G. Fairchild (No. 477, Nov. 20, 1900), February 9, 1901.

"Bohemian brewing barley from the estates of Prince Schwarzenberg, at Jinovic, near Saaz. From sandy loam, soil rich in lime. Much exported to Norway. This is an excellent representative Bohemian barley, though probably not a pure variety." (*Fairchild.*)

5904. CUCUMIS MELO. **Muskmelon.**

From Elgin, Utah. Received through Mr. J. F. Brown, February 9, 1901.

Khira. Seed grown from No. 114, Inventory No. 1.

5905. SECALE CEREALE. **Rye.**

From Tenmile, W. Va. Received through Mr. F. Spiker, February 12, 1901.

Winter Ivanof, grown from No. 1342, Inventory No. 2.

5906. CUCURBITA MAXIMA. **Honey pumpkin.**

From Eden, Nebr. Received through Mr. D. J. Wood, February 14, 1901.

Seed grown from No. 14, Inventory No. 1.

5907. CHAETOCHLOA ITALICA. **Millet.**

From Brookings, S. Dak. Received through Prof. D. A. Saunders, February 15, 1901.

Seed grown from No. 2798, Inventory No. 7.

5908. CUCUMIS MELO. **Muskmelon.**

From Waterloo, Kans. Received through Mr. J. W. Riggs, February 14, 1901.

Maroussia Lesseritsky, grown from No. 27, Inventory No. 1.

5909 to 5918. VITIS VINIFERA. **Grape.**

From Lesina Island, Dalmatia. Received through Mr. D. G. Fairchild (Nos. 486–495), February 20, 1901. A collection of grape cuttings of the following varieties:

5909.

Boglich. "A dark-colored sweet table grape having a thick skin. The bunches are said to grow to a very large size, sometimes weighing as much as fourteen pounds. Suitable for limestone soils." (No. 486.) (*Fairchild.*)

5910.

Marascina. "A small light-brown translucent grape, of unusual sweetness. It is a shy bearer and subject to Peronospora. Originated near Sebenico on mainland. A high-grade dessert wine, known as *Marascina*, is made from this grape. This wine somewhat resembles Marsala, but is considered by some as superior, and sells for a much higher price than any of the other wines of this region." (No. 487.) (*Fairchild.*)

5911.

Stronzo di Gallo. "One of the three best grapes grown on this island. It is a thin-skinned white grape of a peculiar long shape and contains but one seed. It will keep until January. Suitable for poor limestone soils." (No. 488.) (*Fairchild.*)

5909 to 5918—Continued.

5912.

Kurtelaska. "A white wine grape, native of the island, producing medium-sized crowded clusters. A wine known as 'Apollo,' highly prized in Germany and Austria, is made by extracting the juice from the fresh grapes and fermenting it, separated from the skins. Suitable for limestone soils." (No. 489.) (*Fairchild.*)

5913.

Dernekusa. "The black grape from which the common wine of Lesina is made. It is a thin-skinned grape of medium size, and is said to be a fair table grape. It is a heavy producer." (No. 490.) (*Fairchild.*)

5914.

Ugava. "A white grape serving for the production of a bottled wine exported from Lesina. Only a few plantations of this variety exist on the island because the plants require a *rich* soil. The wine is sold for 1.20 to 1.30 florins a liter, which is high, considering that ordinary wines bring from .25 to .50 florin a liter." (No. 491.) (*Fairchild.*)

5915.

Banjoska. "A variety of wine grape brought to the island from a neighboring small island, called 'San Clementi,' according to accounts given me. It makes a strong wine, which is imported especially into Hungary. Berries small. Heavy bearer. Suitable for dry, strong, calcareous situations." (No. 492.) (*Fairchild.*)

5916.

Palarusa. "A white wine variety from which much of the Lesina wine is produced. One hundred kilos of grapes yield, it is said, 90 kilos of wine. Not particular as to soil." (No. 493.) (*Fairchild.*)

5917.

Puiska. "A thick-skinned, firm-fleshed white grape, originally from Apulia, Italy, but grown here many years. Said to be a very heavy bearer." (No. 494.) (*Fairchild.*)

5918.

Trojka. "A very large table grape of excellent flavor. It is a heavy bearer and keeps well. It is a native of Lesina and requires a rich soil." (No. 495.) (*Fairchild.*)

5919. Ficus carica. **Fig.**

From Lesina Island, Dalmatia. Received through Mr. D. G. Fairchild (No. 496, Jan. 7, 1901), February 20, 1901.

San Pietro. "The figs of the small island of Lesina, which lies off the Dalmatian coast, are noted in Triest as the most delicate of any which come to that port, except the high-priced Smyrna sorts. They have not the size or the flavor of the Smyrnas, but, considering the fact that they do not require fertilization with the caprifig insect, they are certainly worthy of a trial in the California fig plantations. This variety is a very early one, ripening here in June. It is also reported to be exceptionally large." (*Fairchild.*)

5920. Ficus carica. **Fig.**

From Lesina Island, Dalmatia. Received through Mr. D. G. Fairchild (No. 497, January 7, 1901), February 20, 1901.

Zarniza. "Cuttings of one of the ordinary figs grown on this island. Dark in color, produces crops twice a year. It is sometimes dried and packed in small barrels and exported." (*Fairchild.*)

5921. FICUS CARICA. **Fig.**

From Lesina Island, Dalmatia. Received through Mr. D. G. Fairchild (No. 498, January 7, 1901), February 20, 1901.

Zamožujič'a. "A good fig with unusually tender skin, far superior to the dried Italian or Greek figs. Many maintain that as far as tenderness of skin is concerned it is really superior to the Smyrna figs. It is not fertilized by the caprifig insect and may prove a superior sort if once fertilized seed are produced. Worthy of trial. This fig is shipped in large quantities to Triest." (*Fairchild.*)

5922. AMYGDALUS PERSICA. **Peach.**

From Lesina Island, Dalmatia. Received through Mr. D. G. Fairchild (No. 500, January 8, 1900), February 20, 1901.

Giallo. "Cuttings of one of the best peaches of Dalmatia, and, although a clingstone, is worth trying in any variety test. Suitable for stony hillsides of a calcareous nature." (*Fairchild.*)

5923. AMYGDALUS PERSICA. **Peach.**

From Lesina Island, Dalmatia. Received through Mr. D. G. Fairchild (No. 501, January 8, 1900), February 20, 1901.

Bianca. "Cuttings of a white-fleshed freestone peach of excellent quality, maturing in August. Suitable for stony hillsides of a calcareous nature." (*Fairchild.*)

5924. PYRUS COMMUNIS. **Pear.**

From Lesina Island, Dalmatia. Received through Mr. D. G. Fairchild (No. 502, January 8, 1901), February 20, 1901.

Nyoko. "Cuttings of a variety of pear said to be of superior quality. Somewhat similar to the Bartlett. Suitable for calcareous hillsides in warm climates like Arizona and southern California." (*Fairchild.*)

5925. BRASSICA OLERACEA. **Cabbage.**

From Osage, Iowa. Received through Mr. George Phillips, February 12, 1901.

Earliest white, grown from No. 6. Inventory No. 1.

5926. BRASSICA OLERACEA. **Cabbage.**

From Osage, Iowa. Received through Mr. George Phillips, February 13, 1901.

White Reval, grown from No. 4. Inventory No. 1.

5927. PHASEOLUS VULGARIS. **Bean.**

From Waynesville, N. C. Received through Dr. G. D. Green, February 13, 1901.

Flageolet, grown from No. 2069. Inventory No. 5.

5928. CICER ARIETINUM. **Garbanzo.**

From Tenino, Wash. Received through Mr. J. F. Cannon, February 25, 1901. Seed grown from No. 2376. Inventory No. 5.

5929. PHASEOLUS VULGARIS. **Bean.**

From Judsonia, Ark. Received through Mr. Jacob C. Bauer, February 23, 1901.

Soissons, grown from No. 2068. Inventory No. 5.

5930. ANDROPOGON SORGHUM. **Sorghum.**

From Scottsville, Ky. Received through Mr. Rupert Huntsman, February, 1901.

Colman, grown from No. 4308. Inventory No. 8.

5931. Prunus domestica. **Plum.**

From Saaz, Bohemia. Presented by Doctor Wolfram through Mr. D. G. Fairchild (No. 476, November 18, 1900). Received February 26, 1901.

Dolan. "Cuttings of a plum originated in the village of Dolan, near Saaz, and said by Doctor Wolfram, one of the best Bohemian horticulturists, to be of superior quality. The dried prunes made from this sort are said to be little, if any, inferior to the famous Bosnian prunes. They are large and sweet, and have a flat stone that separates very easily from the flesh." (*Fairchild.*)

5932. Sorbus edulis. **Sorb apple.**

From Saaz, Bohemia. Presented by Doctor Wolfram through Mr. D. G. Fairchild (No. 474, November 18, 1900). Received February 26, 1901.

"Cuttings of a variety of Sorb apple discovered several years ago in the forests of Moravia, and since distributed by the Austrian Government through its agricultural schools. The fruit is small, about the size of *Vaccinium vitis-idæa*, and, when cooked, the 'compot' closely resembles that made from this cranberry." (*Fairchild.*)

5933. Pyrus malus. **Apple.**

From Saaz, Bohemia. Received through Doctor Wolfram, February 26, 1901.

Calville Madame Lesans. "Similar to *Calville blanc*, but more resistant to fungous attacks." (*Wolfram.*)

5934. Fagopyrum esculentum. **Buckwheat.**

From Berlin, Conn. Received through Mr Earl Cooley, February 26, 1901.

Orenburg, grown from No. 2801. Inventory No. 7.

5935. Astragalus sinicus. **Genge clover.**

From Yokohama, Japan. Received through Suzuki and Iida, March 2, 1901.

5936. Lupinus pilosus caeruleus. **Lupine.**

From Paris, France. Received through Vilmorin-Andrieux & Co., February, 1901.

5937. Lupinus pilosus roseus. **Lupine.**

From Paris, France. Received through Vilmorin-Andrieux & Co., February, 1901.

5938. Avena sativa. **Oat.**

From Proskurow, Russia. Received through Dr. S. de Mrozinski, March 6, 1901.

Sixty-day. Originated by Doctor Mrozinski.

5939. Gossypium barbadense. **Egyptian cotton.**

From Mansourah, Egypt. Received through Mr. Alfred Dale, March 6, 1901.

Jannovitch.

5940. Oryza sativa. **Rice.**

From Mansourah, Egypt. Received through Mr. Alfred Dale, March 6, 1901.

Fino.

5941. Oryza sativa. **Rice.**

From Mansourah, Egypt. Received through Mr. Alfred Dale, March 6, 1901.

Eyne-il-Bint.

5942. LOTUS ULIGINOSUS.

From Paris, France. Received through Vilmorin-Andrieux & Co., March 9, 1901.

5943. PINUS SYLVESTRIS. **Scottish pine.**

From Paris, France. Received through Vilmorin-Andrieux & Co., March 9, 1901.

5944. PINUS SYLVESTRIS. **Scottish pine.**

From Paris, France. Received through Vilmorin-Andrieux & Co., March 9, 1901.

Var. *Rigensis.*

5945. PICEA EXCELSA. **Norway spruce.**

From Paris, France. Received through Vilmorin-Andrieux & Co., March 9, 1901.

5946 to 5957. LINUM USITATISSIMUM. **Flax.**

From Paris, France. Received through Vilmorin-Andrieux & Co., March 9, 1901. A collection of seed of different varieties, as follows:

5946.

Common flax.

5947.

True imported *Riga.*

5948.

French-grown *Riga.*

5949.

White-flowering.

5950.

Yellow-seeded.

5951.

Pskoff.

5952.

Improved Russian imported *Pskoff.*

5953.

Winter.

5954.

Of Belgian origin.

5955.

Of Dutch origin.

5956.

Nostrana of Lombardy.

5957.

Catanian or Sicilian.

5958. CICHORIUM INTYBUS. **Chicory.**

From Görz, Austria. Received through Mr. D. G. Fairchild (No. 515, January 24, 1901), March 11, 1901.

"A white variety of this excellent winter salad plant, which is one of the specialties of Görz." (*Fairchild.*)

5959. BRASSICA OLERACEA. **Cabbage.**

From Görz, Austria. Received through Mr. D. G. Fairchild (No. 516, January 24, 1901), March 11, 1901.

"A variety of cabbage which is noted for its remarkable winter-keeping qualities. Recommended by Director Bolley, of the Görz Experiment Station, for trial in the Southern States." (*Fairchild.*)

5960. BRASSICA OLERACEA. **Cabbage.**

From Bocche di Cattaro, Dalmatia. Received through Mr. D. G. Fairchild (No. 520, February 2, 1901), March 11, 1901.

"Seed of a perennial cabbage known as *Capuzzo,* which forms the principal food of many hundreds of families in Dalmatia. Grown especially in the regions about Cattaro and Ragusa. It grows to a height of 5 feet and bears in this warm climate tender leaves throughout the winter. These are picked off singly, or the whole, rather irregular, small head is cut off. The stems sprout out again and furnish, in a few months, a second crop of edible leaves. They require little culture and are allowed to stand in the fields for three or four years. Other crops are cultivated between the rows of *Capuzzo*. The method of planting is precisely similar to that for cabbages. From the ease with which it is grown and its apparent favor among the common people this plant is worthy a trial in the Southern States." (*Fairchild.*)

5961 to 5963. NICOTIANA TABACUM. **Tobacco.**

From Corfu, Greece. Presented by the director of the Corfu Agricultural Experiment Station through Mr. D. G. Fairchild (Nos. 523–525, February 9, 1901). Received March 11, 1901.

"Seeds of the Turkish tobaccos from which the noted Egyptian cigarettes are made, being exported from parts of Turkey where they are grown, into Egypt where they are manufactured. Egyptian cigarettes are said to be made of blends of these three and other tobaccos." (*Fairchild.*)

5961.

Kavala, from the region in Turkey of this name. (No. 523.)

5962.

Xanthe, from the region in Turkey of this name. (No. 524.)

5963.

Trebizond, from the region in Asia Minor of this name. (No. 525.)

5964. CUPRESSUS SEMPERVIRENS. **Cypress.**

From Ragusa, Dalmatia. Received through Mr. D. G. Fairchild (No. 526, February 7, 1901), March 11, 1901.

"The cypresses of Ragusa and vicinity are very beautiful, and seem to be a distinct strain, much more symmetrical in shape than the common pyramidal kind grown in America." (*Fairchild.*)

5965. VICIA FABA. **Broad bean.**

From Corfu, Greece. Received through Mr. D. G. Fairchild (No. 527, February 9, 1901), March 11, 1901.

"Sample of a variety of broad bean originally from the island of Malta. It is a very heavy bearer and is preferred by the planters of Corfu to the native varieties." (*Fairchild.*)

5966. AVENA SATIVA. **Oats.**

From Proskurow, Russia. Received through Dr. S. de Mrozinski, March 8, 1901.

Polish. "Very fruitful and resistant to all changes of temperature. In spite of great drought, it gives comparatively good yields." (*Mrozinski.*)

5967. AVENA SATIVA. **Oats.**

From Proskurow, Russia. Received through Dr. S. de Mrozinski, March 8, 1901.

Polish. The same as No. 5966.

5968. TRIFOLIUM PRATENSE. **Red clover.**

From Proskurow, Russia. Received through Dr. S. de Mrozinski, March 8, 1901.

5969. TRIFOLIUM PRATENSE. **Red clover.**

From Proskurow, Russia. Received through Dr. S. de Mrozinski, March 8, 1901.

Same as No. 5968.

5970. KOCHIA SCOPARIA.

From Tokyo, Japan. Received through Mr. T. Watase, December 28, 1900.

5971. HUMULUS LUPULUS. **Hop.**

From Tettnang, Bavaria. Received through Mr. D. G. Fairchild (No. 482, December 10, 1900), March 12, 1901.

Tettnang late. Seed.

5972. VIOLA ODORATA. **Violet.**

From Görz, Austria. Received through Mr. D. G. Fairchild (No. 513, January 23, 1901), March 12, 1901.

Czar. "A single violet from Antonio Ferrant's houses that has been cultivated here for many years. It has a decided perfume, but is inferior to the double varieties." (*Fairchild.*)

5973. VIOLA ODORATA. **Violet.**

From Görz, Austria. Received through Mr. D. G. Fairchild (No. 512, January 23, 1901), March 12, 1901.

Conte de Brazza. "A double white violet originated in Italy and brought to Austria by Count de Brazza. It is said to be one of the best white varieties known." (*Fairchild.*)

5974. VIOLA ODORATA. **Violet.**

From Görz, Austria. Received through Mr. D. G. Fairchild (No. 511, January 23, 1901), March 12, 1901.

Parmensis. "An unusually large sweet-scented double violet, somewhat similar to the *Neapolitan.* The favorite market sort of Görz. A native of France, being found wild about Grasse." (*Fairchild.*)

5975. HORDEUM DISTICHUM. **Barley.**

From Leschkau bei Podersam, Bohemia. Presented by Wilhelm Hoffer & Son, through Mr. D. G. Fairchild. Received February, 1901.

Goldfoil.

5976. HORDEUM DISTICHUM. **Barley.**

From Kitzingen, Bavaria. Presented by Nathan Gerste & Son, through Mr. D. G. Fairchild, February, 1901.

Kitzing. "Of the best quality." (*Fairchild.*)

5977. UMBELLULARIA CALIFORNICA. **California laurel.**

From San Bernardino, Cal. Received through Mr. S. B. Parish, February, 1901.

5978. ACTINIDIA sp.

From Ichang, China. Received through Mr. G. D. Brill (No. 2), December, 1900.

Yang tao. "Bears a fruit resembling the gooseberry, about 1¼ inches long and 1 inch in diameter. Skin dull purple and quite tough. Eaten raw or cooked and also used for preserves. There are several species, to all of which the Chinese give the name *Yang tao.*" (*Brill.*)

5979. Actinidia sp.

From Ichang, China. Received through Mr. G. D. Brill (No. 3), December, 1900.

Yang tao. "Fruit larger and more pointed than No. 5978. The skin is a lighter purple and thinner, and when eaten raw this has the better flavor." (*Brill.*)

5980. Eucommia ulmoides.

From Ichang, China. Presented by Mr. E. H. Wilson, of Kew Gardens, through Mr. G. D. Brill (No. 4). Received December, 1900.

Ti Cheng. "A medium-sized tree growing wild around Ichang. It is said to be cultivated in the mountains of Hupei. The bark is used as a medicine and the glutinous seeds to adulterate silk. It is said that rubber can be extracted from the seeds. No successful experiments have, however, been made in the extraction of this supposed rubber." (*Brill.*)

5981. Benthamia fragifera. **Strawberry tree.**

From Ichang, China. Received through Mr. G. D. Brill, December, 1900.

"Medium-sized tree, quite showy, fruit very palatable and used for food in some parts of China." (*Brill.*)

5982. Citrus limonum. **Lemon.**

From Bocce di Cattaro, Dalmatia. Received through Mr. D. G. Fairchild (No. 517, February 1, 1901), March 13, 1901.

Cattaro Giant. "A very large lemon, said to have originated in Mesopotamia. The trees are very vigorous and good bearers. The fruit sometimes weighs four or five pounds, and has a flesh of excellent flavor and juiciness." (*Fairchild.*)

5983. Juglans regia. **Walnut.**

From Bocce di Cattaro, Dalmatia. Received through Mr. D. G. Fairchild (No. 578, February 2, 1901), March 13, 1901.

Giant of Cattaro. "A very large English walnut of fine flavor, which brings double the price of ordinary walnuts on the Dalmatian market. Specimens, which were said to be smaller than the average, measured 2¼ inches long by 1⅝ inches in diameter. The shell is hard and irregular. The tree grows rapidly and is a free bearer. Scions were taken from a tree on the farm of Francesco Navarin. Called to my attention by Cristoforo Spalatin of Castelnuovo." (*Fairchild.*)

5984. Olea europaea. **Olive.**

From Bocce di Cattaro, Dalmatia. Received through Mr. D. G. Fairchild (No. 519, February 2, 1901), March 13, 1901.

Giant of Cattaro. "A very large seedling olive, specimens of which measured 1¾ inches in length by 1 inch in diameter. From two trees growing near Castelnuovo. Called to my attention by Cristoforo Spalatin." (*Fairchild.*)

5985. Vitis vinifera. **Grape.**

From Corfu, Greece. Received through Mr. D. G. Fairchild (No. 521, February 7, 1901), March 13, 1901.

Sultanina. "A light-yellow, transparent, seedless raisin grape. Considered to be one of the most valuable varieties, and that from which the 'Sultanina' seedless raisins of Greece are made. These raisins must not be confused with the 'Corinths,' for they are twice as large, of a light golden color, semitransparent, and much more valuable." (*Fairchild.*)

5986. Citrus limonum. **Lemon.**

From Corfu, Greece. Received through Mr. D. G. Fairchild (No. 522, February 7, 1901), March 13. 1901.

A giant-fruited variety of lemon, probably the same as No. 5982.

5987. PUNICA GRANATUM. **Pomegranate.**

From Patras, Greece. Presented by the British consul, Mr. F. B. Wood, through Mr. D. G. Fairchild (No. 548, February 16, 1901). Received March 14, 1901.

"A very large pomegranate, sometimes at least 6 inches in diameter. The fruit is red and attractive, and instead of being sweet as most sorts are, this is sour like a lemon." (*Fairchild.*)

5988. PUNICA GRANATUM. **Pomegranate.**

From Patras, Greece. Presented by the British consul, Mr. F. B. Wood, through Mr. D. G. Fairchild (No. 549, February 16, 1901). Received March 14, 1901.

"A large sweet-flavored pomegranate of excellent quality." (*Fairchild.*)

5989. CITRUS AURANTIUM. **Blood orange.**

From Patras, Greece. Presented by the British consul, Mr. F. B. Wood, through Mr. D. G. Fairchild (No. 550, February 16, 1901). Received March 14, 1901.

Patras blood. "A small, nearly seedless blood orange, the pulp being the most completely blood-red of any orange I have ever seen, the segment partitions especially so. Skin too thin for a good shipping variety, mottled dark and light, with many large oil glands. It is very juicy, of excellent, almost vinous flavor."—(*Fairchild.*)

5990. CITRUS AURANTIUM. **Blood orange.**

From Corfu, Greece. Received through Mr. D. G. Fairchild (No. 528, February 10, 1901), March 14, 1901.

"A blood variety, the pulp of which is beautifully mottled with light red and the skin with a darker orange color." (*Fairchild.*)

5991. CITRUS LIMONUM. **Lemon.**

From Corfu, Greece. Received through Mr. D. G. Fairchild (No. 529, February 10, 1901), March 14, 1901.

"A variety of lemon which bears quite seedless fruits from the flowers which mature in October, and fruits full of seed from the spring flowers. The seedless fruits are called "mules" or "mulas," and differ in shape from the ordinary, being more globose and possessing a persistent pistil which often projects some distance beyond the circumference of the fruit. Often over 10 and sometimes even 20 per cent of the fruits on a tree are seedless, I am told. I am inclined to attribute the seedlessness to lack of fertilization." (*Fairchild.*)

5992. CORYLUS sp. **Hazelnut.**

From Corfu, Greece. Presented by Antonio Colla through Mr. D. G. Fairchild (No. 540, February 13, 1901). Received March 14, 1901.

"A large thin-shelled, full-meated hazelnut, growing wild in Corfu. The trees are vigorous and good bearers." (*Fairchild.*)

5993. CITRUS LIMONUM. **Lemon.**

From Corfu, Greece. Received through Mr. D. G. Fairchild (No. 530, February 10, 1901), March 14, 1901.

Similar to No. 5991.

5994. POPULUS ALBA (?) **Poplar.**

From Patras, Greece. Presented by the British consul, Mr. F. B. Wood, through Mr. D. G. Fairchild (No. 551, February 16, 1901). Received March 14, 1901.

"Cuttings from a poplar of remarkably rapid growth. The tree is 30 years old and over $3\frac{1}{2}$ feet in diameter, while neighboring trees of about the same age are not more than half that size. The tree is very beautiful, of spreading habit." (*Fairchild.*)

5995. TRITICUM VULGARE. **Wheat.**

From San Giovanni a Teduccio, Italy. Received through Dammann & Co. (No. 1), March 12, 1901.

Scavurso.

5996. TRITICUM VULGARE. **Wheat.**

From San Giovanni a Teduccio, Italy. Received through Dammann & Co. (No. 2), March 12, 1901.

Iumilio.

5997. TRITICUM VULGARE. **Wheat.**

From San Giovanni a Teduccio, Italy. Received through Dammann & Co. (No. 3), March 12, 1901.

Biancolilla.

5998. BORONIA MEGASTIGMA.

From Melbourne, Australia. Presented by Carolin & Co. Received March, 1901.

"Sow in spring in seed pans in light, loamy soil. Plant out in autumn from 2 to 4 feet apart. Use no manure. The plants come into bearing the second year, and live six or seven years." (*Carolin.*)

5999. TRITICUM DURUM. **Wheat.**

From Proskurow, Russia. Presented by Dr. S. de Mrozinski. Received March 19, 1901.

Kubanka. A sample packet of this well-known variety of macaroni wheat.

6000 to 6110.

From Russia, Hungary, and Roumania. Received through Mr. M. A. Carleton, November, 1900.

A collection of seeds secured during the season from June to September, 1900.

6000. TRITICUM VULGARE. **Wheat.**

From Odessa, Russia. "A semihard red wheat; of good quality for milling, but not commonly exported. Adapted for cultivation in the middle States of the Plains." (*Carleton.*)

6001. TRITICUM VULGARE. **Wheat.**

From Odessa, Russia. *Ulta.* "A hard or semihard red spring wheat of excellent quality for milling, forming a large part of the wheat that is exported from the Kherson and Ekaterinoslav governments through Odessa." (*Carleton.*)

6002. TRITICUM VULGARE. **Wheat.**

From Odessa, Russia. *Ghirka.* "This is the principal beardless variety of red spring wheat grown in Russia, particularly in south Russia and the Volga River region. It differs from the usual varieties of Russian spring wheat in being beardless and not quite so hard grained. It forms a large part of the wheat exported from Russia." (*Carleton.*)

6003. TRITICUM VULGARE. **Wheat.**

From Berdiansk, Russia. *Berdiansk.* "A red, hard-grained, bearded winter wheat with white chaff, very similar to Crimean. It is grown in the region north of the Sea of Azov. It is an excellent variety for cultivation in the middle prairie States." (*Carleton.*)

6004. TRITICUM VULGARE. **Wheat.**

From Berdiansk, Russia. *Belokoloska.* "A red, hard-grained, beardless spring wheat with white chaff, very similar to No. 6001. Grown in the vicinity of the Sea of Azov." (*Carleton.*)

6000 to 6110—Continued.

6005. TRITICUM DURUM. **Wheat.**

From Berdiansk, Russia. *Arnautka.* "A very good sample of this variety of wheat commonly grown in the region just north of the Sea of Azov." (*Carleton.*)

6006. TRITICUM VULGARE. **Wheat.**

From Konstantinovskoe, Russia. *Ulta.* See No. 5638.

6007. TRITICUM VULGARE. **Wheat.**

From Tsaritsyn, Russia. *Torgova.* "A very hard-grained, hardy winter wheat grown in the extreme northern portion of Stavropol government, well adapted for trial in Iowa, Nebraska, and South Dakota." (*Carleton.*)

6008. TRITICUM DURUM. **Wheat.**

From Tsaritsyn, Russia. *Black Don or Chernokoloska.* "A very good variety of macaroni wheat, with black chaff, grown in the Don Territory near Poltava, Russia." (*Carleton.*)

6009. TRITICUM DURUM. **Wheat.**

From Tsaritsyn, Russia. *Kubanka.* "A very good sample of this variety of macaroni wheat commonly grown in south Russia." (*Carleton.*) See No. 5639.

6010. TRITICUM VULGARE. **Wheat.**

From Berdiansk, Russia. *Belokoloska.* The same as No. 6004.

6011. TRITICUM DURUM. **Wheat.**

From Saratov, Russia. *Egyptian.* "A very hard-grained variety of macaroni wheat somewhat similar to Kubanka, but having longer grains." (*Carleton.*)

6012. TRITICUM VULGARE. **Wheat.**

From Rostov-on-Don, Russia. *Beloglino.* "One of the hardiest red winter wheats known. Grown near Beloglinskaya, in the northern portion of the Stavropol Government, a region of great extremes of temperature and moisture. The grain is very hard and makes an excellent quality of flour. It is admirably adapted for trial in Iowa, Nebraska, and South Dakota." (*Carleton.*)

6013. TRITICUM VULGARE. **Wheat.**

From Rostov-on-Don, Russia. *Beloglino.* "Practically the same as No. 6012, but a poorer quality." (*Carleton.*)

6014. TRITICUM DURUM. **Wheat.**

From Taganrog, Russia. *Gharnovka.* "A representative sample of the best quality of this macaroni wheat, grown by the peasants in the region south of Taganrog." (*Carleton.*)

6015. TRITICUM VULGARE. **Wheat.**

From Ambrocievka, Russia. *Crimean.* "A very hard red winter wheat, similar to Nos. 5635 and 5636, but grown in the district about 20 miles north of Taganrog, in the Don Territory." (*Carleton.*)

6016. TRITICUM VULGARE. **Wheat.**

From Berdiansk, Russia. *Kerch.* "A hard red winter wheat, very similar to *Crimean*, grown near the Sea of Azov. It is very drought-resistant and well adapted for the middle prairie States. It will probably ripen a little earlier than the variety commonly called *Turkey.*" (*Carleton.*)

6017. TRITICUM VULGARE. **Wheat.**

From Kurman-Kemelechi, Russia. *Crimean.* Same as No. 5635.

6000 to 6110—Continued.

6018. Triticum durum. **Wheat.**

From Berdiansk, Russia. *Arnautka.* "A sample of this excellent macaroni wheat, grown near Taganrog." (*Carleton.*)

6019. Triticum durum. **Wheat.**

From Berdiansk, Russia. *Arnautka.* "The same variety as No. 6018, but of better quality." (*Carleton.*)

6020. Triticum durum. **Wheat.**

From Berdiansk, Russia. *Arnautka.* "Similar to Nos. 6018 and 6019, but of better quality." (*Carleton.*)

6021. Triticum vulgare. **Wheat.**

From Stavropol, Russia. "A hard red winter wheat of excellent quality, very similar to No. 5638." (*Carleton.*)

6022. Avena sativa. **Oat.**

From near Stavropol, Russia. "A large white oat having heavy straw and large, well-filled heads." (*Carleton.*)

6023. Hordeum hexastichum. **Barley.**

From near Stavropol, Russia. *Six-rowed.* "Apparently a standard variety in this region." (*Carleton.*)

6024. Panicum miliaceum. **Proso.**

From Chaplino, Russia. *White.* "One of the varieties of millet commonly grown in the Don Territory, Russia." (*Carleton.*)

6025. Panicum miliaceum. **Proso.**

From Sarepta, Russia. *White.* "A standard variety of millet grown in the lower Volga region." (*Carleton.*)

6026. Panicum miliaceum. **Proso.**

From Sarepta, Russia. *Grey.* "This variety of millet succeeds quite well in the lower Volga region, but is not so commonly grown as other kinds." (*Carleton.*)

6027. Panicum miliaceum. **Proso.**

From Sarepta, Russia. *Yellow.* "One of the standard sorts of millet grown in the lower Volga region." (*Carleton.*)

6028. Zea mays. **Corn.**

From Bukharest, Roumania. *Red Pignoletto.* "A standard variety of Italian *Pignoletto* corn commonly grown in Roumania. *Pignoletto* is a term which perhaps belongs more properly to a group of varieties than to a single variety. It includes some of the best sorts grown in Italy and to a large extent in Roumania." (*Carleton.*)

6029. Zea mays. **Corn.**

From near Taganrog, Russia. *Czekler.* "One of the best varieties of corn grown in South Russia." (*Carleton.*)

6030. Zea mays. **Corn.**

From near Taganrog, Russia. *Bessarabian.* "This is a standard variety of corn, commonly grown in Bessarabia, where a large proportion of the entire Russian corn crop is grown." (*Carleton.*)

6000 to 6110—Continued.

6031. ZEA MAYS. **Corn.**

From near Taganrog, Russia. *Chenkvantino.* "A variety of corn grown to a considerable extent in south Russia, Roumania, Hungary, and Italy." (*Carleton.*)

6032. ZEA MAYS. **Corn.**

From near Taganrog, Russia. *Asiatic.* "A Trans-Caucasian variety of corn considered to be one of the best for south Russia." (*Carleton.*)

6033. ZEA MAYS. **Corn.**

From Ambrocievka, Russia. *Red Flint.*

6034. ZEA MAYS. **Corn.**

From Saratov, Russia. "A large-grained variety of sugar corn grown in the lower Volga region." (*Carleton.*)

6035. CANNABIS SATIVA. **Hemp.**

From Mezohegys, Hungary. "A standard variety of hemp grown in central Hungary." (*Carleton.*)

6036. CAMELINA SATIVA. **False flax.**

From Bukharest, Roumania. "A plant grown to a considerable extent in Russia and Roumania for the oil. It should be used only experimentally, as it is likely to become a bad weed. (*Carleton.*)

6037. CITRULLUS VULGARIS. **Watermelon.**

From Berdiansk, Russia. "A rather small, round, red-fleshed melon of very good flavor." (*Carleton.*)

6038. CITRULLUS VULGARIS. **Watermelon.**

From Berdiansk, Russia. "A red-fleshed melon of average size." (*Carleton.*)

6039. CITRULLUS VULGARIS. **Watermelon.**

From Taganrog, Russia. "An excellent red-fleshed melon of medium size." (*Carleton.*)

6040. CITRULLUS VULGARIS. **Watermelon.**

From Taganrog, Russia. "An excellent melon of medium size, dark-green skin, with red flesh and black seeds." (*Carleton.*)

6041. CITRULLUS VULGARIS. **Watermelon.**

From Rostov-on-Don, Russia. "A very rich melon with red flesh and black seeds." (*Carleton.*)

6042. CITRULLUS VULGARIS. **Watermelon.**

From Tikhoretskaya, Russia. "A medium or small round melon, very light green on the outside with darker green bands. Red flesh and very small black seeds; flavor, excellent." (*Carleton.*)

6043. CITRULLUS VULGARIS. **Watermelon.**

From Stavropol, Russia. "A large red-fleshed melon with black seeds. It is peculiarly colored on the outside, being light green with vertical bands of dark green." (*Carleton.*)

6044. CITRULLUS VULGARIS. **Watermelon.**

From the region about 40 miles east of Stavropol, Russia. "A melon of medium size, dark green outside with light-brown seeds, adapted for cultivation in the semiarid districts." (*Carleton.*)

6000 to 6110—Continued.

6045. CITRULLUS VULGARIS. **Watermelon.**

From Stavropol, Russia. "A melon of medium size, very light green on the outside with darker vertical stripes, red flesh, and spotted brown seeds. Adapted for cultivation in semiarid districts." (*Carleton.*)

6046. CITRULLUS VULGARIS. **Watermelon.**

From Ekaterinodar, Russia. "A rather large melon, dark green on the outside, with red flesh and large brown seeds." (*Carleton.*)

6047. CITRULLUS VULGARIS. **Watermelon.**

From Guiloyaksaiskaya, near Ekaterinodar, Russia. "An excellent melon of rather large size, dark green on the outside, with red flesh, brown seeds, and good flavor." (*Carleton.*)

6048. CITRULLUS VULGARIS. **Watermelon.**

From Tsaritsyn, Russia. "A rather large melon, very light green or nearly white on the outside, with light-green stripes, very small black seeds. This is one of the most common watermelons grown on a commercial scale in the Volga region." (*Carleton.*)

6049. CITRULLUS VULGARIS. **Watermelon.**

From Saratov, Russia. Mixed watermelon seeds.

6050. CITRULLUS VULGARIS. **Watermelon.**

From Uralsk, Russia. "A small round melon, greenish white on the outside, red flesh, red seeds, and very rich flavor. Grown by the Kirghiz on the steppes. Adapted for cultivation in very dry districts." (*Carleton.*)

6051. CITRULLUS VULGARIS. **Watermelon.**

From Uralsk, Russia. "A good melon of medium or small size, round, greenish white on the outside, with red flesh and small black seeds. Grown by the Kirghiz on the steppes. Adapted for cultivation in very dry districts." (*Carleton.*)

6052. CITRULLUS VULGARIS. **Watermelon.**

From Saratov, Russia. "An excellent melon of very large size, round, dark green on the outside, with large reddish-brown seeds. Grown in an extremely dry region, therefore adapted for cultivation in dry districts." (*Carleton.*)

6053. CITRULLUS VULGARIS. **Watermelon.**

From Novokhopersk, Russia. "A very fine rich-flavored melon of unusual appearance. It has the form of a crooked-neck squash, dark green on the outside, netted with lighter green, yellow flesh tinged with salmon-white seeds. Adapted for cultivation in very dry regions." (*Carleton.*)

6054. CITRULLUS VULGARIS. **Watermelon.**

From Blagodat, Russia. "An excellent melon of average size, green outside, with white flesh and spotted dark-brown seeds." (*Carleton.*)

6055. CITRULLUS VULGARIS. **Watermelon.**

From Ambrocievka, Russia. "An excellent melon of large size, dark green on the outside, with red flesh and light-brown seeds." (*Carleton.*)

6056. CITRULLUS VULGARIS. **Watermelon.**

From Dolinskaya, Russia. "A good melon of rather small size, peculiarly colored on the outside, gourd-shaped, with light-brown black-bordered seeds." (*Carleton.*)

6000 to 6110—Continued.

6057. CITRULLUS VULGARIS. **Watermelon.**

From Russia. "A very large rich melon, green outside, with red flesh and light-brown seeds." (*Carleton.*)

6058. CUCUMIS MELO. **Muskmelon.**

From Odessa, Russia. *Bread melon.* "An Egyptian melon of medium size, somewhat flattened vertically, prominently ribbed with a very rough surface, remaining green on the outside for a long time, but turning considerably yellow when fully ripe; flesh yellow, sometimes slightly tinged with salmon, rather firm. When fully ripe the flavor is excellent. It is sometimes called the Pineapple (*Ananas*) melon." (*Carleton.*)

6059. CUCUMIS MELO. **Muskmelon.**

From Sevastopol, Russia. "A melon of average size with greenish-yellow flesh and white seeds." (*Carleton.*)

6060. CUCUMIS MELO. **Muskmelon.**

From Berdiansk, Russia. "One of the common varieties of muskmelon grown in the region north of the Sea of Azov." (*Carleton.*)

6061. CUCUMIS MELO. **Muskmelon.**

From Berdiansk, Russia. "A round, smooth melon of medium size and fine flavor; flesh greenish yellow." (*Carleton.*)

6062. CUCUMIS MELO. **Muskmelon.**

From Taganrog, Russia. "An excellent, smooth-skinned melon; flesh greenish yellow." (*Carleton.*)

6063. CUCUMIS MELO. **Muskmelon.**

From Rostov-on-Don, Russia. "An excellent round melon of medium size; very smooth on the outside; flesh white with pink spots." (*Carleton.*)

6064. CUCUMIS MELO. **Muskmelon.**

From Rostov-on-Don, Russia. *Kochanka.* "One of the most popular melons grown in South Russia; rather small, round and smooth, yellowish white on the outside, with green bands or splotches; flesh green except near the seed, where it is salmon color; seeds rather large and almost white." (*Carleton.*)

6065. CUCUMIS MELO. **Muskmelon.**

From Ekaterinodar, Russia. "A rather large melon, yellowish green on the outside and netted; green flesh, very juicy, and of fairly good flavor." (*Carleton.*)

6066. CUCUMIS MELO. **Muskmelon.**

From Ekaterinodar, Russia. The same variety as No. 6064. Grown in North Caucasus.

6067. CUCUMIS MELO. **Muskmelon.**

From Tsaritsyn, Russia. *Kalminka.* "Name derived from the word Kalmuck. Melon netted, nearly round, yellow, mottled with green when ripe. Flesh green, very sweet, and good. Seeds light yellow." (*Carleton.*)

6068. CUCUMIS MELO. **Muskmelon.**

From Kamishin, Russia. *Krestyanka.* "A rather large, long melon, yellow, slightly netted. Flesh yellow, and fairly good. A popular sort in the north Volga region." (*Carleton.*)

6000 to 6110—Continued.

6069. Cucumis melo. **Muskmelon.**

From Astrakhan, Russia. "A large, round melon of excellent flavor. Seeds below medium size, brownish green in color, rather short and thick." (*Carleton.*)

6070. Cucumis melo. **Muskmelon.**

From Saratov, Russia. *Kalminka.* "A large, rather long melon of light orange color, netted greenish white; flesh very juicy and sweet. Large seeds. One of the best varieties in the Astrakhan government." (*Carleton.*)

6071. Cucumis melo. **Muskmelon.**

From Uralsk, Russia. *Bokhara.* "A rather large melon, yellowish green in color, and netted. Flesh green near the rind; salmon pink near the seeds, with very rich flavor. One of the best sorts grown by the Kirghis farmers on the east side of the Ural River." (*Carleton.*)

6072. Cucumis melo. **Muskmelon.**

From Uralsk, Russia. "A rather long melon, yellow, with dark-green spots; flesh greenish white." (*Carleton.*)

6073. Cucumis melo. **Muskmelon.**

From Povorino, Russia. "A very large melon, yellow, roughly netted with green. Flesh white, or slightly tinged with green, very firm. Flavor good. Seeds nearly white." (*Carleton.*)

6074. Cucumis melo. **Muskmelon.**

From Kharkof, Russia. *Ananas.* "Probably the same as No. 6058." (*Carleton.*)

6075. Cucumis melo. **Muskmelon.**

From Taganrog, Russia. "A melon of medium size, nearly round, yellow, surface considerably netted. Flesh green with very rich, sweet flavor near the rind.' (*Carleton.*)

6076. Cucumis melo. **Muskmelon.**

From Taganrog, Russia. *Ananas.* "Similar to No. 6074." (*Carleton.*)

6077. Cucumis melo. **Muskmelon.**

From Taganrog, Russia. "A small melon with smooth surface, netted yellow and green. Flesh green." (*Carleton.*)

6078. Cucumis melo. **Muskmelon.**

From Blagodat, estate of Mr. Rutchenko, about 20 miles north of Taganrog, Russia. *Rostov.* "An excellent melon of medium to large size, elongated or fairly round, smooth, almost white on the outside. Flesh green, very sweet, and juicy." (*Carleton.*)

6079. Pistacia vera. **Pistache.**

From Stavropol, Russia. "A variety said to come from Syria bearing unusually large nuts." (*Carleton.*)

6080. Cucumis sativus. **Cucumber.**

From Saratov, Bussia. *Pavlovskii.* "One of the standard varieties of garden cucumbers grown in the lower Volga region of Russia." (*Carleton.*)

6081. Cucumis sativus. **Cucumber.**

From Saratov, Russia. *Moscow.* "A long, dark-green variety, grown in the lower Volga region, Russia." (*Carleton.*)

6000 to 6110—Continued.

6082. CUCUMIS SATIVUS. **Cucumber.**

From Saratov, Russia. "One of the standard varieties of cucumber grown in the lower Volga region." (*Carleton.*)

6083. CUCUMIS SATIVUS. **Cucumber.**

From Saratov, Russia. *Muron.* "A rather early variety of cucumber, grown in the lower Volga region." (*Carleton.*)

6084. RAPHANUS SATIVUS. **Radish.**

From Saratov, Russia. *Moscow.* A rather long, early, white variety, grown in the region near Moscow." (*Carleton.*)

6085. RAPHANUS SATIVUS. **Radish.**

From Saratov, Russia. *Delicesse.* "An early variety of excellent flavor, grown in the region near Moscow, Russia." (*Carleton.*)

6086. RAPHANUS SATIVUS. **Radish.**

From Saratov, Russia. *Erfurt.* "A long, white variety of winter radish, grown near Moscow, Russia." (*Carleton.*)

6087. RAPHANUS SATIVUS. **Radish.**

From Saratov, Russia. "A small, round radish of good quality grown near Moscow, Russia." (*Carleton.*)

6088. CUCURBITA MAXIMA. **Pumpkin.**

From Saratov, Russia. "A good variety, grown near Moscow, Russia." (*Carleton.*)

6089. CUCURBITA MAXIMA. **Pumpkin.**

From Saratov, Russia. *Hundred pound.* "A large yellow pumpkin." (*Carleton.*)

6090. LYCOPERSICUM ESCULENTUM. **Tomato.**

From Saratov, Russia. "A very large red tomato, grown in north Caucasus, "Russia." (*Carleton.*)

6091. LYCOSPERSICUM ESCULENTUM. **Tomato.**

From Saratov, Russia. *Trophy.* "A large-fruited, late tomato, grown near Tsaritsyn, Russia." (*Carleton.*)

6092. PHASEOLUS VULGARIS. **Bean.**

From Jassy, Roumania. "A very large, white, kidney-shaped bean, grown in the northern part of Roumania." (*Carleton.*)

6093. HELIANTHUS ANNUUS. **Sunflower.**

From Taganrog, Russia. "A large, dark, gray-seeded variety, commonly used for eating, grown in southern and central Russia." (*Carleton.*)

6094. HELIANTHUS ANNUUS. **Sunflower.**

From the District Experimental Farm at Taganrog, Russia. "A variety of sunflower having small-sized, striped seeds which are used for oil." (*Carleton.*)

6095. HELIANTHUS ANNUUS. **Sunflower.**

From the field near Tikhoretskaya in Kuban Territory, North Caucasus, Russia. "A variety of sunflower having large, rather long, black seeds, much grown in North Caucasus, but not well known in other parts of Russia." (*Carleton.*)

6000 to 6110—Continued.

6096. Prunus sp. **Cherry.**

From Budapest, Hungary. "A small black cherry commonly grown in Hungary." (*Carleton.*)

6097. Prunus sp. **Cherry.**

From Budapest, Hungary. "Seeds of an excellent variety of white cherry grown in the vicinity of Budapest." (*Carleton.*)

6098. Prunus sp. **Cherry.**

From near Budapest, Hungary. *Spanish.* "Seeds of a variety of cherry commonly grown in this vicinity." (*Carleton.*)

6099. Prunus sp. **Cherry.**

From Budapest, Hungary. "Seeds of a large-fruited black cherry extensively grown in this region." (*Carleton.*)

6100. Prunus sp. **Cherry.**

From Budapest, Hungary. "Seeds of a large pink cherry grown in this vicinity." (*Carleton.*)

6101. Ribes rubrum. **Red currant.**

From Budapest, Hungary. "Seeds of a red currant of medium size grown in this vicinity." (*Carleton.*)

6102. Pyrus malus. **Apple.**

From markets of Sevastopol, Russia. *Anis.* "Seeds of one of the best and commonest varieties grown in the Crimea. A very good fruit and quite popular." (*Carleton.*)

6103. Prunus sp. **Plum.**

From Sevastopol, Russia. "A variety very similar to *Green Gage* and grown to a considerable extent in the Crimea." (*Carleton.*)

6104. Prunus sp. **Plum.**

From Sevastopol, Russia. *Ringolot.* "Seeds of one of the best varieties grown extensively in the Crimea." (*Carleton.*)

6105. Prunus sp. **Plum.**

From Sevastopol, Russia. *Mirabelle.* "A large plum of excellent flavor grown to a considerable extent in the Crimea. This and No. 6104 seem to be two of the best varieties in that region." (*Carleton.*)

6106. Prunus sp. **Plum.**

From Sevastopol, Russia. "A green sort grown to a considerable extent in the Crimea." (*Carleton.*)

6107. Prunus sp. **Cherry.**

From Belbek, Russia. "Seeds of a variety of sour cherry commonly grown in the Crimea." (*Carleton.*)

6108. Prunus sp. **Plum.**

From Rostov-on-Don, Russia. "A variety originally from the Crimea, with very large fruit of a delicious flavor when fully ripe. Possibly the same as No. 6105." (*Carleton.*)

6109. Amygdalus persica. **Peach.**

From Rostov-on-Don, Russia. "A small Crimean variety. Fruit round, purple, and very hairy. Flesh sweet near the rind, but sour next the seed." (*Carleton.*)

6000 to 6110—Continued.

6110. Pyrus communis. **Pear.**

From Kharkof, Russia. *Yellow Flesh.* "A pear of medium size, yellow and pink in color. Extremely juicy and having an excellent flavor. By far the best pear in the Kharkof markets." (*Carleton.*)

6111. Triticum vulgare. **Wheat.**

From Proskurow, Russia. Received through Dr. S. de Mrozinski, March 19, 1901.

Podolia. An excellent variety, but not so resistant to drought as Nos. 5999 and 6112.

6112. Triticum vulgare. **Wheat.**

From Proskurow, Russia. Received through Dr. S. de Mrozinski, March 19, 1901.

Poltava. "An extremely drought-resistant variety." (*Mrozinski.*)

6113. Pyrus malus. **Apple.**

From Corfu, Greece. Presented by Mr. Antonio Colla, through Mr. D. G. Fairchild (No. 539, February 13, 1901). Received March 20, 1901.

Corfu. "Scions of a very large and delicious apple, probably a native of the island. It should be tried in the Southern States, Porto Rico, and Hawaii." (*Fairchild.*)

6114. Ficus carica. **Fig.**

From Corfu, Greece. Presented by Mr. Antonio Colla, through Mr. D. G. Fairchild (No. 541, February 13, 1901.) Received March 20, 1901.

Fracatsani of Corfu. "Scions of the largest and finest flavored table fig grown on the island of Corfu. Trees vigorous. Fruit light-colored and unusually large, thin-skinned, and juicy." (*Fairchild.*)

6115. Citrus limonum. **Lemon.**

From Corfu, Greece. Presented by Mr. Antonio Colla, through Mr. D. G. Fairchild (No. 542, February 13, 1901). Received March 20, 1901.

Colla giant. "Scions from a tree bearing immense fruit, some specimens weighing $2\frac{1}{4}$ pounds. Probably the same as Nos. 5982 and 5986." (*Fairchild.*)

6116. Citrus aurantium. **Orange.**

From Corfu, Greece. Presented by Mr. Antonio Colla, through Mr. D. G. Fairchild (No. 543, February 13, 1901). Received March 20, 1901.

"Scions of a variety of seedless orange. Possibly the Maltese variety." (*Fairchild.*)

6117. Citrus limonum. **Lemon.**

From Corfu, Greece. Received through Mr. D. G. Fairchild (No. 544, February 14, 1901), March 20, 1901.

"Scions of a thin-skinned, nearly seedless lemon having salmon-colored flesh. The tree is very ornamental, the leaves being variegated." (*Fairchild.*)

6118. Vitis vinifera. **Grape.**

From Castelnuova, Dalmatia, Austria. Received through Mr. D. G. Fairchild (No. 545, February 14, 1901), March 20, 1901.

Marzamina. "Cuttings of a heavy-bearing excellent variety of wine grape, said to have been grown in the Bocche di Cattaro since the time of the Roman occupation; said to make one of the best of Dalmatian wines." (*Fairchild.*)

6119. VITIS VINIFERA. **Grape.**

From Castelnuova, Dalmatia, Austria. Received through Mr. D. G. Fairchild (No. 546, February 14, 1901), March 20, 1901.

Marzamina genuina. "Cuttings of an old variety of wine grape, probably a native of the country. It is like No. 6118, only of superior flavor and not such a heavy bearer." (*Fairchild.*)

6120. CYDONIA VULGARIS. **Quince.**

From Corfu, Greece. Presented by Mr. Antonio Collas, through Mr. D. G. Fairchild (No. 547, February 13, 1901). Received March 20, 1901.

Corfu. "Cuttings of a very large pear-shaped quince. The trees are handsome, vigorous, and coarse growing. The quality of the fruit is poor, but its size and color may make it a desirable sort for breeders. The flesh is milder flavored than American varieties, and can be eaten raw." (*Fairchild.*)

6121. CITRUS LIMONUM. **Lemon.**

From Patras, Greece. Received through Mr. D. G. Fairchild (No. 552, February 17, 1901), March 15, 1901.

"A variety of lemon which has the reputation of being very nearly seedless." (*Fairchild.*)

6122. PISTACIA VERA. **Pistache.**

From Aintab, Syria. Presented by Rev. A. Fuller, through Mr. W. T. Swingle. Received March 26, 1901.

Aintab. "Scions of what is here regarded as the best variety of the pistachio tree. This tree does best on dry, rocky soil on mountains or hillsides." (*Fuller.*)

6123. PISTACIA VERA. **Pistache.**

From Aintab, Syria. Presented by Rev. A. Fuller, through Mr. W. T. Swingle. Received April 1, 1901.

Aintab. "Scions of what is here regarded as the best variety of the pistachio tree. This tree does best on dry, rocky, deep soil on mountains or hillsides." (*Fuller.*)

6124. VITIS VINIFERA. **Grape.**

From Aintab, Syria. Presented by Rev. A. Fuller, through Mr. W. T. Swingle. Received April 1, 1901.

Hunisa. "A large, dark wine-colored and very beautiful table grape, slightly oblong in shape. Flesh firm and fruity; ripens late (November) and has remarkable powers of keeping. Hung in a dry, cool place it will keep perfectly until April, only slightly withering as it is kept, and the flavor rather improving with age. To my mind it is the best all-round food grape I have ever seen." (*Fuller.*)

6125 to 6130. OLEA EUROPAEA. **Olive.**

From Fresno, Cal. Presented by Mr. George C. Roeding, through Mr. W. T. Swingle. Received April 6, 1901.

A collection of rooted olive cuttings as follows:

6125.
Manzanillo.

6126.
Neradillo.

6127.
Rubra.

6128.
Mission.

6129.
Sevillano.

6130.
Pendulina.

6131. CUCUMIS MELO. **Muskmelon.**

From Marseille, France. Received through Hon. Robert P. Skinner, United States Consul-General, March 21, 1901.

Cavaillon. "These seeds should be planted under glass early in the spring and subjected to the least possible change of temperature until the weather is settled and the plants have become sufficiently advanced to warrant transplanting. This melon is one of the most valued horticultural products of southern France. It might be successfully cultivated in the latitude of Washington, and certainly in our Southern States. The fruit, when ripe, is very much the color of our green watermelons; the flesh is light green in color, highly perfumed and extremely palatable." (*Skinner.*)

6132. CANAVALIA ENSIFORMIS. **Halberd bean.**

From Morioka, Japan. Received through Rev. E. Rothesay Miller, March 9, 1901.

Natu-Mame. "This, as a string bean eaten when young, is one of the finest I have ever tasted. It grows much like pole limas, 10 feet high, and the pods are of immense size, often over a foot long and an inch and a half broad and half an inch thick. The Japanese use them generally for pickling when young, and they are very fine for this purpose, but as a string bean they are well worth introducing into the United States. They are cultivated about like pole limas, but need a warm climate for ripening. Should do well south of the latitude of Pennsylvania." (*Miller.*)

6133. CUCURBITA sp. **Crepe squash.**

From Morioka, Japan. Received through Rev. E. Rothesay Miller, March 9, 1901.

Chirimen Kabucha. "This squash is rather large, of a dark-green color, changing to yellow, sometimes even to a light greenish-blue color. The appearance is like a rough muskmelon, flattened considerably. I think it comes from Shinshu, one of the central provinces of Japan, but grows well here. It is about the best of the Japanese squashes, and is quite different from the varieties commonly grown in the United States, and may be worth cultivation." (*Miller.*)

6134. BRASSICA RAPA. **Turnip.**

From Morioka, Japan. Received through Rev. E. Rothesay Miller, March 9, 1901.

"A large white turnip, possibly worth cultivating for stock feeding." (*Miller.*)

6135. RAPHANUS SATIVUS. **Radish.**

From near Tokyo, Japan. Received through Rev. E. Rothesay Miller, March 9, 1901.

Daikon. "This is the immense radish used by the Japanese for pickling and eaten by them three times a day. The seeds I send are of an especially large and fine variety which grows near Tokyo." (*Miller.*)

6136. RAPHANUS SATIVUS. **Radish.**

From Sakura Island, Japan. Received through Rev. E. Rothesay Miller, March 9, 1901.

Sakura-gima Daikon. "This is another variety of the 'Daikon' radish, grown on Sakura Island, in the Bay of Kagoshima. It is not long, like No. 6135, but turnip shaped, and grows to such an immense size that the natives say two of them make a horse load." (*Miller.*)

6137. RAPHANUS SATIVUS. **Radish.**

From Sakura Island, Japan. Received through Rev. E. Rothesay Miller, March 9, 1901.

Sakura-gima Daikon. "The same as No. 6136, but can be planted about two weeks later." (*Miller.*)

6138. CORYLUS TUBULOSA. **Hazelnut.**

From Rovigno, Austria. Received through Mr. D. G. Fairchild (No. 509, January 19, 1901), March 23, 1901.

Pignatele. "Plants of a small hazelnut, inferior in quality to No. 6139. May, however, be worthy of trial in comparison with American varieties." (*Fairchild.*)

6139. CORYLUS TUBULOSA. **Hazelnut.**

From Rovigno, Austria. Received through Mr. D. G. Fairchild (No. 508, January 19, 1901), March 23, 1901.

Noce lunghe. "Plants of the best variety of Rovigno hazelnut. This variety is grown only in the Province of Istria and because of its scarcity is not much exported. It is a variety not reproduced from seed; requires a calcareous dry soil, and is said to be a heavy bearer. The size of the nuts will recommend them to American growers. In quality of kernel I consider them inferior to those of *Corylus pontica.* The plant forms a small tree, 12 to 15 feet high, with rather handsome trunk and graceful branches; would be an ornament to any garden. This variety will stand a temperature of +14° F. easily and probably much lower. I consider it a promising addition to American nut-bearing trees, and it deserves a thorough distribution through the South. Secured through the kindness of Emil Watzke, of Rovigno." (*Fairchild.*)

6140. VITIS VINIFERA. **Grape.**

From Sebenico, Austria. Received through Mr. D. G. Fairchild (No. 505, January 17, 1901), March 23, 1901.

Marascina. "Cuttings of the delicate variety of grape from which the famous Marascina wine (not the liqueur) is made. The vines are not very hardy and are subject to Peronospora. From the region where the sort originated and the only place where the wine is still manufactured." (*Fairchild.*)

6141. PINUS BRUTIA. **Pyrenean pine.**

From Triest, Austria. Received through Mr. D. G. Fairchild (No. 506, January 18, 1901), March 23, 1901.

"Pyrenean pine, a variety especially valuable for its rapid growth and ability to endure drought. Indigenous to Syria, Asia Minor, Cyprus, Crete, and parts of Italy. This has been used with great success on the dry limestone soil of the *Karst* formation. It makes a handsome showing in from two to three years; especially recommended for planting in the warmer regions of the South on limestone soil." (*Fairchild.*)

6142. CHRYSANTHEMUM CINERARIAEFOLIUM. **Pyrethrum.**

From Milna, Brač Island, Austria. Received through Mr. D. G. Fairchild (No. 507, January 4, 1901), March 23, 1901.

"Seed from a locality noted for its continued profitable production of the Dalmatian insect powder, notwithstanding American and Australian competition." (*Fairchild.*)

6143. CERATONIA SILIQUA. **Carob.**

From Triest, Austria. Received through Mr. D. G. Fairchild (No. 510, January 20, 1901), March 10, 1901.

Carob. (See No. 3112, Inventory No. 7.)

6144. LIATRIS ODORATISSIMA. **Vanilla plant.**

From Biloxi, Miss. Received through Mr. S. M. Tracy, February, 1901.

6145. CRAMBE MARITIMA. **Sea kale.**

From Centralia, Kans. Received through Mr. A. Oberndorf, jr., March 27, 1901.

6146. CUCUMIS MELO. **Muskmelon.**

From Hungary. Presented by Dr. L. Waltherr, Inanda, N. C. Received March 28, 1901.

Turkestan. "The Turkestan muskmelons were imported into Hungary by the famous linguist, Wambery, nearly fifty years ago from Turkestan, Central Asia, and the importation was a great success. The fruit is sometimes round, sometimes oblong, and weighs sometimes even 7 kilograms. The rind has a special yellow color, is sometimes netted; the flesh has a greenish yellow color, is very sweet and juicy, and so soft that it must be eaten with a spoon. It is far superior to any muskmelons of this country." (*Waltherr.*)

6147. CUCUMIS MELO. **Muskmelon.**

From Hungary. Presented by Dr. L. Waltherr, Inanda, N. C. Received March 28, 1901.

Pineapple. "A variety having fruit of the shape of a pineapple, with the same half-yellow, half-green color as that of a half-ripe pineapple, and the rind is sprinkled with small tuberous prominences from the size of a pea to the size of a hazelnut, so that it resembles a pineapple at a distance. The flesh is hard, sweet, and has a deep yellow color like an orange rind." (*Waltherr.*)

6148. CUCUMIS MELO. **Muskmelon.**

From Hungary. Presented by Dr. L. Waltherr, Inanda, N. C. Received March 28, 1901.

"A hybrid of Turkestan No. 6146, and pineapple No. 6147; delicious to eat." (*Waltherr.*)

6149 to 6159. CITRULLUS VULGARIS. **Watermelon.**

From Hungary. Presented by Dr. L. Waltherr, Inanda, N. C. Received March 28, 1901.

A collection of Hungarian varieties as follows:

6149.

6150.

"With white rind and red flesh; very fine." (*Waltherr.*)

6151.

6152.

"Very fine." (*Waltherr.*)

6153.

"Very fine." (*Waltherr.*)

6154.

6155.

6156.

"Very fine." (*Waltherr.*)

6157.

Marsowsky. "Finest kind in Hungary." (*Waltherr.*)

6158.

6159.

6160.

From Guadalupe, Mexico. Presented by Dr. L. Waltherr, Inanda, N. C. Received March 28, 1901.

Cinco palomas. "An ornamental plant, the flowers of which resemble five pigeons; hence the Mexican name 'Cinco palomas.'" (*Waltherr.*)

6161. TAXUS BACCATA. **Yew.**

From Hungary. Presented by Dr. L. Waltherr, Inanda, N. C. Received March 28, 1901.

6162. PYRUS BACCATA. **Siberian crab apple.**

From the Khabarovsk forest. Presented by the Department of Agriculture, St. Petersburg, Russia. Received April 20, 1901.

6163. Spirostachis occidentalis.

From Byron, Cal. Received through Prof. J. Burtt Davy, April 1, 1901.

6164. Cannabis indica. **Hemp.**

From Calcutta, India. Received through Prof. D. Prain, superintendent of the Sibpur Botanical Garden, April, 1901.

Hasheesh, the well-known opiate, is extracted from the resin of this plant.

6165 to 6168. Beta vulgaris. **Chard.**

From San Giovannia a Teduccio, Italy. Received through Dammann & Co., April 1, 1901.

6165.

Chilean scarlet-ribbed.

6166.

Silver-ribbed (yellowish white).

6167.

Chilean yellow-ribbed.

6168.

Silver-ribbed, curled.

6169. Raphanus sativus. **Radish.**

From Acneta, Cal. Received March 25, 1901. Seed grown from No. 1237, Inventory No. 2.

6170. Citrullus vulgaris. **Watermelon.**

From Forestburg, S. Dak. Received through Mr. H. C. Warner, March 19, 1901. Seed grown from No. 61, Inventory No. 1.

"This was the best in quality of 80 varieties in two different seasons. Medium size, oblong, light and dark-green striped, sometimes all light. Flesh dark red, sweet, very rich, early." (*Warner.*)

6171. Citrullus vulgaris. **Watermelon.**

From Forestburg, S. Dak. Received through Mr. H. C. Warner, March 19, 1901. Seed grown from No. 105, Inventory No. 1.

"Medium size, round, light and dark-green striped, flesh red, sweet; productive, early." (*Warner.*)

6172. Zea mays. **Corn.**

From Summerville, S. C. Received through Mr. H. A. Jamison, March, 1901. Egyptian. Seed grown from No. 3998, Inventory No. 8.

6173. Ipomoea batatas. **Sweet potato.**

From Manatee, Fla. Received through Mr. A. J. Pettigrew, March, 1901.

6174. Avena sativa. **Oat.**

From Mustiala, Finland. Received through Messrs. Lathrop and Fairchild (No. 425), April 3, 1901.

North Finnish Black. "Dr. Gösta Grotenfelt, director of the Agricultural Institute of Mustiala, has grown this *Black* oat from seed imported from Torneå, Paavola, and Umeå (this latter in Sweden). He finds the seed from Torneå and Umeå very similar, but the Paavola variety is somewhat browner, not black and gray in color like the other two sorts. He has also compared the *North Finnish Black* with Canadian oats, which he got through the seed-breeding institute of Svalöf, Sweden. The comparison is as follows: *Canada* took one hundred and thirteen days to ripen, while the *North Finnish Black* took only ninety-eight days. The latter is the average for four years (1892–1895). In comparison with all sorts of foreign-grown varieties the figures for the four years stand as 98.9: 111.8 days for ripening period. Dr. Grotenfelt says that the yield is small. For 1895, 42.4 kilos of dried straw and grain (air dried) per *are.* The foreign sorts yielded in the same year 49.1 kilos per *are.* The grain yield of the *North Finnish Black* variety was 12.6 kilos per *are*, while the foreign varieties yielded 16.4 kilos per *are*. These foreign sorts, it must be remarked, were all varieties which had been especially bred—some from Svalöf and others from the experiment station in Tystofte, in Denmark. During *six years of cultivation at Mustiala this North Finnish Black oat has lost none of its early-ripening qualities.* In good years the foreign-grown sorts here yield best, but in bad season *they yield nothing at all, while the North Finnish Black always yields about the same amount.* This variety deserves thorough trial in Alaska and the North Atlantic States, and should be used for breeding purposes wherever an early ripening variety of oat is desired. To get the best results it should be sown as early as possible. These various varieties have been analyzed in Mustiala, and it has been found that the *North Finnish Black* variety has 13.58 per cent of dry weight of *protein*, while the *South Finnish Brown* oat, for example, only 10.7 per cent, and the *South Finnish White* 11.77 per cent, and foreign oats only 11.79 per cent *protein*. Although, because of the small yield of the *North Finnish Black* variety, the actual protein quantity per *are* is smaller than that of the foreign sorts, the fact that the former is really richer in protein is an important point for plant breeders. The figures are: *North Finnish Black*, 1.54 kilos per *are;* foreign, including *Canada* variety, 1.73 per *are*. There have so far been very few experiments here in Finland *en gros*. Those few have been, however, very satisfactory." (*Fairchild.*) (See No. 5513.)

6175. HORDEUM TETRASTICHUM. **Barley.**

From Mustiala, Finland. Received through Messrs. Lathrop and Fairchild (No. 426, August 1, 1900), April 3, 1901.

Four-rowed Lapland. "This comes from Pillo, a town lying 30 kilometers north of the Arctic Circle. It is a stunted variety, which ripens at least 10 to 14 days earlier than South Finnish or European varieties, and although it does not produce large quantities of grain, but small kernels and in small quantity, it deserves the especial attention of plant growers in Alaska. Dr. G. Grotenfelt is at the present time busy with its culture and hopes to maintain its earliness and, by crossing, increase its productiveness. At the present time it is almost ripe here in the Doctor's experimental plats, while all other sorts (except No. 427, L. & F.) are quite green. For a very short-season locality and also for breeding purposes this may prove of considerable value where barley is grown. Secured through Dr. Grotenfelt's kindness." (*Fairchild.*)

6176. BRASSICA RAPA. **Turnip.**

From Mustiala, Finland. Received through Messrs. Lathrop and Fairchild (No. 428, August 1, 1900), April 3, 1901.

White Tankard Purple Top. "A Scottish variety of fodder turnip which has been grown here for fifty years. This variety, grown on Finnish soil, has proved superior to that grown from seed imported from Scotland, and it is worthy a trial in Alaska. Its growth in spring is particularly rapid, and it therefore escapes the attacks of insect enemies better than other sorts. Will be sent by Director G. Grotenfelt in November." (*Fairchild.*)

6177. FAGOPYRUM ESCULENTUM. **Buckwheat.**

From Mustiala, Finland. Received through Messrs. Lathrop and Fairchild (No. 430, August 1, 1900), April 3, 1901.

Finnish. "This buckwheat is for planting in Alaska. It is believed to be an early ripening variety. It is cultivated in east Finland on a large scale, but little in west Finland. It is now in bloom in Doctor Grotenfelt's experimental plats. Will be sent by Doctor Grotenfelt in November." (*Fairchild.*)

6178. BRASSICA CAMPESTRIS. **Turnip.**

From Mustiala, Finland. Received through Messrs. Lathrop and Fairchild (No. 429, August 1, 1900), April 3, 1901.

Mustiala. "A variety of Swedish turnip which has been originated here in Mustiala and grown for over fifteen years. It is the best sort that has been tested here and is very regular in growth and altogether to be recommended for fodder purposes in Alaska." (*Fairchild.*)

6179. BRASSICA RAPA. **Turnip.**

From Mustiala, Finland. Received through Messrs. Lathrop and Fairchild (No. 432, August 1, 1900), April 3, 1901.

Finnish Svedje. "This is one of the few originations of the old Finnish people. It is called *Svedje* because it is grown on soil that has been burned over, i. e., in new clearings. The seed was sown by the peasants by taking into the mouth and spitting out as a Chinaman sprinkles clothes. It is a small variety, said to be of superior flavor, and is baked in the oven in butter after being pulled, a little boiling water being added as the turnips become brown. It can be grown in the Arctic Circle, and is a highly prized vegetable, worthy of especial attention." (*Fairchild.*)

6180. JUGLANS REGIA. **Walnut.**

From Patras, Greece. Received through Mr. D. G. Fairchild (No. 553), April 4, 1901.

"Cuttings from a single tree on the estate of Mr. S. D. Stamo which bears nuts that are unusually large and thin shelled." (*Fairchild.*)

6181. JUGLANS REGIA. **Walnut.**

From Zante, Greece. Received through Mr. D. G. Fairchild (No. 554, February 21, 1901), April 4, 1901.

"Cuttings from a single tree on the estate of Mr. Angalotti, at Bocali, which bore nuts that are somewhat irregular in form, but of very large size, some specimens measuring 6 inches in circumference, and so thin shelled that they can be crushed in the hand; not as large nor as regular in shape, however, as No. 6182. The quality is excellent and the tree reported to be a good bearer." (*Fairchild.*)

6182. JUGLANS REGIA. **Walnut.**

From Zante, Greece. Received through Mr. D. G. Fairchild (No. 555, February 21, 1901), April 4, 1901.

"Cuttings from a single tree growing through the roof of a small shop near the house of one Sig. Machalitza, in the town of Zante. The nuts are regular in form and of very unusual size, measuring $5\frac{13}{16}$ by $5\frac{13}{16}$ inches in both circumferences. Heavy, and said to be well filled with an excellent flavored meat." (*Fairchild.*)

6183. CYDONIA SINENSIS. **Chinese quince.**

From Zante, Greece. Received through Mr. D. G. Fairchild (No. 556, February 21, 1901), April 4, 1901.

"Cuttings of the *scented quinces* called "musk," "citron," or "Japanese" quinces; grown in this vicinity. The fruits are very large and woody and seldom used for preserving. Their principal value is as ornamentals and as perfume fruits to store away with linen to give it an agreeable odor." (*Fairchild.*)

6184. CITRUS AURANTIUM. **Orange.**

From Zante, Greece. Received through Mr. D. G. Fairchild (No. 557, February 21, 1901) April 4, 1901.

Queen. "The trees from which these cuttings were taken are the only bearing trees of the kind on the island. The fruit is of a dark orange color, almost seedless, and of very fine flavor. It is worth trying in California and Florida orchards." (*Fairchild.*)

6185. CITRUS LIMONUM. **Lemon.**

From Zante, Greece. Received through Mr. D. G. Fairchild (No. 558, February 22, 1901) April 4, 1901.

"Cuttings of a thick-skinned, nearly seedless, variety of lemon growing in the monastery garden of Kalitero. Very juicy and extremely acid." (*Fairchild.*)

6186. CYDONIA SINENSIS. **Chinese quince.**

From Zante, Greece. Received through Mr. D. G. Fairchild (No. 559) April 4, 1901.

Cuttings from a seedling quince, possibly the same as No. 6183. *See also* No. 6362.

6187. CYDONIA VULGARIS. **Quince.**

From Zante, Greece. Received through Mr. D. G. Fairchild (No. 560, February 22, 1901) April 4, 1901.

Apple. "Cuttings of the favorite quince of Zante, used for preserves, marmalades, and as a table fruit. When fully ripe they are eaten like apples, which they resemble in shape." (*Fairchild.*)

6188. CYDONIA SINENSIS. **Chinese quince.**

From Zante, Greece. Received through Mr. D. G. Fairchild (No. 561, February 21, 1901) April 4, 1901.

"Cuttings of a small, scented quince grown for its sweet-scented fruit, which is not edible." (*Fairchild.*)

6189. PINUS PINEA. **Stone pine.**

From Zante, Greece. Presented by Count S. Lunzi through Mr. D. G. Fairchild (No. 562, February 21, 1901). Received April 4, 1901.

"The edible seeds of this pine are so thin shelled that they can be easily broken with the fingers, while the ordinary type has such hard-shelled seeds that they must be broken open with a hammer. Should be tried in the dry parts of Florida and the Southwest." (*Fairchild.*)

6190. CITRUS LIMONUM. **Lemon.**

From Zante, Greece. Presented by Mr. Geo. Sargint through Mr. D. G. Fairchild (No. 563, February 22, 1901). Received April 4, 1901.

"A young plant grown from a bud of an old lemon tree that has always borne seedless fruit." (*Fairchild.*)

6191. ERIOBOTRYA JAPONICA. **Loquat.**

From Zante, Greece. Presented by Mr. Geo. Sargint through Mr. D. G. Fairchild (No. 564, February 22, 1901). Received April 4, 1901.

"Two young plants grown by Castagnias Aristides from cuttings of an old loquat tree reported to bear only seedless fruits." (*Fairchild.*)

6192. VIOLA ODORATA. **Violet.**

From Zante, Greece. Received through Mr. D. G. Fairchild (No. 565, February 22, 1901) April 4, 1901.

Parmensis. Plants of a very large double violet exported from Zante to all parts of Greece. Lacking in perfume. Grown in the open air in Zante, not under glass.

6193. CYDONIA VULGARIS. **Quince.**

From Zante, Greece. Received through Mr. D. G. Fairchild, April 4, 1901. No data.

6194. CANNABIS SATIVA. **Hemp.**

From Yokohama, Japan. Received through L. Boehmer & Co., April 5, 1900.

6195. RHUS CORIARIA. **European sumac.**

From Paris, France. Received through Vilmorin-Andrieux & Co., April 5, 1901.

6196. SEQUOIA SEMPERVIRENS. **Redwood.**

From Berkeley, Cal. Received through Mr. Charles H. Shinn, April 6, 1901.

6197. CUCURBITA MOSCHATA. **Cushaw.**

From Oakgrove, Ind. Received through Mr. H. A. Allen, April 4, 1901.

6198. BRASSICA NAPUS. **Rape.**

From La Crosse, Wis. Received through John A. Salzer Seed Company, April, 1901.

Dwarf Victoria.

6199. LINUM USITATISSIMUM. **Flax.**

From Paris, France. Received through Vilmorin-Andrieux & Co., April 8, 1901.

Irish-grown seed.

6200 to 6220. ORYZA SATIVA. **Rice.**

From the Philippine Islands. Presented by Hon. J. Aranato, secretary of agriculture of the island of Negros. Received March 9, 1901.

A collection of native varieties of rice as follows:

6200.

Capao. An early variety, to be sown on irrigated land in May and harvested in September.

6201.

Gui-os. An early variety, sown on irrigated land in May and harvested in September.

6202.

Cabatiñgan. An early variety, sown on irrigated or dry land in May and June and harvested in September and October. The grains of this variety, after being boiled, cling together and are therefore adapted for use in the preparation of jellies.

6203.

Buñga-tagum. An early variety, sown on irrigated land early in June and harvested early in October. The grain is very white and highly esteemed for food.

6204.

Morado.

6205.

Cachuri. An early, "fragrant" variety, sown in April and harvested in August. Cultivated on the mountain slopes. Its principal use is for the manufacture of "Pilipig."

6206.

Mayuro. An early variety, sown on irrigated land early in June and harvested in October. The grain is very white and highly esteemed for food.

6207.

Baráo. An early variety, sown on irrigated land early in June and harvested at the end of October.

6208.

Cotsiam. An early rice, sown on irrigated land in April and May and harvested in August and September.

6200 to 6220—Continued.

6209.

Caugaá. An early variety, sown on irrigated land early in June and gathered in October. The grain is red and is valued as an article of food.

6210.

Cabuulog. A late variety sown on irrigated land at the end of June or early in July and gathered in December or early in January.

6211.

Piracát. An early variety, sown on dry land in May and gathered in September. The grains of this rice cling together after being boiled, and this substance is used in the preparation of dainties.

6212.

Lubang. An early variety, sown on either irrigated land or dry land in May or June and harvested in September or October.

6213.

Lumantao. An early variety, sown on irrigated or dry land in May or June and harvested in September or October.

6214.

Dagul-pilit. A late variety, sown on dry or irrigated lands in May and harvested in November. The grains of this rice cling together after being boiled and are used for making delicacies.

6215.

Cuba. An early variety, sown on irrigated land early in June and harvested the last of October.

6216.

Tapul-pilit. A late variety, sown on irrigated land late in June or early in July and harvested in December and January.

6217.

Calanay-pilit. A late variety, sown on irrigated land late in June or the first of July and harvested in December and January.

6218.

Tapúl-pilit. An early variety, sown on dry land in May and harvested in September. The grains of this are dark, and when boiled cling together and serve for the making of delicacies.

6219.

Macau. A late variety, sown on irrigated lands late in June or early in July and harvested in December and January.

6220.

Soladong. A late variety, sown on irrigated land the last of June and first of July; harvested in December and January.

6221 to 6238.

From the Philippine Islands. Presented by Hon. J. Aranato, secretary of agriculture of the island of Negros. Received March 9, 1901.

A collection of seeds of economic plants grown by the natives, as follows:

6221. CHAETOCHLOA ITALICA. **Millet.**

Dana. An early-maturing grass, the seeds of which are used for making jellies.

6221 to 6238—Continued.

6222. SESAMUM INDICUM. **Sesame.**

Lunga. Sown in May and harvested in October. The oil of "ojonjoli" is extracted from the seeds.

6223. DOLICHOS SINENSIS (?). **Bean.**

Balatong.

6224. PHASEOLUS MUNGO. **Gram.**

Mongo.

6225. **Bean.**

Marayo. A black climbing bean, sown in May and harvested in October; used for pottage.

6226. PHASEOLUS CALCARATUS. **Bean.**

Tajori. A yellow climbing bean, sown in May and harvested in October; used for pottage.

6227. **Pea.**

Native name, *Cadios.* An undetermined variety of pea.

6228. DOLICHOS SINENSIS. **Bean.**

Lestones. A climbing bean, sown in May and harvested in September; used for pottage.

6229. NICOTIANA TABACUM. **Tobacco.**

6230. ZEA MAYS. **Corn.**

An early variety; sown in May and harvested in August and September.

6231. ZEA MAYS. **Corn.**

The first crop from American seed.

6232. ZEA MAYS. **Corn.**

The second crop from American seed.

6233. ZEA MAYS. **Corn.**

An early purple variety; sown in May and harvested in August and September.

6234. MUSA TEXTILIS. **Manila hemp.**

Abaca-Bisaya. In the island of Negros it is the custom to sow the seed of this plant in the months of May, June, and July.

6235. MUSA TEXTILIS. **Manila hemp.**

Abaca-Kinisol. In the island of Negros it is the custom to sow the seed of this plant in the months of May, June, and July.

6236. MUSA TEXTILIS. **Manila hemp.**

Abaca-Moro. In the island of Negros it is the custom to sow the seed of this plant in the months of May, June, and July.

6237. MUSA TEXTILIS. **Manila hemp.**

Abaca-Lono. In the island of Negros it is the custom to sow the seed of this plant in the months of May, June, and July.

6238. (Museum specimen.)

6239. MUSA TEXTILIS. **Manila hemp.**

Museum specimen only.

6240. OLEA EUROPAEA. **Olive.**

From Fresno, Cal. Presented by Mr. George C. Roeding, through Mr. W. T. Swingle. Received April 6, 1901.

Obliza.

6241 to 6243. FICUS CARICA. **Caprifig.**

From Fresno, Cal. Presented by Mr. George C. Roeding, through Mr. W. T. Swingle. Received April 6, 1901.

6241.

Roeding's No. 1 variety.

6242.

Roeding's No. 2 variety.

6243.

Roeding's No. 3 variety.

6244. FICUS CARICA. **Fig.**

From Fresno, Cal. Presented by Mr. George C. Roeding, through Mr. W. T. Swingle. Received April 6, 1901.

Smyrna.

6245. CITRUS AURANTIUM. **Orange.**

From Mustapha, Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Mr. W. T. Swingle. Received April 8, 1901.

6246. CITRUS DECUMANA. **Pomelo.**

From Eustis, Fla. Presented by Mr. Frank W. Savage, through Mr. W. T. Swingle. Received April 8, 1901.

6247. CITRUS NOBILIS (?). **Orange.**

From Eustis, Fla. Presented by Mr. Frank W. Savage, through Mr. W. T. Swingle. Received April 8, 1901.

King, or King of Siam.

6248. CITRUS AURANTIUM. **Orange.**

From Eustis, Fla. Presented by Mr. Frank W. Savage, through Mr. W. T. Swingle. Received April 8, 1901.

Sanford Mediterranean.

6249. CITRUS AURANTIUM. **Orange.**

From Eustis, Fla. Presented by Mr. Frank W. Savage, through Mr. W. T. Swingle. Received April 8, 1901.

Ruby blood.

6250. CITRUS DECUMANA. **Pomelo.**

From Eustis, Fla. Presented by Mr. Frank W. Savage, through Mr. W. T. Swingle. Received April 8, 1901.

Aurantium.

6251. Olea europaea. Olive.

From Mustapha, Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Mr. W. T. Swingle. Received April 30, 1901.

Mascara, a variety from M. Jaubert's place at Inkermann. Thought by Mr. Swingle to be possibly the very large sort, the fruit of which sometimes weighs 17 grams. Doctor Trabut considers it the same as the variety *Bréa* of Tlemsen.

6252. Pistacia vera. Pistache.

From Mustapha, Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Mr. C. S. Scofield. Received May 22, 1901.

Sfax (female). "The sort grown about Sfax, Tunis, where large quantities of pistaches were formerly produced. It is said to be a good variety and was formerly largely exported, but of late prices have declined and exports from Sfax ceased. This variety was obtained last year from the same tree and was sent through the University of California to Mr. G. P. Rixford, who succeeded in grafting it on the terebinth tree on his place in Sonoma County." (*Swingle.*)

6253. Pistacia vera. Pistache.

From Mustapha, Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Mr. C. S. Scofield. Received May 22, 1901.

Sfax (male). "Scions from male tree growing in the botanical garden of the *Écoles Superieures* at Algiers." (*Scofield.*) See No. 6252.

6254. Ficus carica. Caprifig.

From Maison Carrée, near Algiers, Algeria. Presented by M. Lepiney through Mr. C. S. Scofield. Received May 28, 1901.

6255 to 6258.

(Numbers not utilized.)

6259. Ximenia americana. Hog plum.

From Miami, Fla. Presented by Mr. H. C. Henricksen. Received May 21, 1901.

6260 to 6271.

A collection of Danish vegetable seed.

6260. Beta vulgaris. Beet.

Yellowstone. "Yellow, bottle-shaped; is a half-breed beet of unusual yielding ability in connection with great nutritive substance; requires an early sowing, but does not make great claims as to soil. It is a comparatively new variety, which is in great demand." (*Kolle Bros.*)

6261. Beta vulgaris. Beet.

McKinley. "Pink, bottle-shaped. It combines yielding power with nutritive substance, but wants a rich, warm soil. Under these conditions it is a variety of high value." (*Kolle Bros.*)

6262. Beta vulgaris. Beet.

Adam. "White, cylinder-shaped variety, which ranges between the common fodder beets and fodder sugar beets. Combines good yielding power with a respectable nutritive substance. It requires a somewhat low-situated, deep-molded soil, and, thus placed, it will scarcely be exceeded by any other beet variety in regard to yielding power." (*Kolle Bros.*)

6263. Beta vulgaris. Beet.

Red Oberndorfer. "This is an improved old variety which, by strict selection in field and laboratory, has attained its standing among 'bell-shaped beets.' It is particularly fit for a warm, light soil." (*Kolle Bros.*)

6260 to 6271—Continued.

6264. BETA VULGARIS. **Beet.**

Red Eckendorfer. "Like *Red Oberndorfer*, it is an old variety which by treatment has reached perfection. Its value lies in its great yielding power, while its nutritive contents are rather low. In order to attain its full development it should be sown in moldy, well-fertilized, moist soil." (*Kolle Bros.*)

6265. BRASSICA RAPA. **Turnip.**

Fiona.

6266. BRASSICA OLERACEA *var.* BOTRYTIS. **Cauliflower.**

Danish Mammoth. Grown on the island of Fyen, Denmark.

6267. BRASSICA OLERACEA *var.* BOTRYTIS. **Cauliflower.**

Extra Early Dwarf Erfurt. Grown on the farm of the royal palace, Fredricksburg.

6268. BRASSICA OLERACEA *var.* BOTRYTIS. **Cauliflower.**

Danish Snowball.

6269. BRASSICA OLERACEA *var.* BOTRYTIS. **Cauliflower.**

Extra Early Dwarf Erfurt. Grown on the island of Fyen, Denmark.

6270. BRASSICA OLERACEA *var.* BOTRYTIS. **Cauliflower.**

Extra Early Improved Erfurt. Grown on the island of Zealand, Denmark.

6271. BRASSICA OLERACEA *var.* BOTRYTIS. **Cauliflower.**

Copenhagen Snowball. Grown at Copenhagen, Denmark.

6272. TRITICUM VULGARE. **Wheat.**

From Volo, Greece. Presented by Mr. Ar. Tsakonas, of Athens, through Mr. D. G. Fairchild (No. 581, March 23, 1901). Received April 15, 1901.

Diminum. "A spring variety. The name means 'two months.' This is a semihard sort, used in Greece to plant after the failure of the winter wheat is known. It is not a two months' wheat, as the name implies, but matures in about three months, being planted the last of February and harvested the first of June. It is a light bearer and not very highly esteemed in Greece, except for the purpose described." (*Fairchild.*)

6273 to 6278.

From the Philippine Islands. Presented by Hon. J. Aranato, secretary of agriculture of the island of Negros. Received March 9, 1901. A collection of seeds as follows:

6273. ZEA MAYS. **Corn.**

"Early; sown in May, harvested in August and September." (*Aranato.*)

6274. THEOBROMA CACAO. **Cacao.**

6275.

Nanca. "A tree which matures at five or six years of age. The fruits, called 'Nanca,' as well as the leaves, are used as greens when young, and when mature the fruit is used as dessert." (*Aranato.*)

6276.

Dagmay. "A bulbous plant which is sown in May and harvested the January following. It grows well in light, loose, rich soil and requires to be kept well covered to produce any shoots. It is used in cooking to take the place of the sweet potato or ordinary potato." (*Aranato.*)

6273 to 6278—Continued.

6277. DIOSCOREA sp.?

Tamis. "A twining tuberous plant, which is sown in May and harvested the following January. It requires stakes about 7 feet high, grows best in a loose, well-fertilized soil, and its roots should be frequently covered with earth. It is used in cooking as a substitute for the potato and sweet potato." (*Aranato.*)

6278. COFFEA ARABICA. **Coffee.**

6279. PHASEOLUS sp. **Bean.**

From China. Received from Mr. J. Lawton Taylor, Honolulu, Hawaii, April 16, 1901.

Meru (?). "Very mealy or granular when boiled." (*Taylor.*)

6280 to 6299. VITIS sp. **Grape.**

From Departmental Nursery of Maine and Loire, France. Received from Mr. Louis Leroy, Angers, France, April 19, 1901.

A collection of phylloxera-resistant varieties for use as stocks.

6280.
Riparia × *Rupestris* 101.

6281.
Mourvedre × *Rupestris* 1202.

6282.
Bourrisquou × *Rupestris* 603.

6283.
Berlandieri × *Riparia* 157–11.

6284.
Chasselas × *Berlandieri* 41.

6285.
Colorado E.

6286.
Colombaud × *Rupestris* 3103.

6287.
Bourrisquou × *Rupestris* 601.

6288.
Solonis × *Riparia* 1616.

6289.
Riparia grand glabre.

6290.
Pure Berlandieri.

6291.
Monticola × *Riparia* 554.

6292.
Riparia × *Rupestris* 3309.

6293.
Aramon × *Rupestris* 2.

6294.
Aramon × *Rupestris Ganzin* 1.

6296.
Rupestris du Lot.

6297.
Rupestris Martin.

6298.
Aramon × *Rupestris Ganzin* 1.

6299.
Riparia Gloire de Montpellier.

6300 to 6306. VITIS sp. **Grape.**

From Caplat. A collection of grapes, No. 6300 being Japanese and the others Chinese. Received through Mr. Louis Leroy, Angers, France, April 19, 1901.

6300.
Precoçe Caplat.

6301.
Alenconnaise (new).

6302.
Romaneti trilobées.

6303.
Tisserandi. inédite de Mandchurie.

6304.
Morandi.

6305.
Pagnacci.

6306.
Romaneti.

6307 to 6339.

From the Tokyo Seed and Plant Company, Tokyo, Japan. Received April 20, 1901.

A collection of miscellaneous seeds, as follows:

6307. ORYZA SATIVA. **Rice.**

Sugaichi.

6308. ORYZA SATIVA. **Rice.**

Adzuma Nishiki.

6309. CANNABIS SATIVA. **Hemp.**

Shimonita.

6310. CANNABIS SATIVA. **Hemp.**

Hiroshima.

6311. VIGNA CATJANG. **Cowpea.**

Black Jurokusasage.

6312. GLYCINE HISPIDA. **Soy bean.**

Black Flat.

6313. VICIA FABA. **Broad bean.**

Large Soramame.

6314. GLYCINE HISPIDA. **Soy bean.**

Yoshioka.

6315. VICIA FABA. **Broad bean.**

Early Soramame.

6316. PISUM SATIVUM. **Pea.**

6317. CANNABIS SATIVA. **Hemp.**

Tochigi.

6318. PHASEOLUS MUNGO-RADIATUS. **Gram.**

Muroran.

6319. DOLICHOS LABLAB. **Hyacinth bean.**

White.

6320. DOLICHOS LABLAB. **Hyacinth bean.**

Purple.

6321. PHASEOLUS MUNGO-RADIATUS. **Gram.**

Yainari.

6322. CANNABIS SATIVA. **Hemp.**

Aidzu.

6323. CANAVALIA ENSIFORMIS. **Knife bean.**

White Natamame.

6307 to 6339—Continued.

6324. CANAVALIA GLADIATA. **Knife bean.**

Pink Natamame.

6325. CANNABIS SATIVA. **Hemp.**

Iwate.

6326. GLYCINE HISPIDA. **Soy bean.**

Rokugatsu.

6327. VIGNA CATJANG. **Cowpea.**

Kurakake.

6328. VIGNA CATJANG. **Cowpea.**

Kintoki.

6329. ASTRAGALUS SINICUS. **Genge clover.**

An early variety of this clover. (See No. 3725, Inventory No. 8.)

6330. ASTRAGALUS SINICUS. **Genge clover.**

A late variety of this clover. (See No. 3725, Inventory No. 8.)

6331. LESPEDEZA BICOLOR. **Bush clover.**

Hagi.

6332. PISUM SATIVUM (?). **Red fodder pea.**

6333. GLYCINE HISPIDA. **Soy bean.**

Gosha.

6334. GLYCINE HISPIDA. **Soy bean.**

Black Round.

6335. GLYCINE HISPIDA. **Soy bean.**

Green Medium.

6336. GLYCINE HISPIDA. **Soy bean.**

Bakaziro.

6337. BOEHMERIA NIVEA. **Ramie.**

No. 1.

6338. BOEHMERIA NIVEA. **Ramie.**

No. 2.

6339. BOEHMERIA NIVEA. **Ramie.**

No. 3.

6340. QUERCUS ILEX. **Holly oak.**

From Vilmorin-Andrieux & Co., Paris, France. Received April 22, 1901.

6341. CAPPARIS INERMIS. **Caper.**

From Vilmorin-Andrieux & Co., Paris, France. Received April 22, 1901.

A spineless form of caper.

6342. CERATONIA SILIQUA. **Carob.**

From Vilmorin-Andrieux & Co., Paris, France. Received April 22, 1901.

6343. QUERCUS ILEX. **Green truffle oak.**

Obtained through Vilmorin-Andrieux & Co. from Mr. A. Rousseau, Carpentras, Vaucluse, France. Received April 22, 1901.

6344. QUERCUS PUBESCENS. **White truffle oak.**

Obtained through Vilmorin-Andrieux & Co. from Mr. A. Rousseau, Carpentras, Vaucluse, France. Received April 22, 1901.

6345. QUEBRACHIA LORENTZII. **Quebracho colorado.**

From Ronaldo Tidblom, director of agriculture and animal industry, Buenos Ayres, Argentina. Received April 22, 1901.

From the semidesert territories of Chaco and Formosa.

6346. ASPIDOSPERMA QUEBRACHO-BLANCO. **Quebracho blanco.**

Presented by Ronaldo Tidblom, director of agriculture and animal industry, Buenos Ayres, Argentina. Received April 22, 1901.

From the semidesert territories of Chaco and Formosa. The name given by Sig. Tidblom was *A. quebracho* Schlect., which does not appear in the Kew Index.

6347. VACCINIUM VITIS-IDAEA. **Mountain cranberry.**

Presented by Prof. Theodor Erben, of the agricultural-botanical experiment station of Tabor, Bohemia. Received April 25, 1901.

6348. RUBUS IDAEUS. **Raspberry.**

Obtained from France by Mr. G. B. Brackett, Pomologist, U. S. Department of Agriculture.

"This belongs to the *R. idaeus* group. The plant is a strong, upright grower, everbearing in its habit. The fruit is large, red, and of excellent quality. It ripens from July to December." (*Brackett.*)

6349. PISTACIA VERA. **Pistache.**

From Athens, Greece. Received through Mr. D. G. Fairchild (No. 569, March 3, 1901), April 27, 1901.

Female trees. Three-year-old trees budded the winter of 1900–1901 and the preceding winter.

"The pistache is a valuable nut tree, well suited for culture in regions having a hot, dry climate. The nuts sell in this country from 40 cents to $1.25 a pound, wholesale. They are already extensively used in America for flavoring confectionery and ice creams, and it is confidently expected that they will be widely used as a table nut, to be served like the almond, as soon as they become better known. In the eastern Mediterranean countries, where the pistache is the best known and choicest nut, it is much more used for eating from the hand than for flavoring. These nuts are among the most delicious known, rather smaller than the almond, but more delicate in flavor and a little oilier, somewhat resembling in texture and taste the piñon of the Rocky Mountains. Unlike the piñon and almond, the pistache nut has a shell easily opened with the fingers, since it contains two thin valves, which split open and become nearly separated as the fruit dries.

"The sorts having yellow kernels are most used in oriental countries as a nut to eat from the hand, but the green sorts only are in demand for flavoring, since the public has become accustomed to associating this color with pistaches used for this purpose.

The pistache is a small tree, 15 to 30 feet high, belonging to the same family as the sumac (*Anacardiaceae*). The male and female flowers are borne on different trees, and this necessitates securing both kinds of trees for an orchard, or, what is preferable, that scions of the male sort be grafted on the female trees that bear the fruit. One male tree is said to suffice to pollinate from five to ten female trees. The best method of propagation is to graft the pistache on the terebinth tree (*Pistacia terebinthus*), a near relative of the pistache, native of the Mediterranean countries where the pistache is cultivated. It is preferable to grow the terebinth trees from seed in place in the orchard, but they can be transplanted, if necessary. The present importation comprises three-year-old trees which were grafted in nursery rows and dug up early in March.

"The pistache will endure a temperature of from 10° to 20° F. It is about as hardy as the fig and olive, possibly rather hardier. Its crop is not so liable as that of the almond to injury by late frosts, because it flowers much later in spring, a matter of great importance in the Southwest, where the almond is often injured because of its habit of blooming early. The pistache thrives best on a deep soil containing lime, but it succeeds also on other soils. A warm southern hillside is the best location. The tree is adapted especially for culture in regions having a dry summer season. It requires about the same climate as the olive, and will doubtless succeed in parts of California, Arizona, and possibly in some regions in Florida. Around the shores of the Mediterranean, where it is commonly cultivated, the tree is not irrigated. It needs about as much water as the olive, and, like it, can succeed on hillsides too dry to support most other fruit trees.

"The trees comprised under this number are female trees, and should be planted 20 to 25 feet apart, with a male tree (No. 6350) in the center of the group of females. The grafts should be cut back to two buds. The trees should be watered judiciously this season until properly started, after which no special care is necessary. Although these trees are already older than is desirable for transplanting, it is hoped that by care they can all be made to live, and that a small quantity of nuts will be produced year after next. The trees will bear full crops when they are 7 years old. The average yield is about 20 pounds." (*W. T. Swingle and D. G. Fairchild.*)

6350. PISTACIA VERA. **Pistache.**

From Athens, Greece. Received through Mr. D. G. Fairchild (No. 569, March 8, 1901), April 27, 1901.

Male trees. "Three-year-old stocks budded 1899–1900 to male scions." (*Fairchild.*)

6351. NEOWASHINGTONIA FILAMENTOSA. **Fan palm.**

Received March, 1901, through Prof. Charles H. Shinn, from Johnson & Musser Seed Company, Los Angeles, Cal.

6352. ERYTHEA EDULIS. **Guadalupe palm.**

Received March, 1901, through Prof. Charles H. Shinn, from Johnson & Musser Seed Company, Los Angeles, Cal.

6353. HUMULUS LUPULUS. **Hop.**

From Horst Brothers, Horstville, Cal. Received April 25, 1901.

A collection of American varieties.

6354. JUGLANS REGIA. **Walnut.**

From Karpenisi, Greece. Presented by Mr. Xanthopoulo, of the Agricultural Experiment Station of Patras, Greece, through Mr. D. G. Fairchild (No. 568, March, 1901). Received April 27, 1901.

"Plants of a very large, thin-shelled walnut which grows in the mountains of Karpenisi, Southern Thessaly. I did not see specimens of this nut, but heard that an unusually large one from one of these trees was sent to the Paris Exposition of 1898. It was so thin shelled that it was necessary to pack it in cotton. Mr. Xanthopoulo, who secured the plants, says he took them from the original trees in Karpenisi which bore the giant nuts sent to Paris." (*Fairchild.*)

6355. PISTACIA sp. **Pistache.**

From Athens, Greece. Received through Mr. D. G. Fairchild, April 27, 1901.

Stocks originally budded with the pistache (No. 6349), of which the scions died in transit. To be used as stocks upon which to graft the true pistache.

6356. VITIS sp. **Grape.**

Received, through Mr. G. B. Brackett, Pomologist, U. S. Department of Agriculture, from Matthew Crawford, Cuyahoga Falls, Ohio, April 29, 1901.

6357. FICUS CARICA. **Fig.**

From T. S. Williams, Monetta, S. C. Received April 29, 1901.

6358. PYRUS BACCATA. **Siberian crab apple.**

From Troitzkosavsk, Altai Province, Siberia. Received, through A. Fischer von Waldheim, director of Imperial Botanic Gardens, St. Petersburg, Russia, April 30, 1901.

This was marked "*Pyrus baccata genuina.*"

6359. BETA VULGARIS. **Sugar beet.**

Grown in Friedrichswerth, Germany, by Ed. Meyer. Presented by Beet Sugar Gazette Co., Chicago, Ill., April 29, 1901.

Friedrichswerther Elite.

6360. CITRUS LIMONUM. **Lemon.**

From Poros Island, Greece. Received through Mr. D. G. Fairchild (No. 576), April 27, 1901.

"One of the best varieties of Poros lemons, which are noted in Greece as the finest coming to the Athens market. The scions are from trees that often bear nearly or quite seedless fruits." (*Fairchild.*)

6361. CITRUS sp.

From Canné, Crete. Received through Mr. D. G. Fairchild (No. 580, March 14, 1901), April 27, 1901.

"Grafting wood of a remarkable citrous fruit, which resembles in shape a large, somewhat pear-shaped lemon. It is Australian gold in color, with a soft, rather thin skin and a flesh as dark colored as some oranges and of a remarkably agreeable, very mild acid, slightly bitter taste. In resembles in flavor a pomelo, only it is somewhat milder. Altogether a most refreshing fruit and deserving the serious attention of all pomelo and other citrus growers. It is possibly a cross or result of several crosses, including the orange, bergamot, and lemon. There are a few weak spines, the leaf has a winged petiole, and the fruit is borne on long, swinging fruit stalks. The name *lemon pomelo* is suggested because it is shaped like a lemon and tastes something like a pomelo. There is no popular name here in Crete. It is probable, in fact, that there are not more than a half dozen trees in existence on the island." (*Fairchild.*)

6362. CYDONIA SINENSIS. **Chinese quince.**

From Zante, Greece. Received through Mr. D. G. Fairchild, April 27, 1901.

Seeds of No. 6183.

6363. CUCUMIS MELO. **Melon.**

From Zante, Greece. Received through Mr. D. G. Fairchild (No. 567, February 22, 1901), April 27, 1901.

Zante winter. "This is said to be the best of the winter melons of Zante, having a delicious sweet flavor and keeping until the opening of spring. It is cultivated like any ordinary melon, plucked before frost in autumn, and allowed to ripen in a cool place free from frost. In Zante the fruits are hung up to ripen in small fiber slings on the wall. A specimen was tasted by the writer on the 22d of February, and although it was somewhat lacking in sweetness proved a most palatable fruit. Good melon connoisseurs say that these winter melons from Zante are often deliciously sweet, even when kept until spring." (*Fairchild.*)

6364. CUCUMIS MELO. **Winter melon.**

From Zante, Greece. Received through Mr. D. G. Fairchild (No. 566, February 22, 1901), April 27, 1901.

Cephalonia. "A winter canteloupe, which is grown to perfection on the island of Cephalonia, one of the Ionian group. The melons are cultivated in the usual way and in autumn plucked and strung up in a primitive basket of rough twisted grass. Here they are left to ripen and from midwinter until April the inhabitants of both Cephalonia and Zante serve them on their tables. These winter melons have a thin rind, which is loosely attached to the flesh and can be peeled off like the skin of an orange, leaving the most beautiful ice-cream-like, greenish flesh behind. I know of no more beautiful table fruit than a half melon peeled and served in this way. It looks like a mound of pistache ice cream and would captivate any fruit lover." (*Fairchild.*)

6365. CITRUS LIMONUM. **Lemon.**

From Andros Island, Greece. Received through Mr. D. G. Fairchild, April 27, 1901.

Seed from fruits which are nearly seedless.

6366. VITIS VINIFERA. **Corinth.**

From region of Nemeo, Greece. Received through Mr. D. G. Fairchild, April 27, 1901.

Corinth. "Among the clusters of ordinary dried *Corinths*, which are usually seedless, there are generally small branches bearing larger berries. These berries have often one or more seeds in them. These seeds were taken from such berries. It may be possible, by the use of such seeds, to produce new seedless varieties." (*Fairchild.*)

6367. HORDEUM DISTICHUM ERECTUM. **Barley.**

From Patras, Greece. Received through Mr. D. G. Fairchild, April 27, 1901.

6368. MEDICAGO sp.

From mountains of Corfu, Greece. Received through Mr. D. G. Fairchild (No. 537), April 27, 1901.

"One of the numerous leguminous fodder plants which grow rankly on the island and form a large part of the excellent Corfu hay. Procured through the assistance of Mr. Antonio Collas." (*Fairchild.*)

6369. TRITICUM VULGARE. **Wheat.**

From Trieste, Austria. Received through Mr. D. G. Fairchild, April 27, 1901.

Riete Originario. "A noted winter variety, said to be resistant and a good yielder. Grown in the vicinity of Görz and Trieste, Austria." (*Fairchild.*)

6370. TRITICUM VULGARE. **Wheat.**

From Greece. Received through Mr. D. G. Fairchild, April 27, 1901.

Cologna. "A winter variety." (*Fairchild.*)

6371. TRITICUM DURUM. **Wheat.**

From Corfu, Greece. Received through Mr. D. G. Fairchild, April 27, 1901.

Sample only.

6372. TRITICUM POLONICUM? **Wheat.**

From Corfu, Greece. Received through Mr. D. G. Fairchild, April 27, 1901.

"Sample only; probably of Russian origin." (*Fairchild.*)

6373. TRITICUM VULGARE. **Wheat.**

From Greece. Received through Mr. D. G. Fairchild, April 27, 1901.

Sample only, labeled *Jucente* (?).

6374. VITIS VINIFERA. **Corinth.**

From Patras, Greece. Received through Mr. D. G. Fairchild from Cremidi Brothers, of Patras, Greece. Received April 27, 1901.

Corinth. "Large berries containing seeds. These large berries are produced, I am told, occasionally by certain branches of the plant which otherwise bear only seedless fruit. They have often many seeds in them. New varieties of the *Corinth* grape are likely to originate as seedlings from this generally seedless variety." (*Fairchild.*)

6375. NIGELLA AROMATICA. **Fennel flower.**

Grown on the Potomac Flats, District of Columbia, under the direction of W. R. Beattie, from No. 2129.

6376. HIBISCUS ESCULENTUS. **Okra.**

Grown on the Potomac Flats, District of Columbia, under the direction of W. R. Beattie, from No. 3636.

6377. DOLICHOS LABLAB. **Lablab bean.**

Grown on the Potomac Flats, District of Columbia, under the direction of W. R. Beattie, from No. 2083.

6378. PHASEOLUS MUNGO. **Gram.**

Grown on the Potomac Flats, District of Columbia, under the direction of W. R. Beattie, from No. 3868.

6379. GLYCINE HISPIDA. **Soy bean.**

Grown on the Potomac Flats, District of Columbia, under the direction of W. R. Beattie, from No. 3870.

6380. MEDICAGO TURBINATA. **Bur clover.**

Grown on the Potomac Flats, District of Columbia, under the direction of W. R. Beattie, from No. 4187.

6381. OCIMUM BASILICUM. **Sweet basil.**

Grown on the Potomac Flats, District of Columbia, under the direction of W. R. Beattie, from No. 2008.

6382. CAPSICUM ANNUUM. **Red pepper.**

Grown on the Potomac Flats, District of Columbia, under the direction of W. R. Beattie, from No. 3905.

A sweet pepper.

6383. CAPSICUM ANNUUM. **Red pepper.**

From Athens, Greece. Received through Mr. D. G. Fairchild, April 27, 1901.

"A market variety in Athens." (*Fairchild.*)

6384 to 6424.

From Pyeng Yang, Korea. A collection of seeds of economic plants which are cultivated in Korea. Presented by Rev. W. M. Baird. Received May 3, 1901.

6384. ORYZA SATIVA. **Black rice.**

"Plant in May." (*Baird.*)

6385. FAGOPYRUM ESCULENTUM. **Buckwheat.**

6386. GLYCINE HISPIDA. **Soy bean.**

Black.

6384 to 6424—Continued.

6387. Callistephus hortensis. **China aster.**

Red.

6388. Callistephus hortensis. **China aster.**

White.

6389. Chaetochloa italica. **Millet.**

6390. Allium cepa. **Onion.**

6391. Phaseolus sp. **Bean.**

6392. Callistephus hortensis. **China aster.**

Red.

6393. Perilla sp.?

"A fine oil for the table is extracted from the seeds. Sow in April or May." (*Baird.*)

6394. Brassica juncea. **Chinese mustard.**

"Plant in April." (*Baird.*)

6395. Cucumis sativa. **Cucumber.**

"Plant in April or May." (*Baird.*)

6396. Glycine hispida. **Soy bean.**

White.

6397. Glycine hispida. **Soy bean.**

6398. Raphanus sativus. **Radish.**

Large. "Plant in August." (*Baird.*)

6399. Hordeum vulgare. **Barley.**

Late.

6400. Gossypium barbadense. **Cotton.**

"Plant in May." (*Baird.*)

6401. Zea mays. **Corn.**

Late. "Plant in April or May." (*Baird.*)

6402. Cucurbita pepo. **Pumpkin.**

April.

6403. Hordeum vulgare. **Barley.**

"A hull-less variety." (*Baird.*)

6404. Zoysia pungens. **Korean lawn grass.**

Used in Korea for lawns.

6405. Zoysia pungens. **Korean lawn grass.**

Used in Korea for lawns.

6406. Andropogon sorghum. **Sorghum.**

"A kind of grain similar in appearance to broom corn or sugar cane. The seeds are eaten. The canes are very straight and quite useful. Planted in May." (*Baird.*)

6384 to 6424—Continued.

6407. COIX sp. Job's tears.

6408. PANICUM MILIACEUM. Broom-corn millet.

6409. PANICUM CRUS-GALLI. Barnyard grass.

6410. CHAETOCHLOA ITALICA. Foxtail millet.

6411. ANDROPOGON SORGHUM. Sorghum.

"Kind of grain similar in appearance to broom corn and sugar cane. The grain is eaten by Koreans. The canes are straight and valuable." (*Baird.*)

6412. LAGENARIA VULGARIS. Gourd.

6413. VIGNA CATJANG. Cowpea.

6414. GLYCINE HISPIDA. Soy bean.

"Plant in May." (*Baird.*)

6415. PHASEOLUS sp. Bean.

Black.

6416. GLYCINE HISPIDA. Soy bean.

Black.

6417. PHASEOLUS MUNGO-RADIATUS (?). Gram.

6418. PHASEOLUS MUNGO-RADIATUS (?). Gram.

6419. CHRYSANTHEMUM CARINATUM.

"Very good greens for dressing with salad oil are prepared from this." (*Baird.*)

6420. SESAMUM INDICUM. Sesame.

"An oil is extracted from the seeds which is useful for oiling furniture, etc." (*Baird.*)

6421. IMPATIENS BALSAMINA. Balsam.

6422. CELOSIA CRISTATA. Cockscomb.

6423. ZINNIA ELEGANS. Zinnia.

6424. TAGETES sp. Marigold.

6425 to 6428.

From Stockholm, Sweden. Received through Messrs. Lathrop and Fairchild (Nos. 419, 420, 422, 423) from Lindahls Fröhandel, May 6, 1901.

A collection of vegetable seeds as follows:

6425. CUCUMIS SATIVUS. Cucumber.

Stockholm's Torg. "The most popular cucumber in Sweden, suitable for planting in Alaska. It is a white, very hardy variety, though said to be inferior to green sorts." (*Fairchild.*)

6426. CUCUMIS MELO. Muskmelon.

Stockholm's Torg. "The best Swedish market variety of cantaloupe. It is here cultivated under glass, and the melons are sold for 2 to 4 kroner, or 50 cents to $1 apiece." (*Fairchild.*)

6425 to 6428—Continued.

6427. Brassica oleracea. **Cabbage.**

Stockholm's Torg. "A native variety of Swedish cabbage, said to be a very early maturing sort. For planting in Alaska." (*Fairchild.*)

6428. Pisum sativum. **Pea.**

Stensärter äkta. "An early ripening Swedish pea, suitable for Alaska and other northern localities." (*Fairchild.*)

6429. Vitis vinifera. **Corinth.**

From Panariti, Greece. Received through Mr. D. G. Fairchild (No. 575, March 6, 1901), May 9, 1901.

"The variety of grape producing the *currants* or *corinths* of commerce. These cuttings were purchased in the village of Panariti, which lies among the mountains back of Xyloncastron. This village is noted for producing some of the finest corinths in Greece. It is the custom in Greece to plant very long cuttings in the rocky soil, digging down even into the bed rock, upon which the base of the cutting is allowed to rest. In Greece the vines are planted about 5 feet apart each way, and are trained wholly without a wire or other trellis. The claim is made that the fruit is so delicate, being, as is well known, an essentially seedless grape, that it requires the dense shade made by the foliage of the low sprawling canes which spring from the low-cut, upright, main trunk of the plant. As the clusters mature, these sprawling canes are lifted from the ground and supported on short stakes to prevent the grapes from actually lying on the ground. After the petals have dropped from the flowers, i. e., when the fruit is well 'set,' the vines are ringed or girdled. This girdling is done on the main trunk of the vine, a thin quarter-inch-wide ring of bark being removed. This ringing is said to be essential to the production of a large berry. It is the belief that the berries from vines not ringed are richer in sugar, not so filled with juices, and keep better than those from ringed vines. The climate and soil in which the corinth will thrive are various. Necessary requisites are a long summer with good insolation and a not too high temperature, 95° F. being looked on as a very high temperature in the regions where these plants are cultivated. It is a popular belief that the corinth degenerates rapidly on being introduced into foreign countries, and that it even becomes a seed-bearing grape. I can not find that this belief is supported by sufficient evidence. Samples of corinths grown in Australia show that at least the plant does not produce seed there and does produce a utilizable product, which, however, is inferior in size and flavor to good Greece-grown specimens. The small size may be caused by a neglect to ring or a failure to perform this important process at the proper time, i. e., just after the fruit sets. This variety is exceedingly subject to the downy mildew (*Plasmopara viticola*), and the fields of Greece were ravaged by a frightful epidemic of this disease last year. The immediate locality from which these cuttings came was spared." (*Fairchild.*)

6430. Phaseolus viridissimus. **Gram.**

From Athens, Greece. Received through Mr. D. G. Fairchild (No. 571), May 9, 1901.

"One of the smallest and most delicate beans in the world. The beans are not much larger than grains of rice and of a deep green color. They are said to be most delicious when cooked alone or with rice in the national Greek dish called *Pilaff*. Their culture in Greece is a restricted one and the beans are considered a great delicacy. This is a variety which should receive a thorough distribution, as it is one worthy of trial throughout the south. I am indebted to Prof. Th. de Heldreich, of Athens University, for calling my attention to this species of which he has made a special study. Probably a variety of the *gram* of India (*Phaseolus mungo*)." (*Fairchild.*)

6431. Vigna catjang. **Cowpea.**

From Athens, Greece. Received through Mr. D. G. Fairchild (No. 572, March 7, 1901), May 19, 1901.

"This legume is highly prized by the Greeks, who use it as we do the ordinary bean. (*Fairchild.*)

6432. BRASSICA OLERACEA var. BOTRYTIS. **Cauliflower.**

From Athens, Greece. Received through Mr. D. G. Fairchild (No. 573, March 7, 1901), May 5, 1901.

"An early variety of cauliflower which ripens in December in Greece. Its heads attain most unusual proportions and are of quite unusual flavor. It is sown here in August or September." (*Fairchild.*) (See No. 6434.)

6433. LENS ESCULENTA var. MICROSPERMA. **Lentil.**

From Athens, Greece. Received from Dr. Th. de Heldreich through Mr. D. G. Fairchild (No. 570, March 8, 1901), May 9, 1901.

"A small-seeded, very delicate lentil which was first described by Dr. Th. de Heldreich, the noted explorer of the Grecian flora. (See *Revue des Sciences Naturelles Appliquées 37e Anné No. 15.5 Août 1890. Note sur une variété nouvelle ou peu Connue de Lentille.*) The variety is cultivated on the islands of Cephalonia and Leucade, two of the Ionian group, and differs essentially from the ordinary *Lens esculenta* Mch., having smaller elipsoid, even almost spherical, seeds which possess a marginal border very inconspicuous and obtuse. The color is pale yellow and they vary in diameter from three to five millimeters. Their ordinary lentil is lens shaped, circular, and has a sharply defined margin. This *microsperma* is said to be more tender than the ordinary sorts and much more easily cooked, and the flavor is reported to be superior, lacking that pronounced characteristic taste which makes lentils objectionable to some people. Deserves a thorough trial as a vegetable for soups and purées. A calcareous soil is essential to its cultivation. Stalks make a good fodder." (*Fairchild.*)

6434. BRASSICA OLERACEA var. BOTRYTIS. **Cauliflower.**

From Athens, Greece. Presented by Dr. Th. de Heldreich, of Athens University, through Mr. D. G. Fairchild (No. 574, March 7, 1901). Received May 9, 1901.

"A late variety of Grecian cauliflower which is planted in December and matures in March. Is a monster headed white variety of excellent flavor." (See No. 6432.) (*Fairchild.*)

6435. VICIA ERVILIA.

From Canné, Crete. Received through Mr. D. G. Fairchild (No. 594, March 16, 1901), May 17, 1901.

Orobus. "A forage plant very largely cultivated in the island of Crete. It is sown like any ordinary vetch, and the seeds are fed to the oxen and cattle. Cav. G. M. Fumis, inspector of agriculture at Canné, can secure this in quantity should it prove of sufficient interest." (*Fairchild.*)

6436. LATHYRUS OCHRUS.

From Canné, Crete. Received through Mr. D. G. Fairchild, May 17, 1901.

Vicos. "A forage plant cultivated on the island of Crete." (*Fairchild.*)

6437. VICIA sp.

From Canné, Crete. Received through Mr. D. G. Fairchild, May 17, 1901.

Vares or *Gesu.* "A forage plant cultivated on the island of Crete." (*Fairchild.*)

6438. PHOENIX DACTYLIFERA. **Date.**

From Alexandria, Egypt. Received through Mr. D. G. Fairchild (No. 582, March 30, 1901), May 11, 1901.

Hayani. "This is the earliest sort grown in the Delta region of the Nile and one of the best-known kinds there. It is a red table date, becoming black when ripe; 2 to $2\frac{1}{2}$ inches long; cylindrical. It ripens in September or October. Not used as a drying date. It sells in the season for 2 piasters Turkish (10 cents) per oke (3 pounds). Matures its fruit all at once." (*Fairchild.*)

6439. PHOENIX DACTYLIFERA. **Date.**

From Alexandria, Egypt. Received through Mr. D. G. Fairchild (No. 583, March 30, 1901), May 11, 1901.

Zaglul. "A variety from the Nile Delta region. Fruits of this sort are very large, often 3 inches long. They are eaten by the Arabs when red in color and still unripe. They are table dates, but are not prized as highly by Europeans as by the Arabs, who pay a high price for them. It is a variety which hangs on late in the season." (*Fairchild.*)

6440. PHOENIX DACTYLIFERA. **Date.**

From Alexandria, Egypt. Received through Mr. D. G. Fairchild (No. 584, March 30, 1901), May 11, 1901.

Bint Aisha. "The best variety of table date in lower Egypt, at least it is so considered by many Europeans. It is not a keeping date, being so sweet and sticky that when ripe it must be eaten with a fork. A short, black, small ($1\frac{1}{2}$ inches long) date, ripening in December. Skin separates very easily from the flesh. Sells for 10 to 15 cents for three pounds. Stem of mature palm very slender." (*Fairchild.*)

6441. PHOENIX DACTYLIFERA. **Date.**

From Alexandria, Egypt. Received through Mr. D. G. Fairchild (No. 585, March 30, 1901), May 11, 1901.

Samani. "A variety of Delta date; large, yellow, 2 to $2\frac{1}{4}$ inches long, with a thick skin; ripening in November. It is used in making preserves, which are manufactured especially well by a Mr. Tambaco, of Alexandria, who puts them in tin cans for export after they have been stewed in sugar. They must be peeled before canning, as the skin is tough. Thought of very highly by many Europeans as a sweet characteristic preserve. Is also canned with little sugar, as Americans can plums." (*Fairchild.*)

6442. PHOENIX DACTYLIFERA. **Date.**

From Alexandria, Egypt. Received through Mr. D. G. Fairchild (No. 586, March 30, 1901), May 11, 1901.

Dakar Majahel. "A male variety which is used in the Delta for fertilizing purposes. All the varieties, of which there are at least eight in the region of Ramley alone, are fertilized with the pollen of this *Dakar Majahel.* It is claimed to be the only sort that can be used on all these eight varieties." (*Fairchild.*)

6443. ALBIZZIA LEBBEK **Lebbek.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 611, April 18, 1901), May 17, 1901.

"A much used shade tree about Cairo. Owing to the inroads of a borer, however, this species is being gradually replaced in Egypt by other forms such as *Ficus nitida.*" (*Fairchild.*)

6444. KIGELIA PINNATA (?). **Sausage tree.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 612, April 18, 1901), May 17, 1901.

"This sausage tree is not only a very curious species, bearing its flowers and fruit on long pendant pedicels, but it is a foliage and landscape tree of great merit, worthy of introduction into the parks of southern Florida. Its foliage is exceedingly hard and harsh and very brittle and its heavy sausage-shaped fruits are so heavy as to be dangerous when they fall from the tree. In the Ezbekieh Gardens in Cairo a beautiful specimen of this tree is to be seen." (*Fairchild.*)

6445. PHOENIX DACTYLIFERA. **Date.**

From Charkia, Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 606), May 17, 1901.

Amri (fruit bought on the market). "This sort is known as the best drying date in Egypt. It is in its prime in November but keeps until May or June. A large, red date with a dry, though not unpleasant taste. Some of the specimens are two inches long. Skin rather tough and in most respects inferior to Algerian varieties. These seeds are from trees probably pollinated by some other variety, so they may not yield true *Amri* seedlings." (*Fairchild.*)

6446. ELETTARIA CARDAMOMUM. **Cardamom.**

From Heneratgoda, Ceylon. Received from J. P. William & Bros., May 17, 1901.

Malabar. "In planting cardamons, nursery beds should be prepared about 3 feet wide and 6 feet long; if the soil is poor, cow-dung manure or vegetable mold should be mixed with it (half soil and half manure). Sow the seed, covering it lightly with soil, give the young plants shade, and water them regularly once every evening. Seeds will germinate in from six to eight weeks or possibly not for twelve weeks. When the seedlings are 4 to 6 inches high they should be removed to another bed and planted about 6 to 8 inches apart. When they attain 1 to 2 feet high they are ready to plant in the field about 6 to 12 feet apart, according to the nature of the soil, and should be planted in rainy weather. In planting, the bulb of the plant only should be covered and not the stem; in poor soils, holes are necessary about 1 foot deep and 1½ feet wide which are filled with surface soil, mixed with cow-dung manure or vegetable mold. Care should be taken to keep the nursery thoroughly free from weeds." (*William.*)

6447. ERYTHROXYLON COCA. **Coca.**

From Heneratgoda, Ceylon. Received through J. P. William & Bros., May 17, 1901.

Huanuco. "This plant is a native of tropical South America; it thrives from the sea level up to 5,000 feet and over. The large leaved *Huanuco* variety is especially suited to elevations from 2,000 feet and upward." (*William.*)

6448. CROTON TIGLIUM. **Croton oil tree.**

From Heneratgoda, Ceylon. Received through J. P. William & Bros., May 17, 1901.

"This tree grows even in the poorest soil or abandoned coffee plantations from the sea level up to 3,000 feet and over. Once a week a coolie shakes the tree and picks up from the ground what pods have fallen off, then drops the pods in the sun, shells them, and gives another drying, which is all that is required. A net profit of about 1 shilling a tree per annum has been realized from full-grown trees." (*William.*)

6449. SANTALUM ALBUM. **Sandalwood.**

From Heneratgoda, Ceylon. Received through J. P. William & Bros., May 17, 1901.

"This tree yields the sandalwood of commerce. The same tree produces both the white and yellow sandalwood, the last being the inner part of the tree and very hard and fragrant, especially near the roots. The tree grows from sea level up to 5,000 feet on red and stony soils, and among rocks where the soil is good. The principal item of forest revenue in Mysore is sandalwood. The export to Europe and other countries is yearly increasing." (*William.*)

6450. ALEURITES TRILOBA. **Candle nut.**

From Heneratgoda, Ceylon. Received through J. P. William & Bros., May 17, 1901.

"Oil from the large seeds of this tree is much used for lamps under the name of 'Kekuna' oil; also in painting as a drying oil. In the manufacture of soap it replaces cocoanut oil at Othahiti. The cultivation is easy, the culture being possible from the sea level up to 2,000 feet altitude." (*William.*)

6451. ARTOCARPUS INTEGRIFOLIA. **Honey Jack.**

From Heneratgoda, Ceylon. Received through J. P. William & Bros., May 17, 1901.

"The fruits of this tree, including the seeds, are used as food in various ways, and are highly esteemed by the natives. The fruits weigh as much as 100 pounds. The timber is largely used for all kinds of furniture and building purposes. It is also largely exported to Europe. A full-grown old tree is worth £5 and upward. This is one of the best shade trees for coffee, cocoa, and cardamons, and from the sea level up to 2,000 feet its fallen leaves enrich the soil. The demand for jackwood timber is yearly increasing, as well as the price. Leaves are excellent fodder for cattle, goats, and sheep." (*William.*)

6452. Sapindus trifoliatus.

From Heneratgoda, Ceylon. Received through J. P. William & Bros., May 17, 1901.

6453 to 6460. Eriobotrya japonica. **Loquat.**

From Mustapha Supérieur, near Algiers, Algeria. Presented by Rev. Ewyn Arkwright, from Villa Thémely, through W. T. Swingle. Scions obtained in June, 1900. Grafted trees shipped April 13, 1901; received May 18, 1901.

"This valuable collection of loquats comprises most of the large sorts which have originated in Algeria, where much attention has been paid recently to this valuable fruit. Single fruits of some of these varieties weighed 59 grams, or something over two ounces. There are differences in the time of ripening as well as in the size and flavor of these varieties." (*Swingle.*)

6453.

Don Carlos.

6454.

Baronne Hall.

6455.

St. Michel, long.

6456.

Marcadal.

6457.

Olivier.

6458.

Scala.

6459.

St. Michel, round.

6460.

Narbonne.

6461 to 6468. Ficus carica. **Fig.**

From Rouïba, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Messrs. W. T. Swingle and C. S. Scofield. Received May 17, 1901.

"This collection embraces the principal varieties of figs which are grown at Damascus, and was secured by the French consul there on February 14, 1895. They were sent to Dr. L. Trabut, Government Botanist, Algeria, who planted them at Rouïba in March, 1895. The original notes which accompanied the varieties and which, presumably, were prepared by the French consul are given under each of the numbers." (*Swingle.*)

6461.

Kaab el Ghazal. Fruit medium size, white, yellow outside, of the color of honey inside, splitting open when ripe.

6462.

Saltani. Fruit large, yellow outside, red inside, splitting open at maturity. An early variety.

6463.

Mamari (labeled *Mennoni*, probably erroneously). Fruit medium size, yellow outside, red inside, splitting open when ripe. A late variety.

6464.

Malaki blanc. Fruit large, yellow, white outside, red inside; does not split open when ripe.

6461 to 6468—Continued.

6465.

Sultanie. Grows on dry lands. Fruit medium size, yellow outside, white inside, splitting open when ripe.

6466.

Malaki (labeled *Masaki*, probably erroneously). Fruit large, yellow outside, honey colored inside, splitting open when ripe.

6467.

Baalie. Fruit small, green outside, red inside; does not split open when ripe.

6468.

Hamari. This variety is not included in the descriptive list of varieties furnished by the French consul to Dr. Trabut.

6469 to 6471. FICUS CARICA. **Fig**

From Kabylia, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Messrs. W. T. Swingle and C. S. Scofield. Received May 17, 1901.

6469.

Abakour amellal (*early white*). "A fig from Kabylia, a good fig-growing region, said to produce two crops a year, brebas and figs." (*Swingle and Scofield.*)

6470.

Aberkan (*black*). "A fig from Kabylia, a good fig-growing region, said to produce two crops a year, brebas and figs." (*Swingle and Scofield.*)

6471.

Yousef blanche. "A fig from Kabylia found by General Yousef at time of conquest, 1830–45." (*Swingle and Scofield.*)

6472. FICUS CARICA. **Fig.**

From Rouïba, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Messrs. W. T. Swingle and C. S. Scofield. Received May 17, 1901.

Figuier de Smyrne. "An unnamed Smyrna fig obtained by Doctor Trabut through the French consul some years ago. (*Swingle and Scofield.*)

6473. FICUS CARICA. **Caprifig.**

From Rouïba, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Messrs. W. T. Swingle and C. S. Scofield. Received May 17, 1901.

"A wild caprifig having short flat fruits." (*Scofield.*)

6474. FICUS CARICA. **Caprifig.**

From Rouïba, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Messrs. W. T. Swingle and C. S. Scofield. Received May 17, 1901.

"A wild caprifig having long fruits." (*Scofield.*)

6475. FICUS CARICA. **Caprifig.**

From Algiers, Algeria. Received through Mr. C. S. Scofield, May 17, 1901.

Hamma. "A very valuable variety growing by a stone quarry above the Jardin d'Essai du Hamma, near Algiers. Bears large quantities of winter-generation caprifigs (*mamme*). It is probably from this tree that the Blastophaga was introduced into California in 1899. It bears abundant profichi also." (*Swingle.*)

6476. Ficus carica. **Caprifig.**

From Algiers, Algeria. Received through Mr. C. S. Scofield, May 17, 1901.

"Growing at the stone quarry above Jardin d'Essai du Hamma, near Algiers. Did not hold winter fruits well." (*Scofield.*)

6477. Ficus carica. **Caprifig.**

From Biskra, Algeria. Obtained by Mr. W. T. Swingle, May 15, 1900. Grown one year at Algiers. Received May 17, 1901.

Laudi (?). "Cuttings from tree in a garden in old Biskra." (*Swingle.*)

6478. Ficus carica. **Caprifig.**

From Chetma oasis, near Biskra, Algeria. Obtained by Mr. W. T. Swingle, May 14, 1900. Grown one year at Algiers. Received May 17, 1901.

Bsikri. "Cuttings from a tree in a garden." (*Swingle.*)

6479. Ficus carica. **Caprifig.**

From Biskra, Algeria. Obtained by Mr. W. T. Swingle, May 15, 1900. Grown one year at Algiers. Received May 17, 1901.

Bsikri. "Cuttings from a tree in garden in Old Biskra." (*Swingle.*)

6480. Ficus carica. **Fig.**

From Biskra, Algeria. Obtained by Mr. W. T. Swingle, May 15, 1900. Grown one year at Algiers. Received May 17, 1901.

Choer. "Cuttings from a fig tree growing in the road running south along the west side of Biskra oasis. Probably of no great value." (*Swingle.*)

6481. Ficus carica. **Caprifig.**

From Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Messrs. W. T. Swingle and C. S. Scofield. Received May 17, 1901.

Hamma. The same as No. 6475.

6482. Ficus carica. **Caprifig.**

From Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Messrs. W. T. Swingle and C. S. Scofield. Received May 17, 1901.

Wild fig, with entire leaves from stone quarry above the Jardin d'Essai du Hamma, near Algiers.

6483. Ficus carica. **Caprifig.**

From Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Messrs. W. T. Swingle and C. S. Scofield. Received May 17, 1901.

"A variety of caprifig from M. Eymes de Cheffi." (*Swingle and Scofield.*)

6484. Ficus carica. **Caprifig.**

From Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Messrs. W. T. Swingle and C. S. Scofield. Received May 17, 1901.

Sultani. The same as No. 6462.

6485. Ficus carica. **Caprifig.**

From Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Messrs. W. T. Swingle and C. S. Scofield. Received May 17, 1901.

Yousouf blanche. The same as No. 6471.

6486. FICUS CARICA. **Caprifig.**

From Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Messrs. W. T. Swingle and C. S. Scofield. Received May 17, 1901.

Hamari. The same as No. 6468.

6487. FICUS CARICA. **Caprifig.**

From Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Messrs. W. T. Swingle and C. S. Scofield. Received May 17, 1901.

Belamie.

6488. FICUS CARICA. **Caprifig.**

From Chetma oasis, near Biskra, Algeria. Obtained by Mr. W. T. Swingle, May 14, 1900. Grown one year at Algiers. Received May 17, 1901.

Booung. "A late sort considered of fourth quality. Cuttings from a tree in a garden." (*Swingle.*)

6489. FICUS CARICA. **Caprifig.**

From Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Messrs. W. T. Swingle and C. S. Scofield. Received May 17, 1901.

Figue de l'Archipel (*Archipelago fig*).

6490. FICUS CARICA. **Caprifig.**

From Algiers, Algeria. Obtained by Mr. W. T. Swingle. Received May 17, 1901.

Bourlier. "A variety much prized by the Kabyle fig growers who come 15 miles or more to Reghaïa to M. Bourlier's farm to get the fruits to use in caprifying figs." (*Swingle.*)

6491. FICUS CARICA. **Caprifig.**

From Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Messrs. W. T. Swingle and C. S. Scofield. Received May 17, 1901.

Malaki noir (labeled *Masaki noir*, probably erroneously). Fruit large, violet-colored without, red within, not splitting open at maturity. A late variety.

6492. IRIS UNGUICULARIS. **Iris.**

From Algiers, Algeria. Presented by Rev. Ewyn Arkwright, through Mr. C. S. Scofield. Received May 17, 1901.

Iris stylosa (*white sport*). "A very handsome white sport of this curious iris (also called *Iris stylosa*), which bears its fruit capsules at or just below the surface of the ground. The flowers have a tube 8 to 12 inches long which serves to support them at the level of the ends of the leaves differing widely from the ordinary species where the tubes are short and the flowers attached to two stems." (*Swingle.*)

6493. FICUS CARICA. **Fig.**

From Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Messrs. W. T. Swingle and C. S. Scofield. Received May 17, 1901.

Abakour amclab(?) or *Abacour amclale.*

6494. FICUS SAKOUI. **Fig.**

From Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Messrs. W. T. Swingle and C. S. Scofield. Received May 17, 1901.

6495. FICUS CARICA. **Fig.**

From Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Messrs. W. T. Swingle and C. S. Scofield. Received May 17, 1901.

Abakour aberkan (*early black*).

6496. FICUS CARICA. **Fig.**

From Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Messrs. W. T. Swingle and C. S. Scofield. Received May 17, 1901.

Yousouf. "A fig from Kabylia, found by General Yousef at the time of the French conquest, 1830–1845." (*Swingle and Scofield.*)

6497. FICUS CARICA. **Fig.**

From Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Messrs. W. T. Swingle and C. S. Scofield. Received May 17, 1901.

Mamari or *Mennoni.* "An early fig from Damascus obtained by Doctor Trabut through the French consul some years ago." (See No. 6463.) (*Swingle and Scofield.*)

6498. FICUS CARICA. **Fig.**

From Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Messrs. W. T. Swingle and C. S. Scofield. Received May 17, 1901.

Kaab el ghazal. See No. 6461.

6499. FICUS CARICA. **Fig.**

From Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Messrs. W. T. Swingle and C. S. Scofield. Received May 17, 1901.

Aberkan or *aberkane.* "A fig from Kabylia, a good fig-growing region, said to produce two crops a year, brebas and figs." (*Swingle and Scofield.*)

6500. VITIS VINIFERA. **Grape.**

From Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Messrs. W. T. Swingle and C. S. Scofield. Received May 17, 1901.

Sultanie. "A white grape bearing large bunches of fruit suitable for table use or for making a kind of port or Madeira wine." (*Scofield.*)

6501. VITIS VINIFERA. **Grape.**

From Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist, through Messrs. W. T. Swingle and C. S. Scofield. Received May 17, 1901.

Smyrna seedless raisin.

6502 and 6503.

(Numbers not utilized.)

6504. ACTINIDIA sp.

From Kuling, China. Received through Dr. G. D. Brill (No. 7), May 17, 1901.

"Will grow at an elevation of 3,500 feet and over." (*Brill.*)

6505. VITIS ROMANETI. **Wild grape.**

From Kuling, China. Received through Dr. G. D. Brill (No. 8), May 17, 1901.

"Thorny grape, which bears large clusters of good-sized, black berries." (*Brill.*)

6506.

(Number not utilized.)

6507 to 6646.

From China. Received through Dr. G. D. Brill, May 17, 1901.

A collection of seeds and plants made during an extended trip through China in 1900. The notes regarding the various numbers are copied from letters written during this period, no separate descriptive list of the various introductions having been furnished. Doctor Brill's numbers are given.

6507. PYRUS sp. **Pear.**

From Ichang. "Small and medium, russet colored around the half near the stem. Rest of skin covered with russet dots. Skin coarse, flesh firm." (No. 10.) (*Brill.*)

6508. PYRUS sp. **Pear.**

From Ichang. "Medium sized, drum-shaped, skin yellow and dotted." (No. 11.) (*Brill.*)

6509. PYRUS sp. **Pear.**

From Ichang. (No. 12.)

6510. PYRUS sp. **Pear.**

From Ichang. (No. 13.)

6511. PYRUS sp. **Pear.**

From the vicinity of Ichang. (No. 14.)

6512. PYRUS sp. **Pear.**

From the vicinity of Ichang. (No. 15.)

6513. PYRUS sp. **Pear.**

From the vicinity of Ichang. (No. 16.) "Fruit medium small, skin white to greenish, fruit flattened-round. Flesh dry, quality poor." (*Brill.*)

6514. PYRUS sp. **Pear.**

From the vicinity of Ichang. (No. 17.) "A flat pear, reddish in color." (*Brill.*)

6515. PYRUS sp. **Pear.**

From the vicinity of Ichang. (No. 18.) "Fruit medium small, skin white to greenish, fruit flattened-round. Flesh dry, quality poor." (*Brill.*)

6516. PYRUS sp. **Pear.**

From the vicinity of Ichang. (No. 19.) "Ripens in September; a longer and larger pear than the Kieffer; of similar shape, but smoother; color, rich golden yellow; quality, good; free from woody tissue; very handsome; often weighs $1\frac{1}{2}$ pounds." (*Brill.*)

6517. PYRUS sp. **Pear.**

From the vicinity of Ichang. (No. 20.) "Large, but of poor quality; skin brown-russet color, with corky dots the size of sesame seeds; good baked." (*Brill.*)

6518. PYRUS sp. **Pear.**

From the vicinity of Ichang. (No. 21.) "Very large; cavity at stem deep; coarse flesh." (*Brill.*)

6519. PYRUS sp. **Pear.**

From the vicinity o chang. (No. 22.)

6507 to 6646—Continued.

6520. Pyrus sp. **Pear.**

From the vicinity of Ichang. (No. 23.) "Ripens very early; small-medium; flat; color yellow-green; slightly acid." (*Brill.*)

6521. Pyrus sp. **Pear.**

From the vicinity of Ichang. (No. 24.) "Size large; larger around at stem end than blossom end; very sweet and good; texture fine. Chinese say it is 'cooling.'" (*Brill.*)

6522. Diospyros kaki. **Japanese persimmon.**

From the vicinity of Ichang. (No. 25.) "Small fruited." (*Brill.*)

6523. Diospyros kaki. **Japanese persimmon.**

From the vicinity of Ichang. (No. 26.) "Large fruited." (*Brill.*)

6524. Diospyros kaki. **Japanese persimmon.**

From Wuchang. (No. 27.) "Small, rather pointed, red; flesh firm and of good quality, not astringent." (*Brill.*)

6525. Diospyros kaki. **Japanese persimmon.**

From Wuchang. (No. 28.) "Large, red persimmon, rather pointed. Similar to No. 6524, only three times the size." (*Brill.*)

6526. Diospyros kaki. **Japanese persimmon.**

From Wuchang. (No. 29.) "Small, yellow; not as good as the red." (*Brill.*)

6527. Diospyros kaki. **Japanese persimmon.**

From Wuchang. (No. 30.) "Large, flat, ridged, yellow, slightly astringent; has a crease around its greatest diameter as though a string had been tied around it before it was fully ripe." (*Brill.*)

6528. Pyrus sp. **Apple.**

From Wuchang. (No. 31.) "Each tree has buds of three varieties. A soft mealy apple, resembling a Hyslop crab. Of good size and firm flesh. A variety cultivated for flowers." (*Brill.*)

6529. Prunus cerasus. **Cherry.**

From Wuchang. (No. 32.) "Tree small. Fruit rather small, pointed, yellowish-red. Ripens at end of April. Never allowed to attain full size before being picked." (*Brill.*)

6530. Castanea sp. **Chestnut.**

From Hankow. (No. 33.) "Propagated by root cuttings. Large nuts. Tree bears very young, at from 5 to 7 feet." (*Brill.*)

6531. Prunus sp.

From Ichang. (No. 34.) "Came to me as a peach. Chinese name is for cherry." (*Brill.*)

6532. Pyrus sp. **Pear.**

From the vicinity of Ichang. (No. 35.) "Same as No. 6507." (*Brill.*)

6533. Castanea sp. **Chestnut.**

From Ichang. (No. 36.) "Root cuttings of a tree bearing large nuts. Bears early and the tree does not grow large." (*Brill.*)

6534. Prunus armeniaca. **Apricot.**

From Ichang. (No. 37.) "Large and late." (*Brill.*)

6507 to 6646—Continued.

6535.

(Number not utilized.)

6536. PRUNUS sp. **Plum.**

From Sai Tseo, above Hankow. (No. 39.) "Pointed, reddish-yellow, sweet; flesh clings to the stone." (*Brill.*)

6537. PRUNUS sp. **Plum.**

From Ichang. (No. 40.)

6538. PRUNUS sp. **Plum.**

From Ichang. (No. 41.)

6539. PRUNUS sp. **Plum.**

From Ichang. (No. 42.)

6540. PRUNUS sp. **Plum.**

From Sai Tseo, above Hankow. (No. 43.)

6541. AMYGDALUS PERSICA. **Peach.**

From Sai Tseo, above Hankow. (No. 44.) "Flat, freestone, ripens in May." (*Brill.*)

6542. AMYGDALUS PERSICA. **Peach.**

From near Sai Tseo, above Hankow. (No. 45.) "White, fine fleshed, flat, freestone, ripening the middle of May." (*Brill.*)

6543. AMYGDALUS PERSICA. **Peach.**

From Sai Tseo. (No. 46.) "Long, rather pointed, red-fleshed, freestone." (*Brill.*)

6544. AMYGDALUS PERSICA. **Peach.**

From Sai Tseo. (No. 47.) "Medium size, flat, freestone, ripening in May." (*Brill.*)

6545. AMYGDALUS PERSICA. **Peach.**

From Sai Tseo. (No. 48.) "Flat, freestone, quality very good. Ripens in June." (*Brill.*)

6546. PRUNUS sp. **Plum.**

From Sai Tseo. (No. 49.) "Large, round, with deep suture down one side. Flesh, red. Ripens in August." (*Brill.*)

6547. AMYGDALUS PERSICA. **Peach.**

From Ichang. (No. 50.) "White peach." (*Brill.*)

6548. AMYGDALUS PERSICA. **Peach.**

From the mountains above Ichang. (No. 50a.)

6549. ZIZYPHUS JUJUBA. **Chinese date.**

From Ichang. (No. 50a.) "Much used for preserves by drying in sugar or sirup. Also eaten fresh." (*Brill.*)

6550. VICIA FABA. **Broad bean.**

From Hankow. (No. 51.) "Large flat bean, a few in a pod. Used for food green and dry. Planted in October or December." (*Brill.*)

6507 to 6646—Continued.

6551. PISUM SATIVUM. **Pea.**

From the valley of Hankow. (No. 52.) "Much resembles the Canadian field pea. Tender ends of shoots, pods, and the peas, green and dry, are used for food." (*Brill.*)

6552. PISUM SATIVUM. **Pea.**

From the mountains near Hankow. (No. 53.)

6553. VICIA sp. (?) **Pea.**

From Ichang. (No. 54.) "Grown 1,000 to 3,000 feet above river. Taller than the others. Much used as food by boat 'trackers.'" (*Brill.*)

6554. VICIA sp. (?)

From Chiu Niu, near Hankow. (No. 55.) "Used as a green manure for rice fields. Sown in October to November and plowed under in April. Larger than No. 6555." (*Brill.*)

6555. VICIA CRACCA. **Vetch.**

From Wusuel. (No. 56.) "Used especially as a green manure for rice fields. Sown in September to November. Often among the late rice, beans, or buckwheat." (*Brill.*)

6556. GLYCINE HISPIDA. **Soy bean.**

(No. 57.) "Much used for bean curd and oil all over central China. Probably as many of these are grown as all the other varieties together." (*Brill.*)

6557. VIGNA CATJANG. **Cowpea.**

From Hankow. (No. 58.) "Is ground with water into a paste and pressed into long strings, which are dried and boiled in water." (*Brill.*)

6558. GLYCINE HISPIDA. **Soy bean.**

From Hankow. (No. 59.) "Used for bean curd and oil. Considered better than No. 6556." (*Brill.*)

6559. GLYCINE HISPIDA. **Soy bean.**

From beyond Chiu Niu. (No. 60.) "Planted between the rows of rice and ripening late in the fall, after the rice is harvested. Used the same as No. 6556, only quality poorer. Will grow on very wet land." (*Brill.*)

6560. GLYCINE HISPIDA. **Soy bean.**

From beyond Chiu Niu. (No. 61.) "Planted and used the same as No. 6559. Planted in July or August." (*Brill.*)

6561. GLYCINE HISPIDA. **Soy bean.**

From Hankow. (No. 62.) "A black bean, used for same purposes as Nos. 6559 and 6560, but of better quality. Not planted with other crops." (*Brill.*)

6562. PHASEOLUS MUNGO-RADIATUS. **Gram.**

(No. 63.) "Planted on the banks of rice fields and in odd corners. Will grow in hard-baked soils. Used in the same way as No. 6557." (*Brill.*)

6563. VIGNA CATJANG. **Cowpea.**

(No. 64.) "Grows to a height of four feet or more. Used for food." (*Brill.*)

6564. PHASEOLUS MUNGO. **Gram.**

From Ichang. (No. 65.) "Grows on the mountains between the Indian corn. Largely takes the place of rice; is also cooked with vegetables before fully dry." (*Brill.*)

6507 to 6646—Continued.

6565. PHASEOLUS VULGARIS. **Bean.**

From Ichang. (No. 66.) "A climber. Used as a snap bean." (*Brill.*)

6566. VIGNA CATJANG. **Cowpea.**

From Hankow. (No. 67.) "These peas are often ground to a paste with water and fried in a hot kettle, forming a huge pancake." (*Brill.*)

6567. VIGNA CATJANG. **Cowpea.**

From Hankow. (No. 68.) "Long-podded bush bean. Used almost entirely green as a snap bean. It is planted early in the spring in cold frames after being soaked in water, then transplanted." (*Brill.*)

6568. VIGNA CATJANG. **Cowpea.**

From Hankow. (No. 69.) "Same as No. 6567, except a climber, trained on a trellis." (*Brill.*)

6569. DOLICHOS LABLAB. **Bean.**

(No. 70.) "A great trailer. Usually planted above banks or fences. A profuse bearer of flat pods, which later are used green as snap beans. Late variety." (*Brill.*)

6570. CANAVALIA ENSIFORMIS. **Jack bean.**

(No. 71.) "A great climber; strong grower. Often planted around the houses for shade. Pods over 1 foot long, containing about nine large beans. Pods are cut up and eaten green, and also salted. Beans are very good, but expensive." (*Brill.*)

6571. ASTRAGALUS SINICUS. **Genge clover.**

(No. 72.) "A cloverlike plant, sown from September to December. Plowed under in April as a green manure for rice. Grows to a height of 1½ to 2½ feet. Has many tubercles on the roots and will grow in very wet land. Reseeds itself on the overflowed lands." (*Brill.*)

6572. GYMNOCLADUS CHINENSIS. **Soap tree.**

(No. 73.) "Large tree. The pods are pounded to a paste and used as a soap. They have the smell of rancid butter. Seeds are used as a dye." (*Brill.*)

6573. ZEA MAYS. **Corn.**

From the mountains above Ichang. (No. 74.) "Has been grown there for 200 years or more. Originally from America. Resists drought well. Much used as food." (*Brill.*)

6574. ZEA MAYS. **Corn.**

From the mountains above Ichang. (No. 75.) (Same as No. 6573, except in color.)

6575. ORYZA SATIVA. **Rice.**

From Hankow. (No. 76.) "A glutinous rice, very much like No. 6577. It is planted a little earlier and will ripen in two weeks less time." (*Brill.*)

6576. ORYZA SATIVA. **Rice.**

(No. 77.) "A glutinous rice sown in May and harvested in November. Very productive." (*Brill.*)

6577. ORYZA SATIVA. **Rice.**

(No. 78.) "A glutinous rice with red or brown hulls, which are quite easily separated from the kernels. Rather late in ripening." (*Brill.*)

6507 to 6646—Continued.

6578. Oryza sativa. **Rice.**

(No. 79.) "A glutinous rice, ripening a little earlier than No. 6584. The hull is very thin and gives a large proportion of hulled rice. Hulls very long. Mostly used for making candy." (*Brill.*)

6579. Oryza sativa. **Rice.**

(No. 80.) "A hard rice that does not swell a great deal in cooking. Sown in May, transplanted in June, harvested in September. Hulls thin, giving a large per cent of clean rice." (*Brill.*)

6580. Oryza sativa. **Rice.**

(No. 81.) "A hard rice with long awns and brown, thick chaff." (*Brill.*)

6581. Oryza sativa. **Rice.**

(No. 82.) "A round, short-grained, glutinous rice, with small, compact heads. Ripens a week earlier than No. 6578, or about the middle of July." (*Brill.*)

6582. Oryza sativa. **Rice.**

(No. 83.) "Straw large and coarse. Hull quite thick. Best rice of this section." (*Brill.*)

6583. Oryza sativa. **Rice.**

(No. 84.) "A hard rice; straw short and small, but tough; hulls thin; yields well." (*Brill.*)

6584. Oryza sativa. **Rice.**

(No. 85.) "Grows $3\frac{1}{2}$ to 4 feet high. The seed is sown in March and it is ripe in July. Field is then flooded after harvest and suckers start out which produce a smaller crop in September. Yields heavy crop of good rice. More of this is sown than of any other variety around Hankow." (*Brill.*)

6585. Oryza sativa. **Rice.**

From Ichang. (No. 86.) "A brown-hulled rice." (*Brill.*)

6586. Oryza sativa. **Rice.**

From Ichang. (No. 87.) "It is said to ripen three months from sowing the seed." (*Brill.*)

6587. Oryza sativa. **Rice.**

From Ichang. (No. 88.)

6588. Oryza sativa. **Rice.**

From Shasi. (No. 89.) "A glutinous rice sown on the overflowed lands. The plants are said to stand an excess of water and to keep their heads above it better than any other variety." (*Brill.*)

6589. Chaetochloa italica. **Millet.**

From Sai Tseo. (No. 90.) "Much used by the people as porridge in place of rice in the north of the province." (*Brill.*)

6590. Chaetochloa italica. **Millet.**

From Sai Tseo. (No. 91.) "Used in same way as No. 6589." (*Brill.*)

6591. Chaetochloa italica. **Millet.**

From Ichang. (No. 92.) "Grown in the mountains and much used as a substitute for rice." (*Brill.*)

6507 to 6646—Continued.

6592. Chaetochloa italica. **Millet.**

From Ichang. (No. 93.) "Has the same use as No. 6591, but is said to be of a different variety." (*Brill.*)

6593. Chaetochloa italica. **Millet.**

From Ichang. (No. 94.) "Said to be more glutinous than Nos. 6591 and 6592." (*Brill.*)

6594. Chaetochloa italica. **Millet.**

From the plains above Hankow. (No. 95.)

6595. Sesamum indicum. **Sesame.**

From Hankow. (No. 96.) "Black variety, much used for oil; seeds also used in candy and cake; oil is considered the best of all for cooking." (*Brill.*)

6596. Sesamum indicum. **Sesame.**

(No. 97.) "White variety, used the same as No. 6595, but grown in much larger quantities. The oil is considered better than any other vegetable oil for cooking. Exported to France and Germany in large quantities." (*Brill.*)

6597. Hordeum vulgare. **Barley.**

From Chiu Niu, near Hankow. (No. 98.) "Boiled with rice or boiled and eaten in place of rice." (*Brill.*)

6598. Triticum vulgare. **Wheat.**

From near Hankow. (No. 99.) "Fish-headed wheat, with small, compact heads." (*Brill.*)

6599. Triticum vulgare. **Wheat.**

From near Hankow. (No. 100.) "Long-headed wheat." (*Brill.*)

6600. Triticum vulgare. **Wheat.**

(No. 101.) "Variety most sown on the plains after the summer overflow of the river." (*Brill.*)

6601. Hordeum vulgare. **Barley.**

From below Hankow. (No. 102.) "Largely used here for feeding horses." (*Brill.*)

6602. Fagopyrum esculentum. **Buckwheat.**

(No. 103.) "Sown in August or September. Said to be different from No. 6603. Called sweet buckwheat." (*Brill.*)

6603. Fagopyrum esculentum. **Buckwheat.**

(No. 104.) "Sown early in the spring and called bitter buckwheat." (*Brill.*)

6604. Andropogon sorghum. **Sorghum.**

From Hankow. (No. 105.) "Grows to a height of 12 feet or more. Planted on land too dry for rice. Used for distilling, and refuse is used for pigs and cattle. In some places used for human food." (*Brill.*)

6605. Raphanus sativus. **Radish.**

From Hankow. (No. 106.) "Sown from September to November. Grows all winter." (*Brill.*)

6507 to 6646—Continued.

6606. Abutilon avicennae. **Chinese hemp.**

From Hankow. (No. 107.) "Much used for the manufacture of rope and coarse bagging. The plant is cut, tied in small bundles, and packed in mud or water for about five days. The bark is then stripped off by hand and washed, and it is then ready for market." (*Brill.*)

6607. Brassica juncea. **Chinese mustard.**

From Wuchang. (No. 108.) "This seed is planted in August or September. Young plants are then transplanted to rows about 1 to 3 feet apart. The best is grown about Wuchang. Flower stalks are cut all winter continuously. They are eaten much like asparagus. Color, purple, but said to change to green after a season or two if the seed is planted in any other place." (*Brill.*)

6608. Hovenia dulcis. **Raisin tree.**

From Hupeh Province. (No. 109.) "Large, handsome tree. The thickened, sweet seed stems are sold on the street, and the Chinese eat them after feasts of wine, saying they prevent the wine from making them drunk." (*Brill.*)

6609. Pterocarya stenoptera. **Wing nut.**

From Hankow. (No. 100a.) "Large, quick-growing, soft-wooded tree, growing along streams. Planted on the Hankow Bend." (*Brill.*)

6610. Brassica pe-tsai. **Chinese cabbage.**

From Hsiang Yang. (No. 102a.) "Best cabbage of central China. Shipped down the river Han to Hankow in large quantities. Its successful growth appears limited to certain localities. Seeds sown late in April, then transplanted. A month before maturity a rice straw is often tied around the head to make it more compact." (*Brill.*)

6611. Brassica pe-tsai. **Chinese cabbage.**

From Hsiang Yang. (No. 103a.) "Same as No. 6610, only a larger variety." (*Brill.*)

6612. Raphanus sativus. **Radish.**

From Sui Chow. (No. 104a.) "Round, globe shaped, smooth, fine red color. Called a turnip by the Chinese and cooked in the same way." (*Brill.*)

6613. Brassica juncea. **Chinese mustard.**

From Sui Chow. (No. 105a.) "Top and root are salted much the same as sauerkraut and sold in all large towns." (*Brill.*)

6614. Brassica juncea. **Chinese mustard.**

(No. 106a.) "Produces very large leaves which are wilted in the sun and then pickled with salt. May be valuable as a food for sheep." (*Brill.*)

6615. Daucus carota. **Carrot.**

(No. 107a.) "Medium long, yellow. Sown in autumn and generally dug all winter." (*Brill.*)

6616. Spinacia oleracea. **Spinach.**

(No. 108a.) "Much used all winter." (*Brill.*)

6617. Chrysanthemum coronarium. **Edible chrysanthemum.**

(No. 109a.) "A plant much used, cooked with other vegetables." (*Brill.*)

6618. Lactuca sativa. **Lettuce.**

(No. 110.) "Stalk becomes much thickened and succulent, and is cooked as a vegetable. Leaves used only by very poor people. Foreign varieties are used around the ports." (*Brill.*)

6507 to 6646—Continued.

6619. Artemisia sp.

(No. 111.) "Used as greens, cooked." (*Brill.*)

6620. Cucurbita pepo. **Squash.**

(No. 112.) "Long, green skinned, smooth. Flesh very white. Often weighs 65 pounds or more. Shipped to Hankow in large quantities." (*Brill.*)

6621. Cucurbita pepo. **Squash.**

(No. 113.) "Thick, fine skinned, dark yellow, very irregular in shape. Flesh thick, firm, and yellow." (*Brill.*)

6622. Brassica juncea. **Chinese mustard.**

(No. 114.) "A large mustard that might have value for sheep food." (*Brill.*)

6623. Indigofera tinctoria. **Indigo.**

(No. 115.)

6624. Polygonum sp.

(No. 116.) "Very dark color." (*Brill.*)

6625. Sapium sebiferum. **Tallow tree.**

From Hankow. (No. 117.) "Seeds used for wax. Coating around the seed much harder than that in it. Tree has hard white wood, even grained. Used for carving, incense, etc. Much of the tallow is exported from Hankow." (*Brill.*)

6626. Avena sp. **Wild oat.**

(No. 118.) "Grows wild or mixed with barley. Has long awns." (*Brill.*)

6627. Rubus sp. **Raspberry.**

From Yang Tse Gorges, above Kuei Fu. (No. 119.) "Strong grower, prolific bearer. Fruit red, of good size and good flavor." (*Brill.*)

6628. Rubus sp. **Raspberry.**

From near Kuling, near Kukiang. (No. 120.) "Said to be good as to size and quality." (*Brill.*)

6629. Amygdalus persica. **Peach.**

(No. 121.) "Stones of several varieties." (*Brill.*)

6630. Prunus armeniaca. **Apricot.**

(No. 122.) "Stones of several varieties." (*Brill.*)

6631. Prunus cerasus (?). **Cherry.**

(No. 123.)

6632. Canna sp. **Canna.**

From Wau Hsien. (No. 124.) "Growing wild." (*Brill.*)

6633. Thea viridis. **Tea.**

From Yang To Seng. (No. 125.) "Seed from one of the best tea districts of China." (*Brill.*)

6634. Castanea sp. **Chestnut.**

(No. 126.) "Seed mixed, large and medium." (*Brill.*)

6507 to 6646—Continued.

6635. AMYGDALUS PERSICA. **Peach.**

From mountains near Ichang. (No. 127.) "Flowers late, fruit ripens in September. Freestone. Fruit small and quite hairy." (*Brill.*)

6636. CITRUS AURANTIUM. **Orange.**

(No. 128.) "Three varieties of orange seed." (*Brill.*)

6637. BOEHMERIA NIVEA. **Ramie.**

From near Wuchang. (No. 129.)

6638. BOEHMERIA NIVEA. **Ramie.**

From Hunan. (No. 130.) "These roots are from some brought from the best plantations of Hunan for the Viceroy Chang Chi Teng. Hunan is supposed to produce some of the best fiber of China." (*Brill.*)

6639. [Unidentified plant.]

From Loo Ho Ko, on Han River. (No. 131.) "Is cooked much as white potatoes are. Grown from pieces of the root." (*Brill.*)

6640. CITRUS AURANTIUM. **Orange.**

From Ichang. (No. 132.)

6641. CITRUS LIMONUM. **Lemon.**

From Ichang. (No. 133.) "Very juicy, fragrant, full of seeds, large, round, thick-skinned. Used by Chinese as a medicine." (*Brill.*)

6642. CITRUS NOBILIS. **Mandarin orange.**

From Wuchang. (No. 134.) "Medium size, loose-skinned orange, slightly sour." (*Brill.*)

6643. CITRUS MEDICA. **Citron.**

From Wuchang. (No. 135.) "Tight-skinned, round orange." (*Brill.*)

6644. CITRUS NOBILIS. **Mandarin orange.**

From Wuchang. (No. 136.) "Large, loose-skinned." (*Brill.*)

6645. CITRUS DECUMANA. **Pomelo.**

From Ichang. (No. 137.) "Small, white-fleshed."

6646. CITRUS DECUMANA. **Pomelo.**

From Ichang. (No. 138.) "Small, red-fleshed. Considered the best." (*Brill.*)

6647. CITRUS AURANTIUM. **Orange.**

From Corfu, Greece. Presented by Mr. Antonio Colla, through Mr. D. G. Fairchild (No. 533, February 12, 1901). Received May 21, 1901.

"A striking variety of orange which is extremely light in color, and according to Mr. Colla is called in Corfu '*Arancio con pello bianco.*' May be of value for breeders." (*Fairchild.*)

6648. FICUS CARICA. **Fig.**

From Corfu, Greece, Presented by Mr. Antonio Colla through Mr. D. G. Fairchild (No. 536, February 12, 1901). Received May 21, 1901.

"A variety of fig ripening its fruits in February when no leaves are on the tree. The fig is small, but very sweet, and it is very much relished by Europeans in Corfu. It is not a drying fig. Known in Corfu as '*Fico di Febbraio.*'" (*Fairchild.*)

6649. OLEA EUROPAEA. **Olive.**

From Corfu, Greece. Presented by Mr. Antonio Colla through Mr. D. G. Fairchild (No. 535, February 12, 1901). Received May 21, 1901.

"A variety of olive which is said to ripen its fruit in July instead of in October and at the same time to be a heavier yielder than the ordinary sorts grown in Corfu. Called '*Oliro di Estate*,' and I am assured by Mr. Colla, of Corfu, that this variety is known only in a small part of the island of Corfu." (*Fairchild.*)

6650. JUGLANS REGIA. **Walnut.**

From Corfu, Greece. Presented by Mr. Antonio Colla through Mr. D. G. Fairchild (No. 531, February 12, 1901). Received May 21, 1901.

"A very large variety of walnut grown at Paleocastritza, near the town of Corfu. The nut is of quite unusual proportions and the shell is said to be of only medium thickness. The thin skin of the kernel is also said to be less bitter than that of ordinary varieties." (*Fairchild.*)

6651. JUGLANS REGIA. **Walnut.**

From Corfu, Greece. Presented by Mr. Antonio Colla through Mr. D. G. Fairchild (No. 532, February 12, 1901). Received May 21, 1901.

"A variety of walnut having a shell so thin that it splits open of itself as the exocarp or outer covering dries, exposing the kernel within. An interesting house nut, but probably of little commercial value. May, however, be excellent for breeding purposes." (*Fairchild.*)

6652. JUGLANS REGIA. **Walnut.**

From Corfu, Greece. Received May 21, 1901.

(No data.)

6653. LINUM USITATISSIMUM. **Flax.**

From Kafr-el-Zayat, Egypt. Received through Mr. D. G. Fairchild (No. 607, April 18, 1901), May 21, 1901.

"The native Egyptian flax which, according to Mr. Bonaparte's experiments near Cairo, is much inferior to the Belgian imported variety. I can not say positively that this Egyptian variety used by Bonaparte was identical with this seed sent. The stems are long, not blanched near the ground, but of quite miniature and slender size compared with that from Belgian seed. For breeders only." (*Fairchild.*)

6654. CITRUS LIMONUM. **Lemon.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 608, April 18, 1901), May 21, 1901.

Lemon beledi. "A native Egyptian lemon which is not grafted, but grown from seed. It comes true to seed, or reasonably so at any rate. It is a thin-skinned, very juicy variety and is keenly appreciated in Egypt, although a good Syrian variety is common there. This is valued for its great juiciness and wonderfully prolific character." (*Fairchild.*)

6655. GOSSYPIUM sp. **Cotton.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild, May 21, 1901.

"Samples of a variety said to be growing wild in the Sudan, and also a sample from the Province of Tokar, in the Sudan, grown from seed sent up there from Lower Egypt last year to show the quality of Sudan-grown cotton." (*Fairchild.*)

6656. PYRUS MALUS. **Apple.**

Received through Hunter & Sons, Gosford, New South Wales, May 22, 1901.

Irish Peach.

6657. PAULOWNIA sp.

From China. Received through Dr. G. D. Brill (No. 101), May 17, 1901.

6658. HORDEUM VULGARE. **Barley.**

From the Han River, China. Received through Dr. G. D. Brill (No. 102½), May 17, 1901.

"From up the Han River, where it is used for food in place of rice." (*Brill.*)

6659. ACTINIDIA sp.

From China. Received through Mr. G. D. Brill, May 17, 1901.

6660. CRYPTOMERIA JAPONICA.

From Japan. Received through Tokyo Seed and Plant Company, Yokohama, May 22, 1901.

6661. DALBERGIA SISSOO.

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 601, April 18, 1901), May 24, 1901.

"A rapidly growing, hard-wooded tree which is easily propagated by root cuttings. It is a pretty ornamental for warm regions, with delicate foliage of light green, and it is looked upon by the gardener near Cairo, Mr. Stamm, as one of the most promising avenue trees in Egypt. Personally I find that its shade-giving properties are too scanty to recommend it for this purpose. It will do well as a park or garden tree, however. It requires plenty of water and warmth." (*Fairchild.*)

6662. RHAMNUS CALIFORNICA. **Cascara sagrada.**

Presented by Prof. Jos. Burtt Davy, Berkeley, Cal. Received May 27, 1901.

The plant from which the drug cascara of commerce is secured.

6663. MAURANDIA BARCLAIANA.

Presented by Prof. Jos. Burtt Davy, Berkeley, Cal. Received May 27, 1901.

6664. MADIA SATIVA.

Presented by Prof. Jos. Burtt Davy, Berkeley, Cal. Received May 27, 1901.

6665. ELAEAGNUS LONGIPES. **Goumi.**

Presented by Prof. Jos. Burtt Davy, Berkeley, Cal. Received May 27, 1901.

6666. ACACIA RETINODES (?).

Presented by Prof. Jos. Burtt Davy, Berkeley, Cal. Received May 27, 1901.

In Kew Index synonymous with *A. neriifolia.*

6667. EUPHORBIA LATHYRIS.

Presented by Prof. Jos. Burtt Davy, Berkeley, Cal. Received May 27, 1901.

6668. STERCULIA DIVERSIFOLIA.

Presented by Prof. Jos. Burtt Davy, Berkeley, Cal. Received May 27, 1901.

6669. VICIA FABA. **Broad bean.**

Presented by Prof. Jos. Burtt Davy, Berkeley, Cal. Received May 27, 1901.

6670. VICIA GIGANTEA. **Vetch.**

Presented by Prof. Jos. Burtt Davy, Berkeley, Cal. Received May 27, 1901.

6671. CANNABIS INDICA. **Hemp.**

From Royal Botannical Garden, Sibpur, Calcutta, India. Received May 31, 1901.

6672. LARIX LEPTOLEPIS. **Japanese larch.**

From Japan. Received through Vilmorin Andrieux & Co., Paris, France, June 3, 1901.

6673 to 6678. GOSSYPIUM BARBADENSE. **Cotton.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (Nos. 600–605, April 18, 1901), June 10, 1901.

"A collection of cottons which have been selected by Christian Stamm, of Cairo, from fields of the Egyptian cotton and from his own experimental plats.

6673.

Mit Afifi. Selected cream color. First year of selection.

6674.

Very large growing variety, 2 to 2.50 meters high, bearing very large capsules. Grown in Stamm's garden in Cairo.

6675.

Jannovitch. Cream colored, selected from Stamm's own garden.

6676.

The descendant of a cross between a variety sent year before last to Mr. H. J. Webber and a variety called by Stamm "Berla." Shows tendency toward cream color.

6677.

Berla. Second generation. Selected from fields as the yellowest sort among many thousands. The yield of this sort was very high, even double that of many others grown in Stamm's garden.

6678.

"Wild cotton from Omdurman in the Sudan." (*Fairchild.*)

6679. GOSSYPIUM BARBADENSE. **Cotton.**

From Shibin-el-Kanater, Egypt. Received through Mr. D. G. Fairchild, June 10, 1901.

Mit Afifi. Ordinary variety.

6680. TRITICUM DURUM. **Wheat.**

From Minieh, Egypt. Received through Mr. D. G. Fairchild (No. 634, May 5, 1901), June 10, 1901.

Mishriki. "A very fine variety of this wheat which was exhibited last season at the Khedivial Agricultural Society's show in Cairo, and which Mr. George P. Foaden, the secretary of the society, remarked as the finest he has ever seen in Egypt. Secured through Mr. Foaden's kindness from the grower in the province of Minieh, which lies between the twenty-eighth and twenty-ninth degrees of latitude. The wheat is grown on irrigated land, and from all I can ascertain is remarkably pure, considering how mixed almost all Egyptian wheats are. This wheat will probably not withstand the cold winters of the pl-ins at all, but will very likely prove of great value in Texas. It is a hard wheat, whose qualities for macaroni making are quite unknown. Its yielding capacity, I believe, will prove satisfactory, although its resistance to rust, I surmise, may not equal that of other Egyptian sorts, for I notice the beads sent as samples are more or less rusted. Should be planted on soil receiving irrigation and tried as a *winter* wheat in the Southwest on good, rich, stiff soil." (*Fairchild.*) (See No. 7016.)

6681 to 6693.

From Alexandria, Egypt. Presented by the firm of B. Nathan & Co., through Mr. D. G. Fairchild. Received June 10, 1901. A collection of seeds of cultivated plants gathered in the Sudan by one of the firm.

6681. ANDROPOGON SORGHUM. **Sorghum.**

Kusabee, Arabic name.

6682. PANICUM MILIACEUM (?). **Broom-corn millet.**

"Coming from the River Dukhu." (*Fairchild.*)

6683. SESAMUM INDICUM. **Sesame.**

6684. GOSSYPIUM sp. **Cotton.**

A mixed lot of seed of different races and even species.

6685. ANDROPOGON SORGHUM. **Sorghum.**

"Very good quality." (*Fairchild.*)

6686. ANDROPOGON SORGHUM. **Sorghum.**

Aish Abou Girdeh, Arabic name.

6687. CICER ARIETINUM. **Chick-pea.**

Hummos, Arabic name.

6688. LUPINUS sp. **Lupine.**

Tirmoos, Arabic name.

6689. ANDROPOGON SORGHUM. **Sorghum.**

Hajiree, Arabic name.

6690. ANDROPOGON SORGHUM. **Sorghum.**

Hamaisee, Arabic name.

6691. ANDROPOGON SORGHUM. **Sorghum.**

Feterite, Arabic name.

6692. PANICUM MILIACEUM (?). **Broom-corn millet.**

Dukhu, Arabic name.

6693. ANDROPOGON SORGHUM. **Sorghum.**

Safra, Arabic name.

6694 to 6711.

From Pekin, China. Received through Dr. G. D. Brill, June 12, 1901. A collection of seeds of cultivated plants, as follows:

6694. CUCUMIS SATIVUS. **Cucumber.**

"This forcing cucumber is grown with heat during the winter. Many specimens were from 1 foot to 18 inches long, very crisp, and of good quality. Each had a small weight attached to it after it was an inch and a half long to keep it straight." (*Brill.*)

6695. CUCURBITA sp. **Squash.**

6696. SOLANUM MELONGENA. **Eggplant.**

"Large, purple, of very fine quality." (*Brill.*)

6697. CUCUMIS MELO. **Muskmelon.**

"Said to be of very good quality." (*Brill.*)

6694 to 6711—Continued.

6698. Cucurbita sp. **Squash.**

"Flesh very white, much used by Chinese, cooked with meat or alone." (*Brill.*)

6699. Raphanus sativus. **Radish.**

"Large, red, flat variety, resembling a turnip. Kept through the winter and much eaten raw, as well as cooked." (*Brill.*)

6700. Raphanus sativus. **Radish.**

6701. Raphanus sativus. **Radish.**

"A winter variety." (*Brill.*)

6702. Raphanus sativus. **Radish.**

"A forcing variety, grown under mats or under benches in cucumber houses. It is sold in bunches when small. Globe shaped. It is also grown very thickly and the young radishes are pulled when about to send out the third leaf. For use in salads." (*Brill.*)

6703. Raphanus sativus. **Radish.**

"Small, long, red variety." (*Brill.*)

6704. Raphanus sativus. **Radish.**

"Long, white variety." (*Brill.*)

6705. Brassica oleracea. **Cabbage.**

"A very long-headed cabbage, 3 to 5 inches in diameter. The quality is said by foreigners to be excellent. Some say it has a very delicate flavor and can be eaten without causing indigestion by people who can not eat the 'foreign' cabbage." (*Brill.*)

6706. Daucus carota. **Carrot.**

6707. Apium graveolens. **Celery.**

"Not very good in comparison with foreign varieties, but better than that of central China." (*Brill.*)

6708. Cucurbita sp. **Gourd.**

"Hard shells used for drinking cups, etc." (*Brill.*)

6709. Panicum miliaceum. **Broom-corn millet.**

"Much used in the place of rice by the people around Pekin. Cooked as porridge." (*Brill.*)

6710. Andropogon sorghum. **Sorghum.**

"This is much grown for human food around Pekin and is considered much superior to the other varieties." (*Brill.*)

6711. Panicum miliaceum. **Broom-corn millet.**

"This variety is said to withstand drought well." (*Brill.*)

6712. Coffea arabica. **Coffee.**

From Macassar, Celebes, Dutch East Indies. Presented by Mr. K. Auer, U. S. Consular Agent at Macassar, through Messrs. Lathrop and Fairchild. (No. 385.) Received June 12, 1901.

Patjoe or *Bonthain.* A superior variety of coffee grown in southern Celebes.

6713 to 6730. Pyrus malus. **Apple.**

From Gosford, New South Wales. Received through Hunter & Sons, June 19, 1901.

A collection of varieties, as follows:

6713.
Fall Beauty.

6714.
Winter Majetin.

6715.
Autumn Tart.

6716.
Lord Wolseley.

6717.
Ruby Pearmain.

6718.
Golden Queen.

6719.
Northern Spy.

6720.
Menagerie.

6721.
Striped Beaufin.

6722.
Yarra Bank.

6723.
Chatastee.

6724.
Magg's Seedling.

6725.
Early Richmond.

6726.
Tetofsky.

6727.
Primate.

6728.
New England Pigeon.

6729.
Stubbard Codlin.

6730.
Irish Peach.

6731 to 6753. Pyrus malus. **Apple.**

From Emerald, Victoria. Received through Mr. C. A. Nobelius, June 19, 1901.

A collection of varieties, as follows:

6731.
Sharp's Early.

6732.
Cole's Rymer.

6733.
William Anderson.

6734.
Kooroochiang.

6735.
John Sharp.

6736.
Cliff's Seedling.

6737.
Santa Clara King.

6738.
Granny Smith.

6739.
Sharp's Late Red.

6740.
Ruby Gem.

6741.
Northern Spy.

6742.
Statesman.

6743.
Winter Majetin.

6744.
Early Richmond.

6731 to 6753—Continued.

6745.
Sharp's Nonesuch.

6746.
Ruby Pearmain.

6747.
Fall Beauty.

6748.
Irish Peach.

6749.
Magg's Seedling.

6750.
Lord Wolseley.

6751.
The Queen.

6752.
Shroeder's.

6753.
Taupaki.

6754 to 6772. PYRUS MALUS. **Apple.**

From Camden, New South Wales. Received from Ferguson & Son, June 19, 1901.

A collection of varieties, all grafted on Northern Spy stocks, as follows:

6754.
Striped Beaufin.

6755.
Golden Queen.

6756.
New England Pigeon.

6757.
Chatastee.

6758.
American Golden Pippin.

6759.
Menagerie.

6760.
Stubbart Codlin.

6761.
Ruby Pearmain.

6762.
Primate.

6763.
Lord Wolseley.

6764.
Yarra Bank.

6765.
Northern Spy.

6766.
Autumn Tart.

6767.
Winter Majetin.

6768.
Irish Peach.

6769.
Magg's Seedling.

6770.
Tetofsky.

6771.
Early Richmond.

6772.
Fall Beauty.

6773 to 6823. FICUS CARICA. **Caprifig.**

From Kabylia, Algeria. Received through Mr. C. S. Scofield, June 19, 1901.

"This collection, secured by Mr. Scofield in the spring of 1901, consists of cuttings of all the caprifig trees he observed in the vicinity of Tizi Ouzou and Fort National in the mountainous part of Kabylia to the east of the town of Algiers. No data could be secured in regard to most of the numbers and some may prove to be duplicates. All of the 50 numbers are caprifigs, with the exception of 6819, which is an ordinary edible fig. This collection, as well as those enumerated before in this inventory, was secured in the hope of getting an assortment of caprifigs having as wide a range of climatic and soil requirements as possible, in the hope of finding varieties suited to harbor the blastophaga in all parts of California and the Southwest where fig culture is feasible. These varieties are on trial in the Department gardens, and will be distributed when their qualities have been determined." (*Swingle.*)

6773.

"Cuttings from tree No. 18, growing along road from Fort National to Tizi Ouzou." (*Scofield.*)

6774.

"Cuttings from tree No. 11, growing along road from Fort National to Tizi Ouzou." (*Scofield.*)

6775.

"Cuttings from a large tree (No. 33) in the rich bottom lands about a mile or two beyond Tizi Ouzou on the way from Fort National." (*Scofield.*)

6776.

"Cuttings from tree No. 12 along the road from Fort National to Tizi Ouzou." (*Scofield.*)

6777.

"Cuttings from a large and very fine orchard above Mr. Bankhardt's mill, 4 or 5 miles out of Tizi Ouzou on the road to Fort National." (*Scofield.*)

6778.

"Cuttings from a large and very fine orchard just above Mr. Bankhardt's mill, 4 or 5 miles out from Tizi Ouzou on the road to Fort National." (*Scofield.*)

6779.

"Cuttings from tree No. 22 along the road from Fort National to Tizi Ouzou." (*Scofield.*)

6780.

"Cuttings from tree No. 23 along the road from Fort National to Tizi Ouzou." (*Scofield.*)

6781.

"Cuttings from a tree in large and very fine orchard above the mill belonging to Mr. Bankhardt, 4 or 5 miles out from Tizi Ouzou on the road to Fort National." (*Scofield.*)

6782.

"Cuttings from tree No. 10 along the road from Fort National to Tizi Ouzou." (*Scofield.*)

6783.

"Cuttings from tree No. 14 along road from Fort National to Tizi Ouzou. (Possibly *Ghazarh*, *early*. Cuttings from tree in immediate vicinity of Tizi Ouzou. Label lost.)" (*Scofield.*)

6784.

"Cuttings from tree No. 21 along the road from Fort National to Tizi Ouzou." (*Scofield.*)

6785.

"Cuttings from tree No. 6 on the road from Fort National to Tizi Ouzou." (*Scofield.*)

6773 to 6823—Continued.

6786.

"Cuttings from a large and very fine orchard just above Mr. Bankhardt's mill, 4 or 5 miles out from Tizi Ouzou on the road to Fort National." (*Scofield.*)

6787.

"Cuttings from tree No. 24 along the road from Fort National to Tizi Ouzou." (*Scofield.*)

6788.

"Cuttings from tree No. 13 along the road from Fort National to Tizi Ouzou, near Fort National." (*Scofield.*)

6789.

Dhaalou, No. 1. "Cuttings from tree on north side of valley in the immediate vicinity of Tizi Ouzou." (*Scofield.*)

6790.

"Cuttings from tree No. 15 along the road from Fort National to Tizi Ouzou." (*Scofield.*)

6791.

"Cuttings from very fine large tree growing in rich bottom lands a mile or so beyond Tizi Ouzou." (*Scofield.*)

6792.

"Cuttings from tree No. 7 along the road from Fort National to Tizi Ouzou." (*Scofield.*)

6793.

Ghazar, No. 1, an early variety. "Cuttings from tree in immediate vicinity of Tizi Ouzou. (Possibly another kind, No. 14, from tree along road from Fort National to Tizi Ouzou. Label missing.)" (*Scofield.*)

6794.

"Cuttings from tree near Fort National, on the other side (from Tizi Ouzou). Tree still carried the winter fruit in considerable numbers." (*Scofield.*)

6795.

"Cuttings from tree in orchard in rich bottom lands a mile or two beyond Tizi Ouzou (from Fort National), tree of medium size." (*Scofield.*)

6796.

"Cuttings from a tree, No. 25, along the road from Fort National to Tizi Ouzou." (*Scofield.*)

6797.

"Cuttings from tree No. 4 along the road from Fort National to Tizi Ouzou." (*Scofield.*)

6798.

"Cuttings from tree No. 19 along the road from Fort National to Tizi Ouzou." (*Scofield.*)

6799.

"Cuttings from tree No. 17 along road from Fort National to Tizi Ouzou." (*Scofield.*)

6773 to 6823—Continued.

6800.

"Cuttings from tree No. 16 along road from Fort National to Tizi Ouzou." (*Scofield.*)

6801.

Ghazar, No. 3. "Cuttings obtained from large tree, south side of the valley, in immediate vicinity of Tizi Ouzou, rather late." (*Scofield.*)

6802.

"Cuttings from tree No. 8 along the road from Fort National to Tizi Ouzou." (*Scofield.*)

6803.

Texcout, No. 1. "Early variety. Cuttings from tree on north side of valley in the immediate vicinity of Tizi Ouzou." (*Scofield.*)

6804.

"Cuttings from tree on other side of Fort National from Tizi Ouzou. Worthy of mention, as they still carried the winter fruit in considerable numbers—both old and new fruits." (*Scofield.*)

6805.

"Cuttings from tree No. 20 along road from Fort National to Tizi Ouzou." (*Scofield.*)

6806.

"Cuttings from tree on south side of valley in the immediate vicinity of Tizi Ouzou. Name unknown; season medium, intermediate." (*Scofield.*)

6807.

Dhaalou, No. 2. "Cuttings from tree in immediate vicinity of Tizi Ouzou, from north side of valley." (*Scofield.*)

6808.

"Cuttings from a very fine, large tree in orchard in the rich bottom lands a mile or two beyond Tizi Ouzou from Fort National." (*Scofield.*)

6809.

Marza-Ko. "Cuttings from tree on north side of valley in the immediate vicinity of Tizi Ouzou." (*Scofield.*)

6810.

Dhaalou, No. 3. "Cuttings from tree on north side of valley in the immediate vicinity of Tizi Ouzou." (*Scofield.*)

6811.

Ahzaim (2). Late. "Cuttings from tree on north side of valley in immediate vicinity of Tizi Ouzou." (*Scofield.*)

6812.

"Cuttings from tree No. 9 along the road from Fort National to Tizi Ouzou." (*Scofield.*)

6813.

Ahzaim, No. 1. Late. "Cuttings from tree on north side of valley in immediate vicinity of Tizi Ouzou." (*Scofield.*)

6773 to 6823—Continued.

6814.

"Cuttings from tree No. 1, near Fort National, on road to Tizi Ouzou." (*Scofield.*)

6815.

Texkourt (short form). Late. "Cuttings from tree on south side of valley in the immediate vicinity of Tizi Ouzou." (*Scofield.*)

6816.

"Cuttings from tree in a large and very fine orchard just above a flour and oil mill belonging to Mr. Bankhardt. It is 4 or 5 miles out of Tizi Ouzou, on the road to Fort National." (*Scofield.*)

6817.

"Cuttings from a small, scraggy, but heavily fruited tree in orchard in the rich bottom lands a mile or two beyond Tizi Ouzou." (*Scofield.*)

6818.

"Cuttings from medium-sized trees in orchard in the rich bottom lands a mile or two beyond Tizi Ouzou." (*Scofield.*)

6819.

Bakor (not a caprifig). "Excellent tree. Cuttings from tree south of Tizi Ouzou." (*Scofield.*)

6820.

Tetouzel, No. 1. Early. (Spelled Teefouzel or Trefouzel.) "Cuttings from tree on south side of valley in the immediate vicinity of Tizi Ouzou." (*Scofield.*)

6821.

"Cuttings from tree No. 5 on the road from Fort National to Tizi Ouzou." (*Scofield.*)

6822.

"Cuttings from tree south of Tizi Ouzou." (*Scofield.*)

6823.

Ain Hjedjla. "Season medium. Cuttings from tree north of Tizi Ouzou." (*Scofield.*)

6824. PISTACIA VERA. **Pistache.**

From Smyrna, Asia Minor. Received through Mr. George C. Roeding, June 29, 1901.

"Very fine pistache nut from a Greek nurseryman in Smyrna." (*Roeding.*)

6825. TRIFOLIUM SPUMOSUM.

From Mustapha Superieur, near Algiers, Algeria. Received through Mr. C. S. Scofield, May 25, 1901.

"Seed from a plant found in the grounds of the former consulate of Denmark. They are from an especially fine plant and can not be easily replaced." (*Scofield.*)

6826. VERONIA ELEPHANTUM (?)

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 609), May 24, 1901.

"A very pretty shade tree, suitable for planting in southern Florida or southern California. It grows and fruits well in the gardens in Cairo and is considered a desirable ornamental tree for parks." (*Fairchild.*)

6827. ZEA MAYS. **Corn.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 624), July 1, 1901.

Secured for Mr. Fairchild by George P. Foaden, esq., secretary of the Khedivial Agricultural Society of Cairo.

Morelli. "It is a low-growing sort and does not exhaust the soil as the tall-growing American kinds do. As much as 80 bushels per acre are harvested in Egypt. It has been tested in comparison with the following American sorts and yielded heavier and twenty days earlier: *Morelli*, the Egyptian sort, yielded 12$\frac{14}{15}$ ardebs per feddan; *Tender and True*, an American variety, yielded 11$\frac{17}{21}$; *Hickory King*, also American, 10; and *Imperial Leaming* only 9 ardebs. (These are Egyptian units, given only for comparison.) It is a white variety, preferred to most others in Egypt because of its extreme earliness and great productivity. It grows scarcely half as high as the American sorts. Here in Egypt the maize is broadcasted very thickly, much as we plant fodder maize. The hill system is little known. Perhaps this and the irrigation system used in the comparative test may account for the comparatively high yield of the Egyptian. This variety should be tried in irrigated regions, such as those of southern California, and a quantity should be reserved for experiments in the Colorado Desert." (*Fairchild.*)

6828. QUEBRACHIA LORENTZII. **Quebracho colorado.**

From Tucuman, Argentina. Presented by Mr. Joel Blamey, Huasan, Andalgalá Catamarca, Argentina. Received July 5, 1901.

"Large handsome trees, 40 to 50 feet high, found in the heavy river bottom forests of Argentina and Paraguay, not yet introduced into this country. The wood is of a red color, very hard, contains from 25 to 28 per cent of tannin, and is impervious to weather conditions. Logs exposed for a hundred years are still sound. It is used in Argentina for beams in house and bridge building, railroad ties, all kinds of posts, and for tannin. There were imported into the United States in 1901 60,000 tons of extract, worth nearly $300,000. Klipstein & Co., New York, state that 240,000 tons of wood are also imported annually." (*Harrison.*)

6829. **Ebony tree.**

From Tucuman, Argentina. Received through Mr. Joel Blamey, Huasan, Andalgalá Catamarca, Argentina, July 5, 1901.

6830. **Viraris.**

From Tucuman, Argentina. Received through Mr. Joel Blamey, Huasan, Andalgalá Catamarca, Argentina, July 5, 1901.

6831. OLEA EUROPAEA. **Olive.**

From Tunis, nurseries of M. G. Castet. Presented by Dr. L. Trabut, Government Botanist of Algeria, through Mr. C. S. Scofield. Received July 2, 1901.

Chetoni or *Octonbri.* This is described by N. Minangoin as an oil olive "very common in northern Tunis at Tunis, Soliman, Tebourba, Bizerte, and Grombalia, where it enters to at least the extent of two-thirds into the composition of the olive orchards." (*Bulletin de la Direction de l'Agriculture et du Commerce, Regence de Tunis 6 No. 8, January, 1901, p. 35, pl. 6, fig. 11.*)

6832. FICUS CARICA. **Caprifig.**

From Aidin, Asia Minor. Received through Mr. George C. Roeding, July 5, 1901.

"Very large caprifig from S. G. Magnisalis, Aidin." (*Roeding.*)

6833. QUERCUS AEGILOPS. **Valonia oak.**

From Nazli, Province of Smyrna, Asia Minor. Received through Mr. George C. Roeding, July 5, 1901.

This species of evergreen oak is the one furnishing the "Valonia" of commerce, one of the best tanning materials known. The acorn cups are the parts containing the tannin.

6834. OLEA EUROPAEA. **Olive.**

From Aidin, Asia Minor. Received through George C. Roeding, July 5, 1901.

Early Aidin olive grown in the Meander Valley for oil. There must be 5,000,000 rees in this valley.

6835. FICUS CARICA. **Caprifig.**

From Aidin, Asia Minor. Received through Mr. George C. Roeding, June 5, 1901.

"Very largest and finest caprifig from S. G. Magnisalis, Aidin." (*Roeding.*)

6836. FICUS CARICA. **Caprifig.**

From Aidin, Asia Minor. Received through Mr. George C. Roeding, July 5, 1901.

"One of the largest caprifigs from S. G. Magnisalis, Aidin." (*Roeding.*)

6837. FICUS CARICA. **Caprifig.**

From Aidin, Asia Minor. Received through Mr. George C. Roeding, July 5, 1901.

"Another variety of black caprifig from S. G. Magnisalis, Aidin." (*Roeding.*)

6838. FICUS CARICA. **Caprifig.**

From Aidin, Asia Minor. Received through Mr. George C. Roeding, July 5, 1901.

"Very fine caprifig from garden of S. G. Magnisalis, Aidin." (*Roeding.*)

6839. FICUS CARICA. **Caprifig.**

From Aidin, Asia Minor. Received through Mr. George C. Roeding, July 5, 1901.

"Black caprifig from garden of S. G. Magnisalis, Aidin." (*Roeding.*)

6840. FICUS CARICA. **Caprifig.**

From Aidin, Asia Minor. Received through Mr. George C. Roeding, July 5, 1901.

"Loose sample to show method of budding, inclosed with Nos. 6838 and 6839." (*Roeding.*)

6841. PRUNUS ARMENIACA. **Apricot.**

From Aidin, Asia Minor. Received through Mr. George C. Roeding, July 5, 1901.

"A small freestone apricot, having a very sweet kernel, with a flavor like an almond." (*Roeding.*)

6842. MEIBOMIA ILLINOENSIS. **Beggar weed.**

From Manhattan, Kans. Presented by Mr. J. M. Westgate. Received July 8, 1901.

A leguminous plant, possibly of some value for forage or green manure, which grows on the prairie lands of central Kansas. Seed ripens in summer and autumn. This sample was collected in the autumn of 1900.

6843. PUNICA GRANATUM. **Pomegranate.**

From Smyrna, Asia Minor. Received through Mr. George C. Roeding, July 8, 1901.

Schekerdekses. "Seedless pomegranate." (*Roeding.*)

6844. PRUNUS ARMENIACA. **Apricot.**

From Smyrna, Asia Minor. Received through Mr. George C. Roeding, July 8, 1901.

"A very large apricot, growing in the garden of Doctor Lane, American consul, Smyrna. Kernel sweet." (*Roeding.*)

6845. PRUNUS ARMENIACA. **Apricot.**

From Smyrna, Asia Minor. Received through Mr. George C. Roeding, July 8, 1901.

"A large freestone apricot, having sweet kernels like an almond" (*Roeding.*)

6846. PHOENIX DACTYLIFERA. **Date.**

From Orleansville, Algeria. Presented by M. Yahia ben Kassem. Received May, 1901.

Deglet Noor.

6847. POPULUS sp. **Poplar.**

From Kephisia, near Athens, Greece. Received through Mr. George C. Roeding, July 17, 1901.

"A poplar resembling the silver leaf in foliage, but with smaller leaves. Tree very vigorous and of spreading habit. Superior to any poplar I have ever seen. I saw one tree 6 feet in diameter, whose estimated height was 125 feet, and which had a spread of branches of 80 feet." (*Roeding.*)

6848. MORUS sp. **Mulberry.**

From Royal Grounds, Kephisia, near Athens, Greece. Received through Mr. George C. Roeding, July 17, 1901.

"A variety of mulberry with large, dark-green, rough leaves, no gloss, and having very fine fruit." (*Roeding.*)

6849. PISTACIA VERA. **Pistache.**

From Athens, Greece. Received through Mr. George C. Roeding, July 17, 1901.

"Buds of a very fine pistache nut from the garden of the agricultural experiment station at Athens." (*Roeding.*)

6850. FICUS CARICA. **Caprifig.**

From Kephisia, near Athens, Greece. Received through Mr. George C. Roeding, July 17, 1901.

"A late fruiting variety of caprifig." (*Roeding.*)

6851 to 6912.

From Oneco, Fla. Received through the firm of Reasoner Brothers, July 5, 1901.

A collection of ornamental and economic plants (nomenclature is in the main that of the nurserymen):

6851. ABERIA CAFFRA. **Kei apple.**

6852. ANACARDIUM OCCIDENTALE. **Cashew.**

6853. ANONA MURICATA. **Sour sop.**

6854. ARTOCARPUS INTEGRIFOLIA. **Jack fruit.**

6855. COCCOLOBA UVIFERA. **Shore grape.**

6851 to 6912—Continued.

6856. Cupania sapida. **Akee.**

"The fruits are said to be delicious when eaten in omelettes." (*Fairchild.*)

6857. Ficus glomerata. **Cluster fig.**

6858. Malpighia glabra. **Barbados cherry.**

6859. Melicocca bijuga. **Spanish lime.**

6860. Phyllanthus emblica. **Emblic myrobalan.**

"This is not the true myrobalan of commerce, although its fruits are used for tanning purposes, according to Talbot." (*Trees, Shrubs, and Woody Climbers of the Bombay Presidency*, 2d ed., p. 300.)

6861. Spondias dulcis. **Otaheite apple.**

6862. Terminalia catappa. **Tropical almond.**

6863. Rhodomyrtus tomentosa. **Downy myrtle.**

6864. Amomum cardamomum. **Cardamom.**

6865. Cedrela odorata. **Jamaica cedar.**

6866. Cedrela toona. **Toon tree.**

6867. Cinnamomum cassia. **Chinese cinnamon.**

6868. Crescentia cujete. **Calabash tree.**

6869. Garcinia morella. **Gamboge.**

6870. Guaiacum officinale. **Lignum-vitæ.**

6871. Lawsonia alba. **Henna.**

6872. Maranta arundinacea. **Bermuda arrowroot.**

6873. Dittelasma rarak. **Indian soap berry.**

6874. Semecarpus anacardium. **Marking nut tree.**

6875. Zingiber officinale. **Ginger.**

6876. Cupressus funebris. **Funeral cypress.**

6877. Abrus precatorius. **Crab's eye vine.**

6878. Ardisia polycephala.

6879. Baphia racemosa.

6880. Bauhinia acuminata. **Mountain ebony.**

6881. Bauhinia galpini.

6882. Brunfelsia macrophylla.

6883. Butea frondosa. **Bastard teak.**

6884. Poinciana regia. **Royal poinciana.**

6885. Caesalpinia pulcherrima. **Dwarf poinciana.**

6851 to 6912—Continued.

6886. Caesalpinia sappan. **Sappan.**

"The pods and hard wood of this plant yield the valuable red dye used in coloring silk. A native of the Asiatic tropics." (*Talbot.*)

6887. Dillenia indica. **Gunstock tree.**

"Native of India. Ripe fruit eaten in curries. Wood durable, used for gunstocks." (*Talbot.*)

6888. Dracaena draco. **Dragon's blood.**

Native of the Canary Islands, where, until recently, a noted tree of great age and size was standing. A valuable and curious ornamental for parks.

6889. Ficus hispida.

6890. Hibiscus tiliaceus.

"Fiber used in India for the manufacture of elephant timber-dragging ropes." (*Talbot.*)

6891. Jacquinia armillaris.

6892. Maba natalensis.

6893. Thevetia nereifolia. **Trumpet flower.**

6894. Atalantia trimera.

6895. Turraea floribunda (?)

6896. Tutsia ambosensis.

(Not in Kew Index.)

6897. Toddalia lanceolata.

6898. Acrocomia sclerocarpa.

6899. Attalea cohune.

6900. Caryota urens.

6901. Chamaerops humilis.

6902. Chamaerops humilis var. spinosa.

6903. Chamaerops farinosa.

(Not in Kew Index.)

6904. Rhapidophyllum hystrix.

6905. Cocos australis.

6906. Cocos alphonsei.

6907. Cocos bonneti.

6908. Elaeis guineensis. **Oil palm.**

6909. Bactris gasipaës.

6910. Bactris utilis.

6911. Licuala grandis.

6912. Licuala rumphii.

6913 to 6932.

From Mexico. Received through Dr. J. N. Rose, assistant curator, U. S. National Museum, July 9 and 10, 1901.

A collection of Mexican ornamentals and economic plants, many of which have not been specifically identified; made in 1901 by Dr. J. N. Rose. No further data than Doctor Rose's numbers and the generic names were at hand when this inventory was prepared.

6913. Oxalis sp. (No. 207.)

6914. Oxalis sp. (No. 208.)

6915. Oxalis sp. (No. 209.)

6916. Oxalis sp. (No. 210.)

6917. Oxalis sp. (No. 211.)

6918. Oxalis sp. (No. 212.)

6919. Hymenocallis harrisoniana. (No. 222.)

6920. (No. 213.) **"Pepo."**

6913 to 6932—Continued.

6921. Cissus sp. (No. 201.)

6922. Echeveria platyphylla, Rose, n. sp. (No. 202.)

6923. Echeveria maculata, Rose, n. sp. (No. 217.)

6924. Fouquieria splendens. (No. 205.)

6925. Zephyranthes sp. (No. 206.)

6926. Zephyranthes sp. (No. 214.)

6927. Ampelopsis sp. (No. 215).

6928. Tradescantia crassifolia. (No. 216.)

6929. Sedum sp. (No. 218.)

6930. Solanum sp. (No. 219.)

6931. Erythrina sp. (No. 220.)

6932. Tillandsia sp. (No. 221.)

6933 to 6958.

From Malta. Received through Mr. D. G. Fairchild, July 9 and 10, 1901.

A collection of figs, loquats, pomegranates, and citrous fruits secured during a short stay in Malta in May, 1901. In most cases scions only were sent.

6933. Ficus carica. **Fig.**

A large white variety. (No. 685e.)

6934. Ficus carica. **Fig.**

(No. 685.)

6935. Punica granatum. **Pomegranate.**

(No. 679.)

6936. Punica granatum. **Pomegranate.**

(No. 677.)

6937. Punica granatum. **Pomegranate.**

St. Catherine. (No. 673.)

6938. Eriobotrya japonica. **Loquat.**

(No. 681.)

6939. Eriobotrya japonica. **Loquat.**

(No. 684.)

6940. Punica granatum. **Pomegranate.**

St. Joseph. (No. 674.)

6941. Ficus carica. **Fig.**

Xehba. (No. 685c.)

6942. Ficus carica. **Fig.**

Barnisotte. (No. 685f.)

6943. Eriobotrya japonica. **Loquat.**

(No. 680.)

6944. Punica granatum. **Pomegranate.**

Santa Rosa. (No. 675.)

6945. Eriobotrya japonica. **Loquat.**

(No. 682.)

6933 to 6958—Continued.

6946. Ficus carica. **Fig.**

Black Parsot or *Barnisotte.* (No. 685d.)

6947. Citrus aurantium. **Orange.**

"The *round* blood orange of the island of Malta. This variety has nearly always a blood-colored flesh and is one of the best strains of oranges on the island. Probably originated here or was brought here at a very early date. It is quite distinct from No. 6948 and not esteemed so highly." (*Fairchild.*)

6948. Citrus aurantium. **Orange.**

"An *oval* blood orange, said by Dr. Giovanni Borg, a specialist in citrous matters in Malta, to be the finest flavored orange on the island. Personally I find it superior to No. 6947 and unparalleled for its remarkably vinous flavor." (*Fairchild.*)

6949. Eriobotrya japonica. **Loquat.**

"Seeds of some very large loquats from Bosketto Gardens, Malta, collected May 22, 1901." (*Fairchild.*)

6950. Citrus aurantium. **Orange.**

Maltese *oval seedless.* "Cuttings taken from trees in the governor's palace grounds in Malta. This is the best known seedless Malta orange. My experience is that it sometimes has a few seeds or rudiments of seeds in it. By many it is thought to be the best orange in Malta." (*Fairchild.*)

6951. Citrus limetta. **Lime.**

"A variety of lime growing in the gardens of San Antonio near Valetta. The origin of this variety is unknown by Doctor Borg, the citrus specialist. The fruits are almost without exception quite seedless and attain a very considerable size for limes, being often 3 inches long by $2\frac{1}{4}$ inches in smaller diameter. Doctor Borg says that owing to the peculiar flavor (a typical lime flavor) this is not appreciated in Malta, people preferring forms *with* seeds. It is a very juicy sort, with thinnish rind, and of a good color. Possibly this is the same as that sent in by Mr. Swingle (No. 3412) from Algiers. The trees are very vigorous here, even strikingly so. They commonly bear only one crop of fruit, but occasionally two crops are produced. A single fruit yielded one-fourth of an ordinary drinking glass full of juice of good flavor. Secured through the kindness of Dr. Giovanni Borg, of San Antonio Gardens, at the governor's palace." (*Fairchild.*)

6952. Ficus carica. **Fig.**

Tin Baitri or *St. Johns.* "Precocious fig, two cropper." (*Fairchild.*) (No. 685h.)

6953. Ficus carica. **Fig.**

Tina baida. (No. 685b.)

6954. Citrus aurantium. **Orange.**

Lumi-laring. "A remarkable variety of orange otherwise known as the Sweet orange or China orange. It is *always sweet even when quite green and immature.* Doctor Bonavia, well known as a specialist on the oranges of India, speaks of this variety in a recent article in the Journal of the Royal Horticultural Society, April, 1901 (Vol. XXV, pt. 3, p. 308). He remarks: 'I am informed that in Malta there exists a unique orange of the same (Portugal orange) group, but which is never sour from beginning to end, but sweet and juicy. * * * I have never met with an orange of this description in India. It would be worth while getting hold of it for the purpose of multiplying it and bringing it into commerce. Such a unique orange, I believe, has never appeared on the English market.' In Malta this orange is not very highly esteemed, and personally I find it not nearly so agreeable as the sour varieties, but nevertheless it is far superior to an immature sour orange. It is as sweet as sugar and water, and is declared to be just as sweet when half grown as when mature. It may have a decided value commercially, and will find many

6933 to 6958—Continued.

who will appreciate it. If it proves to be early ripening enough it might be sent to market much in advance of the sour sorts, when it would surprise all buyers by its sweet flavor at a time when all other varieties were too sour to be appreciated. It is medium in size, globular in shape, skin good and of fair thickness, flesh fine color and juicy, and color medium dark orange." (*Fairchild.*)

6955. ERIOBOTRYA JAPONICA. **Loquat.**

(No. 683.)

6956. FICUS CARICA. **Fig.**

(No. 685g.)

6957. FICUS CARICA. **Caprifig.**

Duccar. (No. 686.)

6958. ERIOBOTRYA JAPONICA. **Loquat.**

Seeds of large fruits.

6959. TRITICUM sp. **Wheat.**

From Shibin-el-Kanatir, Egypt. Received through Mr. D. G. Fairchild (No. 653, May 11, 1901), July 11, 1901.

"A collection of selected typical races of Egyptian wheat, gathered from the fields about a small village between Zagazig and Cairo. These are the best, and they show how mixed the races of Egyptian wheat are, but at the same time how remarkably free from rust. The wheat was mostly dead ripe when gathered May 7, while American sorts grown at Cairo were several weeks behind. All grown by perennial irrigation." (*Fairchild.*)

6960. CITRUS LIMONUM. **Lemon.**

From Chios, Turkey. Presented by Mr. N. J. Pantelides through Mr. D. G. Fairchild (No. 590, March 23, 1901). Received July 17, 1901.

Paffa. "A variety of almost seedless lemon, grown in the island of Chios." (*Fairchild.*)

6961 to 6977.

From Rouïba, Algeria. Received through Mr. C. S. Scofield.

A collection of the root tubercles of a number of leguminous forage plants collected by Mr. C. S. Scofield in May, 1901, at Dr. L. Trabut's experimental gardens.

6961. VICIA FABA. **Horse bean.**

6962. VICIA LUTEA.

6963. TRIGONELLA FOENUM-GRAECUM.

6964. ASTRAGALUS BOETICUS.

6965. MELILOTUS INFESTA.

6966. ONOBRYCHIS VICIAEFOLIA. **Sainfoin.**

6967. ANTHYLLIS TETRAPHYLLA.

6968. ANTHYLLIS TETRAPHYLLA.

6969. SCORPIURUS SULCATA.

6970. LOTUS TETRAGONOLOBUS. **Square pea.**

6971. LUPINUS ANGUSTIFOLIUS. **Blue lupine.**

6972. LUPINUS TERMIS.

6973. LATHYRUS TINGITANUS.

6974. LATHYRUS CLYMENUM.

6975. LOTUS EDULIS.

6976. LOTUS ORNITHOPODIOIDES.

6977. ONONIS ALOPECUROIDES.

6978 to 6995.

(Numbers not utilized.)

6996. TRITICUM VULGARE. **Wheat.**

From Oklahoma Agricultural Experiment Station Farm, Stillwater, Okla. Received July 26, 1901.

Weissenburg. Box containing a few heads of wheat grown from No. 5499 during season 1900–1901.

6997. TRITICUM VULGARE. **Wheat.**

From Oklahoma Agricultural Experiment Station Farm, Stillwater, Okla. Received July 26, 1901.

Weissenburg. Bag of wheat grown from No. 5499 during season 1900–1901.

6998. MEDICAGO SATIVA. **Alfalfa.**

From Gizeh, near Cairo, Egypt. Received through Mr. D. G. Fairchild, July 1, 1901.

"A small package of dried plants of alfalfa with roots showing very few nodules. These plants were grown from Argentine seed sent to Cairo by the Office of Seed and Plant Introduction and Distribution, U. S. Department of Agriculture, and planted in the spring of 1901." (*Fairchild.*)

6999. CICER ARIETINUM. **Chick-pea.**

From Gizeh, near Cairo, Egypt. Received through Mr. D. G. Fairchild, July 1, 1901.

Package of dried plants and roots for root tubercle germ. (See No. 6961.)

7000. TRIFOLIUM ALEXANDRINUM. **Berseem.**

From Gizeh, near Cairo, Egypt. Received through Mr. D. G. Fairchild, from the agricultural society. Collected about May 1, 1901.

"Roots of berseem dried in the shade. These roots came from a field which had just been grazed over by cattle." (See No. 6961.) (*Fairchild.*)

7001. PHOENIX DACTYLIFERA. **Date.**

From Fayum, Egypt. Received through Mr. D. G. Fairchild (No. 617), July 1, 1901.

Wahi. "Twenty kilos of dried fruit of a variety of date which is said to have been brought from Siwah, a small village in the oasis of Bahriyeh. It is to my taste the sweetest drying date in Egypt—at least it is much sweeter than the Amri or any other I have tasted. It has a very peculiar mealy flesh of golden to greenish yellow. The skin is very thin and smooth and of a golden brown shade. Seed short, rather large, and clinging to the meat rather firmly. The flesh is somewhat granulated with the sugar. I can not be certain that this variety did really come from Siwah, but it certainly is a sort not commonly seen at this season in Cairo, and is superior in flavor to that which is considered the best in Egypt. The word *Wahi* signifies merely oasis, according to Mr. H. A. Rankin, of Fayum." (*Fairchild.*)

7002. PHOENIX DACTYLIFERA. **Date.**

From Fayum, Egypt. Received through Mr. D. G. Fairchild (No. 618), July 1, 1901.

"Dried dates of the common variety of the Province of Fayum. They are of fair quality as a drying date, but are not equal to the 'Wahi' or 'Amri' dates, the former of which was for sale on the same market in Fayoum. It is probable that seedlings from these seeds will be mixed, although in northern Egypt only one variety of male plant is grown." (*Fairchild.*)

7003 to 7010.

From Mexico. A collection of plants received through Dr. J. N. Rose, July 15, 1901.

Doctor Rose's numbers are appended, no further data being on hand regarding the plants.

7003. MAMMILLARIA sp. (No. 204).

7004. MAMMILLARIA sp. (No. 225).

7005. ERYNGIUM sp. (No. 227).

7006. CISSUS sp. (No. 228).

7007. MANFREDA sp. (No. 229).

7008. HYMENOCALLIS sp. (No. 230).

7009. OXALIS PRINGLEI sp. (No. 233).

7010. OXALIS sp. (No. 234).

7011. FICUS SYCOMORUS. **Sycamore fig.**

From Biskra, Algeria. Received through Mr. D. G. Fairchild (No. 719, June 14, 1901), July 17, 1901.

"This is the sacred fig of the Egyptians. The fruit is produced in very large numbers on the main branches and trunk of the tree, being borne in clusters. The tree is used in Egypt extensively as an avenue tree, and forms one of the characteristic landscape trees of Egypt. Along the canals it grows luxuriantly and attains large dimensions. The trunk is often 2 feet or more in diameter, and the spread of the branches makes it an excellent shade tree. The objection is made by old residents, and, I feel, quite justly, that it is a 'dirty' tree, i. e., drops continually débris of green fruit and fruit stalks which have to be cleaned up. As a fruit, it is not highly esteemed by any but Arabs, who will eat almost anything. It is dry and mealy, and personally I do not care for it. The Arabs in Biskra, and also in Egypt, have a practice of cutting off the tips of the immature figs in order to make them ripen. Mr. Columbo, of Biskra, asserts that three days after this cutting is done the cut figs become twice as large as the uncut ones and develop a not unpleasant taste. It is quite possible that in Texas and Louisiana this fig might be keenly appreciated by children and even by adults." (*Fairchild.*)

7012. QUEBRACHIA LORENTZII. **Quebracho colorado.**

From Terr. Nac. de Misiones, Argentina. Presented by Mr. W. G. Davis, of Cordoba. Received July 17, 1901.

"These trees are found in the central northern sections of the Republic. In the provinces of Catamarca and Rioj and San Luis the rainfall rarely exceeds 300 mm. a year. Over a large extent of the quebracho forests in Santiago del Estero the average rainfall does not exceed 200 mm." (*Davis.*) (See No. 6828.)

7013. ASPIDOSPERMA QUEBRACHO-BLANCO. **Quebracho blanco.**

From Terr. Nac. de Misiones, Argentina. Presented by Mr. W. G. Davis, of Cordoba. Received July 17, 1901.

See No. 6828.

7014. COLA ACUMINATA. **Kola nut.**

From Hope Gardens, Kingston, Jamaica. Received through the director, Dr. William Fawcett, July 18, 1901.

7015. CUCUMIS MELO. **Muskmelon.**

From Bassousa, Egypt. Received through Mr. D. G. Fairchild (No. 633, May 1, 1901), July 1, 1901.

Shaman. "A variety of cantaloupe said to be small, oblong, often egg-shaped, and of a peculiarly delicate flavor. Very highly spoken of by Englishmen in Egypt. Bassousa is the most noted melon-growing center of Egypt." (*Fairchild.*)

7016. TRITICUM DURUM. **Wheat.**

From Alexandria, Egypt. Received from George P. Foaden, esq., secretary of the Khedivial Agricultural Society at Gizeh, through Mr. D. G. Fairchild, October 10, 1901.

Mishriki. A red durum wheat, of which samples have already been sent in for inspection. (See No. 6680.)

7017. CICER ARIETINUM. **Chick-pea.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 622, April 26, 1901), July 1, 1901.

"The Syrian variety of chick-pea grown in Egypt and considered equal to the native sort. It has better seeds, however, being plumper and better formed." (*Fairchild.*)

7018. GOSSYPIUM BARBADENSE. **Cotton.**

From Fayum, Egypt. Received through Mr. D. G. Fairchild (No. 613), July 1, 1901.

Ashmuni. "Unginned cotton of this variety collected where it is exclusively grown, i. e., in the oasis of Fayum. I am informed that this variety is the only one which will succeed well in this province. The *Afifi*, *Jannovitch*, and *Abbasi* have all been tried, although, I suspect, not thoroughly. This variety may be better suited to upland cultivation than the *Jannovitch* or *Afifi*, and may be more resistant to the wilt disease." (*Fairchild.*) (See No. 7025 for ginned seed.)

7019. GOSSYPIUM BARBADENSE. **Cotton.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 648, May 11, 1901), July 1, 1901.

Mit Afifi. Secured by George P. Foaden, esq., of the Khedivial Agricultural Society, Cairo.

7020. VICIA FABA. **Horse bean.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 632, April 26, 1901), July 1, 1901.

"These are the varieties which took the prizes at the Agricultural Fair in Cairo last year. They are introduced for comparative trial with the other sorts." (*Fairchild.*)

7021. CICER ARIETINUM. **Chick-pea.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 626, April 26, 1901), July 1, 1901.

Hommos Beledi. "The native variety of chick-pea. This variety is grown usually for food. The green peas are eaten raw, while the ripe peas are cooked. In Egypt this chick-pea is planted in October or November at the rate of from 30 to 40 pounds of seed per acre, depending upon whether it is sown in drills or broadcasted. On irrigable land it is watered when sown, again when in flower, and the third time when the seeds are being formed. This plant will probably prove of value as a winter soiling crop in the Southwestern States. In parts of the country subject to frost it should be sown in May or June. In parts of Egypt the plants are dried and fed to cattle. Care must be taken, however, in using it for this purpose, as it is known sometimes to be injurious to horses and even to cattle. The seeds, however, make an excellent food for domestic animals." (*Fairchild.*)

7022. LUPINUS TERMIS. **Egyptian lupine.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 628, April 26, 1901), July 1, 1901.

"A variety of lupine planted by the Egyptians on the dry sandy edges of the irrigation basins of Upper Egypt. The seeds are sown broadcast after the irrigation water has subsided, and no more attention is given to their culture until the lupines are harvested. It is considered a valuable crop for increasing the nitrogen in the soil and the beans are eaten by the natives after being boiled in salt water. Should be tried as a soiling crop in arid regions where a single irrigation is possible." (*Fairchild.*)

7023. GOSSYPIUM BARBADENSE. **Cotton.**

From Alexandria, Egypt. Received through Mr. D. G. Fairchild (No. 593), July 1, 1901.

Jannovitch. "This variety is said to be losing in popularity in Egypt. Its yield is lighter, at least 10 per cent, and its staple, although longer than that of *Mit Afifi*, is said to be falling off in length. It is open to the serious objection that the bolls open and allow the cotton to fall to the ground early, thus making its cleaning expensive, since the natives pick it up from the ground where it has lain and become filled with dirt." (*Fairchild.*)

7024. VICIA FABA. **Horse bean.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 621), July 1, 1901.

Saida. "This important fodder crop of Egypt, which forms an article of export amounting in 1898 to over one and one-half million dollars' worth, and which seems entirely unknown in America, is worthy of the most serious attention. For the Colorado Desert region and southern Texas, Louisiana, and California, the broad bean may be of great importance. This variety comes from Upper Egypt, where the bean is grown most extensively. It is a *winter* crop in Egypt and must be fitted in to American conditions. It is killed by too cold or too hot weather." (*Fairchild.*)

7025. GOSSYPIUM BARBADENSE. **Cotton.**

From Fayoum, Egypt. Received through Mr. D. G. Fairchild (No. 614, April 21, 1901), July 1, 1901.

Ashmuni. "From the ginning mill of Theodore Bakoum, Fayum. This is probably of a mixed character. See No. 7018 for sample of staple. For trial against the root disease and on uplands. It is all grown here by irrigation and is claimed to be the only sort which pays in the Fayum oasis." (*Fairchild.*)

7026. GOSSYPIUM BARBADENSE. **Cotton.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 649, May 11, 1901), July 1, 1901.

Jannovitch. "Seed from plants which have been grown on land containing from 1 to 1½ per cent of salt. It is presumed that this seed will be adapted to experiments with similar soils in America and possibly will prove more resistant to the wilt disease than the *Jannovitch* seed taken from plants growing in soil with less salt in it or without any. Secured by Mr. Foaden from the lower Delta region. In quality the fiber is said to equal that coming from plants grown on the less saline soils." (*Fairchild.*)

7027. GOSSYPIUM BARBADENSE. **Cotton.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 631, April 26, 1901), July 1, 1901.

7028. ERVUM LENS. **Lentil.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 627, April 26, 1901), July 1, 1901.

Saidi. "The upper Nile lentil, which is cultivated in Egypt, is an important food crop. Lentils amounting in value to over $90,000 were exported in 1898 to England, France, and Turkey. It is remarkable that America should so long neglect the culture of this most excellent food plant. For some years a very well-known invalid food, called 'Revelenta Arabica,' has been manufactured in England which consists exclusively of a flour of the Egyptian lentil. Purées of lentil and lentil soup are delicacies of the European menus quite absent, generally, from American tables. As a forage crop as well, these lentils should receive serious study. This is a typical Egyptian variety. It brings nearly $2 per hectoliter, according to custom-house returns of exports. The yield varies from 20 to 25 bushels per acre and upward. Sown at rate of 1 bushel per acre broadcasted. Grown in irrigation basins. Requires little water." (*Fairchild.*)

7029. TRIGONELLA FOENUM-GRAECUM. **Fenugreek.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 623, April 26, 1901), July 1, 1901.

"*Egyptian fenugreek* or *Helba*, as it is called by the Arabs. This plant yields an important condiment and its root system is so remarkably provided with tubercles that it is worthy serious attention as a green manure crop. The seeds are also of valne for feeding purposes, and a large amount of fodder is produced, which, if cut before seeds ripen, is of excellent quality. The condition powders and condiment foods which are sold in England extensively and fed to ailing horses and cattle are mixtures of the fenugreek with other meals or grains. It is sometimes planted with berseem here to give a slight purgative effect to the green fodder given so commonly in Egpyt to horses and cattle." (*Fairchild.*)

7030. GOSSYPIUM BARBADENSE. **Cotton.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 647, May 11, 1901), July 1, 1901.

Ashmouni. "Secured through the kindness of Mr. George P. Foaden. This should prove valuable for experiments in the hot dry uplands. It is the variety grown especially in the upper Nile region." (*Fairchild.*)

7031. TRIFOLIUM ALEXANDRINUM. **Berseem.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 620, April 26, 1901), July 1, 1901.

Muscowi. "This variety, as noted in No. 4254, is the common variety of the Delta region. It is the variety from which the largest number of cuttings can be made and the one likely to prove of greatest use in America." (*Fairchild.*)

7032. HIBISCUS CANNABINUS. **Ambari hemp or Teale.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 625, April 26, 1901), July 1, 1901.

"This fiber plant, which is used here as a wind-break for the cotton fields, may be worth investigating, as I am assured by Mr. George P. Foaden, of the Khedivial Agricultural Society, that the prices offered for it in the London markets are very high. This *Teale* may be quite a different variety from the ordinary Ambari hemp and better suited to culture in irrigated regions of America. Mr. Foaden intends trying several acres of it as a culture next year. It is planted at the same time as the cotton in a thickly sown row around the cotton field, forming a sort of hedge. This practice is a very old one in Egypt. Some samples of this Egyptian *Teale* were sent to London and a quotation of £20 per ton was secured by Mr. Foaden." (*Fairchild.*) (See Dodge's "Fiber Plants," pp. 192–193.)

7033. TRITICUM VULGARE. **Wheat.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 629, April 26, 1901), July 1, 1901.

Mezzafannager White. "A variety of Indian wheat which has recently been introduced into Egypt and has met with unusual success, being a much heavier yielder than the native. Though small in grain and thin husked, it yielded near Cairo about 12 bushels per acre more than any native sorts. Samples sent to England were pronounced 'the finest of their kind' by experts. The yield of straw was unusually large in some preliminary tests made on the grounds of the Khedivial Agricultural Society. On the Domain's lands last year there were about 1,500 acres of this Indian wheat planted and over 5,000 acres of native wheat. The Indian averaged nearly 12 bushels an acre more than the native. Less seed is required than of ordinary varieties, as the plant stools unusually well. Starts into growth more rapidly than native sorts. A winter wheat for warm climates. For information regarding this Indian wheat apply to George P. Foaden, esq., secretary of the Khedivial Agricultural Society of Cairo, through whose kindness this sample has been secured." (*Fairchild.*)

7034. Allium cepa. **Onion.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 630, April 26, 1901), July 1, 1901.

"A native variety of onion which is grown in immense quantities on the islands and elsewhere on the upper Nile. These are for export mostly and in 1898 over $909,000 worth were exported. Train loads are piled on the wharves in Alexandria in March and April, from which point they are shipped all over Europe and even to New York, $5,365 worth going to this latter port during the quarter ending March 31, 1901. This onion forms one of the army rations now, I am told, and these Egyptian onions are of good, even superior quality. A Texas onion specialist who tested these Egyptian onions two years ago declared them to be the finest pickle onion he had ever seen. Deserves a wide distribution wherever irrigation prevails, as it is an onion for irrigated lands." (*Fairchild.*)

7035. Vicia faba. **Horse bean.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 650), July 1, 1901.

Beheri. "A variety of horse bean which is grown in the province of Beheri in lower Eygpt. It is a distinct variety from the *Saida* and should be tested in comparison with it. Especially valuable for experiments in irrigated regions of California, Arizona, and Texas. Secured through Mr. George P. Foaden, of the Khedivial Agricultural Society." (*Fairchild.*)

7036. Gossypium barbadense. **Cotton.**

From Alexandria, Egypt. Received through Mr. D. G. Fairchild (No. 592), July 1, 1901.

Mit Afifi. "This variety is now more commonly grown than any other, and the *Jannovitch* variety, so popular two years ago, is said to be a lighter yielder and, by some, to be rapidly deteriorating. The *Mit Afifi* is not a white but a cream-colored cotton, and is prized especially for the manufacture of cream-colored underwear, hosiery, etc. It is also mixed with silk and is especially suited for this purpose." (*Fairchild.*)

7037. Hedysarum coronarium. **Sulla.**

From Malta. Received through Mr. D. G. Fairchild (No. 689), July 23, 1901.

Malta. "Sulla from the island of Malta. This is a late maturing sort, useful when rains are abundant. It is a heavier yielder than that from Gozzo, and hence preferred by Maltese in places where there is plenty of moisture." (*Fairchild.*)

7038 to 7045. Mangifera indica. **Mango.**

From Bombay, India.

A collection of grafted mango plants, arranged for by Mr. John B. Beach, of West Palmbeach, Fla., through Latham & Co., Bombay. Received July 24, 1901.

7038.

Bath.

7039.

Fernandez.

7040.

Goa Alfonso.

7041.

Kala Alfoos.

7042.

Mazagon.

7043.

Roos.

7044.

Alfonso, or Alfoos.

7045.

Cowasjee Patel.

7046. GYMNOCLADUS CANADENSIS. **Kentucky coffee tree.**

From Botanic Gardens, Washington, D. C. Received through Mr. G. W. Oliver, July 23, 1901.

7047 to 7057.

From City of Mexico, Mexico. Received through Dr. J. N. Rose, July 26, 1901.

A collection of economic and ornamental plants and seeds made in Mexico in the summer of 1901. Doctor Rose's numbers are retained for identification.

7047. ERYTHRINA sp.

(No. 5301.)

7048. VITIS sp. **Grape.**

"A grape the stems of which die down to the ground every year. Fruit very large." (*Rose.*) (No. 5349.)

7049. ROSA sp. **Rose.**

(No. 5368.)

7050. OXALIS sp.

"Has beautiful red foliage." (*Rose.*) (No. 5389.)

7051. HYPTIS sp.

"Flowers red." (*Rose.*) (No. 5412.)

7052. TRIFOLIUM sp.

"A showy clover with large heads." (*Rose.*) (No. 5486.)

7053. CARDIOSPERMUM sp.

"A vine." (*Rose.*) (No. 5490.)

7054. ALBIZZIA sp.

"A beautiful leguminous tree cultivated in Mexico at an altitude of 7,000 feet. Flowers in spikes 2 or 3 inches long." (*Rose.*) (No. 5281.)

7055. **Zapote borracho.**

"A cultivated fruit." (*Rose.*) (No. 252.)

7056. PASSIFLORA sp.

"Edible fruit sold in markets." (*Rose.*) (No. 254.)

7057. CULPHEA sp.

(No. 5353.)

7058. COCHLEARIA ARMORACIA. **Horse-radish.**

From Stockholm, Sweden. Received through Lindahl's seed firm, July 27, 1901. (L. & F. No. 421.)

Enköping. A variety of horse-radish grown at Enköping, near Stockholm. It is as noted a sort in Sweden as the *Maliner Kren* is in Austria, and is cultivated in a similar way.

7059. CERATONIA SILIQUA. **Carob.**

From Alicante, Spain. Received through Mr. D. G. Fairchild (No. 742), July 29, 1901.

"A male variety of carob. In this region all trees of carobs are grafted or budded with this male sort. A large branch or, oftener, a secondary trunk is trained up into the center of the tree to furnish the pollen for the female flowers. This practice, which I have not observed in Greece or Algiers in the same degree of perfection, accounts no doubt for the heavy yields obtained here. This may be what is called *La Borrera.*" (*Fairchild.*)

7060. CERATONIA SILIQUA. **Carob.**

From Alicante, Spain. Received through Mr. D. G. Fairchild (No. 744), July 29, 1901.

Vera. "This is the sweetest carob I have ever tasted." (*Fairchild.*)

7061. AMYGDALUS COMMUNIS. **Almond.**

From Alicante, Spain. Received through Mr. D. G. Fairchild (No. 740), July 29, 1901.

Mollar. "A soft-shelled variety of almond grown in Alicante for table use. Especially relished when still green. The consumption of these green almonds in Mediterranean countries is very great. They are eaten with salt. This variety is not an exporting one, but may prove an addition to the orchards of California." (*Fairchild.*)

7062. AMYGDALUS COMMUNIS. **Almond.**

From Alicante, Spain. Received through Mr. D. G. Fairchild (No. 741), July 29, 1901.

Planeta. "The great exporting almond of this part of Spain. It is the variety best known and most extensively cultivated, not because it is altogether the best, according to local taste, but because of its shipping and good marketing qualities. It is wedge-shaped in form, with *hard* shell and a flat, heart-shaped kernel with medium thin skin. The *Jordan* almond, which fetches higher prices, I am told, is not grown here in Alicante. It has a thinner skin and finer flavor. The *Planeta* is, however, one of the first-class hard-shelled almonds." (*Fairchild.*)

7063. CERATONIA SILIQUA. **Carob.**

From Alicante, Spain. Received through Mr. D. G. Fairchild (No. 743), July 29, 1901.

Negra. "The commonest variety of carob grown around Alicante. It is a variety used for horse food almost entirely, and its yields are very large and regular. Every year a tree 20 years old will yield from 50 cents' worth to a dollar's worth of fruit. The culture is suited to waste places in dry soil. Trees here 200 years old yield yearly up to $3 worth apiece. This variety has little sugar in it and the seeds are surrounded by parchment. Not for table purposes." (*Fairchild.*)

7064 to 7070.

From City of Mexico, Mexico. Received through Dr. J. N. Rose, July 29, 1901.

A collection of economic and ornamental plants made in Mexico in 1901. The numbers given by Doctor Rose are retained for identification.

7064. COTYLEDON sp.

(No. 260.)

7065. MAMILLARIA sp.

(No. 261.)

7066. SEDUM sp.

(No. 263.)

7067. SEDUM sp.

(No. 264.)

7068. RUBUS sp. **Raspberry.**

"A fine raspberry and worthy of cultivation. Obtained a root and one ripe fruit. It grows at an elevation of 10,400 feet." (*Rose.*) (No. 265.)

7069. COMMELINA sp.

"A very beautiful greenhouse plant. It grows in Alpine meadows at 10,000 feet elevation." (*Rose.*) (No. 266.)

7070. SOLANUM sp.

(No. 267.)

7071. TRIGONELLA FOENUM-GRAECUM. **Fenugreek.**

From Batna (Constantin), Algeria. Received through Mr. D. G. Fairchild (No. 720), July 31, 1901.

"Sample of fenugreek seed arranged for by Mr. C. S. Scofield, coming from the mountains of the Aurès east of the town of Batna, on the high Algerian plateau. Used, as in Tunis, by the Jewesses to induce an excessive fleshiness, which is the fashion among them. This may prove a different variety and should be reserved for breeding purposes. Sent through the kindness of Mr. John Wild, of Batna." (*Fairchild.*)

7072 to 7100.

From Mexico. Received through Dr. J. N. Rose, July 31, 1901.

A collection of economic and ornamental plants made in Mexico in 1901. Doctor Rose's numbers are retained for identification.

7072. **Palm.**

(No. 253.)

7073. SOLANUM sp. **Potato.**

(No. 257.)

7074. SEDUM sp.

(No. 248.)

7075. BEGONIA sp.

(No. 238.)

7076. SEDUM sp.

(No. 239.)

7077. BEGONIA GRACILIS.

(No. 243.)

7078. SEDUM sp.

(No. 237.)

7079. DAHLIA sp.

(No. 242.)

7080. SEDUM sp.

(No. 235.)

7081. COTYLEDON sp.

(No. 245.)

7082. COTYLEDON sp.

(No. 236.)

7083. SEDUM sp.

(No. 247.)

7084. COTYLEDON sp.

(No. 255.)

7085. CEREUS sp.

(No. 223.)

7086. CEREUS sp.

(No. 224.)

7087. AGAVE sp.

(No. 246.)

7088. TILLANDSIA BENTHAMIANA.

(No. 241.)

7089. **Cactus.**

(No. 226.)

7090. **Cactus.**

(No. 203.)

7091. SENECIO sp.

(No. 256.)

7092. SENECIO sp.

(No. 258.)

7093. TILLANDSIA sp.

(No. 232.)

7072 to 7100—Continued.

7094. Orchid.

(No. 231.)

7095. Cactus.

(No. 251.)

7096. Cactus.

(No. 250.)

7097. NOLINA sp.

(No. 240.)

7098. COTYLEDON sp.

(No. 244.)

7099. TIGRIDIA sp.

(No. 269.)

7100. DASYLIRION sp.

(No. 262.)

7101 to 7108. MANGIFERA INDICA. **Mango.**

From Bangalore, India. Received through A. Lehmann, Ph. D., July 31, 1901.

A collection of grafted mangoes.

7101.

Peterpasand.

7102.

Mullgoa (*Mulgoba*).

7103.

Badami.

7104.

Amini.

7105.

Rajabury or *Rajpury.*

7106.

Rasphury.

7107.

Gada Mar.

7108.

Sandersha or *Sandershaw* (*Soondershaw*).

7109 to 7116.

From Avalon, Santa Catalina Islands, California. Received through Mrs. Blanche Trask, July, 1900.

A collection of seeds of native plants, as follows:

7109. HOSACKIA VENUSTA.

7110. HOSACKIA TRASKIAE.

7111. RHUS OVATA.

7112. GALIUM CATALINENSE.

7113. SENECIO HYONI.

7114. PHACELIA LYONI.

7115. LYONOTHAMNUS FLORIBUNDUS.

7116. ERIOGONUM GIGANTEUM.

7117. DANTHONIA CALIFORNICA.

From Berkeley, Cal. Received through Miss Alice F. Crane, January, 1901.

7118 to 7129.

From Berkeley, Cal. Received through Miss Alice F. Crane, January, 1901.

A collection of seeds of native Trifoliums, as follows:

7118. TRIFOLIUM GRACILENTUM.

7119. TRIFOLIUM BIFIDUM.

7118 to 7129—Continued.

7120. Trifolium ciliatum.

7121. Trifolium macraei.

7122. Trifolium involucratum.

7123. Trifolium pauciflorum.

7124. Trifolium pauciflorum.

7125. Trifolium tridentatum.

7126. Trifolium microcephalum.

7127. Trifolium microdon.

7128. Trifolium fucatum.

7129. Trifolium fucatum, var. flavulum.

7130. Solanum melongena. **Eggplant.**

From Raleigh, N. C. Received through Prof. W. F. Massey, March 18, 1901.

7131. Passiflora sp.

From Melbourne, Australia. Received from Carolin & Co. through Mr. G. W. Hill, Chief of the Division of Publications, U. S. Department of Agriculture.

7132. Ceratonia siliqua. **Carob.**

From Alicante, Spain. Received through Mr. D. G. Fairchild (No. 744), August 3, 1901.

Vera. "This is a poor yielder, but its fruits are so full of sugar that drops of sirup run out when the pods are broken. It is too dear for horse food and is eaten by the people as a delicacy. Its flesh is very crisp and lacks the harshness of other varieties. Its seeds are of a lighter color and the pods thicker. As a shade tree it is a finer looking variety, with larger leaves, than No. 7063." (*Fairchild.*) (See also Nos. 7060 and 7461.)

7133. Amygdalus communis. **Almond.**

From Alicante, Spain. Received through Mr. D. G. Fairchild (No. 745), August 3, 1901.

Castillet. "A superlative sort of hard-shelled almond which was found in a garden at Mucha Miel, near Alicante. I have not been able to learn that this sort is known on the markets, although the owner assured me it brought a higher price than the *Planeta.* It is a larger, fuller shaped almond." (*Fairchild.*)

7134. Amygdalus communis. **Almond.**

From Alicante, Spain. Received through Mr. D. G. Fairchild (No. 746), August 3, 1901.

Planeta. "Taken from an orchard at Mucha Miel, near Alicante. The names of these varieties are often mixed, and this may be slightly different from No. 7062." (*Fairchild.*)

7135. Amygdalus communis. **Almond.**

From Alicante, Spain. Received through Mr. D. G. Fairchild (No. 748), August 3, 1901.

Fabrica. "A smaller and inferior sort to the *Planeta*, but said to be a good bearer. It is ten to fifteen days later than the *Planeta*, ripening about the middle or last of August." (*Fairchild.*)

7136. Prunus armeniaca. **Apricot.**

From Alicante, Spain. Received through Mr. D. G. Fairchild (No. 749), August 3, 1901.

Patriarca. "One of the largest fruited varieties of apricot in eastern Spain. Said to be of excellent quality. The apricots of Spain probably were introduced from

France originally, but have undergone changes in size and character, suiting them to the drought and heat of this more southern region. This *Patriarca* is the best large variety about Alicante, and is said to be a local sort." (*Fairchild.*)

7137. AMYGDALUS COMMUNIS. **Almond.**

From Alicante, Spain. Received through Mr. D. G. Fairchild (No. 755a), August 3, 1901.

Pastaneta. "A variety differing in form very materially from the other Spanish varieties. It has a truncated apex and is more or less rectangular. This variety is not planted largely about Alicante, but is the prevailing sort grown at Murcia, I am told. It fetches as high or even a higher price than the *Planeta.*" (*Fairchild.*)

7138. TRIFOLIUM PRATENSE. **Red clover.**

From New York. Received through J. M. Thorburn & Co., August 5, 1901.

7139. CICHORIUM ENDIVIA. **Endive.**

From Cassel, Germany. Received through Mr. George C. Roeding, August 5, 1901.

Self-closing, yellow Cassel summer endive.

7140. PRUNUS ARMENIACA. **Apricot.**

From Alicante, Spain. Received through Mr. D. G. Fairchild (No. 750), August 9, 1901.

Ull blanc. "A medium sized apricot famed as the finest small fruited variety in the neighborhood of Alicante. I did not have a chance to taste it, and can not vouch for its superiority." (*Fairchild.*)

7141 to 7145. MORUS sp. **Mulberry.**

From Murcia, Spain. Received through Mr. D. G. Fairchild (No. 757), August 10, 1901.

A collection of cuttings from the gardens of the Sericultural Institute of Murcia, Spain. The nomenclature is that furnished by the head gardener.

7141.
Esteril.

7142.
Arantiana.

7143.
Common, of Italy.

7144.
Glemosa.

7145.
Colson or *Lotson*, of Italy.

7146 to 7340.

From Erfurt, Germany. Received through Haage & Schmidt, seedsmen, August 10, 1901.

A collection of seeds as follows (the nomenclature is in the main that of the seedsmen):

7146. STRELITZIA AUGUSTA.

7147. AGERATUM CONYZOIDES (?)
Prinzessin Victoria Luise.

7148. AQUILEGIA CHRYSANTHA FLORE PLENO.

7149. AGERATUM CONYZOIDES (?)

7150. CUPRESSUS FUNEBRIS.

7151. ADENANTHERA PAVONINA.

7152. ANONA MACROCARPA (?)

7153. BETA CHILENSIS.
Golden yellow.

7154. MUSA MANNII (?)

7146 to 7340—Continued.

7155. IMPATIENS SULTANI SPLENDENS.

7156. PHLOX DRUMMONDII.

Brilliant.

7157. PRIMULA OBCONICA GRANDIFLORA VIOLACEA.

7158. CROTON SEBIFERUM.

7159. ANONA SUAVISSIMA (?)

7160. CAMPANULA PERSICIFOLIA FLORE ALBA.

7161. ILLICIUM FLORIDANUM.

7162. BEGONIA SEMPERFLORENS HYBRIDA FLORE PLENO.

7163. ANTIRRHINIUM MAJUS GRANDIFLORUM LUTEUM.

7164. PAPAVER ORIENTALE HYBRIDUM.

7165. AQUILEGIA CAERULEA FLORE LUTEO.

7166. CINCHONA OFFICINALIS.

7167. ACANTHUS MOLLIS.

7168. IMPATIENS SULTANI NACRÉ ROSÉ.

7169. STRELITZIA REGINAE.

7170. ANONA RENIFORMIS (?)

7171. CORDYLINE AUSTRALIS.

7172. PHORMIUM TENAX VARIEGATA.

7173. ANONA CHERIMOLIA.

7174. ANONA SQUAMOSA.

7175. TORENIA FOURNIERI (EDENTULA) COMPACTA ALBA.

7176. EUCALYPTUS ROBUSTA.

7177. PHLOX DRUMMONDI CINNABARINA.

7178. TORENIA FOURNIERI GRANDIFLORA.

7179. BETA BRASILIENSIS CARMOISIN-CARMOISI (?)

7180. TORENIA FOURNIERI (EDENTULA) COMPACTA COELESTINA.

7181. BETA CHILENSIS CARMOISIN-CHAMOISI.

7182. ADANSONIA DIGITATA.

7183. AMARANTHUS CAUDATUS.

7184. LYCHNIS COELI-ROSA.

7185. PRIMULA OBCONICA GRANDIFLORA ROSEA.

7186. PAPAVER BRACTEATUM.

7187. TORENIA FOURNIERI (EDENTULA) GRANDIFLORA COELESTINA.

7188. RHEUM PALMATUM TANGUTICUM.

7189. PHORMIUM TENAX VEITCHII.

7190. JATROPHA GLAUCA (?)

7191. FICUS MACROPHYLLA.

7192. QUASSIA AMARA.

7193. CINCHONA SUCCIRUBRA.

7194. LINDELOFIA SPECTABILIS.

7195. CHRYSANTHEMUM MAXIMUM.

7196. CAMPANULA PERSICIFOLIA COERULEA.

7197. TORENIA FOURNIERI SPECIOSA.

The Bride.

7198. CARICA PAPAYA PYRIFORMIS.

7199. BETA BRASILIENSIS (?). White.

7200. ANTIRRHINUM MAJUS NANUM ALBUM.

7201. ANTIRRHINUM MAJUS SULPHUREUM RUBRO-VENOSUM.

7202. (Blank. Omitted unintentionally.)

7203. ANTIRRHINUM MAJUS NIGRO PURPUREUM.

7204. ANTIRRHINUM MAJUS INSIGNE.

7205. CLITORIA TERNATEA.

7146 to 7340—Continued.

7206. CAESALPINIA SAPPAN.

Sappan.

7207. GAILLARDIA AMBLYODON.

7208. ANTIRRHINUM MAJUS GRANDIFLORUM ALBUM.

7209. CARICA PAPAYA ATROVIOLACEA ELEGANTISSIMA.

7210. STRYCHNOS NUX-VOMICA.

7211. PRIMULA OBCONICA KERMESINA.

7212. PITHECOLOBIUM PRUINOSUM.

7213. ANTIRRHINUM MAJUS.

Romeo.

7214. RHEUM PALMATUM TYPICUM.

7215. ACANTHUS NIGER.

7216. GAILLARDIA PULCHELLA LORENZIANA.

7217. TORENIA FOURNIERI.

7218. PHLOX DRUMMONDII ALBA OCULATA SUPERBA.

7219. GAILLARDIA PULCHELLA.

7220. PAPAVER ORIENTALE.

7221. PRIMULA OBCONICA GRANDIFLORA.

7222. FICUS ELASTICA.

7223. CEDRELA ODORATA.

7224. CINCHONA LEDGERIANA.

7225. AQUILEGIA CAERULEA FLORE ALBA.

7226. EUCALYPTUS GLOBULUS.

7227. BERBERIS DARWINII.

7228. IMPATIENS sp.

7229. CINCHONA CALISAYA.

7230. AQUILEGIA CALIFORNICA HYBRIDA.

7231. BEGONIA SEMPERFLORENS VULCAN-VULCAIN.

7232. PHORMIUM TENAX IMPORTIRT GR. IMPORTEÉS.

7233. PRIMULA OBCONICA GRANDIFLORA ALBA.

7234. PHORMIUM TENAX COLENSOI ARG. var.

7235. TORENIA FOURNIERI (EDENTULA) SPECIOSA.

Violetta.

7236. TORENIA FOURNIERI (EDENTULA) SPECIOSA.

7237. STERCULIA ACERIFOLIA.

7238. CEDRELA TOONA.

7239. EUCALYPTUS CITRIODORA.

7240. MUSA SUMATRANA.

7241. TORENIA FOURNIERI (EDENTULA) COMPACTA.

7242. AQUILEGIA CAERULEA.

7243. JATROPHA MANIHOT.

7244. CHRYSANTHEMUM sp.

7245. CINCHONA HYBRIDA.

7246. JATROPHA CURCAS.

7247. CARICA CANDAMARCENSIS.

7248. CENTAUREA AMERICANA.

7249. GAILLARDIA PICTA MARGINATA ALBA.

7250. PAPAVER ORIENTALE SEMIPLENUM.

7251. PAPAVER ORIENTALE PARKINANSII.

7252. PAPAVER ORIENTALE.

Prince of Orange.

7253. PAPAVER BRACTAETUM NANUM SPLENDENS.

7254. STERCULIA ACERIFOLIA.

7255. PITHECOLOBIUM UNGUIS-CATI.

7256. CEDRELA SINENSIS.

7257. JATROPHA MULTIFIDA.

7258. AQUILEGIA CHRYSANTHA.

7146 to 7340—Continued.

7259. Musa martini (?)

7260. Musa rosacea.

7261. Musa superba.

7262. Musa rosacea.

7263. Phormium tenax.

7264. Impatiens sultani hybrida nana.

7265. Primula obconica grandiflora hybrida.

7266. Caesalpinia pulcherrima.

7267. Caesalpinia coriaria.

7268. Sterculia diversifolia.

7269. Acanthus candelabrum (?)

7270. Laurus canariensis.

7271. Pterocarya caucasica.

7272. Bombax ochroma (?)

7273. Chamaerops arborea (?)

7274. Chamaerops canariensis (?)

7275. Raphis cochinchinensis.

7276. Chamaerops elegans (?)

7277. Trachycarpus excelsus.

7278. Chamaerops farinosa.

7279. Chamaerops humilis.

7280. Chamaerops humilis argentea.

7281. Chamaerops macrocarpa.

7282. Chamaerops olivaeformis (?)

7283. Chamaerops robusta (?)

7284. Chamaerops tomentosa.

7285. Phoenix dactylifera.

7286. Jubaea spectabilis.

7287. Kentia alexandria (?)

7288. Hyphaene benguelensis.

7289. Elaesis guineensis.

7290. Raphia pedunculata.

7291. Pistacia terebinthus.

7292. Acrocomia sclerocarpa.

7293. Livistona jenkinsiana.

7294. Anacardium occidentale.

7295. Musa ensete.

7296. Phoenix reclinata.

7297. Erythea edulis.

7298. Thrinax barbadensis.

7299. Livistona australis.

7300. Chamaedorea corallina (?)

7301. Chamaedorea ernesti augusti.

7302. Chamaedorea geonomaeformis.

7303. Chamaedorea gracilis.

7304. Livistona altissima.

7305. Livistona rotundifolia.

7306. Sterculia platanifolia.

7307. Campanula persicifolia flore albo pleno.

7308. Campanula persicifolia grandiflora alba.

7309. Campanula persicifolia grandiflora alba gigantea.

7310. Campanula persicifolia caeruleo pleno.

7311. Begonia semperflorens atropurpurea compacta.

7312. Begonia semperflorens flore pleno.

Bijo des Jardin.

7313. Begonia semperflorens grandiflora atropurpurea.

7146 to 7340—Continued.

7314. PRIMULA OBCONICA GRANDIFLORA FIMBRIATA.

7315. PRIMULA OBCONICA GRANDIFLORA VIOLACEA.

7316. AQUILEGIA FLABELLATA NANA ALBA.

7317. AQUILEGIA GRANDULOSA.

7318. AQUILEGIA HAYLODGENSIS.

7319. AQUILEGIA SKINNERI.

7320. AQUILEGIA STUARTI (?)

7321. AQUILEGIA VERVAENEANA FOL. VAR.

7322. HYDRIASTELE WENDLANDIANA.

7323. THRINAX ALTISSIMA.

7324. ACANTHUS MOLLIS.

7325. CAESALPINIA SEPIARIA.

7326. PYRETHRUM ROSEUM HYBRIDUM (?)

7327. BOCCONIA FRUTESCENS.

7328. CARICA PAPAYA.

7329. ACANTHUS MOLLIS.

7330. BERBERIS WALLICHIANA.

7331. CORYPHA ELATA.

7332. LIVISTONA AUSTRALIS MACROPHYLLA.

7333. ULEX EUROPAEUS.

7334. CERATONIA SILIQUA.

7335. PISTACIA VERA. **Pistache.**

7336. PISTACIA LENTISCUS. **Mastic.**

7337. PINANGA DECORA (?)

7338. THRINAX ARGENTEA.

7339. COCOS ROMANZOFFIANA.

7340. PANDANUS AQUATICUS.

7341. LUPINUS HIRSUTUS. **Blue lupine.**

From Vomero, near Naples, Italy. Received through Mr. C. Sprenger, August 13, 1901.

Used as an ornamental plant, also valued for fodder and as a green manure.

7342 to 7365.

From London, England. Received through Mr. William Bull, August 14, 1901.

A collection of plants, as follows (the nomenclature is in the main that given by Mr. Bull):

7342. JASMINUM NITIDUM.

7343. LICUALA MUELLERI.

7344. CAMOENSIA MAXIMA.

7345. CEROPEGIA WOODI.

7346. CODIAEUM VARIEGATUM. Croton broomfieldii.

7347. CODIAEUM VARIEGATUM. Croton excurrens.

7348. CODIAEUM VARIEGATUM. Croton insignis.

7349. CODIAEUM VARIEGATUM. Croton memphis.

7350. CODIAEUM VARIEGATUM. Croton sceptre.

7351. CODIAEUM VARIEGATUM. Croton elysian.

7352. CODIAEUM VARIEGATUM. Croton elvira.

7353. CODIAEUM VARIEGATUM. Croton euterpe.

7354. CODIAEUM VARIEGATUM. Croton hermon.

7355. FICUS RADICANS VARIEGATA.

7356. FICUS INDICA.

7342 to 7365—Continued.

7357. Cinchona officinalis. **Peruvian bark.**

7358. Calodendrum capensis. **Cape chestnut.**

7359. Hibiscus elatus.

7360. Psychotria (?) ipecacuanha. **Ipecacuanha.**

7361. Kicksia africana. **Lagos rubber.**

7362. Salvadora persica. **Mustard tree of Scripture.**

7363. Epipremnum mirabile. **Tonga.**

7364. Antiaris toxicaria. **Upas tree.**

7365. Stangeria paradoxa.

7366. Ananas sativus. **Pineapple.**

From West Palmbeach, Fla. Received from Mr. George C. Matthams, August 13, 1901.

Ripley Queen.

7367 to 7396.

From Mexico. Received through Dr. J. N. Rose (Nos. 270–299), August 15, 1901.

A collection of Mexican plants and bulbs, as follows (Doctor Rose's numbers are retained for identification):

7367. Tillandsia sp.
(No. 270.)

7368. Cotyledon sp.
(No. 271.)

7369. Cotyledon sp.
(No. 272.)

7370. Cotyledon sp.
(No. 273.)

7371. Agave sp.
(No. 274.)

7372. Agave sp.
(No. 275.)

7373. Cotyledon sp.
(No. 276.)

7374. Cotyledon sp.
(No. 277.)

7375. (No. 278.) **Cactus.**
Flat-spined.

7376. (No. 279.) **Cactus.**
Long-spined.

7377. (No. 280.) **Cactus.**
Round.

7378. (No. 281.) **Cactus.**
Four-spined.

7379. Opuntia sp.
(No. 282.)

7380. Mamillaria sp.
(No. 283.)
Oblong.

7381. Mamillaria sp.
(No. 284.)
Round.

7382. (No. 285.) **Cactus.**
Tall.

7367 to 7396—Continued.

7383. CISSUS sp. (No. 286.)

7384. TILLANDSIA sp. (No. 287.)

7385. TILLANDSIA sp. (No. 288.)

7386. TILLANDSIA sp. (No. 289.)

7387. HECHTIA sp. (No. 290.)

7388. FOUQUIERIA sp. (No. 291.)

7389. (No. 292.)

7390. COTYLEDON sp. (No. 293.)

7391. NOLINA sp. (No. 294.)

7392. YUCCA sp. (No. 295.)

7393. ZEPHYRANTHES sp. (No. 296.)

7394. COTYLEDON sp. (No. 297.)

7395. SOLANUM sp. (No. 298.) **Potato.**

Half-wild potatoes from Mount Orizaba.

7396. SOLANUM sp. (No. 299.) **Potato.**

A small wild potato from near City of Mexico.

7397. CUCUMIS MELO. **Muskmelon.**

From Savannah, Ga. Received through Mr. D. G. Purse, president of the Savannah Board of Trade, August 17, 1901.

Seeds from a 32-pound muskmelon.

7398. AMYGDALUS COMMUNIS. **Almond.**

From Malaga, Spain. Received through Mr. D. G. Fairchild (No. 765), August 19, 1901.

Jordan. "Bud sticks of the famous *Jordan* almond of commerce, which is imported into America in large quantities every year. These bud sticks were taken before the almonds were harvested in almost all cases, and from trees still bearing the *Jordan* almonds. They were difficult to obtain, and it is hoped can be grafted this autumn. This variety is without question the finest almond of its class in the world. It is exported from Spain, largely as shelled kernels, to England and the United States, and is used extensively in these places for the manufacture of confectionery. Its typical long, plump shape distinguishes it from any other sort grown in Spain. It has a very thin, delicate skin and fine, white, highly flavored flesh. There are orchards of considerable size in Spain of this variety, but as a rule the trees are scattered irregularly over the hillsides among the Sierras back of Malaga. A famous locality for them is at Alora, a half hour's railroad ride from Malaga. No special care is given the trees and many of the orchards are quite old. The soil on which they are grown is a light gravel, not fitted for any other culture. In summer it gets exceedingly dry, but the trees seem to withstand the drought very well." (*Fairchild.*)

7399 and 7400. CERATONIA SILIQUA. **Carob.**

From Malaga, Spain. Received through Mr. D. G. Fairchild (No. 766), August 19, 1901.

Castillana. "One of the best varieties of carob, or St. John's bread, in Spain, and probably one of the best in the world. It is eaten by the natives in the same way that the variety *Vera* is in the region of Alicante. It has a very thick, medium-sized pod, which is very sweet. Produces abundantly and is not grafted with the male variety, as in Alicante." (*Fairchild.*) See No. 7132.

7401. AMYGDALUS COMMUNIS. **Almond.**

From Malaga, Spain. Received through Mr. D. G. Fairchild (No. 771), August 20, 1901.

Jordan. "Bud sticks from the garden of Cristobal Paloma, of Malaga. These are probably like the former buds of this same variety, but are forwarded to make sure of getting the best strains." (*Fairchild.*)

7402 to 7413.

From Mexico. Received through Dr. J. N. Rose, August 20, 1901.

A collection of native plants, bulbs, and seeds, as follows (the numbers given by Doctor Rose are retained for identification):

7402. Zephyranthes sp. (No. 268.)

7403. Cotyledon sp. (No. 300.)

"Large red flowers." (*Rose.*)

7404. Argemone sp. (No. 301.)

"Large white flowers." (*Rose.*)

7405. Zephyranthes sp. (No. 302.)

7406. Cucurbita sp. (No. 5287.)

7407. Rubus sp. (No. 5380.)

"A beautiful flowering shrub." (*Rose.*)

7408. Pithecolobium sp. (No. 5840.)

"A shrub." (*Rose.*)

7409. Cucurbita sp. (No. 5899 ?.)

7410. Solanum sp. (No. 5944.)

"Large purple flowers." (*Rose.*)

7411. Sphaeralcea sp. (No. 5945.)

"A large, beautiful flowering shrub much used in Mexican parks." (*Rose.*)

7412. Oxalis sp. (No. 5956.)

7413. [Undetermined.] (No. 303.)

"Forty-nine bulbs of a beautiful white flowering water lily. The flowers stand up above the water." (*Rose.*)

7414 to 7421.

From Naples, Italy. Received from Dammann & Co., August 20, 1901.

A collection of seeds as follows (the nomenclature is in large part Dammann's):

7414. Anacardium occidentale,

7415. Inga dulcis.

7416. Trachycarpus excelsus.

7417. Ficus elastica.

7418. Ficus macrophylla.

7419. Gazania hybrida.
Nora.

7420. Gazania hybrida.
Diana.

7421. Gazania hybrida.
Blondine.

7422. Triticum sp. **Wheat.**

From Girgeh Province, Egypt. Received through Mr. D. G. Fairchild (No. 655), August 20, 1901.

"Selected Egyptian wheat secured through the kindness of Sir William Willcocks, from typical 'basin' irrigated lands of the upper Nile. This is especially for trial in the Colorado Desert experiments. It is a winter wheat in Egypt, but matures by the first (or middle at latest) of May. Probably will be more or less mixed and contain both hard and soft varieties." (*Fairchild.*)

7423. CORYLUS AVELLANA.

From Alicante, Spain. Received through Mr. D. G. Fairchild (No. 752), August 30, 1901.

"Sample seeds of what are called here on the market 'Avellinas.' They are grown near Valencia, I am told, and are one of the common sorts of hazelnuts. It is a fairly thin-shelled nut but its skin is flakey and too heavy to make it of first quality." (*Fairchild.*)

7424. CYPERUS ESCULENTUS. **Chufas.**

From Alicante, Spain. Received through Mr. D. G. Fairchild (No. 753), August 30, 1901.

"Sample of the 'Chufa' of Spain, for planting in Louisiana and other places in the South. The culture is said to be simple and lucrative in Spain. When soaked in water the rootstocks swell up and are then very sweet and palatable. They are sold as we sell peanuts on the streets. Children are very fond of them, and they are used very extensively in the manufacture, in Madrid, of a delicious ice called '*Horchata di Chufas.*'" (*Fairchild.*)

7425. TRITICUM DURUM. **Wheat.**

From Cordova, Spain. Received through Mr. D. G. Fairchild (No. 764), August 30, 1901.

Negro. "A black-bearded durum wheat grown largely about Cordova. It is called *Negro* simply, but I believe is the *Barba Negro*, from which the *Pelissier* wheat is said to have originated. None of these wheats are much exported, and it is impossible to determine here their macaroni-making properties." (*Fairchild.*)

7426. VICIA FABA. **Broad bean.**

From Alicante, Spain. Received through Mr. D. G. Fairchild (No. 755), August 30, 1901.

Mahonesas. "A variety of broad bean, preferred for boiling purposes by Alicantians. Comes from Mahon in the Balearic Islands." (*Fairchild.*)

7427. HORDEUM TETRASTICHUM. **Barley.**

From Albacete, Spain. Received through Mr. D. G. Fairchild (No. 761). Sample received August 21, 1901; 88 kilos received January 14, 1902.

Albacete. "The barley of this dry plateau region of southeastern Spain is used for brewing purposes. Although its quality for this purpose can not compare with the best *Hanna* barley, it is a good variety and worthy of trial by breeders in the southwest." (*Fairchild.*)

7428. TRITICUM DURUM. **Wheat.**

From Albacete, Spain. Received through Mr. D. G. Fairchild (No. 758), January 14, 1902.

"This is the ordinary durum wheat of this dry plateau. It is not, I am told by a dealer in Murcia, as 'strong' a variety as the Russian so-called *Taganrog*, and hence is not exported, but from what I saw of it I judge it will prove resistant to rust in a fairly high degree. No distinctive name was discoverable. It is the only hard variety." (*Fairchild.*)

7429. TRITICUM VULGARE. **Wheat.**

From Albacete, Spain. Received through Mr. D. G. Fairchild (No. 759), January 14, 1902.

Candial. "A soft variety of wheat grown on this dry plateau in southeastern Spain. This variety is very highly esteemed as a bread-making sort for home use. It may prove valuable for our dry southern plains, for it is grown without irrigation. It is quite distinct from the variety known by the name of Candeal in South America, being a soft wheat, while the South American kind is a hard wheat." (*Fairchild.*)

7430. TRITICUM DURUM (?) **Wheat.**

From Albacete, Spain. Received through Mr. D. G. Fairchild (No. 760), January 14, 1902.

Gejar. "A semihard wheat, which is said to be the best for the manufacture of macaroni of any in Spain. It is not so 'strong' as the *Taganrog*, I am told, but has a very fine gluten, which makes it sought after by Spanish macaroni makers. It is grown on the high plateau of southeastern Spain without irrigation, and is suited for trial in the southwest." (*Fairchild.*)

7431 to 7438. MORUS sp. **Mulberry.**

From Murcia, Spain. Received through Mr. D. G. Fairchild (No. 757, f, g, h, i, j, k, l, m, n), August 21, 1901.

Various species of mulberry for silkworm feeding. All dead except:

7431. *Alba nervosa.* (757 f.)

7436. *Fertil de Italia.* (757 l.)

(See Nos. 7141 to 7145.)

7439. AGAVE UNIVITATTA. **Lechuguilla.**

From Tamaulipas, Mexico. Received through Mr. L. H. Dewey, August 31, 1901. Presented by Mr. H. Riehl.

A Tampico fiber plant.

7440. PUNICA GRANATUM. **Pomegranate.**

From the island of Chios, Turkey. Presented by Mr. N. J. Pantelides, through Mr. D. G. Fairchild. Received August 23, 1901.

"Scions of a variety of pomegranate which has seeds that are very tender coated. Probably a similar variety to that commonly cultivated on the coast of Spain and considered the best market variety there." (*Fairchild.*)

7441 to 7445.

From Nice, France. Presented by Mr. A. Robertson-Proschowsky. Received August 23, 1901.

A collection of seeds as follows:

7441. TRACHYCARPUS EXCELSUS.

7442. PHOENIX RECLINATA.

7443. PHOENIX.

Hybrid pollinated with *P. reclinata.*

7444. PHOENIX PUMILA.

Pollinated with *P. reclinata.*

7445. PSIDIUM CATTLEYANUM.

7446.

From Mexico. Received through Dr. J. N. Rose (No. 304), August 24, 1901.

7447.

From Mexico. Received through Dr. J. N. Rose (No. 305), August 24, 1901.

7448. CAPSICUM ANNUUM. **Red pepper.**

From Alicante, Spain. Received through Mr. D. G. Fairchild (No. 754), August 21, 1901.

"A very fine variety of red pepper grown at Aspra, not far from Elche, near Alicante. It forms a showy object in the market place and is grown extensively." (*Fairchild.*)

7449. PIMPINELLA ANISUM. **Anise.**

From Alicante, Spain. Received through Mr. D. G. Fairchild, August 24, 1901.

"The anise seed of southeastern Spain is noted. One firm here has exported 40,000 '*rielas*' in a single year. Used in Amsterdam for the manufacture of anisette." (*Fairchild.*)

7450. AVENA SATIVA. **Oat.**

From Alicante, Spain. Received through Mr. D. G. Fairchild, August 24, 1901.

"Sample of oats from market." (*Fairchild.*)

7451. HORDEUM VULGARE. **Barley.**

From Alicante, Spain. Received through Mr. D. G. Fairchild, August 24, 1901.

"Sample of barley from market." (*Fairchild.*)

7452 to 7458. AMYGDALUS COMMUNIS. **Almond.**

From Alicante, Spain. Received through Mr. D. G. Fairchild, August 24, 1901.

Almond fruits as follows:

7452.

Mollar. From same tree as No. 7061.

7453.

Planeta. From same tree as No. 7134.

7454.

Castillet. From same tree as No. 7133.

7455.

Fabrica. From same tree as No. 7135.

7456.

Planeta. From a grower.

7457.

Planeta. From a grower.

7458.

Pastaneta. From a grower.

7459. TRITICUM DURUM. **Wheat.**

From near Alicante, Spain. Received through Mr. D. G. Fairchild, August 24, 1901.

"Sample of wheat from threshing floor." (*Fairchild.*)

7460. CERATONIA SILIQUA. **Carob.**

From Alicante, Spain. Received through Mr. D. G. Fairchild (No. 743), August 24, 1901.

Negra. Seed pods from same tree as cuttings. (No. 7063.)

7461. CERATONIA SILIQUA. **Carob.**

From Alicante, Spain. Received through Mr. D. G. Fairchild, (No. 744) August 24, 1901.

Vera. "Seed pods. This is said to be one of the sweetest varieties known. It is planted for table use especially and is too valuable for horse food. The yield is irregular and small compared with other sorts." (*Fairchild.*)

7462. CICER ARIETINUM. **Chick-pea.**

From Cordova, Spain. Received through Mr. D. G. Fairchild, August 24, 1901.

7463. TRITICUM DURUM. **Wheat.**

From Alicante, Spain. Received through Mr. D. G. Fairchild (No. 763), August 24, 1901.

Berberisco. "A variety of wheat which was introduced into Spain many years ago from Barbary, and which has won for itself the reputation of being a larger yielder and having better grain than the durum wheat *Blanco*, No. 7464. It would be interesting to try this in comparison with Algerian wheats, which are said to have originated (part of them at least) from imported Spanish sorts." (*Fairchild.*)

7464. TRITICUM DURUM. **Wheat.**

From Cordova, Spain. Received through Mr. D. G. Fairchild (No. 762), August 24, 1901.

Blanco. "A native variety of hard wheat grown about Cordova which has the reputation of being of a fair quality and, although not so productive as the so-called *Berberisco*, it is more resistant to drought. I believe it will also prove resistant to rust in a fair degree." (*Fairchild.*)

7465. TRITICUM DURUM. **Wheat.**

From Uralsk, Russia. Received through Mr. A. A. Vannohin, August 29, 1901.

Kubanka. (See No. 5639, Inventory No. 10.)

7466. TRITICUM VULGARE. **Wheat.**

From Padui, Russia. Received through Mr. M. Narishkin, August 29, 1901.

Padui. (See No. 5640, Inventory No. 10.)

7467. TRITICUM VULGARE. **Wheat.**

From Kharkof, Russia. Received through Dr. A. Boenicke, August 29, 1901.

Kharkof. (See No. 5641, Inventory No. 10.)

7468. GARCINIA MANGOSTANA. **Mangosteen.**

From Heneratgoda, Ceylon. Received through J. P. William & Bros., August 29, 1901.

7469 to 7490.

From Mexico. Received through Dr. J. N. Rose (Nos. 306 to 327), August 30, 1901.

A collection of Mexican plants and bulbs as follows (Doctor Rose's numbers are given for purposes of identification):

7469. Orchid.

(No. 306.)

7470. Orchid.

(No. 307.)

7471. Orchid.

(No. 308.)

7472. Orchid.

(No. 309.)

7469 to 7490 Continued.

7473. Orchid.
(No. 310.)

7474. Orchid.
(No. 311.)

7475. Orchid.
(No. 312.)

7476. Orchid.
(No. 313.)

7477. Orchid.
(No. 314.)

7478. Orchid.
(No. 315.)

7479. Cotyledon sp.
(No. 316.)

7480. Arum sp. (?).
(No. 317.)

7481. Tillandsia sp.
(No. 318.)

7482. Tillandsia sp.
(No. 319.)

7483. Tillandsia sp.
(No. 320.)

7484. Tillandsia sp.
(No. 321.)

7485. Zephyranthes sp.
(No. 322.)

7486. Tillandsia sp.
(No. 323.)

7487. Cotyledon sp.
(No. 324.)

7488. Agave sp.
(No. 325.)

7489. Solanum sp. Potato.
(No. 326.)

7490.
(No. 327.)

7491 to 7495.

From Mexico. Received through Dr. J. N. Rose (Nos. 6259 and 328 to 331), August 31, 1901.

A collection of Mexican plants and bulbs, as follows:

7491.
(No. 6259.)

7492.
(No. 328.)

7493.
(No. 329.)

7494.
(No. 330.)

7495.
(No. 331.)

7496. Cissus.

From Eagle Pass, Tex. Received through Dr. J. N. Rose, September 5, 1901.

7497.

From Mexico. Received through Dr. J. N. Rose (No. 259), September 5, 1901.

7498. Vicia faba. **Broad bean.**

From Vomero-Naples, Italy. Received through Mr. C. Sprenger, September 5, 1901.

St. Pantaleone. "A new variety of bean having very long pods." (*Sprenger.*)

7499. Anacardium occidentale. **Cashew.**

From Kingston, Jamaica. Received through Mr. W. Harris, assistant superintendent of the Hope Gardens, September 5, 1901.

7500. Medicago sativa. **Alfalfa.**

From Oued Rirh oasis, northern Sahara Desert. Received through Mr. W. T. Swingle from French and Arab foremen of the European date plantations. Received May, 1901.

"An early sort, resisting drought and alkali much better than the ordinary alfalfa." (*Swingle.*)

7501. Spondias sp. **Ciruela.**

From Iguala, Mexico. Received through Mr. Elmer Stearns, Los Angeles, Cal., September 10, 1901.

Dried fruit.

7502. Zea mays. **Corn.**

From Tampico, Mexico. Received through Mr. Elmer Stearns, Los Angeles, Cal., September 10, 1901.

Large White Mexican.

7503. Phaseolus vulgaris. **Bean.**

From City of Mexico, Mexico. Received through Mr. Elmer Stearns, Los Angeles, Cal., September 10, 1901.

Large Purple.

7504. Phaseolus vulgaris. **Bean.**

From City of Mexico, Mexico. Received through Mr. Elmer Stearns, Los Angeles, Cal., September 10, 1901.

Ballo Gordo. A yellow bean.

7505. Casimiroa edulis. **White sapota.**

From Guadalajara, Mexico. Received through Mr. Elmer Stearns, Los Angeles, Cal., September 10, 1901.

Zapote Blanco.

7506. (Unidentified seeds.)

From City of Mexico, Mexico. Received through Mr. Elmer Stearns, Los Angeles, Cal., September 10, 1901.

Pepita para mole verde. "Sold in roasted condition on streets of Mexico." (*Stearns.*)

7507. Opuntia sp.

From City of Mexico, Mexico. Received through Mr. Elmer Stearns, Los Angeles, Cal., September 10, 1901.

Tuna Colorado. "Fruit is the size of a duck's egg, and has very red flesh." (*Stearns.*)

7508. CUCURBITA sp. **Pumpkin.**

From City of Mexico, Mexico. Received through Mr. Elmer Stearns, Los Angeles, Cal., September 10, 1901.

Spargel Kurbis.

7509. CEREUS sp. (?) **Pitahaya.**

From Tampica and Guadalajara, Mexico. Received through Mr. Elmer Stearns, Los Angeles, Cal., September 10, 1901.

"Fruit pink, large, sweet, and fine eating." (See Cont. U. S. Herb., Vol. V, No. 4, pp. 220–221.)

7510. CARICA PAPAYA. **Papaw.**

From Tampico, Mexico. Received through Mr. Elmer Stearns, Los Angeles, Cal., September 10, 1901.

"Fruit very large." (*Stearns.*)

7511. CUCUMIS SATIVUS (?). **Cucumber.**

From City of Mexico, Mexico. Received through Mr. Elmer Stearns, Los Angeles, Cal., September 10, 1901.

"Fruit of fine flavor, round, the size of a large apple. Bears large crop." (*Stearns.*)

7512 to 7515. TRITICUM VULGARE. **Wheat.**

From Proskurow, Russia. Received through Dr. S. Mrozinski, September 9, 1901.

Samples of wheat as follows:

7512.

Sandomirka. "A beardless wheat grown in Podolia. It is very resistant to frost, heat, and drought. This wheat was first grown in the vicinity of Sandomir, in Poland." (*Mrozinski.*)

7513.

Plock. "A variety of wheat introduced into Podolia from Plock, Poland. It is especially noted for its resistance to the effect of rain storms." (*Mrozinski.*)

7514.

Triumph of Podolia. "An improved local species, very productive and resistant to all climatic changes." (*Mrozinski.*)

7515.

Banat. "Selected from the original Hungarian *Banat*. It is noted for not degenerating as easily as the original." (*Mrozinski.*)

7516 and 7517. AMYGDALUS COMMUNIS. **Almond.**

From Malaga, Spain. Received through Mr. D. G. Fairchild (No. 769), September 13, 1901.

Jordan. "Bought in the shell from a grower in the Sierra, at a small village called Almogia, one hour's mule ride from the well-known road of Antiquera. This is a collection as it came from the trees, small and large together, and is for purposes of seed selection. It is highly probable that new varieties (seedlings) can be secured from these seeds, and they should be distributed to breeders of *Prunus*. Almost all the trees about Malaga, where this particular variety is grown and from which place almonds are shipped in large quantities to America, are budded trees. The stock is the bitter almond, seeds of which (No. 7517) are included in the same box with the Jordans. I am told, however, that seedling plants are employed and that they bear fruit reasonably true to type. The soil on which these trees are grown is very rocky and light and at this season is quite dry and dusty. Hillsides and high-lying valleys are the favorite spots for their cultivation, and the secret of their culture seems to lie in the freedom from spring frosts. They flower in January and February, and even about Malaga a crop is often lost by a frost at flowering time. These frosts being quite local, one often hears in one valley of a total loss of the crop in a neighboring one. These seeds may prove very valuable in originating later-blooming sorts of good quality and in discovering valleys suited to their culture. The seed should be carefully inspected and all specimens with gum adhering discarded. I recommend, further, that the remaining be washed with copper sulphate or some other disinfectant and well rinsed with fresh water. The disease called *Gummosis* is a troublesome one and exists in all the orchards I have visited. It is important that this disease, if it really is one, be not introduced into California. I am unaware if it is already there and has been studied. I have seen trees that appeared to be dying of the disease. Nuts attacked by it are worthless. These seeds should be stratified and planted without cracking in rich garden earth. Budding is done here only in April." (*Fairchild.*)

7518. ROMNEYA COULTERI. **Matilija poppy.**

From Los Angeles, Cal. Received through Mr. Elmer Stearns, September 20, 1901.

7519. CEREUS sp. (?) **Pitahaya.**

From Guadalajara, Mexico. Received through Mr. Elmer Stearns, Los Angeles, Cal., September 20, 1901.

"Fruit three to four inches long and two inches in diameter. Skin reddish pink. Pulp white and jellylike, with the seeds distributed through it. Sweet and fine eating." (*Stearns.*)

7520 to 7534.

From Paris, France. Received through Vilmorin-Andrieux & Co., September 21, 1901.

A collection of agricultural seeds, as follows:

7520. TRIGONELLA FOENUM-GRAECUM. **Fenugreek.**

7521. LATHYRUS CICER. **Vetch.**

Gesse jarosse.

7522. ERVUM MONANTHOS. **Lentil.**

One-flowered lentil.

7523. ERVUM LENS HIEMALE. **Lentil.**

Red winter lentil.

7524. LUPINUS ALBUS. **Lupine.**

White lupine.

7525. LUPINUS LUTEUS. **Lupine.**

Yellow lupine.

7526. ONOBRYCHIS ONOBRYCHIS. **Sainfoin.**

7527. ONOBRYCHIS ONOBRYCHIS. **Sainfoin.**

Sainfoin à deux coupes.

7528. HEDYSARUM CORONARIUM. **Sulla.**

Spanish Sulla.

7529. TRIFOLIUM INCARNATUM. **Crimson clover.**

Early variety.

7520 to 7534—Continued.

7530. Trifolium incarnatum. **Crimson clover.**

Very late variety, with white flowers.

7531. Secale cereale. **Rye.**

Giant winter.

7532. Vicia narbonnensis. **Narbonne vetch.**

7533. Vicia villosa. **Hairy vetch.**

7534. Lathyrus ochrus. **Vetch.**

7535. Lupinus angustifolius. **Blue lupine.**

From Eustis, Fla. Sent by Mr. F. W. Savage through Mr. W. T. Swingle. Received September 23, 1901.

A North African variety. Grown from No. 5583.

7536 to 7556.

From Paris, France. Received through Vilmorin Andrieux & Co., September 23, 1901.

A collection of seeds as follows:

7536. Albizzia julibrissin (?)

7537. Morus alba. Hat-var. Moretti.

7538. Schinus molle.

7539. Schinus terebinthifolius.

7540. Ficus elastica.

7541. Caesalpinia bonducella.

7542. Hura crepitans.

7543. Swietenia mahagoni.

7544. Coluifera balsaminum.

7545. Arenga saccharifera.

7546. Cycas normanbyana.

7547. Licuala grandis.

7548. Livistona jenkinsiana.

7549. Cinchona calisaya.

7550. Cinchona ledgeriana.

7551. Cinchona calisaya.

7552. Cinchona succi-rubra.

7553. Lespedeza sieboldi.

7554. Ilex integra.

7555. Abrus precatorius.

7556. Leucadendron argenteum.

7557 to 7574.

From St. Albans, England. Received through Sander & Co., September 24, 1901.

A collection of plants as follows:

7557. Richardia sp.

Calla leucoxantha.

7558. Leea sambucina.

7559. Panax aureum.

7560. Passiflora pruinosa.

7561. Dianthus caryophyllus. **Carnation.**

Ivanhoe.

7557 to 7574—Continued.

7562. Dianthus caryophyllus. **Carnation.**

J. Coles.

7563. Dianthus caryophyllus. **Carnation.**

Lily Measures.

7564. Dianthus caryophyllus. **Carnation.**

Mrs. F. Sander.

7565. Dianthus caryophyllus. **Carnation.**

Monica.

7566. Dianthus caryophyllus. **Carnation.**

Mrs. Joicey.

7567. Richardia sp.

Calla Elliottiana Rossii.

7568. Acanthophoenix crinita.

7569. Bentinckia nicobarica.

7570. Cocos coronata.

7571. Cyrtostachys renda.

7572. Heterospathe elata.

7573. Ptychoraphis augusta.

7574. Kentia sanderiana.

7575 and 7576. Triticum durum. **Wheat.**

Grown by Oscar C. Snow, Mesilla Park, N. Mex., under contract. Distributed from the New Mexico Agricultural Experiment Station. Reported ready for delivery September, 1901.

7575. *Gharnovka*, grown from No. 5643.

7576. *Kubanka*, grown from No. 5639.

7577. Physalis peruviana. **Cape gooseberry.**

From Lima, Peru. Received through Mr. Elmer Stearns, Los Angeles, Cal., September 26, 1901.

Naranjilla. "Plant 2 to 3 feet tall, branching, leaves large. Fruits abundant. The local name means Little Orange." (*Stearns.*)

7578. Triticum durum. **Wheat.**

From province of Oran, Algeria. Received through Messrs. D. G. Fairchild and C. S. Scofield (No. 721), September 26, 1901.

Marouani. "This wheat is cultivated extensively on the elevated rolling lands in the western part of the province, and is one of the best of the types of durum wheats cultivated by the Arabs. The quantity obtained is from the estate of M. J. Labouresse, at Tessala, near Sidi-bel-Abbès. It has been carefully selected by Mr. Labouresse from year to year until a fairly pure and very vigorous stock has been obtained. The variety is very hardy, resistant to rust, and succeeds fairly well under rather droughty conditions. The grain is especially adapted for the manufacture of semolina. In the province of Oran the wheat is sown in November and ripens in June, but it might succeed as a spring wheat in the spring-wheat region of the northern United States." (*Fairchild and Scofield.*)

7579. Triticum durum. **Wheat.**

From Sidi-bel-Abbès, province of Oran, Algeria. Received through Messrs. D. G. Fairchild and C. S. Scofield (No. 722), September 26, 1901.

Medeah. "This is one of the best-known macaroni wheat varieties of western Algeria. When grown on the high rolling lands in the vicinity of the city of Medeah it produces a grain with very valuable macaroni-making qualities. It was recently introduced into the vicinity of Sidi-bel-Abbès, where it gives promise of being a very valuable sort, ripening ten to fifteen days earlier than the Marouani and similar sorts grown in that vicinity. It is ordinarily sown here in November and ripens early in June, but it is worth trying as a spring wheat in the northern United States. The sample obtained is from the farm of M. J. Labouresse, of Tessala, near Sidi-bel-Abbès, which latter is one of the noted wheat growing districts of Algeria, possessing a light rich soil." (*Fairchild and Scofield.*)

7580. TRITICUM DURUM. **Wheat.**

From Batna, Constantine, Algeria. Received through Messrs. D. G. Fairchild and C. S. Scofield (No. 729), September 26, 1901.

Adjini. "This wheat is from stock grown by the Arabs on the rolling lands of the Aurès Mountains, east of Batna, where the summer temperature often reaches 100° F. and where it frequently drops to zero in winter. It is a variety highly spoken of by the macaroni manufacturers of Marseille, and, although rapidly deteriorating in quality, when cultivated there, has given very good yields when grown without irrigation on lower lands of the high plateau of the province of Constantine. The soil on these lands is excessively rich in sulphate of magnesia and is of a hard and gravelly nature. Although a winter wheat in Batna, being sown in December or January and harvested early in July, it will be worth a trial in the spring-wheat region. The seed obtained is from Arab growers, whose methods of culture are very primitive, and the Department is indebted to Mr. G. Ryf, manager of the Geneva Society of Setif, for its purchase from them." (*Fairchild and Scofield.*)

7581. TRITICUM DURUM. **Wheat.**

From El-Outaya, Constantine, Algeria. Received through Messrs. D. G. Fairchild and C. S. Scofield (No. 730), September 26, 1901.

Kahla. "This wheat will be found to differ from the *Kahla*, No. 7794, of the high plateau region, as it comes from plants grown by irrigation on the somewhat salty sands of the northern Sahara Desert. It is one of the few sorts of wheats that maintain their good quality when grown year after year in slightly alkaline soils. It is highly valued by the Arabs for its rich content of elastic gluten. It is grown on land that probably has at least 5 per cent of salt in it and the irrigation water itself with which the plants are irrigated is slightly salty, not so salty, however, as to be quite undrinkable. The wheat is planted in El-Outaya in December or January, but it might be worth trying as a spring wheat in the North. This seed is from the farm of Mr. Charles des Places at El-Outaya. As a macaroni wheat its rank is not known, but its ability to grow in alkaline soil makes it especially valuable for any experiments in the irrigated salt lands of America. We were told that a change of seed was especially beneficial on these salt lands. Quantities of wheat are brought down from the neighboring mountains to plant on these salt lands. This change of seed forbids the formation of any salt-resistant race, but does not change the interest in these wheats for other salt lands." (*Fairchild and Scofield.*)

7582. TRITICUM VULGARE. **Wheat.**

From El-Outaya, Constantine, Algeria. Received through Messrs. D. G. Fairchild and C. S. Scofield (No. 731), September 26, 1901.

Fretes. "This variety, sometimes called *Freitiss*, is one of the few soft wheats grown in Algeria. It is particularly noted for its early maturity and is often extensively planted in the Sahara Desert in seasons when the winter rains occur so late that the durum varieties usually grown would not have time to mature. When planted in November, as it is in Algeria, at the same time with durum varieties, it is said to ripen two months in advance of them. The seed obtained was grown on the rather salty desert sands in the vicinity of El-Outaya, north of Biskra, and watered with somewhat alkaline but still drinkable irrigation water. The variety is said to have originated from a shipment of Russian wheat which was made into Algeria at the time of a famine many years ago. Its early maturing qualities attracted attention, and it has been cultivated in small quantities by the Arabs ever since. The seed obtained is from the farm of Mr. Charles B. des Places." (*Fairchild and Scofield.*)

7583. HORDEUM TETRASTICHUM. **Barley.**

From El-Outaya, Constantine, Algeria. Received through Messrs. D. G. Fairchild and C. S. Scofield (No. 732), September 26, 1901.

Beldi. "This and the following variety (No. 7584) are sorts planted on the saline soils of the edge of the Sahara Desert. They are grown by irrigation, but the irrigation water itself is saline. In quality they are neither of them of superior excellence and are little used, if any, for beer-making purposes. The yield is small when compared with that of barley grown on good soils, but it nevertheless seems to pay the French colonists to grow it in these regions where very few plants of any kind succeed. The Arabs feed their horses largely on barley and even eat it themselves. Mr. des Places says, however, that on these saline soils where this barley is grown he finds a change of seed beneficial, even necessary, and he imports every year or two his seed barley and seed wheat from the mountains, because it so rapidly degenerates. These barleys are introduced for a trial on the salt lands of the Southwest. The names given are Arab ones for slightly different strains. Secured of Mr. Charles B. des Places." (*Fairchild and Scofield.*)

7584. HORDEUM TETRASTICHUM. **Barley.**

From El-Outaya, Constantine, Algeria. Received through Messrs. D. G. Fairchild and C. S. Scofield (No. 733), September 26, 1901.

Telli. "A barley for salt lands under irrigation. See No. 7583 for description." (*Fairchild and Scofield.*)

7585. TRITICUM TURGIDUM. **Wheat.**

From Oran, Algeria. Received through Messrs. D. G. Fairchild and C. S. Scofield (No. 734), September 26, 1901.

Black Poulard. "This is one of the so-called Poulard wheats, a class which is commonly grown in France on stiff or heavy soils unfavorable to the culture of less vigorous sorts. The quality of the grain is considered inferior to that of either *T. durum* or *T. vulgare.* It is particularly valuable on account of its vigorous growth and hardiness. It is usually grown as an autumn wheat, but is worthy of trial on any land too heavy or too coarse to produce ordinary wheats to good advantage. The seed was secured from M. Vermeil, professor of agriculture at Oran, who has it growing in his experimental plats under the Arabic name of 'Kahla,' a name which, however, is applied in other parts of Algeria to a quite different variety of wheat. (See Nos. 7581 and 7794.) This is not a macaroni wheat, but may be used for flour making." (*Fairchild and Scofield.*)

7586. MEDICAGO SATIVA. **Alfalfa.**

From Setif, province of Constantine, Algeria. Received through Messrs. D. G. Fairchild and C. S. Scofield (No. 735a), November 11, 1901.

"A wild variety which has been introduced into culture by Mr. G. Ryf, of Setif, who is conducting experiments, the results of which are published by the "Comice Agricole," of Setif, of which Mr. Ryf is a prominent member. This variety has been remarkable in its variation since its introduction to cultivation, and the seed should prove an excellent foundation stock from which to select varieties for special soils and conditions. In general it has been found very resistant to drought and well adapted to soils rich in phosphates. Mr. Ryf has an interesting method of cultivating it. He plants the seed in rows 39 inches apart and cultivates between the rows the first season. The following season the crops of hay are cut as rapidly as they come on, and the plants spread out, forming broad bands or rows. The season following, the space between the rows and all but a narrow band 8 inches wide of the alfalfa is plowed under and well tilled. After this cultivation a crop of wheat is sown between the rows of alfalfa, and when this is matured and removed a light cultivation is given, and the following year the rows of alfalfa are allowed to spread out and crops of hay are taken off. In this way wheat and alfalfa are alternated from year to year. Mr. Ryf finds that by following this method the perennial leguminous forage crops give much better results than annual ones. This he attributes largely to the extra amount of cultivation that this method permits. In fact he finds that for his conditions an extra cultivation of the soil gives better results in the following crop than the planting of an annual leguminous crop, with which cultivation is impossible. This is seed from a procumbent form of the plant." (*Fairchild and Scofield.*)

7587. MEDICAGO SATIVA. **Alfalfa.**

From Setif, Constantine, Algeria. Received through Messrs. D. G. Fairchild and C. S. Scofield (No. 735a), November 11, 1901.

A wild variety, with erect form. (See No. 7586.)

7588. MEDICAGO MEDIA. **Sand lucern.**

From Setif, Constantine, Algeria. Received through Messrs. D. G. Fairchild and C. S. Scofield (No. 735a+), November 11, 1901.

Luzerne rustique.

7589. BAUHINIA sp. **White bauhinia.**

From Mount Silinda, Melsetter district, Rhodesia, South Africa. Received through Dr. Wm. L. Thompson, October 1, 1901.

"Is quite rare. The flowers are large and beautiful and very abundant, but very delicate. The plant seems quite sensitive to frost and many plants have been injured by it this year." (*Thompson.*)

7590. BAUHINIA sp. **Red bauhinia.**

From Mount Silinda, Melsetter district, Rhodesia, South Africa. Received through Dr. Wm. L. Thompson, October 1, 1901.

"The red variety is very widely and generally distributed over this region." (*Thompson.*)

7591 to 7630.

From London, England. Received through James H. Veitch & Sons, October 3, 1901.

A collection of ornamental plants as follows (nomenclature is that of the seedsmen):

7591. BEGONIA sp. **Begonia.**

Winter Cheer.

7592. BEGONIA sp. **Begonia.**

Adonis.

7593. BEGONIA CARMINATA. **Begonia.**

7594. BEGONIA sp. **Begonia.**

Ensign.

7595. BEGONIA EUDOXA. **Begonia.**

7596. BEGONIA INCOMPARABILIS. **Begonia.**

7597. BEGONIA sp. **Begonia.**

John Heal.

7598. BEGONIA sp. **Begonia.**

Mrs. Heal.

7599. BEGONIA sp. **Begonia.**

Venus.

7600. BEGONIA sp. **Begonia.**

Winter Perfection.

7601. CODIAEUM VARIEGATUM. **Croton.**

Mrs. McLeod.

7602. CODIAEUM VARIEGATUM. **Croton.**

Aigburth Gem.

7603. CODIAEUM VARIEGATUM. **Croton.**

Mrs. Iceton.

7591 to 7630—Continued.

7604. Codiaeum variegatum. **Croton.**

Princess of Wales.

7605. Dracaena sp.

Duchess of York.

7606. Dracaena sp.

Esckhantei.

7607. Dracaena sp.

The Sirdar.

7608. Dracaena sp.

Exquisite.

7609. Dracaena sp.

Donsetti.

7610. Amasonia calycina.

7611. Maranta major.

7612. Allamanda blanchetii.

7613. Medinilla bornensis.

7614. Medinilla magnifica.

7615. Mussaenda grandiflora.

7616. Roupala pohlii.

7617. Vriesia fenestralis.

7618. Tillandsia lindeniana.

7619. Guzmania musaica.

7620. Urceolina pendula.

7621. Zingiber officinale.

7622. Richardia elliottiana.

7623. Richardia pentlandi.

7624. Hedychium gardnerianum.

7625. Dianthus caryophyllus. **Carnation.**

Blush White.

7626. Dianthus caryophyllus. **Carnation.**

Lady Grimstone.

7627. Dianthus caryophyllus. **Carnation.**

Lord Rosebery.

7628. Dianthus caryophyllus. **Carnation.**

Trumpeter.

7629. Dianthus caryophyllus. **Carnation.**

George Maquat.

7630. Semele androgyna.

7631 to 7636. Phoenix dactylifera. **Date palm.**

From Egypt. Received through Mr. D. G. Fairchild (No. 597) from Mr. Em. C. Zervudachi, Alexandria, October 2, 1901.

7631.

Amri. "One of the best varieties, of large size; color, garnet verging on black." (*Zervudachi.*)

7632.

Oga of Bedrichen. "Of medium size; color, garnet verging on black." (*Zervudachi.*)

7633.

Nagl-el-Basha. "One of the best varieties, of large size; color, yellowish." (*Zervudachi.*)

7631 to 7636—Continued.

7634.

Sultani or *Soubaa-el-Sitti.* "One of the best varieties, of medium size; color, yellowish." (*Zervudachi.*)

7635.

Birket-el-Haggi. "Of medium size; color, garnet verging on black." (*Zervudachi.*)

7636.

Am-hat. "Of small size and yellowish color." (*Zervudachi.*)

7637. LATHYRUS TINGITANUS. **Tangier scarlet pea.**

From Algeria. Received through Mr. D. G. Fairchild, September 26, 1901.

7638. CICER ARIETINUM. **Chick-pea.**

From Rouïba, Algeria. Received through Mr. D. G. Fairchild, September 26, 1901.

7639. LATHYRUS SATIVUS.

From Rouïba, Algeria. Received through Mr. D. G. Fairchild, September 26, 1901.

7640 to 7645.

From Tunis, Tunis. Received through Mr. D. G. Fairchild (Nos. 697 to 702), October 4, 1901.

Samples of miscellaneous seeds presented by the School of Agriculture of Tunis.

7640. HORDEUM VULGARE. **Naked barley.**

Chair-en Nebbi. "Originated in Tunis, but grown in the trial gardens of the college for three years." (No. 697.) (*Fairchild.*)

7641. HORDEUM VULGARE. **Naked barley.**

"From Turkestan. Grown three years in Agricultural College garden, Tunis." (No. 698.) (*Fairchild.*)

7642. TRIGONELLA FOENUM-GRAECUM. **Fenugreek.**

"The grain is eaten by the Jewish women of Tunis in large quantities in order to increase their avoirdupois, it being the fashion to weigh as much as 200 pounds or more. Primarily, however, a forage and soiling crop." (No. 699.) (*Fairchild.*)

7643. ANDROPOGON HALAPENSIS.

Sorgho d'Alep. "This is an important grain crop of north Africa. It hybridizes easily with broom corn and causes the latter to deteriorate." (No. 700.) (*Fairchild.*)

7644. CARTHAMNUS TINCTORIUS. **Safflower.**

"Grown as an oil plant." (No. 701.) (*Fairchild.*)

7645. GUIZOTIA ABYSSINICA.

"An oil-producing plant used like sesame. It is grown similarly." (No. 702.) (*Fairchild.*)

7646. PENNISETUM SPICATUM. **Pearl millet.**

From Tunis, Tunis. Received through Mr. D. G. Fairchild (No. 696), October 4, 1901.

Millet de Chandelles. "Probably grown extensively in the south of the province of Tunis, about Gabez. Arabs use it for food, Europeans for forage. May be useful for breeding. From School of Agriculture, Tunis." (*Fairchild.*)

7647. GOSSYPIUM sp. **Cotton.**

From Tunis, Tunis. Received through Mr. D. G. Fairchild (No. 695), September 26, 1901.

Coton bruine de Mallaganza. "Single boll of a brown cotton from the collection of cottons at the School of Agriculture of Tunis. Its origin is quite unknown." (*Fairchild.*)

7648. LINUM USITATISSIMUM. **Flax.**

From Oran, Tunis. Received through Mr. D. G. Fairchild (No. 717), September 26, 1901.

"Said to resist drought very well." (*Fairchild.*)

7649. LINUM USITATISSIMUM. **Flax.**

From Tunis, Tunis. Received through Mr. D. G. Fairchild (No. 716), September 26, 1901.

"Also said to be drought resistant." (*Fairchild.*)

7650 to 7653. TRITICUM DURUM. **Wheat.**

From Tunis, Tunis. Presented by the School of Agriculture of Tunis through Mr. D. G. Fairchild (Nos. 703 to 706). Received September 26, 1901.

Samples of wheat from the collection in the School of Agriculture of Tunis. They bear the following native names, for whose spelling Mr. R. Gagey, instructor at the college, is responsible:

7650.

Sba er Roumi (*Sboa-el-Roumia*). (No. 706.)

7651.

Azizi. (No. 705.)

7652.

Médeah. (No. 704.)

7653.

Abd-el-Kader. (No. 703.)

7654. CAPSICUM ANNUUM. **Red pepper.**

From Tunis, Tunis. Received through Mr. D. G. Fairchild (No. 718), September 26, 1901.

"A large, very fine, long red pepper from market of Tunis." (*Fairchild.*)

7655. CICER ARIETINUM. **Chick-pea.**

From Tunis, Tunis. Received through Mr. D. G. Fairchild (No. 707, May 27, 1901), September 26, 1901.

"The native chick-pea of Tunis for comparative tests as to nodule-producing properties and resistance to drought. From the School of Agriculture in Tunis." (*Fairchild.*)

7656. LOTUS TETRAGONOLOBUS. **Square pea.**

From Tunis, Tunis. Received through Mr. D. G. Fairchild (No. 715, May 27, 1901), September 26, 1901.

"A new forage and seed legume being tried at the Tunis Agricultural College. Its root nodules are remarkable for their size and number, and its seed-bearing capacity is extraordinary." (*Fairchild.*)

7657. TRIFOLIUM ALEXANDRINUM. **Berseem.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 642, May 9, 1901), October 10, 1901.

Saida. "This variety stands somewhat intermediate in character between *Muscowi* and *Fachl.* Its long-root system enables it to withstand dry weather very well, and it is considered in Egypt as a variety of dry-land Berseem. It yields two cuttings only, and is therefore sown in such regions as can be irrigated two or three times. It should be sown in autumn, on land with a limited power of irrigation, and will yield, on an average, about 6 tons of green fodder per acre at the first cutting and 4 or 5 at the second. It makes better hay than the *Muscowi*, but can not be considered of as great importance as that variety. The root system of this variety is longer than in either of the others." (*Fairchild.*)

7658. TRIFOLIUM ALEXANDRINUM. **Berseem.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 643, May 9, 1901), October 10, 1901.

Fachl. "This variety differs materially from the *Muscowi* (No. 7659), being used on land which is irrigated by the basin system, that is, by being overflowed for forty days in the autumn. The seed is broadcasted at the rate of a bushel an acre on the mud, and no later irrigations are found necessary, as the plant gives only one cutting. This, however, yields 9 tons of green fodder per acre and makes a better hay than the *Muscowi.* In order to secure the seed of this variety it is the practice to sow the same broadcast with wheat or barley, and the seed is separated from the grain by thrashing, it being much smaller and lighter. This variety will be limited in its use to regions where only one irrigation can be given during the winter, or possibly may prove valuable as a spring forage crop." (*Fairchild.*)

7659. TRIFOLIUM ALEXANDRINUM. **Berseem.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 644), October 10, 1901. Secured through the kindness of the secretary of the Khedivial Agricultural Society of Egypt, Mr. George P. Foaden.

Muscowi. "The great fodder and soiling crop of Egypt. An annual, leguminous, green fodder crop, considered indispensable by the Egyptians as a half-year rotation with cotton. Its fodder-producing value, effect upon the soil in storing up nitrogen, and cleansing effect are considered exceptional. It will be best suited to irrigated lands in warm climates, but might also be tested as a spring fodder crop in the northwestern coast States. In Egypt the seed is sown generally in October, after the soil has been thoroughly irrigated to prepare a moist bed for the seed. It is sown broadcast at the rate of not less than 40 pounds per acre. Even as high as 50 to 60 pounds are sown. This is due in part to the prevalence of weevils in the seed, which sometimes destroy the germinating power of a large percentage. The seed should be harrowed into the soil lightly, and when started the young plants should be given plenty of water. In Egypt the plants grow so rapidly that if sown toward the end of October a first cutting can be made after forty-five or fifty days, but if sown later, after the cooler weather has set in, it takes a much longer time for the plants to develop. Depending upon the amount of water and the temperature, the plants yield from four to five cuttings, yielding for the first and second cuttings about 8 tons of green forage per cutting and for the third and fourth cuttings somewhat less. In order to secure seed for next year's planting the plants should be left to stand after the fourth cutting, when they will go to seed. In Egypt the seed production is larger and heavier than in the case of clover. After each cutting a sufficiently long period should elapse before the plants are irrigated again, to allow the cut surfaces of the stems to dry out; otherwise the water will rot the plants. This fodder plant deserves a thorough test in the Colorado Desert region, beet-sugar regions of the Southwest, and as a soiling crop in the orchards of California." (*Fairchild.*)

7660. TRITICUM VULGARE. **Wheat.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 638, May 9, 1901), October 10, 1901.

Bohi. "A soft wheat which is grown popularly about Cairo, and is considered one of the best soft wheats of Egypt. This sample comes from the grounds of the Khedivial Agricultural Society and was remarkably free from *Puccinia*, although the American wheat varieties, *Henderson's Pedigreed* and *Gold Corn*, growing adjacent, were very badly rusted. This *Bohi* is an early ripening sort, at least one month earlier than above-mentioned American wheats. It is improbable that this variety will withstand a very low temperature, and it ought to do best in irrigated regions of the Southwest. It is planted about the 20th of November in Egypt and is cut the first week in May, although, from an American standpoint, it would be ripe by the last week in April. All wheat is left until dead ripe before cutting in Egypt. The temperature during the winter seldom goes below 40° F." (*Fairchild.*)

7661. Sesamum indicum. **Sesame.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 635, May 9, 1901), October 10, 1901.

White. "This forms an important, profitable crop on the basin irrigated lands. It should be tried as late as the beginning of July after floods of Colorado River have subsided and might mature by the end of October. The seed should be broadcasted on the mud at a rate of about a bushel per acre. If possible, two subsequent waterings should be made, one when a few inches high and another later. If mud is not fresh it would be best to plow the land and harrow in the seed. (See No. 3972, Inventory No. 8, for description of oil making.) Lord Cromer, in his last report, mentions that sesame is exported from Egypt to Europe. It is largely used for making the Turkish sweetmeat *Chacla*(?). Profits in Egypt are estimated at about $40 an acre. For use in the Colorado River experiments. Secured through the kindness of Mr. George P. Foaden, secretary of the Khedivial Agricultural Society." (*Fairchild.*)

7662. Sesamum indicum. **Sesame.**

From Cairo, Egypt. Received through Mr. D. G. Fairchild (No. 636, May 9, 1901), October 10, 1901.

Brown. "I can not find that this has any advantage over the white, or vice versa, but it may prove better adapted to growth in the Colorado River flood plain. Secured through the kindness of Mr. George P. Foaden, secretary of the Khedivial Agricultural Society." (*Fairchild.*)

7663 to 7677.

From Asia Minor. Received through Mr. George C. Roeding, October 11, 1901.

A collection of economic plants secured in September, 1901, as follows:

7663. Ficus carica. **Caprifig.**

From Aidin. Designated "F."

7664. Ficus carica. **Caprifig.**

From Aidin. "*D.*" "A very large caprifig (same as No. 6832), from the garden of S. G. Magnisalis." (*Roeding.*)

7665. Ficus carica. **Caprifig.**

From Aidin. "*E.*" "One of the largest caprifigs from the garden of S. G. Magnisalis. (Same as No. 6836.)" (*Roeding.*)

7666. Ficus carica. **Caprifig.**

From Aidin. "*I.*" "A variety from the garden of S. G. Magnisalis, near the ruined mosque. This is not the variety especially mentioned by Mr. W. T. Swingle." (*Roeding.*)

7667. Ficus carica. **Caprifig.**

From Aidin. "*G.*" Very largest and finest caprifig from the garden of S. G. Magnisalis. Same as No. 6835." (*Roeding.*)

7668. Pistacia vera. **Pistache.**

From Smyrna. "From the Greek nurseryman near Smyrna." (*Roeding.*)

7669. Pyrus sp. **Pear.**

From Smyrna. "Wild pear growing near Smyrna, a good stock, valuable for clay ground." (*Roeding.*)

7670. Amygdalus persica. **Peach.**

From Smyrna. "A yellow cling, yellow to the pit, ripening in August. From Pounar Bashi." (*Roeding.*)

7663 to 7677—Continued.

7671. VITIS VINIFERA. **Grape.**

From Smyrna. "A superior variety of Malaga called *Rezaki.* Probably *Datte de Beyrouth.*" (*Roeding.*)

7672. PRUNUS ARMENIACA. **Apricot.**

From Smyrna. "From Pounar Bashi near Smyrna. An apricot with a sweet kernel like an almond." (*Roeding.*)

7673. PISTACIA TEREBINTHUS. **Terebinth.**

From Smyrna. *Karabanour.* "Buds from male pistachio terebinth." (*Roeding.*)

7674. PUNICA GRANATUM. **Pomegranate.**

From Smyrna. *Tcherkerdeksis.* "The seedless pomegranate from Pounar Bashi." (*Roeding.*)

7675. OLEA EUROPAEA. **Olive.**

From Smyrna. "Pickling and oil olive from Greek nurseryman near Smyrna." (*Roeding.*)

7676. PUNICA GRANATUM. **Pomegranate.**

From Smyrna. *Feysinar.* "Pomegranate from Pounar Bashi." (*Roeding.*)

7677. PUNICA GRANATUM. **Pomegranate.**

From Smyrna. *Kadinar.* "Pomegranate from Pounar Bashi." (*Roeding.*)

7678. COFFEA ARABICA. **Coffee.**

From Macassar, Celebes. Received through Messrs. Lathrop and Fairchild (No. 386a, February 11, 1900), October 15, 1901. Sent by Hon. K. Auer, United States consul.

Menado. "The bean of this famous coffee is very large. It is one of the highest priced coffees on the market. Sells dry in Amsterdam at 70 to 80 cents Dutch per one-half kilo. Best 'Java Brown' brings no more." (*Fairchild.*)

7679. VICIA HIRTA.

From Tessala, Algeria. Obtained by Mr. C. S. Scofield, April, 1901. Received October 21, 1901.

"Dried roots and tubercles from barley field at Tessala." (*Scofield.*)

7680. LATHYRUS SATIVUS.

From Oran, Algeria. Obtained by Mr. C. S. Scofield, April, 1901. Received October 21, 1901.

"Dried roots and tubercles of the 'Pois Carré' from salt-impregnated field near Oran. Much cultivated." (*Scofield.*)

7681. LUPINUS LUTEUS. **Yellow lupine.**

From Rouïba, Algeria. Obtained by Mr. C. S. Scofield, April 10, 1901, through Dr. L. Trabut. Received October 21, 1901.

"Dried roots and tubercles. Tubercle growth considered by Doctor Trabut as pathological and characteristic of *Lupinus luteus.*" (*Scofield.*)

7682. TRIFOLIUM ANGUSTIFOLIUM.

From Kabylia, Algeria. Obtained by Mr. C. S. Scofield, April, 1901. Received October 21, 1901.

"Roots and tubercles." (*Scofield.*)

7683. TRIFOLIUM PANORMITANUM.

From Rouïba, Algeria. Obtained by Mr. C. S. Scofield, April 10, 1901. Received October 21, 1901.

"Roots and tubercles." (*Scofield.*)

7684. AMYGDALUS COMMUNIS. **Almond.**

From Malaga, Spain. Received through Mr. D. G. Fairchild (No. 768, July 31, 1901), October 21, 1901.

"Supposed to be grafted plants of the famous Jordan almond. Upon arrival they proved to be only ungrafted seedlings, and not at all as per the contract made with the Spanish gardener." (*Fairchild.*)

7685. TRITICUM VULGARE. **Wheat.**

From Volo, Greece. Received through Mr. D. G. Fairchild (No. 581, March 23, 1901), September 28, 1901.

Diminum. "A variety of spring wheat called *Diminum*, meaning 'two months.' This is a semihard wheat used in Greece to plant after the failure of the winter wheat. It is not a two-month wheat, as its name implies, but matures in about three months, being planted the last of February and harvested the first of June. It is a light bearer, not very highly esteemed in Greece except for a catch crop, as it were, when winter wheat has failed. Sent by kindness of Mr. Ar. Tsakonas, of Athens, who can secure a large quantity in June, if desired." (*Fairchild.*)

7686. NICOTIANA TABACUM. **Tobacco.**

From Godwinsville, Ga. Received through Mr. H. J. Webber, October 28, 1901.

Asmyr. A Turkish cigarette tobacco. About 6 ounces of seed obtained by Mr. Webber through Mr. Robert Viewig, who imported the original seed from Turkey and grew it at Godwinsville, Ga. A crop was grown in 1899, from which the present seed was taken. Production usually very light, but product of superior quality.

7687. VITIS sp. **Grape.**

From southern Mexico. Received through Dr. J. N. Rose (No. 5349), October 28, 1901.

"A new grape, collected in southern Mexico this past season. It is a very remarkable species in that it dies down to the ground each year, apparently arising from the big deep-set tuber or tuberous root. It produces an immense growth of vines, the internodes often being $1\frac{1}{2}$ to 2 feet long. The fruit is borne in large clusters, sometimes nearly a foot long, individual grapes being about the size of the fox grape." (*Rose.*)

7688. HEERIA JALAPA.

From southern Mexico. Received through Dr. J. N. Rose (No. 6081), October 28, 1901.

"A very beautiful little trailing plant, well suited for baskets or for a carpet plan It belongs to a genus of plants much cultivated." (*Rose.*)

7689 to 7765.

From Algeria. Secured by Mr. C. S. Scofield, April to June, 1901. Receive at the Department in October, 1901. Turned over to the Office of Seed and Plant Introduction and Distribution, March 6, 1903.

"The following collection of leguminous plants was obtained by Mr. C. S. Scofield, in many cases through the kindness of Dr. L. Trabut, government botanist of Algeria. This collection represents the results of many years careful study by Doctor Trabut, who, with Doctor Battangier, published a flora of Algeria, in which some of these species were described for the first time. Doctor Trabut familiarized himself with the indigenous flora of Algeria by many expeditions to all parts of the colony, and some of the most promising species for culture were found to be very rare in a wild state, having been almost exterminated by herbivorous animals. The collection here enumerated was obtained for study and not for distribution. It is of the very greatest value and the various species are now being cultivated in a preliminary way by the Department of Agriculture to get information as to their adaptability to American conditions. As the life histories of the various species are worked out so that reasonable prognosis can be made as to the value of the plant for forage or for hay or green manure and some information can be given as to the regions where it is most likely to succeed, and where seed can be grown at a reasonable cost, then this species will be introduced into practical culture. It is likely that many plants of the greatest value for the future development of American agriculture, especially in the dry regions of the West, are included in this collection, which is the cream of what has been brought together by twenty years' study in North Africa, one of the richest regions of the world for leguminous plants suitable for field culture." (*Swingle.*)

7689. Lupinus termis. **White lupine.**

"This plant is one of the prominent lupines which has a place in general culture. It has a vigorous, upright growth." (*Scofield.*)

7690. Lupinus angustifolius.

"Specimen found near Fort National, where the soils are evidently of marble or limestone origin." (*Scofield.*)

7691. Ononis avellana.

"This plant is too coarse for use as a forage plant; it may have a place as a soil fixer or for green manuring." (*Scofield.*)

7692. Melilotus macrostachys.

"Specimen obtained from trial plats at the botanical station at Rouïba. This is one of the most promising plants of this genus. It is the only one not objectionable for forage purposes on account of its odor. It has a vigorous growth, often reaching 3½ feet in height, and has a large leafy surface." (*Scofield.*)

7693. Melilotus speciosa.

"Specimen from botanical garden at Rouïba. Several varieties of this species are under cultivation. It is a fairly good forage plant, being erect and producing an abundance of foliage." (*Scofield.*)

7694. Melilotus sulcata.

"Specimen from the garden of the school of medicine of Algiers. This plant is one of the least valuable of this genus. It has rather harsh stems and does not have an abundant leaf growth. It seeds very freely." (*Scofield.*)

7695. Medicago arborea.

7696. Cytisus proliferus.

"Specimen from botanical station at Rouïba. This plant has been introduced into Algeria from the Canary Islands. It is a shrub, often 12 to 14 feet high; very leafy and producing a large number of seed pods. The new shoots are often trimmed from the tree and used in the dryer countries." (*Scofield.*)

7697. Cytisus linifolius.

7698. Scorpiurus vermiculata.

"Specimen from botanical station at Rouïba, where it is both wild and cultivated. Plant has creeping habit, rather vigorous, but seldom more than 7 or 8 inches high; fruits very freely. There are large numbers of nodules. The plant is principally for sheep pasturing and for enriching the soil in nitrogen." (*Scofield.*)

7689 to 7765—Continued.

7699. TRIFOLIUM PANORMITANUM.

"Specimen found growing wild near botanical station at Rouïba. This plant closely resembles *T. alexandrinum* in general appearance and habit of growth. The lower tooth of the calyx is very much longer than the other four teeth, making identification simple. This plant is little or not at all cultivated as yet in Algeria, but was found to have gained possession of some wild hay fields near Tizi Ouzou. It is very vigorous and upright in habit of growth, often over 2 feet in height." (*Scofield.*)

7700. LOTUS TETRAGONOLOBUS. **Square pea.**

"Specimen found growing wild near botanical station at Rouïba. Plant has a reclining or creeping habit, seldom growing more than 10 or 12 inches in height; it is very vigorous, leaves of a very bright green color, flowers brilliant, rosy red. It fruits freely and bears large numbers of root nodules; has been introduced into America in an experimental way through the Department of Agriculture. It deserves further attention." (*Scofield.*)

7701. VICIA HIRTA.

"Specimen obtained from botanical station at Rouïba, where the plant grows wild. It has been tried in culture there, but has not done well enough to hold a place in competition with other species of the same genus. The stem is upright, but rather weak, sometimes reaching 2 feet in height." (*Scofield.*)

7702. VICIA FABA.

7703. VICIA FULGENS.

"From small plat growing at botanical station at Rouïba. This species is one of the very important ones introduced by Dr. Trabut into culture in Algeria. It seeds very freely and produces a large amount of foliage." (*Scofield.*)

7704. VICIA NARBONNENSIS.

"Specimen from botanical station at Rouïba, where it is both wild and cultivated. This plant is erect, very succulent, and robust. It is often sown with winter oats to be cut for green forage. It seeds freely and matures early in May. A close relative of this plant, possibly a variety of the species, is often confused with it, the other variety being entirely glabrous, while the type is decidedly hispid." (*Scofield.*)

7705. VICIA BENGALENSIS.

(This seed was never turned over to the Office of Seed and Plant Introduction and Distribution, as it was all used in experiments by the Office of Vegetable Pathological and Physiological Investigations.) (See No. 5576.)

7706. VICIA CALCARATA.

"Specimen found near botanical station at Rouïba, probably not from cultivated plats. This plant is commonly found along the Algerian coast, growing in hay fields and waste places. So far as known it is not at all cultivated." (*Scofield.*)

7707. VICIA SATIVA.

Vicia sativa de Toulouse.

7708. VICIA SATIVA.

Blanche.

7709. VICIA SATIVA.

Vicia sativa de Tunis.

7710. HEDYSARUM CORONARIUM.

"Specimen found growing in the garden of the School of Medicine of Algiers. Source of seed not known. Plant very robust; stems rather weak." (*Scofield.*)

7689 to 7765—Continued.

7711. Hedysarum pallidum.

"Specimen obtained from near Oran by Mr. D. G. Fairchild. It was nearly matured. The plant is mentioned by Battandier as being perennial, having large, ornamental flowers which are white and streaked with purple; the stem fleshy, decumbent; the leaves somewhat pubescent, not as long as the flower clusters; the leaflets 10 to 20 mm. by 5 to 10; flowers in oblong flower clusters; the pod spiny, 4 to 7 articulations with vertical spines at the ends; common in salty and gypsum soils." (*Scofield.*)

7712. Hedysarum mauritanicum.

"Specimen from garden of the School of Medicine of Algiers; seed probably brought by Doctor Trabut from somewhere in the province of Oran. The plant is somewhat less vigorous than *H. coronarium;* stems reclining; plant often more than 2 feet in height." (*Scofield.*)

7713. Trigonella foenum-graecum. **Fenugreek.**

"Specimen from the garden of the School of Medicine of Algiers. This plant has an upright habit of growth, reaching 18 to 20 inches in height; has a very important place in general culture as a soil enricher and a green forage crop. It is often planted in the autumn between rows of grapevine and turned under the following spring, when the cultivation of the grapes begins. When used as a green forage crop, or when the seed is used, the fat producing effect is very noticeable. The plant has a very strong odor when dried, and animals fed on the dry grain or green forage are strongly affected by the odor. Eggs from hens fed on this plant are uneatable. Meat of animals having access to it can not be used as human food; as a horse food it is of considerable importance. The Jewish women eat a meal prepared from the grain of this plant and become enormously fat. It is already used to some extent in Virginia, and very widely cultivated throughout Persia and India. About 1,000 tons of this seed are sold annually by one dealer, Schempft & Co., in the Liverpool Stock Exchange. This seed forms an essential quality of nearly all prepared stock foods. The root bears a large number of nodules." (*Scofield.*)

7714. Trigonella corniculata.

7715. Festuca fanara.

7716. Vicia lutea.

7717. Vicia sicula.

"Specimen found growing wild near the botanical station at Algiers. So far as known, the plant is not cultivated, but is found very commonly along the Algerian coast. The stems are rather small. It is of no present value as a forage plant." (*Scofield.*)

7718. Vicia egyptiana.
(Not in Kew Index.)

7719. Astragalus boeticus.

"Specimen found growing wild in the garden of the School of Medicine of Algiers. So far as known, this plant has not been introduced into culture. The stem is upright, though inclined to be weak, 20 to 24 inches high; rather straggling in habit of growth; plant deserves attention for improvement." (*Scofield.*)

7720. Anthyllis tetraphylla.

"Specimen found in the woods above Mustapha. This plant is said to be adapted for use in arid regions. It has a creeping habit of growth, fruits very freely, and produces a large number of root nodules." (*Scofield.*)

7721. Anthyllis vulneraria.

"Specimen found in the woods above Mustapha. This plant is not common in Algeria. It has a decidedly different habit of growth from that of *A. tetraphylla.* It grows very commonly along the bluffs above Hussien Dey." (*Scofield.*)

7689 to 7765—Continued.

7722. CERATONIA SILIQUA. **Carob.**

"Seeds of an improved variety from Blidah." (*Scofield.*)

7723. BRASSICA OLERACEA. **Cabbage.**

"A few seeds of a wild cabbage from Rouïba." (*Scofield.*)

7724. AEGILOPS OVATA.

From Bouli Bree (?)

7725. HEDYSARUM PALLIDUM.

From Oran.

7726. HIPPOCREPIS MULTISILIQUOSA.

"Specimen from the garden of the School of Medicine of Algiers. So far as known, this plant is not of great importance as a forage plant. It rarely reaches 20 inches in height, and has a straggling habit of growth. The stem is hard and produces few leaves." (*Scofield.*)

7727. HYMENOCARPUS CIRCINATA.

"This plant is described by Battandier as being velvety pubescent; stems about 1 foot in height, erect or blanched; lower leaves entire, obtuse, attenuated at the petiole, 4 to 6 cm. by 2; leaf pinnately divided with an odd leaf at the end; flowers 2 to 4 in a peduncle, umbel exceeding the leaf; pod velvety, flattened, orbiculate, sometimes spiny at the back, sometimes not, 15 mm. in diameter. This plant is extremely rare and difficult to find, but Doctor Trabut is of the opinion that it is of very great value as a forage plant, although it is not yet evident that he has experimental proof to support the belief. Secured by Mr. Fairchild from wild plants growing not far from Oran through assistance of Prof. M. Doumergue, of Oran." (*Scofield.*)

7728. LATHYRUS TINGITANUS.

"This grows from year to year in the garden of the School of Medicine of Algiers, producing a large number of flowers which are nearly or quite all fertile." (*Scofield.*)

7729. LATHYRUS NUMIDICUS.

"Specimen found growing in the garden of the School of Medicine of Algiers. The original seed was found by Doctor Trabut on the rocks near El Kantara. The plant has a creeping habit of growth; matures very early and produces a large number of well filled pods; grain rather small, round, dark gray." (*Scofield.*)

7730. LOTUS ORNITHOPODIOIDES.

"Specimen from the garden of the School of Medicine of Algiers. This plant is common in waste places near Algiers; has not very robust stems; some reclining; grows in rather poor soil; may reach a height of 15 inches. The roots bear numerous peculiarly globose nodules. The plant bears seed very freely." (*Scofield.*)

7731. LOTUS EDULIS.

"Specimen from garden of the School of Medicine of Algiers. This plant has a creeping habit of growth, and produces many pods which are fleshy, with comparatively small seeds, and the pods when green are sweet to the taste. Doctor Trabut thinks that this plant can be improved to be used as a vegetable." (*Scofield.*)

7732. LUPINUS LUTEUS.

7733. LUPINUS sp.

"A violet lupine of Spanish origin." (*Scofield.*)

7734. MEDICAGO DENTICULATA var. APICULATA.

7689 to 7765—Continued.

7735. Medicago echinus.

"Specimen found near Oued Smaar, Algeria. This plant is one of the important annual medicagos. It has an inclining or creeping habit of growth; is very vigorous, and produces a large number of fruits." (*Scofield.*)

7736. Medicago helix var. rigidula.

7737. Medicago denticulata.

7738. Medicago orbicularis.

7739. Medicago truncatula.

7740. Medicago turbinata.

"Specimen found in woods above Mustapha. This plant has an inclining, or sometimes upright, habit of growth. It is an annual, and deserves a trial." (*Scofield.*)

7741. Medicago truncatula.

7742. Medicago ciliaris.

7743. Medicago secundiflora.

"Obtained on Ain el Hadjar Plateau." (*Scofield.*)

7744. Melilotus macrocarpa.

"Specimen found near Hotel Continental, Mustapha. It is not particularly common. The plant is mentioned by Battandier as being upright, profusely branched, with bright green leaflets, very large, obovate, glaucous underneath; flowers about 6 mm. long, pale yellow, in loose bunches, exceeding the leaves. The fruit is almost as large as a small pea, ovoid, obtuse, or spherical; seeds, one or two, large, tuberculate. It is said that Arabs sometimes use these fruits as a spice, since they have the odor of the melilot in a very high degree." (*Scofield.*)

7745. Ononis sp.

7746. Onobrychis sp.

7747. Ononis avellana.

7748. Eriobotrya japonica. **Loquat.**

(Seed never turned over to the office of Seed and Plant Introduction and Distribution.)

7749. Genista sphaerocarpa.

7750. Scorpiurus vermiculata.

7751. Scorpiurus sulcata.

"Specimen found near Hotel Continental, Mustapha. This plant seems to be at present of very little value. Like *S. vermiculata* it never attains any considerable height, and is, if anything, less vigorous than *S. vermiculata*. It thrives, however, in very poor soil, and is a harmless weed." (*Scofield.*)

7752. Trigonella gladiata.

"Nearly related to *T. foenum-graecum*." (*Scofield.*)

7753. Trifolium angustifolium.

"Specimen from grounds of Danish consulate, Mustapha. This plant is closely allied to *T. incarnatum*. It does not thrive well in Algeria, seldom reaching more than 1 foot in height, and producing few, if any, branches. Some very vigorous specimens were seen near Oran and west of there, where it is more common than near Algiers. It is an annual, maturing early in May." (*Scofield.*)

7689 to 7765—Continued.

7754. Trifolium lappaceum.

"Specimen from the grounds of the Danish consulate, Mustapha. This plant is one of the less vigorous of the genus. It has a somewhat reclining habit of growth; stems seldom more than 12 to 15 inches long, rather soft and delicate. This plant is common in waste places in the vicinity of Algiers." (*Scofield.*)

7755. Trifolium glomeratum.

"Specimen found near Oued Smaar, Algeria. This plant has a creeping, or at least an inclining habit of growth; is found on roadsides or in waste places; is as yet of no particular importance as a forage plant." (*Scofield.*)

7756. Trifolium pallidum.

"Specimen from the garden of the School of Medicine of Algiers. This plant is common in the fields and waste places along the coast near Algiers; it resembles *T. pratense* somewhat in habit of growth, though it inclines to be smaller and less vigorous." (*Scofield.*)

7757. Trifolium panormitanum.

7758. Trifolium repens.

"Specimen from nursery of Mr. Labatut, of Tizi Ouzou. It grows to a height of 8 to 10 inches from its creeping stem; produces seed freely; leaves and stems bright green; very succulent." (*Scofield.*)

7759. Trifolium spumosum.

"Specimen found growing wild near botanical station at Rouïba. The plant is an annual, vigorous and succulent, with rather weak stems, sometimes reaching a height of 20 to 24 inches under favorable conditions, i. e., in soils of limestone origin; the root nodule development is very pronounced. So far as known this plant is not yet cultivated, but it has the appearance of being of great value should it be introduced and somewhat improved by selection. It seeds very freely, producing grains somewhat larger than *T. pratense*." (*Scofield.*)

7760. Trifolium stellatum.

"Specimen from near botanical station at Rouïba. This plant is very common along the roadsides and in the waste places of Algiers. It is not of great importance as a forage plant. It seldom reaches a height of more than ten inches, and the stem branches very little." (*Scofield.*)

7761. Trifolium tomentosum.

7762. Vicia sativa.

"Large seeded variety." (*Scofield.*)

7762a. Vicia sativa.

" A small seeded variety." (*Scofield.*)

7763. Vicia sativa.

"Specimen from the garden of the School of Medicine of Algiers. There are very many varieties of this species growing wild in Algiers." (*Scofield.*)

7764. Vicia hirta.

From Tessala, Algeria.

7765. Vicia sativa, var. macrocarpa.

"Specimen found in grounds of Danish consulate, Mustapha Superieure. This is doubtless the variety known as 'Macrocarpa,' but very little is definitely known about the varieties of *Vicia sativa*. They grow in very large numbers, and attempts to classify them have up to the present time been fruitless." (*Scofield.*)

7766 to 7768.

(Numbers not utilized.)

7769. Fragaria spp. **Strawberry.**

From Mexico. Received through Dr. J. N. Rose, October 30, 1901.

Seeds of cultivated varieties for plant-breeding purposes.

7770. Sabal eatonia.

From Miami, Fla. Received through Mr. H. C. Henricksen, October 26, 1901. Collected by Mr. P. H. Rolfs.

7771. Thrinax floridana.

From Miami, Fla. Received through Mr. H. C. Henricksen, October 26, 1901.

7772. Serenoa serrulata.

From Miami, Fla. Received through Mr. H. C. Henricksen, October 26, 1901.

7773. Inodes palmetto.

From Miami, Fla. Received through Mr. H. C. Henricksen, October 26, 1901.

7774. Coccothrinax garberi.

From Miami, Fla. Received through Mr. H. C. Henricksen, October 26, 1901.

7775. Coffea arabica. **Coffee.**

From Macassar, Celebes. Received through Messrs. Lathrop and Fairchild (No. 386a, February 11, 1900), October 30, 1901. Sent by K. Auer, United States Consular Agent.

Menado. (See No. 7678.)

7776. Punica granatum. **Pomegranate.**

From Oran, Algeria. Received through Messrs. D. G. Fairchild and C. S. Scofield (No. 738, June 14, 1901), October 30, 1901.

"Grafting wood of several varieties of pomegranates of Algerian origin from the *Orphelinat de Misserghin*, near Oran." (*Fairchild.*)

7777. Ceratonia siliqua. **Carob.**

From Oran, province of Oran, Algeria. Received through Messrs. D. G. Fairchild and C. S. Scofield (No. 737, June 14, 1901), October 30, 1901.

"Large fruited variety of carob, introduced into Algeria from Spain. Said to be monœcious, not requiring the presence of male trees to make it fruitful. Pods are large, thick, and of reported superior excellence." (*Fairchild.*)

7778 to 7780. Amygdalus communis. **Almond.**

From Alicante, Spain. Received October 30, 1901.

7778.

Marcona. Nuts of this Spanish variety of almond.

7779.

Pastaneta. Nuts of this Spanish variety of almond.

7780.

Costereta. Nuts of this Spanish variety of almond.

7781. Capsicum annuum. **Red pepper.**

From Los Angeles, Cal. Received October 26, 1901, from Mr. Elmer Stearns.

"From seed in mixed spices from Japan." (*Stearns.*)

7782. Capsicum annuum. **Red pepper.**

From Los Angeles, Cal. Received October 26, 1901, through Mr. Elmer Stearns.

"Originally from Juarez, Mexico. Forms a bush nearly 4 feet high, with peppers erect instead of hanging." (*Stearns.*)

7783. Capsicum annuum. **Red pepper.**

From Los Angeles, Cal. Received October 26, 1901, through Mr. Elmer Stearns.

"Originally from Juarez, Mexico." (*Stearns.*)

7784. Hedysarum coronarium. **Sulla.**

From Malta. Received through Mr. D. G. Fairchild (No. 688, May 22, 1901), July 23, 1901.

Gozzo. "An early ripening variety of sulla from the little island of Gozzo, near Malta. This is said to be superior to the kind grown on Malta in seasons when spring rains are scanty, as it matures properly, while the Malta variety fails to ripen well. In seasons of abundant spring rainfall it is not economical, because it matures too soon. The seed in the seed pod is used in Malta, and it was not possible to get cleaned or decorticated seed. According to the literature, sulla should be planted in deep soil. This variety forms the principal fodder and soiling crop of an island where soil is not much over 6 to 8 inches deep on a bed of calcareous rock. It is sown here in July and August on the wheat or barley stubble and allowed to 'scorch' in the burning sun until the September or October rains begin to mature it, as they say. (The use of a seed scratcher might make quick germination possible and probably largely increase the stand.) It is cut here only when in full bloom, for, if left to stand, the leaves fall. The yield per acre is unusual. Some growers report 40 to 90 tons of green fodder, but no definite information on this point was obtained. It is the great green cover crop of Malta, and a rotation of wheat or oats and sulla is very common here. Everywhere the fields are filled with big stacks of the bundles of this plant. In some countries the seed is immersed for five minutes in hot water to hasten germination. The fleshy roots are often dug by peasants and fed to the hogs or horses. They are full of starch and sugar. The root tubercles are rather small and delicate, but very numerous. Attempts to cultivate the specific germ of these tubercles are being made from dried roots sent to Dr. George T. Moore from Malta." (*Fairchild.*)

7785. Triticum durum. **Wheat.**

From Vesoul-Benian, Algeria. Received through Messrs. D. G. Fairchild and C. S. Scofield (No. 723, June 20, 1901), November 6, 1901.

Pelissier. "This wheat, which is one of the best varieties of macaroni wheats grown in Algeria, is said to have been originated by selection from native Algerian durum wheats by a Mr. Pelissier, at Pont de l'Isser, a small town in western Oran. From there it was introduced into the western part of the province of Algiers. Mr. Paul Chalvin, of Vesoul-Benian, received a small quantity of seed from Doctor Trabut, botanist of the Government of Algeria, and by a rough en masse selection he has kept it almost pure. The variety under the name *Pelissier* is better known in the province of Algiers than in that of Oran, where it is said to have originated; in fact, we found no one growing it, even in Mr. Pelissier's neighborhood. Mr. Chalvin, from whom this seed was bought, sells his whole crop for seed purposes, and has practiced for four years a selection of the best ears. These are collected by his Arab foreman and thrashed by hand. About 200 kilos of this selected grain are sown, and the process is repeated every year. Last year this selection was not done. This wheat sent is about four generations from such selection. Mr. Chalvin believes the field from which it was taken will produce about 45 bushels per acre. At the Paris Exposition Mr. Chalvin took a gold medal on a sheaf of this wheat. Owing to its hardiness, vigorous growth, and large yield, this wheat is gradually replacing all other sorts in the vicinity of Vesoul-Benian, and at Doctor Trabut's botanical experiment station at Rouïba, Algiers, it has ranked among the best in yielding capacity and resistance to rust. The climate of Vesoul-Benian (altitude 700 meters) is a warm one, −25° and +23° F. being the usual minimums in winter. The snows, sometimes a foot or more deep, are of very short duration. The mean yield of this variety was about 16 to 22 bushels per acre on stiff clay soil without hardpan. It is on this stiff soil that the variety seems to do best. The resistance to drought shown by this sort is evidenced by the fact that it has proved a success in the Chelif Valley, where as early as the beginning of June the thermometer rises to 107° F., and droughts of long duration are said to occur in the spring. In Algeria the wheat is planted in November and harvested in June, but it is worth while testing it in America as a spring wheat in the northern States. The only noticeable weeds in the fields from which this seed was bought were wild anise, a wild oat (*Avena sterilis*), and a large flowered carrot, none being of a serious character except the wild anise, which ripens about the same time with the wheat. It is, however, a light seeded plant, and its seeds are easily blown out by the fanning mill." (*Fairchild and Scofield.*)

7786. TRITICUM VULGARE. **Wheat.**

From Kharkof, Russia. Received November 9, 1901, through Dr. A. Boenicke, president of the Kharkof Agricultural Society.

Kharkof. (Same as No. 7467.)

7787. TRITICUM VULGARE. **Wheat.**

From Rostov-on-Don, Russia. Received through Hon. W. R. Martin, acting United States consular agent, November 9, 1901.

Beloglina. A variety of hard winter wheat from Byelaya Glinskaya station, Don Territory. (See Nos. 6012 and 6013.)

7788. HEDYSARUM CORONARIUM ALBIDUM. **Sulla.**

From Setif, Province of Constantine, Algeria. Received through Messrs. D. G. Fairchild and C. S. Scofield (No. 735c), November 11, 1901.

"This variety, which differs from the type of the species by having white flowers, is found by Mr. Ryf (see No. 7586) to be much longer lived and in general preferable to the ordinary *H. coronarium* of the region. The seeds, however, are very slow in germinating and should be put through some sort of a seed-scratching device before planting." (*Fairchild and Scofield.*)

7789. HEDYSARUM NAUDINIANUM.

From Setif, Province of Constantine, Algeria. Received through Messrs. D. G. Fairchild and C. S. Scofield (No. 735b), November 11, 1901.

"This is a very hardy, narrow leaved, bushy variety, indigenous to the vicinity of Setif. It has been recently introduced into cultivation by Mr. Ryf (see No. 7586), who is trying it under the same cultural methods that he uses with his new strain of alfalfa. His experiments are not yet completed, but he has reasons to hope that this species will prove of value, especially for dry and rather poor soils." (*Fairchild and Scofield.*)

7790. HEDYSARUM CORONARIUM. **Sulla.**

From Setif, Province of Constantine, Algeria. Received through Messrs. D. G. Fairchild and C. S. Scofield, November 11, 1901.

Red Flowered. "This is the ordinary type which is widely grown as a forage or soiling crop in Algeria. It is perennial and yields abundant crops under favorable conditions. It is widely used in all countries bordering on the western Mediterranean. As a hay crop, its greatest weakness is that its leaves fall easily when they become dry." (*Fairchild and Scofield.*)

7791. MELILOTUS sp. **Melilot.**

From China. Received from Dr. C. Sprenger, Vomero, near Naples, Italy, November 1, 1901.

7792. TRITICUM DURUM. **Wheat.**

From Setif, Constantine Province, Algeria. Received through Messrs. D. G. Fairchild and C. S. Scofield (No. 724, June 20, 1901), November 6, 1901.

Mahmoudi. "This is quite similar to a well-known Algerian variety called 'Nab-el-bel.' It is one of the most highly valued wheats for the macaroni trade which Setif furnishes. The latter locality is probably the largest primary market for macaroni wheats in Algeria. The seed obtained is from that grown by the Arabs in the vicinity of Setif and the purity of type can not be guaranteed. This quantity is secured through the kindness of Mr. G. Ryf, manager for the *Société Genevoise de Sétif*. In the country of its origin, this wheat is sown in November or December and ripens late in June or early in July. It may be worth while trying it, however, in the spring-wheat regions of America, where it would be classed as one of the so-called 'goose' wheats." (*Fairchild and Scofield.*)

7793. TRITICUM DURUM. **Wheat.**

From Setif, Constantine Province, Algeria. Received through Messrs. D. G. Fairchild and C. S. Scofield (No. 725, June 20, 1901), November 6, 1901.

Mohamed ben Bachir. "This variety of wheat is one of the prominent sorts grown by both Arabs and French farmers on the high plateau of the Province of Constantine. It is one of the sorts highly prized by manufacturers of macaroni, although its name has not won for itself a reputation in the trade. It is one of the several valuable sorts commonly cultivated in this justly celebrated wheat region. The saying is that this wheat was originally brought from Mecca by the pilgrim whose name it bears. In botanical characters it is much like the *Pelissier* variety (No. 7785), and it is possible that the *Pelissier* was obtained from this stock. This seed was purchased of Mr. G. Ryf, of Setif, manager of the Geneva Company, and one of the best cultivators in the country." (*Fairchild and Scofield.*)

7794. TRITICUM DURUM. **Wheat.**

From Setif, Constantine Province, Algeria. Received through Messrs. D. G. Fairchild and C. S. Scofield (No. 726, June 20, 1901), November 6, 1901.

Kahla. "This is one of the wheats commonly grown by Arabs throughout Algeria. As the name *Kahla* signifies, this is a black-chaffed sort. It is generally considered to be one of the best of the Algerian wheats for adaptability to a wide variety of adverse conditions. When such are favorable it produces grain of excellent quality for macaroni manufacture. Under certain favorable climatic conditions the chaff loses color somewhat, but under native culture on the gravelly hills of Algeria or in the semiarid plains the purple-black of the chaff is a striking feature. This seed is furnished the Department by Mr. G. Ryf, manager of the Geneva Society of Setif. Commonly planted in November or December and harvested in June or July." (*Fairchild and Scofield.*)

7795. TRITICUM DURUM. **Wheat.**

From Setif, Constantine Province, Algeria. Received through Messrs. D. G. Fairchild and C. S. Scofield (No. 727, June 20, 1901), November 6, 1901.

Richi. "This variety is one of the best known from the Setif region, which latter is perhaps the most important wheat-growing center of Algeria. It is very highly prized for its good qualities as a macaroni-making wheat. The seed introduced was grown by Arabs in the vicinity of Setif, and it may be mixed, but a little careful selection to prominent type should give a good stock of pure seed. This wheat is a vigorous grower, often succeeding fairly well on even very poor soil. As to quality for macaroni making, it ranks very high. It is usually sown in December or January and harvested in June or July, but might be worthy of trial in the spring-wheat region of the United States. Seed was obtained through Mr. G. Ryf, of Setif. The region of Setif is on the high Algerian plateau, 3,500 feet above sea level. The winters there are more severe than in many parts of Algeria, the temperature frequently dropping to zero and snow being not infrequent." (*Fairchild and Scofield.*)

7796. HORDEUM TETRASTICHUM. **Barley.**

From Setif, Constantine Province, Algeria. Received through Messrs. D. G. Fairchild and C. S. Scofield (No. 728, June 20, 1901), November 6, 1901.

Tetcherit. "The barleys of Algeria are nearly all four-rowed or six-rowed varieties and have, as do most barleys grown in hot climates, thick glumes. A cross section shows them to be remarkably mealy, and we were told they are exported into Antwerp and Dunkirk, France, for beer-making purposes. The Belgian beer is not noted for its fine quality, and from the appearance of the grain I do not believe it will prove as good a brewing barley as many American sorts. The fact, however, that it is grown in such a warm climate and has nevertheless a certain renommé as a brewing barley, entitles it to a preliminary trial. The types will be found more or less mixed, as no process of selection has been practiced. Resistance to drought will be found one of its primary characteristics. Purchased of Mr. G. Ryf, manager of the Geneva Company of Setif. This latter place is on the high plateau, 3,500 feet above the sea, where the thermometer falls to about zero and where snows of considerable depth sometimes occur. This variety will be found to have much of the 'wild' character objectionable to barley breeders, but may show qualities of hardiness in spring droughts which will be of value. It should be tested in the Southwest and in California." (*Fairchild and Scofield.*)

7797. ANDROPOGON SORGHUM. **Sorghum.**

From El Outaya, Algeria. Received through Mr. C. S. Scofield, November 14, 1901. Obtained June 16, 1901.

Beshna. "White sorghum. Sample from El Outaya in the edge of the Sahara Desert, where it is used as a summer growing soiling crop. Seed probably came from Kabylie, where this crop is very generally grown. The seed is sometimes used as human food." (*Scofield.*)

7798. PHOENIX DACTYLIFERA. **Date.**

From Paris, France. Received through Mr. C. S. Scofield. November 13, 1901.

Deglet noor, probably. Seeds of dates bought in Paris.

7799 to 7847.

From Erfurt, Germany. Received through Haage & Schmidt, nurserymen, November 4, 1901. The nomenclature is, in the main, that of the seedsmen.

A collection of plants as follows:

7799. CALADIUM ADAMANTINUM.

7800. CALADIUM ALBANENSE.

7801. CALADIUM ASSUNGUY.

7802. CALADIUM BILANTRA.

7803. CALADIUM CACAPAVA.

7804. CALADIUM.

Comte de Germiny.

7805. CALADIUM.

Duchesse de Mortemarte.

7806. CALADIUM.

Ibis Rose.

7807. CALADIUM.

L'Insolite.

7808. CALADIUM.

Marambeia.

7809. CALADIUM.

Mary Freeman.

7810. CALADIUM.

Ouro Fino.

7811. CALADIUM.

Rio de Janeiro.

7812. CALADIUM VENOSUM.

7813. RICHARDIA ELLIOTTIANA.

7814. RICHARDIA NELSONI.

7815. RICHARDIA PENTLANDI.

7816. EPIPREMNUM MIRABILE.

7817. PHYLLOSTACHYS AUREA.

7818. BAMBUSA AUREO-STRIATA.

7819. ARUNDINARIA JAPONICA.

7820. PHYLLOSTACHYS MITIS.

7821. BAMBUSA DISTICHA.

7822. PHYLLOSTACHYS NIGRA.

7823. ARUNDINARIA SIMONI.

7799 to 7847—Continued.

7824. Phyllostachys violascens.

7825. Desfontainea spinosa.

7826. Sparrmannia africana.

7827. Sparrmannia africana flo. pl.

7828. Holbaellia latifolia.

7829. Testudinaria elphantipes.

7830. Cascarilla muzonensis(?)

7831. Cedrela odorata.

7832. Dorstenia contrajerva.

7833. Dracaena draco.

7834. Malpighia urens.

7835. Myristica Horsfieldii.

7836. Helleborus hybridus.

7837. Helleborus niger.

7838. Hepatica triloba fl. caerulea pl.

7839. (Number not utilized.)

7840. Hepatica triloba fl. rubra pl.

7841. Leucanthemum uliginosum.

7842. Viola odorata.

Princess Beatrix.

7843. Viola odorata.

Reine des Violettes.

7844. Viola odorata, rossica.

7845. Viola odorata.

Victoria Regina.

7846. Viola odorata.

Belle de Châtenay.

7847. Viola odorata.

Mad. Millet.

7848 to 7859. Lilium. **Lily.**

From Yokohama, Japan. Received from Suzuki & Iida, American agents of The Yokohama Nursery Company, November 6, 1901.

A collection of lilies as follows:

7848. Lilium auratum rubra vittatum.

7849. Lilium auratum platyphyllum.

7850. Lilium auratum wittei.

7851. Lilium maculatum.

7852. Lilium browni.

7853. Lilium maximowiczii.

7854. Lilium longiflorum variegatum.

7855. Lilium speciosum.

7856. Lilium japonicum.

7857. Lilium elegans.

Alice Wilson.

7858. Lilium elegans semi pleno.

7859. Lilium rubellum.

7860 to 7901.

From near Berlin, Germany. Received from Mr. L. Spath, November 14, 1901.

A collection of plants as follows (nomenclature of Mr. Spath retained):

7860. Actinidia arguta.

7861. Amygdalus davidiana.

7862. Amygdalus davidiana fl. alba pl.

7863. Amygdalus persica dianthiflora pl.

7864. Aymgdalus persica fl. pl.

7865. Amygdalus persica fol. pur.

7860 to 7901—Continued.

7866. AMYGDALUS PERSICA.
Kaiser Friedrich III.

7867. AMYGDALUS PERSICA.
Klara Mayer.

7868. AMYGDALUS PERSICA PYRAMIDALIS.

7869. BERBERIS ILICIFOLIA.

7870. BERBERIS STENOPHYLLA.

7871. BERBERIS THUNBERGII MINOR.

7872. BUXUS HANDSWORTHIENSIS.

7873. CERATOSTIGMA PLUMBAGINOIDES.

7874. CERCIDIPHYLLUM JAPONICUM.

7875. CLEMATIS sp.
André Leroy.

7876. CLEMATIS sp.
Barillet Deschamps.

7877. CLEMATIS sp.
Belisaire.

7878. CLEMATIS sp.
Belle of Woking.

7879. CLEMATIS sp.
Blue Gem.

7880. CLEMATIS sp.
Claude de Lorraine.

7881. CLEMATIS sp.
Duchess of Edinburgh.

7882. CLEMATIS sp.
Edith Jackmann.

7883. CLEMATIS sp.
Fairy Queen.

7884. CLEMATIS sp.
Jackmani.

7885. CLEMATIS sp.
Jackmani alba.

7886. CLEMATIS sp.
La Gaule.

7887. CLEMATIS sp. LANUGINOSA.
Marie Defosse.

7888. CLEMATIS sp.
Mrs. Geo. Jackman.

7889. CLEMATIS sp.
Prince of Wales.

7890. CLEMATIS sp.
Lawsoniana.

7891. CLEMATIS sp.
Star of India.

7892. CLEMATIS sp.
Elsa Spath.

7893. CLEMATIS sp. RUBELLA.

7894. CLEMATIS sp.
Madam Granger.

7895. CLEMATIS sp.
Princess Mary.

7896. CLEMATIS sp. VELUTINA PURPUREA.

7897. LONICERA CAPRIFOLÍUM.

7898. LONICERA HUMILIS.

7899. PARROTIA PERSICA.

7900. PRUNUS PANICULATA fl. ros. pl.

7901. RIBES SANGUINEUM.

7902 to 7907. THEA VIRIDIS. **Tea.**

From "Pinehurst," near Summerville, S. C. Received through Dr. Charles U. Shepard, special agent in charge of tea culture investigations, United States Department of Agriculture, November 18, 1901.

American grown tea seed as follows:

7902.

Japanese. Very hardy.

7903.

Amoy. A very hardy Chinese variety.

7904.

Darjeeling. Tender, but very fine.

7905.

Kangra. Hardy, fragrant, and dwarf.

7906.

Assam Hybrid. Good and reliable.

7907.

Chinese Dragon's Pool. Very good, but probably the plants are short lived.

7908. BETA VULGARIS. **Beet.**

From Eisleben, Saxony. Presented by Mr. Franz Jodl, of Prague, Bavaria. Received November 14, 1901.

Verbesserte Kleinwanzleben. This seed was grown by W. Ramdohr, on the Wimmelburg domain, Saxony.

7909 to 7941a. CHRYSANTHEMUM spp.

From Paris, France. Received from Vilmorin-Andrieux & Co., November 20, 1901.

A collection of 34 varieties of large-flowering chrysanthemums, planted in the Department greenhouses.

7909.

Alcor.

7910.

Alcyone.

7911.

Altair.

7912.

Antares.

7913.

Bellatrix.

7914.

Fatinte.

7915.

Henry.

7916.

Megrez.

7917.

Orves.

7918.

Perfection Rose.

7919.

Perle.

7920.

Princesse Galitzine.

7921.

Mrs. A. Barrest.

7922.

Miss Ida Barwood.

7923.

Mrs. Ch. Birch.

7924.

Alice F. Carey.

7925.

Miss Lucy Chesseman.

7926.

Col. Baden-Powell.

7909 to 7941a—Continued.

7927.
M. Hugh Crawford.

7928.
Madeline Davis.

7929.
Lady Janet Clarke.

7930.
Lord Cromer.

7931.
Major Mathew.

7932.
Meredith.

7933.
Mermaid.

7934.
Florence Molyneux.

7935.
James Molyneux.

7936.
Onion.

7937.
Ralph Hatton.

7938.
Silver Queen.

7939.
Souvenir de Marchioness of Salisbury.

7940.
J. R. Upton.

7941.
Von Andre.

7941a.
Henry Weeks.

7942 to 7945.

From Paris, France. Received through Vilmorin-Andrieux & Co., November 22, 1901.

Seeds of leguminous plants as follows (nomenclature of seed firm retained):

7942. VICIA FABA EQUINA. **Horse bean.**
Féverole d'hiver.

7943. VICIA FABA EQUINA. **Horse bean.**
Féverole de Loraine.

7944. AVENA SATIVA. **Oat.**
Belgian Winter.

7945. MEDICAGO MEDIA. **Sand lucern.**
Luzerne rustique.

7946. ERIOBOTRYA JAPONICA. **Loquat.**

From Vomero, Naples, Italy. Received through Dr. C. Sprenger, November 27, 1901.

A seedless or one-seeded variety originated by Doctor Sprenger.

7947 and 7948.

(Numbers not utilized.)

7949. PISTACIA VERA. **Pistache.**

From Aintab, Turkey in Asia. Received through Rev. A. Fuller, November 15, 1901.

7950. PISTACIA VERA × PALAESTINA. **Butum.**

From Aintab, Turkey in Asia. Received through Rev. A. Fuller, November 15, 1901.

7951. PISTACIA MUTICA. **Menengech.**

From Aintab, Turkey in Asia. Received through Rev. A. Fuller, November 15, 1901.

7952. MEDICAGO GETULA.

From Mustapha, Algeria. Received through Dr. L. Trabut, Government Botanist, November 22, 1901.

7953. JUGLANS CINEREA. **Butternut.**

From Biltmore, N. C. Received through Dr. C. A. Schenck, November 25, 1901.

7954. JUGLANS NIGRA. **Black walnut.**

From Biltmore, N. C. Received through Dr. C. A. Schenck, November 25, 1901.

7955 and 7956. ABERIA CAFFRA. **Kei apple.**

From Cape Town, South Africa. Presented by Prof. Peter MacOwan, botanist and horticulturist, department of agriculture of Cape Colony. Received November 26, 1901.

7955. Seeds gathered in June, 1901.

7956. Seeds gathered October 30, 1901.

7957 to 7961.

From Paris, France. Received through Vilmorin-Andrieux & Co., November 30, 1901.

A collection of asparagus seed as follows:

7957. ASPARAGUS OFFICINALIS.

Violette de Hollande.

7958. ASPARAGUS OFFICINALIS.

Blanche d'Allemagne.

7959. ASPARAGUS OFFICINALIS.

Tardive d'Argenteuil.

7960. ASPARAGUS VERTICILLATUS.

Grimpante.

7961. ASPARAGUS SPRENGERI.

7962 to 7968.

From Mexico. Received through Dr. J. N. Rose (Nos. 345 to 351), U. S. National Museum, November 26, 1901.

A collection of Mexican seeds and plants as follows:

7962.

"Unknown variety of shrubby plant. Elevation nearly 6,000 feet. Flowers yellow and fine. Plant given for identification." (*Rose.*) (No. 345.)

7963. CHRYSANTHEMUM sp.

"Flowers white and very floriferous. Worthy of introduction." (*Rose.*) (No. 346.)

7964. COSMOS sp.

"Includes three or four varieties of *Cosmos* and seeds of two new plants, one of the latter tuberous rooted and valuable." (*Rose.*) (No. 347.)

7962 to 7968—Continued.

7965.

"New tuberous-rooted plant." (*Rose.*) (No. 348.)

7966. DAHLIA SILVESTRE.

"Red and yellow; single. I also send tubers." (*Rose.*) (No. 349.)

7967. DAHLIA sp.

"*Red.*" (*Rose.*) (No. 350.)

7968. DAHLIA sp.

"*Yellow.*" (*Rose.*) (No. 351.)

7969 and 7970. HORDEUM VULGARE. **Barley.**

From Smyrna, Asia Minor. Received through Mr. George C. Roeding, Fresno, Cal., from Mr. B. J. Agadjanian, of Smyrna, November 15, 1901.

7969. *White.*

7970. *Black.*

7971. CRESCENTIA ALATA.

From Jalisco, Mexico. Received through Mr. Elmer Stearns, Los Angeles, Cal., November 15, 1901.

7972. CUCUMIS MELO. **Winter muskmelon.**

From Zante, Greece. Presented by Count N. Salamo Lunzi through Mr. D. G. Fairchild. Received September 25, 1901.

Green. See No. 6363.

7973. LESPEDEZA BICOLOR. **Bush clover.**

From Japan. July, 1901. Presented by John D. Jones, esq., Augusta, Ga., through Dr. B. T. Galloway.

Said to be a fine fodder plant.

7974. CANAVALIA ENSIFORMIS. **Knife bean.**

From Japan. Received through Dr. B. T. Galloway, July, 1901.

7975 to 7984.

From Erfurt, Germany. Received through Haage & Schmidt, December 6, 1901.

A collection of seeds obtained for experimental work on rust diseases, being conducted by Mr. John L. Sheldon, of the University of Nebraska:

7975. ASPARAGUS OFFICINALIS.

Schneekopf.

7976. ASPARAGUS OFFICINALIS.

Ruhm von Braumschweig.

7977. ASPARAGUS OFFICINALIS.

Erfurt Giant.

7978. ASPARAGUS OFFICINALIS.

Burgunder Riesen.

7979. DIANTHUS ALPINUS.

7980. DIANTHUS ARENARIUS (?)

7981. DIANTHUS ARMERIA (?)

7982. DIANTHUS CHINENSIS.

7983. DIANTHUS CHINENSIS.

7984. DIANTHUS CHINENSIS.

7985 to 7989. AMYGDALUS COMMUNIS. **Almond.**

From Alicante, Spain. Received through Mr. D. G. Fairchild (Nos. 740–765), December 7, 1901.

A collection of young almond trees budded on Myrobolan stocks by M. Georges Boucher, Paris, France, with buds secured in Spain by Mr. Fairchild, as follows:

7985.

Mollar. (*Fairchild.* No. 740, July 19, 1901.)

7986.

Planeta. (*Fairchild.* No. 741, July 19, 1901.)

7987.

Castillet. (*Fairchild.* No. 745, July 20, 1901.)

7988.

Pastaneta. (*Fairchild.* No. 755a, July 19, 1901.)

7989.

Jordan. (*Fairchild.* No. 765, July 30, 1901.)

7990 and 7991. HICORIA PECAN. **Pecan.**

From Morgan City, La. Received through Mr. B. M. Young, December 7, 1901.

7990.

Frotscher. "Very large, soft shelled." (*Young.*)

7991.

Stuart. "Very large, soft shelled." (*Young.*)

7992. HORDEUM DISTICHUM. **Barley.**

From Munich, Bavaria. Received through Mr. D. G. Fairchild (No. 467, November 10, 1900), January, 1901.

"A variety of barley grown by Mich. Hartmann, of Mainstockheim, Bavaria, which took a prize at the Munich Barley and Hop Exposition, 1900." (*Fairchild.*) (See Nos. 5788–5792.)

7993 to 8071. VITIS VINIFERA. **Grape.**

From Thomery, France. Received through Etienne Salomon & Sons, December 11, 1901.

A collection of grafted grapevines, as follows:

7993. ADMIRAL DE COURTILLER on RIPARIA RUPESTRIS, 3309.

7994. AGOSTENGA on RIPARIA RUPESTRIS, 3306.

7995. BICANE on RIPARIA GLOIRE.

7996. BLACK ALICANTE on RIPARIA RUPESTRIS, 3306.

7997. BLANC D'AMBRE on RIPARIA RUPESTRIS, 3306.

7998. CHASSELAS DORÉ on RIPARIA GLOIRE.

7999. CHASSELAS CIOTAT on RIPARIA RUPESTRIS, 3306.

8000. CHASSELAS BOUCHES DU RHONE on RIPARIA RUPESTRIS, 3309.

8001. CHASSELAS BESSON on RIPARIA RUPESTRIS, 3306.

8002. CHASSELAS NEGROPONT on RIPARIA GLOIRE.

7993 to 8071—Continued.

8003. Chasselas duhamel on Aramon rupestris, G. No. 1.

8004. Chasselas musque vrai on Rupestris du lot.

8005. Chasselas napoleon on Riparia rupestris, 3306.

8006. Chasselas rose royal on Aramon rupestris, G. No. 1.

8007. Chasselas tokay des jardins on Aramon rupestris, G. No. 1.

8008. Chasselas vibert on Riparia rupestris, 3306.

8009. Chasselas vibert on Aramon rupestris, G. No. 1.

8010. Cinsault on Riparia gloire.

8011. Clairette gros grains on Riparia rupestris, 3306.

8012. Clairette mazel on Riparia gloire.

8013. Clairette mazel on Aramon rupestris, G. No. 1.

8014. Clairette musque talabot on Aramon rupestris, G. No. 1.

8015. Cornichon blanc on Riparia gloire.

8016. Cornichon violet on Riparia gloire.

8017. Cornichon violet on Aramon rupestris, G. No. 1.

8018. Foster's White Seedling on Riparia gloire.

8019. Frankenthal hatif on Riparia rupestris, 101–114.

8020. Gen. de la Marmora on Riparia rupestris, 3306.

8021. Golden champion on Aramon rupestris, G. No. 1.

8022. Gradiska on Riparia gloire.

8023. Joannenc charnu on Aramon rupestris, G. No. 1.

8024. Le commandeur on Riparia rupestris, 3306

8025. Madeleine blanche on Riparia rupestris, 3306.

8026. Madeleine blanche de jacques on Aramon rupestris, G. No. 1.

8027. Madeleine royale on Riparia rupestris, 3306.

8028. Madeleine rose on Riparia gloire.

8029. Malaga blanc on Rupestris du lot.

8030. Mamelon on Riparia rupestris, 3306.

8031. Meslier hatif on Aramon rupestris, G. No. 1.

8032. Morillon bicolor on Riparia rupestris, 3306.

8033. Muscat albarians on Rupestris du lot.

8034. Muscat bifere on Aramon rupestris, G. No. 1.

8035. Muscat bifere on Riparia rupestris, 3306.

8036. Muscat de Hamburgh on Rupestris du lot.

7993 to 8071—Continued.

8037. Muscat rouge de madere on Riparia rupestris, 3306.

8038. Petite st. jean on Riparia gloire.

8039. Pis de chevre des alpes on Riparia rupestris, 3306.

8040. Precoçe de kientzheim on Riparia gloire.

8041. Rosaki on Riparia rupestris, 3306.

8042. Raisin Boisselot on Riparia rupestris, 3306.

8043. Roussanne on Riparia rupestris, 3306.

8044. Saint Antonio on Riparia gloire.

8045. Satine Jaune on Riparia rupestris, 3306.

8046. Servan blanc on Riparia rupestris, 3306.

8047. Sicilien on Riparia, G. No. 1.

8048. Souvenir du Congress on Riparia rupestris, 3306.

8049. Sucre de Marseille on Riparia rupestris, 3306.

8050. Sultanieh Rose on Riparia rupestris, 3306.

8051. Teneron Vaucluse on Rupestris du Lot.

8052. Tokay Angevin on Riparia gloire.

8053. Trentham Black on Riparia rupestris, 3306.

8054. Chasselas vibert on Aramon rupestris, G. No. 1.

8055. Burgrave de Hongrie on Rupestris du Lot.

8056. Pis de Chevre noir on Rupestris du Lot.

8057. Verdelho de Madere on Riparia gloire.

8058. Sultanina on Rupestris du Lot.

8059. Leani Zolo on Rupestris du Lot.

8060. President Cardenaux on Rupestris du Lot.

8061. Sauvignon blanc on Rupestris du Lot.

8062. Tsien tsien on Mourvedre Rupestris, 202.

8063. Ulliade blanche on Rupestris du Lot.

8064. Chasselas Bulhery on Riparia gloire.

8065. Precoçe de Kientzheim on Riparia gloire.

8066. Seibel No. 1, American hybrid.

8067. Seibel No. 2, American hybrid.

8068. Bourrisquou 3907, American hybrid.

8069. Aramon rupestris G. No. 1, American Lot.

7993 to 8071—Continued.

8070. Olivier de Serres or Aramon rupestris, G. No. 1.

8071. Olivette de Cadenet or Riparia rupestris, 3306.

(By "American Lot" is understood in France the stock on which the European Lot is grafted.)

8072 to 8121. Paeonia moutan. **Tree peony.**

From Yokohama, Japan. Received through the Yokohama Nursery Company, November 23, 1901.

A collection of grafted plants as follows:

8072.
Yoyo-no-homare.

8073.
Yaso-okino.

8074.
Kamadafuji.

8075.
Kumoi-dsuru.

8076.
Gioku-sho-kaku.

8077.
Adumu-saki.

8078.
Nishiki-gawa.

8079.
(Number not utilized.)

8080.
Kumoma-no-tsuki.

8081.
Fuji-araski.

8082.
Adzuma-nishiki.

8083.
Ginfukurin.

8084.
Michi-shiba.

8085.
Renkaku.

8086.
Kagurajima.

8087.
Kumo-no-nishiki.

8088.
Anyoji.

8089.
Iwato-Kagami.

8090.
Yuki-arashi.

8091.
Kokirin.

8092.
Akusho-jishi.

8093.
Hakubanrya.

8094.
Hakugan.

8095.
Hinode-dsuru.

8096.
Tokiwadsu.

8097.
Asahi-minato.

8098.
Ruriban.

8099.
Kame-asobi.

8100.
Saishoji.

8101.
Konron-koku.

8072 to 8121—Continued.

8102.
Akashi-gata.

8103.
Bunbudo.

8104.
Nishikishima.

8105.
Adzumakagami.

8106.
Fuji-no-mine.

8107.
Hana-tachabana.

8108.
Shishi-gashiri.

8109.
Shi-un-ryu.

8110.
Gabisan.

8111.
Shoki-kaguru.

8112.
Gioku-senshin.

8113.
Seirin.

8114.
O-sakadasuki.

8115.
Fukashigi.

8116.
Kausenden.

8117.
Daikagura.

8118.
Muhensai.

8119.
Saigyo sakura.

8120.
Momo-zono.

8121.
Ivo-no-seki.

8122 to 8188.

From Yokohama, Japan. Received through Suzuki & Iida, American agents of The Yokohama Nursery Company, New York, December 13, 1901.

A collection of plants as follows (the nomenclature in the main is that of the nursery company):

8122. Michelia compressa.

8123. Clerodendron squamatum.

8124. Deutzia sieboldiana.

8125. Styrax japonica.

8126. Styrax obassia.

8127. Ligustrum ciliatum.

8128. Pittosporum tobira.

8129. Quercus acuta.

8130. Quercus cuspidata.

8131. Quercus dentata.

8132. Quercus dentata aurea.

8133. Quercus glandulifera.

8134. Quercus glauca.

8135. Quercus lacera (?)

8136. Quercus laevigata (?)

8137. Quercus phillyreoides.

8138. Quercus pinnatifida.

8139. Quercus serrata.

8140. Ginkgo biloba variegata.

8141. Chamaecyparis obtusa, var. Kamukura-hiba.

8142. Chamaecyparis obtusa, var. Hotaru-hiba.

8122 to 8188—Continued.

8143. CHAMAECYPARIS OBTUSA, var. EMBI-HIBA.

8144. CHAMAECYPARIS OBTUSA, var. KANA-AMI.

8145. DAPHNE GENKWA.

8146. EDGEWORTHIA GARDNERI.

8147. KADSURA JAPONICA.

8148. KADSURA JAPONICA, spotted.

8149. KADSURA JAPONICA, white variegated.

8150. ACER TANABATA.

Various cultural varieties.

8151. ACER SANGUINEUM.

8152. ACER ATROPURPUREUM.

8153. ACER OSHIU-BENI.

8154. ACER JAPONICUM.

8155. ACER SANGUINEUM, Seigen.

8156. ACER ROSEUM.

8157. ACER VERSICOLOR.

8158. ACER OSAKA-ZUKI.

8159. ACER ATRO-DISSECTUM VARIEGATUM.

8160. ACER ATROPURPUREUM DISSECTUM.

8161. ACER RETICULATUM.

8162. ACER OKUSHIMO.

8163. ACER ATRO-DISSECTUM (green).

8164. ACER URIME.

8165. ACER KINUKASAYAMA.

8166. ACER AOBA.

8167. ACER HATCUYUKI KAIDO.

8168. ACER AUREUM.

8169. ACER SCOLOPENDRIFOLIUM RUBRUM.

8170. ACER SCOLOPENDRIFOLIUM (green).

8171. ACER ATROPURPUREUM VARIEGATUM.

8172. ACER AKIKAZE-NISHIKI.

8173. ACER ROSA-MARGINATIA.

8174. ACER CARPINIFOLIUM.

8175. ACER TRIFIDUM.

8176. ACER RUFINERVE.

8177. ACER TSUMAGAKI.

8178. ACER TSURU-NISHIKI.

8179. ACER MUSATORIYAMA.

8180. ACER PICTUM ALBUM.

8181. ACER JAPONICUM FILICIFOLIUM.

8182. ACER NISHIKIGASANE.

8183. ACER PICTUM AUREUM.

8184. ACER MURAKUMO.

8185. ACER KOMONUISHIKI.

8186. ACER JAPONICUM.

8187. ACER JAPONICUM.

8188. ACER JAPONICUM.

8189 to 8192.

From Yokohama, Japan. Received through Suzuki & Iida, American agents of the Yokohama Nursery Co., New York City, December 17, 1901.

A collection of seeds as follows:

8189. HAMAMELIS JAPONICA.

8190. STERCULIA PLATANIFOLIA.

8191. XANTHOXYLON PIPERITUM.

8192. PODOCARPUS MACROPHYLLA.

8193 to 8199.

From Lucknow, India. Received through the Government Horticultural Garden, December 16, 1901.

A collection of plants as follows:

8193. Bombax malabaricum.

8194. Clausena excavata.

8195. Dillenia speciosa.

8196. Ficus indica.

8197. Stigmaphyllon periplocaefolium.

8198. Rondeletia chinensis.

8199. Ruscus hypophyllum.

8200 to 8203. Hicoria pecan. **Pecan.**

From Ocean Springs, Miss. Received through The Stuart Pecan Company, December 21, 1901.

8200.

Russell.

8201.

Stuart.

8202.

Jewett.

8203.

Van Deman.

8204. Pistacia vera × Pistacia terebinthus.

From San Francisco, Cal. Received through Mr. W. T. Swingle from Mr. G. P. Rixford, secretary of the California Academy of Sciences, December 23, 1901.

8205 and 8206.

From Paris, France. Received through Vilmorin-Andrieux & Co., December 27, 1901.

8205. Cinchona officinalis.

8206. Agathis australis.

8207. Coffea arabica. **Coffee.**

From Macassar, Celebes. Received through Messrs. Lathrop and Fairchild from Hon. Karl Auer, United States Consul, December 28, 1901.

Timor.

8208. Juglans regia. **Walnut.**

From Zante, Greece. Presented by Mr. Alfred L. Crow, through Mr. D. G. Fairchild, January 6, 1902.

Large Zante.

8209. Cydonia sinensis. **Chinese quince.**

From Zante, Greece. Presented by Mr. Alfred L. Crow, through Mr. D. G. Fairchild. Received January 6, 1902.

Scented quince.

8210. Citrus nobilis × citrus bigaradia. **Orange.**

From Mustapha, Algiers, Algeria. Received through Dr. L. Trabut, Government Botanist, January 7, 1902. (A second packet January 14, 1902.)

Clementine. A hybrid of *Citrus nobilis* and *Citrus bigaradia sinensis salicifolia*, var. *granito.*

"Fruit very fine and beautiful. I recommend it." (*Trabut.*)

8211. COFFEA ARABICA. **Coffee.**

From Macassar, Celebes. Received through Messrs. Lathrop and Fairchild, from Hon. Karl Auer, United States Consul, January 7, 1902.

Chemnitz (?).

8212 and 8213. TRITICUM DURUM. **Wheat.**

From Uralsk, Russia. Purchased from the Ural Millers' Association. Received January 9, 1902.

8212.

Kubanka. Crop of 1900.

8213.

Kubanka. Crop of 1901.

8214. PROSOPIS JULIFLORA. **Mesquite.**

From Honolulu, Hawaiian Islands. Received through Mr. Jared G. Smith, director of the agricultural experiment station, January 10, 1902.

8215. POLYGONUM TATARICUM. **India wheat.**

From the Himalaya Mountains. Received through Dr. C. Sprenger, Vomero, near Naples, Italy, January 15, 1902.

"A large growing specimen." (*Sprenger.*)

8216 to 8218. CYPERUS ESCULENTUS. **Chufa.**

From Spain. Received through Mr. D. G. Fairchild (No. 772, Aug. 9, 1901), January 14, 1902. Secured through kindness of Hon. R. M. Bartleman, United States Consul at Valencia.

"Chufa cultivation in southeastern Spain is one of its most profitable industries; the underground tubers are used to make the *Horchata de chufas*, a favorite ice, sold very extensively in all the large cities in Spain." (*Fairchild.*)

8216.

From Alboraya.

8217.

From Balasuar.

8218.

From Algemese.

8219. CUCUMIS MELO. **Winter muskmelon.**

From Valencia, Spain. Received through Mr. D. G. Fairchild (No. 772, August 9, 1902), January 14, 1902.

8220 and 8221. TRITICUM VULGARE. **Wheat.**

From northern China. Received through Mr. G. D. Brill, January 17, 1902.

8220.

Red.

8221.

White.

8222 to 8225. AGARICUS CAMPESTRIS. **Mushroom.**

From Paris, France. Received through Dr. B. M. Duggar, January 18, 1902.

Mushroom spawn from Vilmorin-Andrieux & Co., as follows:

8222.

Triple. Virgin spawn, white variety.

8223.

Double. Virgin spawn, brown variety.

8224.

Ordinaire. Virgin spawn, brown variety.

8225.

Crop spawn, brown variety.

8226 to 8228. THEA VIRIDIS. **Tea.**

From Heneratgoda, Ceylon. Received through J. P. William & Bros., January 18, 1902.

Tea seed, as follows:

8226.

"Assam hybrid tea seed of highest class *Jat*, light leaf variety from Invery Estate, Dickoya, Ceylon, elevation 4,500 feet." (*William.*)

8227.

"Highest class *Jat* Assam Hybrid tea seed from Abbotsford Estate, Dimbulla, Ceylon, elevation 5,500 feet." (*William.*)

8228.

"Pure Manipuri indigenous tea seed, of highest class *Jat*, from Pen-y-len Estate, Dolosbage, Ceylon, over 4,000 feet elevation." (*William.*)

8229. BETA VULGARIS. **Sugar beet.**

From Wimmelburg, near Eisleben, Germany. Presented by Frantisek Jodl, Prague, Bohemia, January 18, 1902.

Kleinwanzleben improved.

8230 to 8232. TRITICUM DURUM. **Wheat.**

From Ambrocievka, Russia. Received from the estate of A. Michalkov, January 21, 1902.

Macaroni wheats as follows:

8230.

Yellow Gharnovka.

8231.

Velvet Don. (Chernouska.)

8232.

Black Don. (Chernokoloska.)

8233 to 8236. ERIOBOTRYA JAPONICA. **Loquat.**

From Mustapha, Algiers, Algeria. Received through Messrs. D. G. Fairchild and C. S. Scofield (Nos. 690 to 693), January 22, 1902.

8233.

Marcadal. "A nearly seedless variety from the Rev. Mr. Arkwright's garden." (*Fairchild.*)

8234.

Olivier. "From the Rev. Mr. Arkwright's garden. Fruits weigh over $52\frac{2}{5}$ grams apiece." (*Fairchild.*)

8235.

St. Michele. "From the Rev. Mr. Arkwright's garden. Said to weigh as much as 75 grams." (*Fairchild.*)

8236.

Meffre's No. 2. "Said by its originator, M. Henri Meffre, of El Merdj, to exceed in size any of the foregoing and to be of excellent quality." (*Fairchild.*) No. 693.

8237. MINA TRILOBATA.

From Mustapha, Algiers, Algeria. Received from Meffre & Salom Sons, January 22, 1902.

8238. Beta vulgaris. **Sugar beet.**

From Athensleben bei Löderburg, Germany. Received through H. Bennecke & Son, January 23, 1902.

Kleinwanzlebener Nachzucht. This seed was presented to Dr. H. W. Wiley, Chief of Bureau of Chemistry, United States Department of Agriculture.

8239. Solanum dregei. **Natal thorn.**

From Los Angeles, Cal. Received through Mr. Elmer Stearns, January 24, 1902.

Grown from seed of No. 1987, Inventory No. 5.

8240. Spondias lutea. **Ciruela amarillo.**

From Iguala, Guerrero, Mexico. Received through Mr. Elmer Stearns, Los Angeles, Cal., January 24, 1902.

8241 to 8298.

From Nice, France. Received through Mr. A. Robertson-Proschowsky, January 27, 1902.

A collection of seeds as follows: The determination of these species is that of Mr. Robertson-Proschowsky.

8241. Agapanthus umbellatus.

8242. Agave lophantha, Schiede?

8243. Albizzia lophantha.

8244. Arbutus unedo.

8245. Aristolochia elegans.

8246. Artemisia argentea.

8247. Araujia sericifera Brot.?

8248. Asparagus sprengeri.

8249. Bignonia tweediana.

8250. Cardiospermum halicacabum.

8251. Carica quercifolia.

8252. Cassia corymbosa.

8253. Cassia occidentalis (?)

8254. Casuarina equisetifolia.

8255. Ceanothus azureus Desf. (hybridus Hort.)

Gloire de Versailles.

8256. Clerodendron hastatum.

8257. Cordyline australis.

Cordyline indivisa of the trade.

8258. Dolichos lablab.

8259. Eremocarpus scaber.

8260. Elaeagnus pungens var. simoni.

8261. Nicotiana glauca.

8262. Olearia haasti.

8263. Passiflora pruinosa.

8264. Perimedium discolor (?)

8265. Phoenix reclinata.

8266. Phoenix pumila × Phoenix reclinata.

"Fruits of rather good taste when fresh. In moist climates, like Florida, other species than *Phoenix dactylifera* might in time, through selection and hybridization, produce good varieties." (*Proschowsky.*)

8267. Phormium tenax.

8268. Plectranthus striatus (?)

8269. Podachaenium paniculatum.

8270. Polygonum lanigerum.

8271. Porana racemosa (?) Roxb.

8272. Prosopis glandulosa (?)

8241 to 8298—Continued.

8273. Richardia africana Kth.

8274. Richardia albo-maculata.

8275. Ricinus communis, var. 1.

8276. Ricinus communis, var. 2.

8277. Ruscus hypoglossum.

8278. Schinus molle.

8279. Senecio longifolius.

8280. Solanum sp.

8281. Solanum laciniatum Ait. (S. reclinatum l'Herit).

8282. Solanum marginatum.

8283. Solanum pseudocapsicum.

8284. Solanum warszewiczii.

8285. Sollya heterophylla.

8286. Thalia dealbata.

8287. Vitex incisa.

8288. Wigandia sp. (hybrid?)

8289. Euphorbia sp.

8290. Ficus macrophylla.

8291. Gomphocarpus textilis.

8292. Globularia salicina Lam.

8293. Hedychium gardnerianum Rosc.

8294. Jacaranda ovalifolia.

8295. Iochroma tabulosa Benth.

8296. Ligustrum japonicum.

8297. Mesembryanthemum acinaciforme.

8298. Mespilus germanica. **Medlar.**

8299. Medicago elegans.

From Mustapha, Algiers, Algeria. Received through Dr. L. Trabut, Government Botanist, January 27, 1902.

8300 to 8306. Oryza sativa. **Rice.**

From Kobe, Japan. Received through Dr. S. A. Knapp, January 27, 1902.

Seed rice as follows, Japanese names being given:

8300.

Shinriki. From Hyogo district.

8301.

Shiratama. From Fukuoka district.

8302.

Komachi. From Kumamoto district.

8303.

Omase. From Kumamoto district.

8304.

Miyako. From Yamaguchi district.

8305.

From Chiugoku district.

8306.

From Chikuzen district.

8307. Juglans regia. **Walnut.**

From Aintab, Asia Minor. Received through Rev. A. Fuller, January 28, 1902.

Wild Persian walnuts.

8308 to 8310. CUCUMIS MELO. **Muskmelon.**

From Lisbon, Portugal. Received through Señor Abel Fontoina da Costa, January 30, 1902.

8308.

Amarello.

8309.

Alpiaca.

8310.

Palha (Valentien).

8311. KHAYA SENEGALENSIS. **African mahogany.**

From Mount Silinda, Melsetter district, Rhodesia, South Africa. Received through Dr. Wm. L. Thompson, January 31, 1902.

Ubaba. This is one of the finest timber trees of South Africa, growing to a large size, sometimes 6 feet or more in diameter. Resists the attacks of insects and is very durable. Generally grows near streams, but is also found in other places. Called by the natives "Ubaba," from the bitter bark.

8312. SIMMONDSIA CALIFORNICA. **Jojoba.**

From Las Flores, Lower California, Mexico. Received through Mr. F. Plunk, jr., January 30, 1902.

8313 to 8329.

From Erfurt, Germany. Received through Haage & Schmidt, February 1, 1902.

A collection of seeds as follows:

8313. CARYOTA MITIS.

8314. COCOS YATAY.

8315. CHRYSALIDOCARPUS LUTESCENS.

8316. PYRETHRUM ROSEUM.

8317. LEUCADENDRON ARGENTEUM.

8318. CINNAMOMUM sp.

8319. PAPAVER BRACTEATUM.

8320. PHORMIUM TENAX.

8321. COCOS DATIL.

8322. EUTERPE EDULIS.

8323. OREODOXA REGIA.

8324. CHAMAEDOREA SARTORI.

8325. OREODOXA OLERACEA.

8326. ACANTHOPHOENIX CRINITA.

8327. KENTIOPSIS MACROCARPA.

8328. BEGONIA REX × DIADEMA.

8329. KENTIA MACARTHURI. (Horticultural variety.)

8330. AMYGDALUS PERSICA. **Peach.**

From near North Gate, Canton, China. Received through Messrs. Lathrop and Fairchild (No. 774, December 20, 1901), February 3, 1902.

"A variety of peach growing in a Chinese orchard at Ngau lan Kong. The habit of this tree resembles that of an apricot, and, although I saw none of the fruit, I believe it is quite a distinct type from the ordinary Eagle Beak peach, which is the common variety about Canton. I was not able to get a name for this variety." (*Fairchild.*)

8331 to 8334. AMYGDALUS PERSICA. **Peach.**

Eagle Beak peach from Canton, China. Received through Messrs. Lathrop and Fairchild (No. 775, December 20, 1901), February 3, 1902.

"From orchard trees growing near the Great North Gate of Canton, at Ngau lan Kong, of the *Ying tsui t'o* or Eagle Beak peach. This variety resembles the Honey closely, except that the pointed tip of the fruit is more curved, according to Dr. J. M. Swan, of the Canton Hospital. I saw no specimen myself. According to Doctor Swan's gardener this variety blooms in March and April, while other sorts here bloom in February. The peach is said to be very sweet, even inclined to be a bit mawkish in flavor. The fruit is brought to the market some time early in July. The market for peaches in Canton is a short one, being in all not over five weeks—the last three weeks of June and the first two weeks of July. The *Peen t'o* type of peach is unknown here in Canton, so far as I can ascertain. It certainly must be a rare form here if it occurs at all. These cuttings were taken from small commercial orchards, and, it being winter, I am obliged to take the identification through an interpreter that they are the Eagle Beak. To insure getting all the varieties in the orchard, I got several lots from the different parts of the orchard. These I have marked 775, a, b, c, respectively. The numbers 8331, 8332, 8333, and 8334 correspond with these numbers. This peach is not larger than the Honey, but may prove later blooming and be valuable on this account." (*Fairchild.*)

8335. MORUS MULTICAULIS. **Chinese mulberry.**

From Canton, China. Received through Messrs. Lathrop and Fairchild (No. 776), February 3, 1902.

"A variety of mulberry cultivated for its leaf, used in feeding silkworms. The method of culture is to plant the cuttings deep in the ground, leaving two buds above the soil. The plant is never allowed to make a tree, but is cut down every year to the ground. The plants are only 6 to 8 inches apart, in rows 1½ feet from one another." (*Fairchild.*)

8336. POPULUS sp. (?) **Poplar.**

From Canton, China. Received through Messrs. Lathrop and Fairchild (No. 777, December 20, 1901), February 3, 1902.

"A low growing poplar with small leaves of a peculiar, truncated shape, which color up in December here in southern China a beautiful wine red. The splashes of color which this poplar gives to the landscape are very beautiful and the species is worth growing as an ornamental for this purpose alone." (*Fairchild.*)

8337. AMYGDALUS PERSICA. **Peach.**

From Canton, China. Received through Messrs. Lathrop and Fairchild (No. 778, December 20, 1901), February 3, 1902.

Ying tsui t'o. "Eagle Beak peach from a garden at Fati, opposite the island of Shameen. Probably much the same as Nos. 8331 to 8334, but as all these peaches seem to be grown from seed and are not grafted it may be slightly different." (*Fairchild.*)

8338. PRUNUS sp. **Red plum.**

From Canton, China. Received through Messrs. Lathrop and Fairchild (No. 779, December 20, 1901), February 3, 1902.

Hung Mui. "The flower and fruit are both said to be red and the latter to be an inch or more in diameter. It flowers somewhat later than the *Tsing Mui*, which is beginning to bloom now. This is from Yat Chun garden, at Fati, near Canton. These Chinese plums are said to be good canners, but likely to have a bitter taste on standing. They are not highly prized by the Europeans, who say they are hard and have a tendency to be astringent. The trees I saw at Fati were not remarkable, except for the great vigor of some young shoots springing from the old trunk which had been cut down. I can not vouch positively for the name of the variety as I worked through an interpreter." (*Fairchild.*)

8339. PRUNUS sp. **Plum.**

From Canton, China. Received through Messrs. Lathrop and Fairchild (No. 780, December 20, 1901), February 3, 1902.

Nam Wa Li. "A variety of plum called the Southern Glorious plum, according to Dr. J. M. Swan's translation. It is a red plum, about three-fourths of an inch in diameter, quite round, skin not tough, seed small. The sauce made from this variety turns bitter if left to stand for even an hour. If the tree is given good culture it produces fruits 1½ inches in diameter. It flowers in March. The tree I saw was quite vigorous and not grafted." (*Fairchild.*)

8340. Amygdalus persica. **Peach.**

From Canton, China. Received through Messrs. Lathrop and Fairchild (No. 781, December 20, 1901), February 3, 1902.

Pak Wat tim To. "A slightly sweet, white stone variety of rather small size, preferred by some to the *Ying tsai To*, which, it is said, has too sweet a flavor. It has no beak like the latter, but is a typical south Chinese shape, according to Dr. J. M. Swan, of the Canton Hospital, who very kindly described this variety." (*Fairchild.*)

8341. Diospyros kaki. **Persimmon.**

From Canton, China. Received through Messrs. Lathrop and Fairchild (No. 782, December 20, 1901), February 3, 1902.

Hung tsi. "A soft persimmon, of dark-red color, which is preferred by many Europeans to the hard type that is only edible after soaking in water for an hour. This is grown at Fati, near Canton." (*Fairchild.*)

8342. Prunus sp. **Plum.**

From Canton, China. Received through Messrs. Lathrop and Fairchild (No. 783, December 20, 1901), February 3, 1902.

Pak Mui. "A white plum, according to the interpreter. The tree is a fairly vigorous grower and abundant producer of flowers. It is not cultivated extensively here, so far as I can find out, and I have been unable to get a description of the variety." (*Fairchild.*)

8343. Amygdalus persica. **Peach.**

From Canton, China. Received through Messrs. Lathrop and Fairchild (No. 784, December 20, 1901), February 3, 1902.

Ying tsai To, or the Eagle Beak peach, from Fati, near Canton. "These are from different trees than Nos. 8331 to 8334, and may prove to have superior qualities. All that I have seen are seedling trees. Few peaches seem to be grafted." (*Fairchild.*)

8344. Psidium guajava. **Guava.**

From Canton, China. Received through Messrs. Lathrop ana Fairchild (No. 785, December 20, 1901), February 3, 1902.

"A reputed large-fruited (2 inches or so in diameter) yellow guava of good quality. The guavas about Canton are grown in the same fields with the rice. A single patch is often planted to a mixture of peach and guava trees, and both are grown on low ridges about 6 to 8 feet apart each way. No name was obtained." (*Fairchild.*)

8345. Prunus sp. **Plum.**

From Canton, China. Received through Messrs. Lathrop and Fairchild (No. 786, December 20, 1901), February 3, 1902.

Tsing mui. "A white-flowered, green-fruited plum. The fruit reaches 1 inch in diameter and is round in shape. This was just beginning to flower on December 20, much earlier than the *Hung Mui* or *Nam wa li* (*li* is pronounced as if spelled 'lay' in this word)." (*Fairchild.*)

8346. Ficus sp. **Milk tree.**

From Canton, China. Presented by Dr. J. M. Swan, of the Canton Hospital, through Messrs. Lathrop and Fairchild (No. 802, December 20, 1901), February 3, 1902.

Nau Nai Shu. "A large entire-leaved species of *Ficus*, which bears, even when quite young, large quantities of figs, at least an inch in diameter and quite sweet. Used as a shade tree in Canton. This was taken from Doctor Swan's yard at the Canton Hospital." (*Fairchild.*)

8347. CITRUS LIMETTA (?) **Lime.**

From Canton, China. Sent by Messrs. Lathrop and Fairchild (No. 803, December 20, 1901), February 3, 1902.

"Orange-fruited lime. Scions taken from some fruit in the market of Canton of a variety of lime about 2 inches in diameter. In color this lime is as dark orange as a blood orange from Malta, and its flesh is not light, as the lime is generally, but a deep orange. It seems like a very sour orange. It is used everywhere here in place of lemon or other kinds of lime. I did not see the trees growing, so can not describe them." (*Fairchild.*) (These scions were not received.)

8348. AMYGDALUS COMMUNIS. **Almond.**

From Malaga, Spain. Received through Mr. D. G. Fairchild (No. 767, July 31, 1901), February 4, 1902.

Jordan. "Bud sticks sent by Francisco Borgos Himenez, of Alhaurin, a village near Cartama, one and one-half hour's ride from Malaga." (*Fairchild.*)

8349. PISTACIA VERA. **Pistache.**

From Aintab, Syria. Received through Rev. A. Fuller.

8350 to 8352. VIOLA ODORATA. **Violet.**

From Paris, France. Received through Vilmorin-Andrieux & Co., February 4, 1902.

A collection of violet seed for experimental work, as follows:

8350.

Perpetual.

8351.

Perpetual, white.

8352.

The Czar.

8353. VIOLA CORNUTA. **Violet.**

From Paris, France. Received through Vilmorin-Andrieux & Co., February 4, 1902.

Blue.

8354. VIGNA CATJANG. **Cowpea.**

From Morioka, Japan. Received through Rev. E. Rothesay Miller, February 4, 1902.

A variety of cowpea having pods 3 feet long. Cooked and eaten like string beans.

8355 to 8357. DOLICHOS LABLAB. **Bean.**

From Morioka, Japan. Received through Rev. E. Rothesay Miller, February 4, 1902.

Edible podded beans as follows:

8355.

Green pods.

8356.

Purplish pods.

8357.

Purple pods.

8358. VICIA FABA. **Broad bean.**

From Canton, China. Received through Messrs. Lathrop and Fairchild (No. 791, December 21, 1901), February 5, 1902.

"A green variety of broad bean found on the market of Canton. This is used for human food, and is grown extensively in Central China, and I have seen large gardens of broad beans near Shanghai." (*Fairchild.*)

8359. ORYZA SATIVA. **Rice.**

From Canton, China. Received through Messrs. Lathrop and Fairchild (No. 788, December 21, 1901), February 5, 1902.

Si Mu. "Rice from Ching Shieng district, Canton province, 20 miles from Canton. It is a low-growing variety. This rice is imported to America for Chinese use, and is very highly prized by the Chinese because of its fine quality and especially because of its fine aroma. The price per katty is 6 cents, while ordinary rice costs about 4. Coolies often smuggle this rice out of the country, because there is an export duty on rice in Canton and this kind is the finest known to the Cantonese." (*Fairchild.*)

8360. ORYZA SATIVA. **Rice.**

From Canton, China. Received through Messrs. Lathrop and Fairchild (No. 790, December 21, 1901), February 5, 1902.

No Mai. "Old man's rice, a variety used for flour and pastry making. It is said to be very tough and nutritious and satisfying. Not generally employed for boiling purposes. It is a very expensive rice, bringing 8 cents a katty. Not classed with the ordinary boiling rices." (*Fairchild.*)

8361. ORYZA SATIVA. **Rice.**

From Canton, China. Received through Messrs. Lathrop and Fairchild (No. 789, December 21, 1901), February 5, 1902.

Wong Chim. "A variety of rice grown in Ching Sien or Ching Shien. I am told this is, next to No. 8359, the finest rice in Canton, but is not exported. It brings only 5 cents a katty when the other brings 6 cents. Vermicelli is said to be made of it." (*Fairchild.*)

8362. CASTANEA sp. **Chestnut.**

From Canton, China. Received through Messrs. Lathrop and Fairchild, February 6, 1902.

8363. PRUNUS ARMENIACA. **Apricot.**

From Canton, China. Received through Messrs. Lathrop and Fairchild (No. 800, December 20, 1901), February 5, 1902.

"Dried apricots from the Canton market. There seem to be no apricots grown about Canton, at least none of the Europeans I have talked with have seen any, and these are probably imported from north China." (*Fairchild.*)

8364. CANARIUM ALBUM. **Chinese olive.**

From Canton, China. Received through Messrs. Lathrop and Fairchild (No. 798, December 20, 1901), February 5, 1902.

Pak Lam. "This is a fruit sold in China by the thousands of tons, both in the dried state and pickled, and stained a light-yellow color. The plant is grown in orchards up the river from Canton and forms a very important article of commerce. Scarcely a fruit stall of any size is without it. The methods of preparation seem to be numerous. Worthy of preliminary plantings in Florida and southern California." (*Fairchild.*)

8365. PRUNUS sp. **Plum.**

From Canton, China. Received through Messrs. Lathrop and Fairchild (No. 799, December 20, 1901), February 5, 1902.

"Dried plums from the market in Canton. The origin of the trees is quite uncertain, but the fruit probably came from somewhere up the West or North rivers. The dealer said they came from Foo Chow, but no reliance is to be put on this statement." (*Fairchild.*)

8366. ELEOCHARIS TUBEROSA. **Water chestnut.**

From Canton, China. Received through Messrs. Lathrop and Fairchild (No. 801, December 20, 1901), February 5, 1902.

"An especially fine variety of the water chestnut, which is imported in large quantities into Canton from Kwai Lam, up the river. It is larger and better than the ordinary sort and should be given a trial in California, where the Chinese already grow the ordinary variety. (See Bulletin No. 68 of the Office of Experiment Stations.) There are numerous uses to which this swamp plant is put. Worthy of consideration as a plant for cultivation in the swamps of the South." (*Fairchild.*)

8367. CITRUS NOBILIS × CITRUS BIGARADIA. **Orange.**

From Mustapha, Algiers, Algeria. Received through Dr. L. Trabut, Government Botanist, January 5, 1902.

Clementine.

8368. CITRUS NOBILIS × CITRUS DECUMANA. **Orange.**

From Mustapha, Algiers, Algeria. Received through Dr. L. Trabut, Government Botanist, January 5, 1902.

8369 to 8385.

From Erfurt, Germany. Received through Haage & Schmidt, February 5, 1902.

A collection of seeds, as follows:

8369. VIOLA MUNBYANA (?).

8370. VIOLA ODORATA BARRENSTEINI.

8371. VIOLA ODORATA BARRENSTEINI, fl. ALBO.

8372. VIOLA ODORATA.

Czar.

8373. VIOLA ODORATA.

Czar fl. albo.

8374. VIOLA ODORATA.

Kaiserin Augusta.

8375. VIOLA ODORATA.

Lancheana.

8376. VIOLA ODORATA.

Reine des Violettes.

8377. VIOLA ODORATA ROSSICA.

8378. VIOLA ODORATA SEMPERFLORENS.

8379. VIOLA ODORATA SEMPERFLORENS fl. ALBO.

8380. VIOLA ODORATA SEMPERFLORENS.

Hamburger treib.

8381. VIOLA ODORATA.

Victoria Reginae.

8382. CAMPANULA MEDIUM.

8383. CODONOPSIS VIRIDIFLORA (?)

8384. DIANTHUS BARBATUS.

8385. DELPHINIUM ZALIL.

8386. THEA VIRIDIS. **Tea.**

From Tokyo, Japan. Received through The Tokyo Plant and Seed Company, February 10, 1902.

Formosa.

8387 to 8409.

From Yokohama, Japan. Received through L. Boehmer & Co., February 3, 1902.

A collection of plants and bulbs, as follows:

8387. LILIUM LONGIFLORUM.

8388. IRIS LAEVIGATA.

8389. IRIS JAPONICA.

8390. IRIS TECTORUM.

Blue.

8391. IRIS TECTORUM.

White.

8392. PAEONIA MOUTAN.

8393. CASTANEA CRENATA.

Japanese mammoth chestnut.

8394. DAPHNE ODORA.

Pink.

8395. DAPHNE ODORA.

White.

8387 to 8409—Continued.

8396. HYDRANGEA HORTENSIS var. AIGAKU.

8397. HYDRANGEA HORTENSIS var. AJISAI.

8398. HYDRANGEA HORTENSIS var. BENJAKU.

8399. HYDRANGEA HORTENSIS.

8400. MAGNOLIA PARVIFLORA ERECTA.

8401. MAGNOLIA PARVIFLORA PENDULA.

8402. MAGNOLIA GRANDIFLORA EXONIENSIS.

8403. CORNUS KOUSA.

8404. CINNAMOMUM LOUREIRII.

8405. RAPHIOLEPIS JAPONICA.

8406. RHUS SUCCEDANEA.

8407. RHUS VERNICIFERA.

8408. ZELKOVA ACUMINATA.

8409. STAUNTONIA HEXAPHYLLA.

8410. CITRULLUS VULGARIS. **Watermelon.**

From Elgin, Utah. Received through Mr. John F. Brown, February 12, 1902.

Winter. A round, white melon, which will keep in perfect condition for several months after maturing. Flesh crimson, very sweet and tender. Seeds small and black. Rind quite tough when fully ripe. The average weight of these melons is about 20 pounds, although specimens weighing 40 pounds have been grown.

8411 to 8413. MANGIFERA INDICA. **Mango.**

From Colombo, Ceylon. Presented by Dr. C. Drieberg, of the Agricultural School, Cinnamon Gardens, Colombo, through Messrs. Lathrop and Fairchild (Nos. 805 to 807), January 13, 1902. Received February 15, 1902.

Scions of three varieties of mangoes, as follows:

8411.

Jaffna. "A long-fruited, medium-sized green mango. The seed is fairly large; flesh golden yellow. It is edible even before fully ripe. A vigorous grower and good bearer. This is the best market mango in Ceylon, and is the one generally planted about the villages. The name would imply its origin in the northern province of Ceylon, but Doctor Willis, of Peradeniya Gardens, says the variety is scarcely known in that province." (*Fairchild.*) (No. 805.)

8412.

Rupee. "The largest fruited variety of mango grown in Ceylon. It is called the Rupee, or two-shilling mango, because of the price paid for a single fruit. Its origin is unknown. It is very large, sometimes 5 inches long, nearly globular, light green in color when ripe. A shy bearer. Skin tender and easily bruised, rendering it a poor shipper. Flesh a golden yellow. Seed small in proportion to the size of the fruit. A rare variety even in Ceylon. The fruits are considered a great delicacy and much sought after by those who know it. Flesh free from stringiness and flavor delicious, but only when properly and perfectly ripened. The tree is not very robust, and Doctor Drieberg does not recommend the variety for general planting." (*Fairchild.*) (No. 806.)

8411 to 8413—Continued.

8413.

Thurston. "These scions are from a single tree (there is only one on the island of Ceylon) growing directly in front of Doctor Drieberg's bungalow, at the agricultural school at Colombo (Cinnamon Gardens). This tree was planted by a Mr. Thurston, and for convenience I have given it his name. It is not a variety known elsewhere on the island. The tree is between 30 and 40 years old and is a very heavy bearer. The fruit is of medium size, short, and somewhat globular. The stone is of medium size and the skin is dark green even when ripe. It ripens well off the tree. It is a vigorous grower, has a sweet flavor, and, according to Doctor Drieberg, is acid when not fully ripe. The flesh is greenish in color near the skin and slightly fibrous." (*Fairchild.*) (No. 807.)

8414. CITRUS NOBILIS × CITRUS DECUMANA. **Orange.**

From Mustapha, Algiers, Algeria. Received through Dr. L. Trabut, Government Botanist, February 15, 1902.

Seeds.

8415. CITRUS AURANTIUM. **Orange.**

From Mustapha, Algiers, Algeria. Received through Dr. L. Trabut, Government Botanist, February 15, 1902.

Merki. A small packet of seeds of a variety of sweet orange.

8416. CERATONIA SILIQUA. **Carob.**

From Candia, Crete. Presented by H. B. M. consul, Walter E. Lanson, of Candia, through Mr. D. G. Fairchild (No. 579), February 17, 1902.

"Cuttings of the best variety of carob, or St. John's bread, for grafting on seedling trees. I am informed that the Candian variety of carob is one of the best in the market, bringing the highest prices. It is a tree which is being more extensively planted every year on the island of Crete, and its pods already form one of the principal exports, both of Crete and Cyprus. It is exported to England, France, and Italy, where it is used for cattle food and for a surrogate to mix with chocolate. According to the inspector of agriculture of Crete, Cavre. G. M. Fumis, this Candian variety has more sugar in it than the other sorts grown in Crete." (*Fairchild.*)

8417. CARICA PAPAYA. **Papaw.**

From Honolulu, Hawaii. Received through Mr. Jared G. Smith, special agent in charge of the agricultural experiment station, February 17, 1902.

Seed grown from No. 5112, Inventory No. 8.

8418. VIGNA CATJANG. **Cowpea.**

From Monetta, S. C. Received through Mr. T. S. Williams, December 5, 1901.

Iron. This variety of cowpea is noted for its remarkable resistance to wilt disease and root-knot.

8419 to 8421. MANGIFERA INDICA. **Mango.**

From Bombay, India. Received through Messrs. Lathrop and Fairchild (Nos. 810 to 812, January 21, 1902), February 24, 1902.

Scions of three varieties of mangoes, as follows:

8419.

Douglas Bennett's Alphonse. "The Bombay mangoes are noted all over the Orient, and they are generally classed as a single sort, but in reality there are numerous varieties. The Alphonse, or, in Hindustani, Alfoos, is considered by connoisseurs as the very finest. These scions are taken from a tree on the estate of Mr. Cooper, near Goregon Station, one hour's ride from Bombay, and

8419 to 8421—Continued.

represent an especially fine strain of the Alphonse mango, which was called to our attention by Mr. Douglas Bennett, superintendent of markets in Bombay, who desires that it be given his name. He says that all he knows of its origin is that over one hundred and thirty years ago it was discovered by a Parsee merchant, and that grafts were put down at Gwalia Tank Road, below Combali Hill, in Bombay, but that now very few of these are to be seen. The supply of this mango is so limited that fancy prices are paid for it, and few Europeans even have ever tasted the fruit. In size it is 3 by 4 by 2 inches and in color a golden yellow when ripe. The flesh is quite without stringiness, stone small, and flavor, according to Mr. Bennett, the best in the world. It is a large-leaved variety and forms a good-sized tree, but is of scraggly growth." (*Fairchild.*) (No. 810.) (See No. 8727.)

8420.

Bottle. "A good market sort, of Bombay. Green in color, ripening to reddish yellow. Flesh is yellowish in color and is not stringy. The fruit is long and slender, hence the name 'Bottle.' The stone is small. The fruit ripens, as do most of the Bombay mangoes, from April to May." (*Fairchild.*) (No. 811.)

8421.

Pirie. "A green, pointed-shaped variety from the Cooper estate at Goregon. Said by the owner, an inspector in the Bombay markets, to be, next to the *Alphonse*, the best of the Bombay mangoes. The seed is larger than that of the *Alphonse* and the flavor is excellent. Has the undesirable quality of being a poor keeper, losing its flavor quickly after fully ripe." (*Fairchild.*) (No. 812.)

8422 to 8424. GLYCINE HISPIDA. **Soy bean.**

From Yokohama, Japan. Received through Dr. S. A. Knapp, February 24, 1902.

8422.

Ita Name. Early.

8423.

Ita Name. Medium.

8424.

Ita Name. Late.

8425. JUGLANS CORDIFORMIS. **Walnut.**

From Yokohama, Japan. Received through Dr. S. A. Knapp, February 24, 1902.

8426. JUGLANS SIEBOLDIANA. **Walnut.**

From Yokohama, Japan. Received through Dr. S. A. Knapp, February 24, 1902.

8427. PHYLLOSTACHYS MITIS. **Bamboo.**

From Yokohama, Japan. Received through Dr. S. A. Knapp, February 24, 1902.

Moso chiku.

8428. PHYLLOSTACHYS QUILIOI. **Bamboo.**

From Yokohama, Japan. Received through Dr. S. A. Knapp, February 24, 1902.

Madake.

8429. JUNCUS EFFUSUS. **Rush.**

From Yokohama, Japan. Received through Dr. S. A. Knapp, February 24, 1902.

8430 to 8433. Punica granatum. **Pomegranate.**

From Valetta, Malta. Presented by Baron Testaferrata Abela, through Mr. D. G. Fairchild. Received February 25, 1902.

Cuttings as follows:

8430.

Giuseppe. Prima quality.

8431.

Due Colon, di S. Caterina.

8432.

Frances.

8433.

S. Rosa.

8434. Eleusine coracana. **Ragi millet or Kurakkan.**

From Colombo, Ceylon. Received through Messrs. Lathrop and Fairchild (No. 809, January 13, 1902), February 25, 1902.

"A species of millet which is planted all over Ceylon by the Singalese. It is a most important food crop for the natives, although given little attention by Europeans. Watt's Dictionary of Indian Products, 1890, Vol. III, p. 237, gives a long account of the use of this species in India, where it forms one of the great staples. Ferguson describes it as the most prolific of cultivated grasses. One variety, *E. stricta* Roxb., gives an increase of 120 fold, another 500 fold, and a single seed has been calculated to produce no less than 8,100 seeds in a single year. These seeds are very small, however. The food made from this species is coarse, though nourishing. When boiled the flour forms a sticky paste, which must be eaten with greasy gravy to be palatable. There are two varieties in this sample, mixed together, this being the way the field was sown. The two sorts are called *Hanasu Kurakkan*, or *Black Kurakkan*, and *Kiri* (White or Milk) *Kurakkan.* The seed is broadcasted and raked in or trampled in with the feet in May, in Ceylon, and the crop ripens in three months. It seems, however, to be sometimes planted at other times of the year. These varieties are suited only to irrigated lands and for trial in tropical regions with an abundance of rain. This species is a native of Ceylon, but varieties of the same species are cultivated under the native names of *Marua Kairarii* or *Kelvaragu* in continental India. This whole question of the Indian millets, many of which withstand severe dry weather, Watt says, is worthy of especial attention, and all the best varieties should be secured. Doctor Drieberg, superintendent of School Gardens, Cinnamon Gardens, Colombo, should be applied to for a larger quantity of this seed, which at this season is difficult to secure in good condition. As a chicken food this is reputed to be unsurpassed, fattening poultry with great rapidity. This is grown in a region which has 75 to 100 inches of rainfall a year." (*Fairchild.*)

8435. Citrus decumana. **Pomelo.**

From Poona, India. Received through Messrs. Lathrop and Fairchild (No. 815, January 26, 1902), February 25, 1902.

"A variety of pomelo which is said to be practically seedless, though not of first quality. It may prove useful for crossing purposes. It is medium large and has a thick skin. The flesh is too dry." (*Fairchild.*)

8436. Vitis vinifera. **Grape.**

From Poona, India. Received through Messrs. Lathrop and Fairchild (No. 816, January 27, 1902), February 25, 1902.

Bhokri. "A sweet, white sort, with rather tough skin, but very productive. This is one of the best varieties for general cultivation about Poona, which has a high altitude, tropical climate, temperature as high as 120°, and with 30 inches of rainfall. It is said to have originated in the north of India. It bears two crops a year, only the second one, however, being sweet." (*Fairchild.*)

8437. Jasminum sambac. **Arabian jasmine.**

From Poona, India. Received through Messrs. Lathrop and Fairchild (No. 817, January 25, 1902), February 25, 1902.

"A variety of jessamine much cultivated by the natives of India and used by them in their worship under the name of *Mogaree.* It is a vigorous growing shrub and bears an abundance of very large, double, white flowers, which are highly perfumed. Some of these flowers are said to be as large as a camelia blossom. The plant requires rich soil and is very sensitive to cold. It is strictly a tropical plant, although doing well in gardens in Cairo. The cuttings should be treated in the usual way, i. e., rooted in moist sand, and the plants can be set out in a rich border. This is the largest variety of the jessamine I know, and if not already introduced into Hawaii, southern California, or Florida, deserves to be generally propagated and distributed. From the Empress Gardens, in Poona, India." (*Fairchild.*)

8438. POINSETTIA PULCHERRIMA. **Poinsettia.**

From Poona, India. Received through Messrs. Lathrop and Fairchild (No. 818, January 25, 1902), February 25, 1902.

"A double poinsettia of rare beauty. Instead of the usual whorl of bright red leaves characteristic of the ordinary poinsettia this sort has from three to five such whorls. These are at their best when the green leaves have fallen and the light gray stems are quite bare. As a decorative plant for giving a splash of the brightest red to a landscape this plant is unequalled." (*Fairchild.*)

8439. CITRUS AURANTIUM. **Orange.**

From Poona, India. Received through Messrs. Lathrop and Fairchild (No. 819, January 26, 1902), February 25, 1902.

Kowla. "Described by Woodrow in his 'Gardening in India,' page 193, as an indifferent dessert fruit, but considered by the natives of India as well worth attention and, in fact, recommended as a good sort. A distinct variety, and hence worthy of a collection." (*Fairchild.*)

8440. MANGIFERA INDICA. **Mango.**

From Poona, India. Received through Messrs. Lathrop and Fairchild (No. 820, January 26, 1902), February 25, 1902.

Alphonse or *Aphoos.* "From a tree in the Empress Gardens at Poona. It may prove a different strain from Nos. 8419 and 8727. This is the best Bombay mango and is remarkable for its good shipping qualities. It can be picked when still green, laid or shipped in straw with plenty of air, and kept for six weeks. Even after ripe, fruits can be kept for a week or more. A much better shipper than the *Mulgoba* and more productive." (*Fairchild.*)

8441. CITRUS AURANTIUM. **Orange.**

From Poona, India. Received through Messrs. Lathrop and Fairchild (No. 821, January 26, 1902), February 25, 1902.

Ladoo. "This is a popular orange in India and is of the mandarin class, although not so fine looking in appearance. The oil glands are finer and the color is a duller orange, sometimes russet. It deserves a place in every collection of oranges as a distinct type. Woodrow, in his 'Gardening in India,' page 209, figures this variety and recommends it for planting. It is a loose-skinned sort but the skin is more nearly filled by the flesh than the ordinary mandarin and in texture it is unusually crisp and of good flavor. Very little fiber is one of its characteristics. In size it is about the average of the mardarin type. Secured by the superintendent of the Empress Gardens in Poona." (*Fairchild.*)

8442. MANGIFERA INDICA. **Mango.**

From Poona, India. Received through Messrs. Lathrop and Fairchild (No. 822, January 26, 1902), February 25, 1902.

Borsha. "See Woodrow, Gardening in India, page 248. Fruit weighs on an average 10 ounces. Ripens by the first of July. Flesh is as dry as that of *Mulgoba* or *Alphonse* and can be cut like cheese. It is three to four weeks later in ripening than the *Alphonse* and is considered almost its equal in quality. One large tree of this variety is said to have often yielded over $150 worth of fruit in a single crop. It should be planted in alluvial soil and given plenty of bone ash. The banks of a river or irrigation canal are especially well suited to mango culture. This variety is distinguished from the *Mulgoba* by its young shoots, which are distinctly reddish in color. Mangoes are sometimes shipped from Bombay to London, which is eighteen days' or more of sea travel." (*Fairchild.*)

8443. Citrus sp.

From Poona, India. Received through Messrs. Lathrop and Fairchild (No. 823, January 26, 1902), February 25, 1902.

Jamburee or *Jamboorre.* "A variety of *Citrus* which is used in India extensively for stocks on which the orange is grafted. Considerable discussion regarding its influence on the scions of sweet oranges will be found in Woodrow's 'Gardening in India,' pages 214 and 215. In one place Woodrow calls this a lime, in another a citron." (*Fairchild.*)

8444. Mangifera indica. **Mango.**

From Poona, India. Received through Messrs. Lathrop and Fairchild (No. 824, January 26, 1902). February 25, 1902.

Pakria. "Described at some length by Woodrow, page 247, in his Gardening in India, and considered by some as one of the three best mangoes in the Bombay presidency; at any rate it is a sort in big demand for planting. It ripens three or four weeks later than the *Alphonse*—i. e., from the end of May to the end of June. Secured through the kindness of Mr. Kannetkar, superintendent of Empress Gardens in Poona. (*Fairchild.*)

8445. Thysanolaena agrostis.

From Poona, India. Received through Messrs. Lathrop and Fairchild (No. 825, January 26, 1902), February 25, 1902.

"Two pieces of rhizome of an ornamental cane from the Himalayas. It flowers profusely and remains in flower for four months. The inflorescences are steel-gray and great masses of them are produced. The plant grows to a height of 8 to 10 feet and forms large clumps like pampas grass or like some species of *Arundo.* It is altogether the handsomest cane for borders that I have ever seen. It deserves a wide distribution in Hawaii and southern California. As seeds were not procurable the experiment of sending two rhizomes in a perforated tin case by sample post has been attempted. If successful more can be had of the superintendent of the Empress Gardens in Poona. Seed may be had of the Calcutta Botanic Gardens. The plant requires good rich soil and plenty of moisture. In the Poona Gardens it is grown on irrigated land because there are only about 25 inches of yearly rainfall. The cuttings should be given such treatment as would be given the ordinary ornamental canes." (*Fairchild.*)

8446. Citrus aurantium. **Orange.**

From Poona, India. Received through Messrs. Lathrop and Fairchild (No. 826, January 26, 1902), February 25, 1902.

Cintra or *Suntura.* "Woodrow (Gardening in India, p. 210), says this is the finest orange in India. It weighs from 7 to 10 ounces. One sort has loose skin, the other tightly fits the pulp. It has very few seeds, and is often quite seedless. The flesh is unusually crisp and has almost no fiber, but is somewhat lacking in sweetness. The oil glands are very small and close together in the skin. The color is not so bright as that of the mandarin of Japan. This variety is of especial interest only because of its reported seedlessness and the fiberless nature of the flesh, which is quite remarkable. I am assured this is the tight-skinned variety, which is superior to the loose-skinned one. The type is distinctly a mandarin one. Through the kindness of Superintendent Kannetkar of the Empress Gardens, Poona." (*Fairchild.*)

8447. Citrullus vulgáris. **Watermelon.**

From the Agricultural Experiment Station, Pomona, Cal. Received February 20, 1902.

Khama or *Tsamma.* This melon is very valuable for stock feeding in dry countries, as it thrives with very little water. (Grown from No. 4322.)

8448 to 8453. Pyrus malus. **Apple.**

From Misserghin, near Oran, Algeria. Received through Messrs. D. G. Fairchild and C. S. Scofield, from the Nursery of the Orphelinat de l'Annonciation, February 26, 1902.

8448 to 8453—Continued.

Apple trees and scions as follows:

8448.

Algerienne.

8449.

D'Ere.

8450.

De Chataignier.

8451.

Nain Paradis.

8452.

Precoce de Tunis.

8453.

Nain de Mahon.

8454 and 8455. CYDONIA VULGARIS. **Quince**

From Misserghin, near Oran, Algeria. Received through Messrs. D. G. Fairchild and C. S. Scofield from the Nursery of the Orphelinat de l'Annonciation, February 26, 1902.

Quince scions as follows:

8454.

De Laghouat.

8455.

De Mahon.

8456 to 8460.

From San Giovanni á Teduccio, Italy. Received through Dammann & Co., March 3, 1902.

8456. VIOLA CORNUTA.

8457. VIOLA CORNUTA ALBA.

8458. VIOLA CORNUTA.

Admiracion.

8459. VIOLA CORNUTA.

Blue Perfection.

8460. VIOLA ODORATA SEMPERFLORENS.

8461. LATHYRUS sp.

From the Vomero, Naples, Italy. Received through Dr. C. Sprenger, March 5, 1902.

"A native of Mexico." (*Sprenger.*)

8462. VITIS VINIFERA. **Grape.**

From Kurrachee, India. Received through Messrs. Lathrop and Fairchild (No. 827, February 2, 1902), March 10, 1902.

Sufetha. "An indigenous white grape, grown successfully at Kurrachee. It is one of the three best in cultivation here, where there is only 7 inches of rainfall and the temperature in summer goes to 110° F. from March to the end of June, and the soil is noticeably alkaline. Berry large and round; bunches $4\frac{1}{2}$ pounds in weight; long, crowded, heavy cropper; flavor good; skin thick and leathery. It is said to be a good keeper and shipper, being shipped from Kurrachee to Bombay and Lahore. These cuttings are from the Kurrachee Public Gardens." (*Fairchild.*)

8463. VITIS VINIFERA. **Grape.**

From Kurrachee, India. Received through Messrs. Lathrop and Fairchild (No. 829, February 2, 1902), March 10, 1902.

Goolabie. "An indigenous variety of grape which thrives better than such forms as the *Black Hamburg*, and, according to our informant, Mr. Lester, superintendent of the public gardens of Kurrachee, it is considered superior in flavor to the *Black Hamburg*. This is the favorite grape for Kurrachee conditions, which resemble those of Tulare (California) and Arizona, being a desert where only 7 inches of rain falls and where, for the summer months, a temperature of 110° is of daily occurrence. The soil is decidedly alkaline, in fact too much so for ordinary European grapes. The variety is said to be a purple, small-berried kind, a very heavy cropper, fruiting the end of April. The bunches weigh 1½ to 2 pounds. The berry has a very thin skin and two or three seeds. The name means 'rose flavored' and the flavor is that of rose petals. It was introduced into Poona, India, but did not succeed there." (*Fairchild.*)

8464. VITIS VINIFERA. **Grape.**

From Kurrachee, India. Received through Messrs. Lathrop and Fairchild (No. 828, February 2, 1902), March 10, 1902.

Kandhari. "A long-berried, thin-skinned, white grape with very large bunches, 3 to 4 pounds in weight. It is a vigorous grower, but light bearer. An indigenous sort, of fine flavor, suited to an arid climate, and alkaline soil in a very warm climate." (*Fairchild.*)

8465 to 8475. CITRULLUS VULGARIS. **Watermelon.**

From Monetta, S. C. Received through Mr. T. S. Williams, November 5, 1901.

Seeds from hand-pollinated melons, grown from seeds imported by the Office of Seed and Plant Introduction:

8465. From No. 16.

Melon of average size with dark-green stripes. Flesh orange-colored and of very fine flavor. Vine small and not vigorous. This is an excellent melon for home use.

8466. From No. 35.

A small green melon with white spots. The flesh is deep red and very fine. The vine is small, but strong.

8467. From No. 68, which is evidently mixed seed.

A large, pale-green melon with broad, dark stripes. The flesh is orange-colored and of very fine flavor. The vine is very vigorous.

8468. From No. 68.

A medium-sized, pale-green melon with broad, dark-green stripes. The flesh is orange colored and of good flavor. The vine is very vigorous.

8469. From No. 46.

A large, light-gray melon. The flesh is deep red and of fine flavor. The vine is very vigorous.

8470. From No. 93.

A rather large, gray melon, with green stripes. The flesh is pink and of very fine flavor. The vine is vigorous.

8471. From No. 2847.

A fairly good, green melon of average size. The flesh is pale red and of good flavor. The vine is strong.

8472. From No. 2847.

A medium-sized, mottled-green melon. The flesh is red and of good flavor. The vine is strong.

8473. From No. 2848.

A large, white melon. The flesh is deep red, of fine texture and very fine flavor.

8474. From No. 2849.

A medium-sized, dark-green melon, with small white stripes. The flesh is deep red, of fine texture and delicious flavor.

8475. From No. 6151.

A very large, dark-green, striped melon. The flesh is pink, of rather coarse texture, but fine flavor.

8476. Pistacia mutica. **Menengech.**

From Aintab, Syria. Presented by Rev. A. Fuller, through Mr. W. T. Swingle. Received March 10, 1902.

8477 and 8478. Pistacia vera. **Pistache.**

From Aintab, Syria. Presented by Rev. A. Fuller, through Mr. W. T. Swingle. Received March 10, 1902.

8477.

Large red.

8478.

Large green.

8479 to 8482. Pistacia vera. **Pistache.**

From Aintab, Syria. Presented by Rev. A. Fuller, through Mr. W. T. Swingle. Received March 10, 1902.

8479.

Selected mixed fresh pistache nuts from the market.

8480.

Aleppo red. Very large and fine.

8481.

A large, unnamed, green variety.

8482.

Koz. Known as the "Walnut" pistache.

8483. Pistacia vera × (?) **Butum.**

From Aintab, Syria. Presented by Rev. A. Fuller, through Mr. W. T. Swingle. Received March 10, 1902.

Fresh, selected "Butum" nuts.

8484. Pistacia mutica. **Menengech.**

From Aintab, Syria. Presented by Rev. A. Fuller, through Mr. W. T. Swingle. Received March 10, 1902.

Selected fresh seeds.

8485. Pistacia mutica. **Menengech.**

From Aintab, Syria. Presented by Rev. A. Fuller, through Mr. W. T. Swingle. Received March 10, 1902.

Ordinary seeds from the market.

8486 to 8501.

From Washington, D. C. Received March 10, 1902.

A collection of seeds grown on the Potomac Flats by Mr. W. R. Beattie from seeds furnished by the Office of Seed and Plant Introduction.

8486. Phaseolus mungo. Grown from No. 6321.

8487. Phaseolus mungo. Grown from No. 6417.

8488. Phaseolus mungo. Grown from No. 6318.

8489. Glycine hispida. Grown from No. 6314.

8490. Glycine hispida. Grown from No. 6333.

8491. Glycine hispida. Grown from No. 6334.

8486 to 8501—Continued.

8492. GLYCINE HISPIDA. Grown from No. 6386.

8493. GLYCINE HISPIDA. Grown from No. 6396.

8494. GLYCINE HISPIDA. Grown from No. 6336.

8495. GLYCINE HISPIDA. Grown from No. 6397.

8496. GLYCINE HISPIDA. Grown from No. 6416.

8497. GLYCINE HISPIDA. Grown from No. 6312.

8498. VIGNA CATJANG. Grown from No. 6311.

8499. VIGNA CATJANG. Grown from No. 6327.

8500. VIGNA CATJANG. Grown from No. 6328.

8501. VIGNA CATJANG. Grown from No. 6413.

8502. MAGNOLIA KOBUS. **Magnolia.**

From Yokohama, Japan. Received through L. Boehmer & Co., March 13, 1902.

8503. PAEONIA MOUTAN. **Tree peony.**

From Yokohama, Japan. Received through L. Boehmer & Co., March 13, 1902.

8504. ZAMIA FLORIDANA. **Coontie.**

From Miami, Fla. Received through Prof. P. H. Rolfs, in charge of the Subtropical Laboratory of the United States Department of Agriculture.

8505. THEA VIRIDIS. **Tea.**

From Heneratgoda, Ceylon. Presented by Messrs. J. P. William & Bros. Received March 17, 1902.

Formosa.

8506 and 8507. FICUS CARICA. **Fig.**

From the island of Chios, Turkey. Presented by Mr. N. J. Pantelides, through Mr. D. G. Fairchild. Received March 19, 1902.

Fig cuttings as follows:

8506.

Figue de Chios. "Very fine when fresh." (*Pantelides.*)

8507.

Figue de Syria. Lombardica. "A very fine, large variety, blackish on the outside and bright red inside." (*Pantelides.*)

8508 to 8515. ORYZA SATIVA. **Rice.**

From Japan. Received through Dr. S. A. Knapp, March 19, 1902.

Seed rice as follows:

8508.

Fusakichi. From Bizen district. (I)

8509.

Mansaku bozu. From Fukuoka district. (J)

8510.

From Ise district. (K)

8511.

From Buzen district. (L)

8512.

From Iyo district. (M)

8513.

From Higo district. (N)

8514.

From Bizen district. (O)

8515.

From Banshu (?) district. (P)

8516. CANNABIS SATIVA. **Hemp.**

From Danville, Ky. Received through Mr. George Cogar, March 20, 1902.

8517 to 8520. PISTACIA VERA. **Pistache.**

From Marseille, France. Received through Mr. Claude Montel, March 21, 1902.

8517. Grafted female pistache trees.

8518. Grafted male pistache trees.

8519. Female pistache scions.

8520. Male pistache scions.

8521. PISTACIA TEREBINTHUS. **Terebinth.**

From Marseille, France. Received through Mr. Claude Montel, March 21, 1902.

Terebinth stocks for grafting.

8522 and 8523. TRITICUM DURUM. **Wheat.**

From Brookings, S. Dak. Seed grown in 1901 under contract by Prof. J. H. Shepard, of the South Dakota Agricultural Experiment Station.

8522.

Kubanka. Grown from No. 5639.

8523.

Velvet Don. Grown from No. 5641.

8524 to 8529.

From Paris, France. Received from Vilmorin-Andrieux & Co., March 27, 1902.

8524. LINUM USITATISSIMUM. **Flax.**

Original *Riga.*

8525. CANNABIS SATIVA. **Hemp.**

Russian.

8526. THYMUS VULGARIS. **Thyme.**

8527. THYMUS SERPYLLUM. **Creeping thyme.**

8528. LAVANDULA VERA. **Lavender.**

8529. LAVANDULA SPICA. **Spike lavender.**

8530 to 8537.

Received from J. M. Thorburn & Co., of New York City, March 29, 1902. A collection of foreign-grown seeds of medicinal plants, for use in experimental work under the direction of Dr. R. H. True, of the Department of Agriculture.

8530. ATROPA BELLADONNA. **Belladonna.**

8531. ARNICA MONTANA. **Mountain tobacco, or mountain snuff.**

8532. DIGITALIS PURPUREA. **Foxglove.**

8533. GLYCYRRHIZA GLABRA. **Licorice.**

8534. DATURA STRAMONIUM. **Thorn apple.**

8535. HYOSCYAMUS NIGER. **Henbane.**

8536. PAPAVER SOMNIFERUM. **Poppy.**

8537. ACONITUM NAPELLUS. **Aconite.**

8538. Avena sativa. **Oat.**

From Bozeman, Mont. Presented by the Director of the Agricultural Experiment Station. Received April 1, 1902.

Swedish Select. Grown from No. 2788.

8539 to 8542.

From Poona, India. Received through Dr. S. A. Knapp, April 1, 1902.

8539. Phaseolus aconitifolius.

Math. "This legume is grown in the Deccan and the Gujarat as a 'kharif,' or rain crop, sown only in the rainy season. It does well on light, stony, upland soil, with an average annual rainfall of 30 inches. The usual method is to sow a mixture of 8 pounds of *Bajri* (*Pennisetum typhoideum*) and 1½ pounds of *Math* per acre in July, the crop being harvested in November or December." (*Knapp.*)

8540. Phaseolus mungo.

Mug. "This plant is largely grown as a 'kharif,' or rain crop, and also as a 'rabi' (cold-weather crop) in many parts of India. As a 'kharif' crop it is mixed with sorghum (*Jowari*), while as a 'rabi' crop it is sown after rice has been harvested. It does best in a deep, black soil, with an average rainfall of from 30 to 35 inches. It ripens in three months after sowing." (*Knapp.*)

8541. Phaseolus radiatus.

Udid. "This bean is largely cultivated in India as a subordinate crop with sorghum (*Jowari*), the usual amount sown being 6 pounds of *Jowari* and 3 pounds of *Udid.* It does best if sown in June in deep, black soil, with a rainfall of from 30 to 35 inches, being harvested in September. *Udid* is also grown in some sections as a second crop after rice." (*Knapp.*)

8542. Dolichos uniflorus.

Kulthi. "This plant is largely grown on light soils of a strong or sandy nature, and thrives with a moderate rainfall. It is usually sown with bulrush millet (*Pennisetum typhoideum*), the rate per acre being 8 pounds of millet to 2 pounds of *Kulthi.*" (*Knapp.*)

8543 to 8547.

From Nagpur, India. Received through Dr. S. A. Knapp, April 1, 1902.

8543. Oryza sativa. **Rice.**

Dhan. A quick-ripening variety.

8544. Triticum durum. **Wheat.**

Haura Gahoo.

8545. Dolichos lablab. **Lablab bean.**

Tal, Val, or *Popat.*

8546. Andropogon sorghum. **Sorghum.**

A late variety used for forage.

8547. Andropogon sorghum. **Sorghum.**

Used for forage.

8548 to 8552.

From Lahore, India. Received through Dr. S. A. Knapp, April 1, 1902.

A collection of wheats as follows:

8548. Triticum vulgare.

Pure red wheat, grown without irrigation on land near the river. (No. 1.)

8548 to 8552—Continued.

8549. TRITICUM VULGARE.

Pure white wheat, grown on slightly salty land irrigated with canal water. (No. 2.)

8550. TRITICUM DURUM.

Round red wheat, grown on slightly salty land irrigated with canal water. (No. 3.)

8551. TRITICUM DURUM.

Round white wheat, grown on strong black soil irrigated with canal water. (No. 4.)

8552. TRITICUM DURUM.

Wadanak. Grown on light, slightly sandy soil irrigated with well water.

8553 to 8562.

From Christiania, Norway. Presented by Prof. C. Doxrud, of the Christiania School of Technology, for testing in comparison with seeds from other countries. Received April 2, 1902.

8553. PHLEUM PRATENSE. **Timothy.**

8554. DACTYLIS GLOMERATA. **Orchard grass.**

8555. TRIFOLIUM PRATENSE. **Red clover.**

8556. TRIFOLIUM HYBRIDUM. **Alsike clover.**

8557. PISUM SATIVUM. **Pea.**

Early.

8558. AVENA SATIVA. **Oat.**

8559. HORDEUM HEXASTICHUM. **Barley.**

8560. HORDEUM DISTICHUM. **Barley.**

8561. TRITICUM VULGARE. **Wheat.**

Red spring.

8562. PISUM SATIVUM. **Pea.**

Sueding.

8563 and 8564. PHOENIX DACTYLIFERA. **Date.**

From Kurrachee, India. Received through Messrs. Lathrop and Fairchild (No. 830, February 1, 1902), April 4, 1902.

Cupcap, *Chupchap*, or *Cupcup*. "This is a variety of the *Karak pokhta*, or cooked dates, and is considered one of the best of its class. These cooked dates are prepared in the following way: The fruits are picked before fully ripe, while still full, plump, and slightly astringent. They are boiled for an hour in fresh water, to which one handful of salt per gallon of water is added. After boiling they are spread out in the sun to dry. These boiled dates are sold in large quantities in India. They form an indispensable part of every marriage feast. Higher prices are paid for them in India, I am informed, than for the dates shipped to America. This sort is, when properly prepared, quite sweet, in fact, tastes quite as if candied. The slight flavor of tannin may be due to careless preparation. It is a fairly early date, coming into fruit about Maskat in July. It is also a good date to eat fresh. It keeps almost indefinitely. There are several qualities of this variety. That marked *a* came from Kurrachee, while *b* was secured in Maskat." (*Fairchild.*)

8565. CAPSICUM ANNUUM. **Red pepper.**

From Kurrachee, India. Received through Messrs. Lathrop and Fairchild (no number), April 4, 1902.

Bird's bill.

8566. CAPSICUM ANNUUM. **Red pepper.**

From Kurrachee, India. Received through Messrs. Lathrop and Fairchild (No. 828, February 6, 1902), April 4, 1902.

"The common red pepper in use in Kurrachee. It is mild in comparison with the Maskat variety. It is dark wine-red in color, and long and conical in shape. Bought in a Maskat market." (*Fairchild.*)

8567. PHOENIX DACTYLIFERA. **Date palm.**

From Kurrachee, India. Received through Messrs. Lathrop and Fairchild (no number), April 4, 1902.

"*Bagist* or *Dairi* dates, a second-class variety eaten by the common people." (*Fairchild.*)

8568. CAPSICUM ANNUUM. **Chili pepper.**

From Maskat, India. Received through Messrs. Lathrop and Fairchild (No. 837, February 6, 1902), April 4, 1902.

"A very hot orange or light-red variety of red pepper, reputed to be one of the hottest peppers on the Persian Gulf. Bought in a Maskat bazaar." (*Fairchild.*)

8569. PHOENIX DACTYLIFERA. **Date palm.**

From Maskat, India. Received through Messrs. Lathrop and Fairchild (No. 831, February 6, 1902), April 4, 1902.

Burni. "Dried dates of one of the *Karak pokhta* or cooking class. This date is also said to be a first-class drying or pressed date, but with poor keeping qualities. It is so delicate that it can not be sent successfully to America, but it is considered superior in flavor to the *Fard* date, which is the variety commonly shipped to America. It is the earliest date known at Maskat, and one of the very finest flavored sorts. It ripens in Maskat in June, but this region of Maskat has a temperature in summer of 110° and even 117° F. in the shade, so that the sort might ripen later if transplanted to a region with a cooler summer temperature. The dates sent are of the boiled sort only, the dried kind being quite unobtainable." (*Fairchild.*)

8570. PHOENIX DACTYLIFERA. **Date palm.**

From Kurrachee, India. Received through Messrs. Lathrop and Fairchild (No. 834, Feb. 2, 1902), April 4, 1902.

Jahadi. "Dried dates of one of the second quality sorts shipped into India from the Persian Gulf. This variety is probably shipped to America." (*Fairchild.*)

8571. PHOENIX DACTYLIFERA. **Date palm.**

From Maskat, India. Received through Messrs. Lathrop and Fairchild (No. 833, February 6, 1902), April 4, 1902.

Khanezi. "Dried dates of a first-class Persian Gulf sort sent largely to America. This is considered inferior to the *Fard*, but still ranks as a very good sort." (*Fairchild.*)

8572. PHOENIX DACTYLIFERA. **Date palm.**

From Kurrachee, India. Received through Messrs. Lathrop and Fairchild (No. 832, February 5, 1902), April 4, 1902.

Fard. "Dried dates of the variety most commonly shipped from the Persian Gulf to America. This is not considered the finest of the dates, but is one of the best shippers. It is a dark, medium-sized sort, of good quality. It is grown about Maskat and the southern part of the Persian Gulf. It is a medium early date, later than *Burni*." (*Fairchild.*)

8573. Phoenix dactylifera. **Date palm.**

From Bahrein, Arabia. Received through Messrs. Lathrop and Fairchild (No. 835, February 10, 1902), April 4, 1902.

Khalasa. "Dried dates of one of the finest varieties in the Persian Gulf. These dates are so delicate that they are not shipped to America, although they may be kept several months, as is evidenced by the present samples. They are reported to suffer by the sea voyage. The date has very little fiber, being a sticky sort with a decidedly caramel-like texture. The flavor is superior to that of the best *Fard* date and the skin is soft and delicate. The stone is small, but not unusually so. It is considered the best date on the Persian Gulf by Mr. J. C. Gaskin, British consul, who has been a dealer in one of the largest date firms at Bassorah, and by Mr. S. M. Zwemer, who has traveled all over Arabia. Personally I prefer the *Pangh Ghur* date and the *Deglet Noor*, but the *Khalasa* approaches these closely for sweetness and delicacy. It is sticky, however, and might not be well suited to such style of packing as is in vogue with the French packers in Algiers. Secured through the kindness of Messrs. Gaskin and Zwemer, of Bahrein." (*Fairchild.*) (See No. 8753.)

8574. Pistacia vera. **Pistache.**

From Bunder Abbas, Persia. Received through Messrs. Lathrop and Fairchild (No. 839, February 11, 1902), April 4, 1902.

"Bought in the market of Bunder Abbas. They were said to have been brought down some nineteen days by caravan from the town of Kerman, in the interior. They were fresh in December or November. The trees were probably grafted, although no definite information on this point could be obtained. Kerman is said to have a temperate climate." (*Fairchild.*)

8575. Lagenaria sp. **Gourd.**

From Jask, Persia. Received through Messrs. Lathrop and Fairchild (No. 840, February 11, 1902), April 4, 1902.

"A white, edible gourd growing to a large size, 1½ feet long by 8 inches in diameter. It forms a pretty trellis plant in Jask, where the temperature rises to 110° F. and no rain falls. It is grown by irrigation. It may prove of value in the Colorado desert region. It is prepared by boiling in salt water like any of the squash family. The leaves are large and the flowers are white with long tubes to the corolla." (*Fairchild.*)

8576. Vitis candicans. **Mustang grape.**

From Tiger Mill, Texas. Presented by Mr. H. T. Fuchs to Hon. A. S. Burleson and by him to this Department. Received April 7, 1902.

Seeds of the finest wild grapes of Texas, according to Mr. Fuchs' letter.

8577. Carica papaya. **Papaw.**

From Mexico. Presented by Mr. Elmer Stearns, 3226 Manitou avenue, Los Angeles, Cal. Received March 29, 1902.

"These seeds were from a fruit 6 inches long by 3½ inches in diameter, grown in the hot country southwest of Guadalajara." (*Stearns.*)

8578. Opuntia sp. **Prickly pear.**

From Guadalajara, Mexico. Presented by Mr. Elmer Stearns, 3226 Manitou avenue, Los Angeles, Cal. Received March 29, 1902.

Tuna colorado. "These seeds were from a fruit 2 inches by 1½ inches in diameter." (*Stearns.*)

8579. Opuntia sp. **Prickly pear.**

From City of Mexico, Mexico. Presented by Mr. Elmer Stearns, 3226 Manitou avenue, Los Angeles, Cal. Received March 29, 1902.

Tuna amarilla.

8580. CEREUS sp. **Pitahaya.**

From Mexico. Presented by Mr. Elmer Stearns, 3226 Manitou avenue, Los Angeles, Cal. Received March 29, 1902.

"These seeds were from a fruit weighing 1 pound, grown in the foothills 75 miles west of Tampico, Mexico." (*Stearns.*)

8581 to 8583. VITIS VINIFERA. **Grape.**

From Aintab, Syria. Received through Rev. A. Fuller, April 15, 1902.

Grape cuttings as follows:

8581.

Aintab Summer (Nabodada). "A large, oblong, white grape. The flesh is rather coarse, but it is much prized for table use." (*Fuller.*)

8582.

Aintab Autumn (Kabbajuk). "A medium-sized, round, white grape, much prized for table use. It ripens in July and August." (*Fuller.*)

8583.

Aintab Winter (Hunisa). "A large, wine-colored, oblong grape. It ripens in October and November and keeps until March." (*Fuller.*)

8584 to 8589.

From Chin-kiang, China. Received through Dr. S. A. Knapp from Rev. Dr. S. P. Barchet, Shanghai, China, April 15, 1902.

8584. GLYCINE HISPIDA. **Soy bean.**

"A very prolific, nearly white variety, used for making oil and also for food. It is sometimes ground into flour and used for making cakes." (*Knapp.*)

8585. PHASEOLUS sp. **Bean.**

"Used for food and for making starch. It grows well on sandy soil." (*Knapp.*)

8586. GLYCINE HISPIDA. **Soy bean.**

"A very oily variety, used chiefly for fattening purposes. Planted in July or August." (*Knapp.*)

8587. VICIA FABA. **Broad bean.**

"A large, rank-growing variety that will stand frost. It is planted in November." (*Knapp.*)

8588. PISUM sp. **Pea.**

"A rank-growing variety used for food. It is planted in November." (*Knapp.*)

8589. TRITICUM VULGARE. **Wheat.**

"A hardy, rust-proof variety. Sown in October or November. (*Knapp.*)

8590 to 8592.

From Shanghai, China. Received through Dr. S. A. Knapp from Rev. Dr. S. P. Barchet, April 15, 1902.

8590. ORYZA SATIVA. **Rice.**

"An early variety. It is sown late in May or early in June." (*Knapp.*)

8590 to 8592—Continued.

8591. Oryza sativa. **Rice.**

"A late variety. It is sown late in June or early in July." (*Knapp.*)

8592. Vicia faba. **Broad bean.**

"Quite similar to No. 8587, but not so large." (*Knapp.*)

8593 and 8594. Oryza sativa. **Rice.**

From Kiang-si Province, China. Received through Dr. S. A. Knapp from Rev. Dr. D. W. Nichols, Nan-chang, China, April 15, 1902.

8593.

Wan Ku (late rice). "A beautiful white grain, quite flaky when cooked." (*Nichols.*)

8594.

Tsoa Ku (early rice). "A crop of this and the preceding variety can be grown on the same ground the same year." (*Nichols.*)

8595. Thea viridis. **Tea.**

From Calcutta, India. Received from the Pashok Tea Company (Limited), Kilburn & Co., agents, April 15, 1902.

Pashok Darjeeling.

8596. Vicia faba. **Broad bean.**

From Sheridan, Mont. Presented by Mr. S. M. Wilson, April 15, 1902.

These beans are said by Mr. Wilson to come from northern Sweden, and to endure a degree of cold that kills other tender vegetation.

8597 and 8598.

From Erfurt, Germany. Received through Haage & Schmidt, seedsmen, April 19, 1902.

8597. Caryota urens. **Wine or toddy palm.**

8593. Ravenala madagascariensis. **Travelers' tree.**

8599. Punica granatum. **Pomegranate.**

From Bagdad, Arabia. Received through Messrs. Lathrop and Fairchild (No. 883, March 8, 1902), April 21, 1902.

Achmar or *Red.* "This variety bears fruit of a very large size. I have seen a specimen over 2 pounds in weight. The skin is thin, but there are many thick walls dividing the segments. The seeds are large, each with a deep, very juicy, wine-red arillus. Remarkable for its size and red color." (*Fairchild.*)

8600. Zizyphus jujuba. **Jujube.**

From Bagdad, Arabia. Received through Messrs. Lathrop and Fairchild (No. 887, March 8, 1902), April 21, 1902.

Nebuk or *Nabug ajam.* "A Persian variety, called the red jujube. A variety larger than the *Bagdad*, but not of as good flavor. These jujube trees, as they are grown in Mesopotamia, are the most picturesque, in fact the only conspicuous shade trees in the region, and are worthy of trial along irrigation canals. They bear enormous crops of small fruits, about the size of cherries, which are greedily sought after by the children. The fruits taste much like baked apples. There is a variety in which the seed, instead of being hard, like a date stone, is thin shelled, and one can eat it easily." (*Fairchild.*) (See No. 8702.)

8601. CITRUS LIMONUM. **Lemon.**

From Bagdad, Arabia. Received through Messrs. Lathrop and Fairchild (No. 889, March 8, 1902), April 21, 1902.

Hameth. "A Bagdad variety which is of most excellent quality and characterized by a dark orange 'blush' at the stem end, making it a peculiar and showy fruit. The skin is very thin, and the fruit very juicy and of medium size. The shape of those I saw was almost that of an egg." (*Fairchild.*)

8602. CITRUS AURANTIUM. **Orange.**

From Bagdad, Arabia. Received through Messrs. Lathrop and Fairchild (No. 890, March 8, 1902), April 21, 1902.

Portugal Asfar. "A common Bagdad orange which is in all respects, except the presence of seeds, a remarkably fine orange. It does well in the alluvial adobe soil of Bagdad, and even where there is some alkali in the soil. These scions came from the garden of Abdul Kader Kederry, at Bagdad." (*Fairchild.*)

8603. CITRUS AURANTIUM. **Orange.**

From Bagdad, Arabia. Received through Messrs. Lathrop and Fairchild (No. 891, March 8, 1902), April 21, 1902.

Aboul serra. "A navel orange, with seeds, of especially fine aroma, I am told, which is cultivated by Sheik Abdul Kader Kederry, and is worth testing as a new variety. The oranges of Bagdad are in general excellent, and this one, although I was unable to test it, may be no exception." (*Fairchild.*)

8604. CITRUS AURANTIUM. **Orange.**

From Bagdad, Arabia. Received through Messrs. Lathrop and Fairchild (No. 892, March 8, 1902), April 21, 1902.

Narinji. "A variety of orange with a 'button' at the flower end; from a tree in the garden of Sheik Abdul Kader Kederry. It has an excellent flavor and has few seeds. This is one of the common varieties of Bagdad, and is an excellent orange." (*Fairchild.*)

8605. VITIS VINIFERA. **Grape.**

From Bagdad, Arabia. Received through Messrs. Lathrop and Fairchild (No. 893, March 9, 1902), April 21, 1902.

(L. & F. No. 893 is *Citrus aurantium*, but the tube so marked contained grape cuttings without data.)

8606. CITRUS DECUMANA. **Pomelo.**

From Bagdad, Arabia. Received through Messrs. Lathrop and Fairchild (No. 894, March 9, 1902), April 21, 1902.

"A species of pomelo or shaddock, of which the skin is used for making preserves. I did not have an opportunity to taste the fruit, but presume it is of second quality." (*Fairchild.*)

8607 to 8642. CITRULLUS VULGARIS. **Watermelon.**

From Monetta, S. C. Received November 5, 1901.

A collection of seeds of hand-pollinated watermelons grown by Mr. T. S. Williams from seed furnished by the Office of Seed and Plant Introduction.

8607. Grown from No. 18.

8608. Grown from No. 25.

8609. Grown from No. 26.

8610. Grown from No. 33.

8611. Grown from No. 39.

8612. Grown from No. 48.

8613. Grown from No. 55.

8614. Grown from No. 84.

8607 to 8642—Continued.

8615. Grown from No. 84.

8616. Grown from No. 85.

8617. Grown from No. 86.

8618. Grown from No. 86.

8619. Grown from No. 87.

8620. Grown from No. 88.

8621. Grown from No. 98?

8622. Grown from No. 98?

8623. Grown from No. 102.

8624. Grown from No. 104.

8625. Grown from No. 2739.

8626. Grown from No. 2740.

8627. Grown from No. 2843.

8628. Grown from No. 2844.

8629. Grown from No. 2845.

8630. Grown from No. 106.

8631. Grown from No. 2846.

8632. Grown from No. 2850.

8633. Grown from No. 3680.

8634. Grown from No. 3680.

8635. Grown from No. 4899.

8636. Grown from No. 6149.

8637. Grown from No. 6170.

8688. Grown from No. 6038.

8639. Grown from No. 6039.

8640. Grown from No. 6046.

8641. Grown from No. 6052.

8642. Grown from No. 6056.

8643. PUNICA GRANATUM. **Pomegranate.**

From Bassorah, Arabia. Received through Messrs. Lathrop and Fairchild (No. 847, February 26, 1902), April 22, 1902.

Mellasi. "A large 'seedless' pomegranate with light-colored flesh. This is said to be the best variety in Arabia and to be quite free from seeds; i. e., the coats of the seeds are probably so delicate that they offer no resistance to the teeth when eating the fruit. Secured through the kindness of Mr. Raphael Sayegh, of Bassorah." (*Fairchild.*)

8644. PYRUS MALUS. **Apple.**

From Bassorah, Arabia. Received through Messrs. Lathrop and Fairchild (No. 848, February 26, 1902), April 22, 1902.

Persian. "This apple will grow well in a region where dates are produced and where for three months the thermometer keeps about the 100° F. mark. It is not of the best quality, but is quite edible, and should be tested in the desert regions of the Colorado River and in the dry regions of Texas. It requires irrigation." (*Fairchild.*)

8645. CYDONIA VULGARIS (?)

From Bassorah, Arabia. Received through Messrs. Lathrop and Fairchild (No. 849, February 26, 1902), April 22, 1902.

Bahamro. "A stock which is used in Arabia, especially in Mesopotamia, on which to graft apples, pears, and quinces. It is reported to be an excellent stock in this very hot region of the Tigris Valley, where the thermometer stands for three months near the 100° F. mark and where it often rises to 117° F. It is cultivated here on adobe soil under irrigation." (*Fairchild.*)

8646. PUNICA GRANATUM. **Pomegranate.**

From Bassorah, Arabia. Received through Messrs. Lathrop and Fairchild (No. 850, February 26, 1902), April 22, 1902.

Nejidi. "A red-fleshed variety of pomegranate which is considered second only to the seedless or *Mellasi* variety. The fruit is large and has a very thin skin." (*Fairchild.*)

8647. VITIS VINIFERA. **Grape.**

From Bassorah, Arabia. Presented by Hadji Abdulla Negem through Messrs. Lathrop and Fairchild (No. 854, February 25, 1902). Received April 22, 1902.

Abiat. "A white grape which is medium in time of ripening and of reputed excellent quality. It is trained from trunk to trunk of the date palms at Abu Kasib. Soil an adobe with abundant moisture in it." (*Fairchild.*)

8648. VITIS VINIFERA. **Grape.**

From Bassorah, Arabia. Received through Messrs. Lathrop and Fairchild (No. 855, February 25, 1902), April 22, 1902.

Asuad Suamee. "A black, early grape, with very large berries and rather tough skin, which is cultivated among the date groves at Abu Kassib. The quality of this sort is reported to be exceptionally good. The practice of grape growing under the palms is rapidly spreading in Mesopotamia. It is worthy of trial in Arizona and southern California." (*Fairchild.*)

8649. VITIS VINIFERA. **Grape.**

From Bassorah, Arabia. Presented by Hadji Abdulla Negem through Messrs. Lathrop and Fairchild (No. 856, February 25, 1902). Received April 22, 1902.

Bengi. "A late, black grape of superior quality, according to the report of Europeans in the region. It is said to be the best variety here in Bassorah and to be really 'as fine as the hothouse-grown *Black Hamburgh.*' Grown under the date palms at Abu Kassib." (*Fairchild.*)

8650. AVENA SATIVA. **Oat.**

From Mustiala, Finland. Received through Messrs. Lathrop and Fairchild from Mustiala Landtbruks och Mejeri-Institut, April 25, 1902.

North Finnish Black.

8651. FATSIA JAPONICA.

From Paris, France. Received through Vilmorin-Andrieux & Co., April 26, 1902.

8652. TRITICUM DICOCCUM. **Emmer.**

From Dunseith, N. Dak. Received through Mr. Arthur Hagendorf, April 29, 1902.

8653. ANONA CHERIMOLIA. **Custard apple.**

From Chile. Presented by Dr. A. W. Thornton, of Ferndale, Wash. Received April 28, 1902.

Cherimoya. Seeds of a choice variety.

8654 to 8679a.

From Ootacamund, India. Presented by R. L. Proudlock, esq., Curator of the Government Botanic Gardens. Received April 30, 1902.

8654. ACROCARPUS FRAXINIFOLIUS.

8655. CUPRESSUS TORULOSA.

8656. LASIOSIPHON ERIOCEPHALUS.

8657. MELIOSMA ARNOTTIANA.

8658. ROSA GIGANTEA.

8659. ACER OBLONGUM.

8660. CEDRELA TOONA.

8661. CLEMATIS WIGHTIANA.

8662. DALBERGIA LATIFOLIA.

8663. EXACUM BICOLOR.

8664. ILEX WIGHTIANA.

8665. PHOTINIA LINDLEYANA.

8666. PTEROCARPUS MARSUPIUM.

8654 to 8679—Continued.

8667. Rhodomyrtus tomentosa.

8668. Urceola esculenta.

8669. Celtis serotina.

8670. Microtropis ovalifolia.

8671. Turpinia pomifera.

8672. Elettaria cardamomum.

8673. Michelia nilagirica.

8674. Phoenix rupicola.

8675. Agapanthus umbellatus.

8676. Cassia grandis.

8677. Pedicularis zeylanica.

8678. Pinus longifolia.

8679. Santalum album,

8679a. Litsea zeylanica.

8680. Mangifera indica. **Mango.**

From Colombo, Ceylon. Received through Messrs. Lathrop and Fairchild (No. 948, April 6, 1902), May 5, 1902.

Jaffna. "For a description of this variety see No. 8411. I have tasted this mango but find it, although not stringy, far inferior to the *Alphouse* Bombay mango. It lacks the fine aroma and dark orange colored flesh." (*Fairchild.*)

8681 and 8682.

From Heneratgoda, Ceylon. Received through J. P. William & Bros., May 5, 1902.

8681. Coffea liberica. **Coffee.**

8682. Coffea hybrida. **Coffee.**

8683. Luffa aegyptiaca. **Sponge gourd.**

From Springfield, Mo. Presented by Mr. Joe P. Wilson. Received May 10, 1902.

Grown from No. 3982, Inventory No. 8.

8684 and 8685.

From Poona, India. Received through Dr. S. A. Knapp, May 10, 1902.

8684. Triticum durum. **Wheat.**

Kala Kushal.

8685. Andropogon sorghum. **Sorghum.**

Hasar. Grown in Sampayam, Belyaum district.

8686 to 8692.

From Surat, India. Received through Dr. S. A. Knapp, May 10, 1902.

8686. Dolichos lablab. **Bean.**

Kadrá Vál or *Kadrá Wál.*

8687. Vigna catjang. **Cowpea.**

Chowali, *Chola*, or *Choli.*

8688. Oryza sativa. **Rice.**

Kamoda. From Ahmedabad, Geyarat.

8689. Oryza sativa. **Rice.**

Sunkharel. From Surat, Geyarat.

8690. Oryza sativa. **Rice.**

Ambamore. From Surat, Geyarat.

8686 to 8692—Continued.

8691. ANDROPOGON SORGHUM. **Sorghum.**

Sholapuri.

8692. ANDROPOGON SORGHUM. **Sorghum.**

Perio.

8693. THEA VIRIDIS. **Tea.**

From Colombo, Ceylon. Received through Messrs. Lathrop and Fairchild (No. 947, April 6, 1902), May 14 and May 29, 1902.

Assam. "Sent by Mr. Hadden, of Kotiyagala, Ceylon, through Director John C. Willis, of the Peradeniya Gardens." (*Fairchild.*)

8694 to 8697.

From Santiago, Chile. Presented by Señor Federico Albert, chief of the Section of Zoological and Botanical Investigations. Received May 14, 1902.

8694. ARISTOTELIA MACQUI. **Maqui.**

8695. KAGENECKIA sp.

8696. TREVOA QUINQUENERVIA. **Tralhuen.**

8697. TREVOA TRINERVIA. **Trevu.**

8698. HIBISCUS SABDARIFFA. **Roselle.**

From Punjab, India. Presented by Abdulla Khan, clerk in the office of director of land records, through Dr. S. A. Knapp, agricultural explorer. Received May 14, 1902.

Patma. Common red.

8699. ORYZA SATIVA. **Rice.**

From Hongkong, China. Received through Dr. S. A. Knapp, agricultural explorer, May 16, 1902.

Simi.

8700. PRITCHARDIA GAUDICHAUDII. **Fan palm.**

From Honolulu, Hawaii. Presented by Mr. Jared G. Smith, director of the Hawaii Agricultural Experiment Station. Received May 22, 1902.

8701. MANGIFERA INDICA. **Mango.**

From Saigon, Cochin China. Received through Messrs. Lathrop and Fairchild (No. 949, April 16, 1902), May 22, 1902.

Cambodiana or *Xoài Vói.* "This is a delicious mango, of medium size, furnished with a short beak, yellow when ripe, with a faint but agreeable aroma. The flesh varies slightly from light to deep orange in color. Has an excellent, fine, delicate flavor and is never stringy. It is not as rich as the *Alphonse*, of Bombay, either in aroma or flavor, but nevertheless worthy of rank among the best mangoes I have ever eaten. Doctor Haffner, of the botanic gardens of Saigon, informs me that this sort is never grafted, but is a variety which reproduces itself from seed. This being the case, I deem it probable that out of the lot of over a hundred seeds which we are sending some remarkable ones ought to be secured. I believe there is a slight variation among the seedlings, although it is a surprisingly constant variety." (*Fairchild.*)

8702. ZIZYPHUS JUJUBA. **Jujube.**

From Bassorah, Arabia. Received through Messrs. Lathrop and Fairchild (No. 851, February 26, 1902), May 22, 1902.

Nabug. "The seed in this fruit, instead of being covered with a very hard shell, is like paper, giving the variety the name of being seedless. The tree is the most satisfactory shade tree in this hot region, having a spreading top with somewhat drooping branches covered with small, dark-green leaves. The plant is a most prolific bearer. The fruits when ripe are like Haws in mealiness, and they are keenly relished by the Arabs. They are about one-half to three-fourths inch in diameter. This so-called seedless sort is, paradoxically enough, propagated by seed, and is said to come true to them. It is a tree well suited to the banks of irrigation canals in the hottest regions which we have." (*Fairchild.*)

8703. ZIZYPHUS JUJUBA. **Jujube.**

From Bassorah, Arabia. Received through Messrs. Lathrop and Fairchild, May 22, 1902.

"Seeds of the common jujube largely grown throughout this arid country." (*Fairchild.*)

8704. QUERCUS CORNEA. **Oak.**

From Hongkong, China. Received through Messrs. Lathrop and Fairchild (No. 950, April 29, 1902), May 22, 1902.

"Edible acorns from a species of oak which grows in southern China, even on the island of Hongkong. The acorns have a hard, horny shell and a sweet flesh of very agreeable flavor. The acorns are sent in very large quantities to Hongkong from Canton. They are eaten by the Chinese with great pleasure, and are often roasted. They would be acceptable, I believe, to Americans, and the tree ought to do well in the Southern States. If the tree, which is a pretty one, proves a success, large quantities can be had through the botanic gardens at Hongkong, but only at this season of the year." (*Fairchild.*)

8705. PRUNUS sp. **Plum.**

From Hongkong, China. Received through Messrs. Lathrop and Fairchild (No. 951, April 19, 1902), May 22, 1902.

"A beautiful little plum, said to be grown in Canton. It was purchased on the Hongkong market. It is of a beautiful, transparent, wine red color, with a delicate skin which is covered with the finest, most delicate pubescence imaginable, resembling a bloom which can not be rubbed off. When ripe the fruit has a delicate, agreeable aroma, which is that of a half-ripe Japanese quince. In taste the plum is not very good, but decidedly refreshing. It is sour with a slightly bitter taste. The flesh is yellow in color and inclined to be solid and stringy. The stone is a cling, being covered with many long fibers. In shape it is pointed with a distinct keel. The skin is very delicate but in flavor is *intensely bitter.* It separates from the flesh with difficulty." (*Fairchild.*)

8706. CITRUS AURANTIUM. **Orange.**

From Kabylia, Algeria. Presented by Dr. L. Trabut, Government Botanist, Mustapha, Algiers, Algeria. Received May 26, 1902.

Bandja. A late, sweet orange, which reproduces itself from seed.

8707. PISTACIA MUTICA. **Menengech.**

From Smyrna, Asia Minor. Presented by Mr. George C. Roeding, of Fresno, Cal. Received May 26, 1902.

8708. PRITCHARDIA MARTII. **Fan palm.**

From Olaa, Hawaii. Presented by Mr. Jared G. Smith, special agent in charge of the Hawaii Agricultural Experiment Station at Honolulu.

From an altitude of from 2,000 to 2,500 feet.

8709. EUCOMMIA ULMOIDES.

From Paris, France. Received through Vilmorin-Andrieux & Co., May 29, 1902.

Tu Chung. Rooted cuttings of this Chinese plant. It is used medicinally. It is claimed that the leaves contain a large amount of gutta-percha.

8710 to 8726. Pyrus malus. **Apple.**

From New South Wales, Australia. Presented by Messrs. Hunter & Sons, of "The Penang," near Gosford, through Hon. D. C. McLachlan, undersecretary, department of mines and agriculture, Sydney, to replace trees and cuttings received in bad condition in June, 1901. Received May 29, 1902. Hunter & Sons' numbers are given.

Apple trees as follows:

8710.

Allsops early. (No. 237.)

8711.

American Golden Pippin. (No. 256.)

8712.

Carrington, Small's. (No. 238.)

8713.

Early Richmond. (No. 83.)

8714.

George Neilson. (No. 157.)

8715.

Lady Hopetown. (No. 234.)

8716.

Menagerie. (No. 220.)

8717.

Perfection, Shepherd's. (No. 4.)

8718.

Sharp's Early. (No. 232.)

8719. (Label missing.)

Apple scions as follows:

8720.

Autumn Tart.

8721.

Chestattee. (No. 221.)

8722.

Fall Beauty. (No. 80.)

8723.

Jupp's Carrington. (No. 210.)

8724.

Lord Wolseley. (No. 50.)

8725.

Ruby Pearmain. (No. 228.)

8726.

Yarra Bank. (No. 252.)

8727. Mangifera indica. **Mango.**

From Bombay, India. Received through Messrs. Lathrop and Fairchild (No. 814, January 28, 1902), June 5, 1902.

Douglas Bennett's Alphonse. "Named in honor of the superintendent of markets in Bombay, who has called our attention to this superlative strain and who has very kindly donated to the American Government the trees which he guarantees to be of this special variety. This sort should be compared with No. 8419, which latter number is composed of scions from the tree of which these are believed to be grafts." (*Fairchild.*)

8728. Gossypium brasiliense (?) **Kidney cotton.**

From Ciego de Avila, Cuba. Presented by Mr. Felix M. Catala. Received June 5, 1902.

Wild Cuban kidney cotton.

8729 to 8734. Mangifera indica. **Mangoes.**

From Bombay, India. Received through Messrs. Lathrop and Fairchild (No. 944, March 30, 1902), June 7, 1902.

A collection of trees donated to the Department by Mr. J. N. Tata, of Bombay, who has a very large collection of the best mangoes from all over India. These are those he considers the finest of his whole collection, which is one of the largest in the world. These include, doubtless, some of the most valuable sorts of mangoes of all India.

8729.

Nowshirwani.

8730.

Paheri.

8731.

Ameeri.

8732.

Totafuri.

8733.

Hafu or *Alphouse.*

8734.

Jamshedi.

8735. CURCUMA LONGA. **Turmeric.**

From Bombay, India. Received through Dr. S. A. Knapp, June 7, 1902.

8736. ZINGIBER OFFICINALE. **Ginger.**

From Bombay, India. Received through Dr. S. A. Knapp, June 7, 1902.

8737. TRITICUM DURUM. **Wheat.**

From Bombay, India. Received through Dr. S. A. Knapp, June 7, 1902.

Hansoli. Grown at Surat, in Gujarat.

8738 to 8745. PHOENIX DACTYLIFERA. **Date palm.**

From Bagdad, Arabia. Received through Messrs. Lathrop and Fairchild (Nos. 866 to 873, March 10, 1902), June 7, 1902.

8738.

Kustawi. "Considered one of the two best dates in the region of Bagdad. It is a variety which, though acknowledged to be far superior to the sorts which are sent to America, is not exported because of its poor shipping quality. If this date succeeds in America it can, without doubt, be easily shipped by rail, as I have eaten here in Bagdad good specimens over five months old. It is a sticky sort, as packed by the Arabs, although I believe its skin is thick enough to allow of its being packed as the *Deglet Noor* of Algiers is packed. The fruit is not over 1¼ inches long, as judged by dry specimens, and has a seed about seven-eighths inch in length by five-sixteenths inch in diameter. The flesh is not very thick, but exceedingly sweet and, like the other good dates of this region, of a decidedly gummy consistency. It is placed by the Arabs second in rank to the *Maktum*, which is richer in sugar and somewhat fleshier. I have only tasted the *Maktum* once, but I believe it superior in flavor to the *Kustawi*, owing to the fact that the region of Bagdad is much drier than that of Bassorah. This date is probably better suited to conditions prevailing in California and Arizona than the sorts grown in Bassorah. It is considered, however, one of the most delicate dates to cultivate, requiring much more care than such sorts as the *Zehedy*, *Ascherasi*, and *Bedraihe*. Not being a date for export the price is low, as is the case with the *Berhi* of Bassorah. It sells for about $2.60 to $3 per 210 pounds, while the *Bedraihe* brings about $4 to $4.40. This variety begins to ripen about the 1st of August in this exceedingly hot climate. It should be planted with the growing bud 2 inches above the soil. The best ground will be an adobe, like the silt of the Colorado River, or such as occurs in certain places on the experimental farm at Phoenix. This sort is said to be a good bearer, but I do not know just how heavy the yields are. There is very little fiber to the date, and it is altogether an exceptionally fine sort." (*Fairchild.*) (No. 866.)

8739.

Ascherasi. "One of the highest-priced dates on the market in Bagdad. It is, as I have seen it, always a more or less dry sort, never pressed into a conglomerate mass in the way the other sorts are. It is the sort preferred by

8738 to 8745—Continued.

Bagdadians to eat with walnuts, and is preferred by many to any other kind. Personally, I found it a very eatable date, and it has the very great advantage of not soiling the hands. The flesh is, however, even when fresh, hard enough to allow shipping. In fact the dates are even sent, when fresh, from Mundeli to Bagdad in skins. Generally, however, the fruit is allowed to dry on the tree until it becomes hard. It is not exported from Bagdad, but consumed in Mesopotamia. The price sold dry is about $3.20 to $3.60 per 100 kilos on the Bagdad market. It is suited to a region with less water than that of Bassorah. It matures about the middle of September to the 1st of October in Bagdad." (*Fairchild.*) (No. 867.)

8740.

Bedraihe. "This ripens in September and the first of October, and is allowed to dry on the trees. As sold here in the markets it is a yellow date, about 1¼ to 1½ inches long and three-fourths inch to 1 inch in diameter. The base of the date is quite dry, as I have seen it, but the tip is transparent or semitransparent and quite sweet, although at this season of too gummy a consistency to be agreeable. In Bagdad this date is generally sold dry, and brings $4 to $4.20 for 210 pounds, i. e., it is the most expensive according to weight, but the other sorts, having a great deal of water in their composition, contain proportionately less food. Many Bagdadians prefer this sort, when fresh and softer, to all other kinds. There is an immense consumption of this variety in Bagdad. I believe this date would be a success in America because it is so different from other sorts, and for the reason that it is a remarkably good keeper, and when not too old is really very good eating. It is far superior to the dry dates of Egypt, and not to be confused with dry dates in general, for it has scarcely any disagreeable fibers about the seed. It deserves attention in American plantations." (*Fairchild.*) (No. 868.)

8741.

Maktum. "Considered by the Arab sheik, Abdul Kader Kederry, of Bagdad, to be the finest date, except one, in the world, the *Mirhage* from Mandele, which it resembles, being superior. It is a date not often seen on the Bagdad market, and I was unable to get any of good quality to taste. A very fine date, which was said to be of the *Maktum* sort, which I tasted, was a richer date than the *Kustawi*, although of the same general type. The probabilities are that this is a delicate sort which produces only a small quantity of fruit. The date I tasted came from Kasimain, but the tree is cultivated up the river from Bagdad. These trees were donated to the Department by Sheik Abdul Kader Kederry, of Bagdad." (*Fairchild.*) (No. 869.)

8742.

Burni. "For a description of this date see No. 8569. I believe it properly belongs to Maskat. It being winter I am not able to verify the identification of these varieties, but must buy the plants of Arabs or others who know the sorts." (*Fairchild.*) (No. 870.)

8743.

Zehedi. "This is probably the commonest date about Bagdad. It is the *quickest to develop* and the *heaviest yielder of all the dates about Bagdad*, according to Mr. Raphael Casparkan, of Bagdad, who very kindly donated a lot of twenty-four palms to the Department, including part of these. It is a cheap date here, selling for only $1.40 to $2 per 210 pounds. The date is small, not over 1½ inches long by three-fourths inch in diameter. It is not entirely like Egyptian dates, but is so dry that the individuals do not stick together. They have very little fiber, the stone is small, and the flesh quite sweet even when dry. When fresh this sort is packed in skins and exported to Egypt and Singapore, under the name of *Kursi.* It is often sold on the bunch when fresh and called *Zehedi Gus*, in which shape it is very highly thought of. I tasted the so-called *Kursi* and found it decidedly inferior in flavor and amount of flesh to the *Kustawi.* The variety is, however, I am assured, *the most resistant of any, so far as water is concerned, being quite drought resistant*, and although the

8738 to 8745—Continued.

product is a cheap one, the heavy yields make it a very profitable sort. It ripens about September or October. It sells in Bagdad (dry), I am told, for $1.40 to $2 per 210 pounds." (*Fairchild.*) (No. 871.)

8744.

Barban. "This date is reported to ripen in July and yield only fairly good fruits. It is the earliest ripening of the Bagdad dates, I am told, and deserves a place in the gardens for this reason. This variety is red before ripening but turns black when mature. It is not a very sweet sort, and not very highly thought of by the Bagdadians. It is rarely cultivated except outside of Bagdad. Its early ripening qualities are what make it worthy of trial in America. It is probable that this sort will not ripen so early in America because the amount of heat is probably considerably less." (*Fairchild.*) (No. 872.)

8745.

Sukeri. "A very large variety of date, said by Mr. Raphael Casparkan to be 2 inches or more in length, and when fresh, to be of good quality. Mr. Casparkan donated these to the Government, and the determinations are his, for I could not distinguish the different varieties which he selected. Worthy of trial in Arizona on account of its large size." (*Fairchild.*) (No. 873.)

8746 to 8752. PHOENIX DACTYLIFERA. **Date palm.**

From Bassorah, Arabia. Received through Messrs. Lathrop and Fairchild (Nos. 895 to 901, February 25, 1902), June 7, 1902.

8746.

Berhi. "A variety of date which, though never shipped to the American market, is said by every one in this region to be unquestionably the best date in this part of the Persian Gulf, inferior only to the *Khalasa* date of Hassa. It ripens, as do most all these Shat-el-Arab dates, in the month of September, and it is therefore likely to prove very valuable because of its superior quality and its early ripening character. It ripens in September in Bassorah, where the temperature goes to 117° F. in the shade. It is a sticky date, but nevertheless a variety with a very fine flavor, and grows well on adobe alluvial deposits. It is watered by canal irrigation as often during the year as the tide rises, viz, twice a day. I have tasted this *Berhi,* and it is superior to the *Halawi,* the principal export sort, and also to the *Taberzal.* The seed is very small." (*Fairchild.*) (No. 895.)

8747.

H'weis or *Herezi.* "One of the best dates of the Persian Gulf. A delicate, light-colored date of medium size, with medium-sized stone. It ripens in Bassorah in September. It is very little known, even at Bassorah. Grown, as are all of the dates on the Shat-el-Arab River, in stiff clay, almost adobe soil, in raised areas surrounded by canals, which are flooded twice a day by water from the river as it is backed up by the tides, the variety is a sticky sort, but deserves the serious attention of experimenters with date palms, on account of its superior flavor and excellent color. The summer temperature of Bassorah rises to 117° and sometimes to 120° F. in the shade. In winter it drops to below 50°. The soil where the date is grown is distinctly saline. This date has not been shipped to American markets, but would be a good selling date, and for this reason it is well worth planting in southern California (Colorado Desert) and Arizona." (*Fairchild.*) (No. 896.)

8748.

Sayer or *Ustaamran.* "A variety of date darker in color than the *Halawi,* but of fair flavor. A standard sort in New York. It is said to do best on a light sandy soil, and to require less water than No. 8747. *Sayer* is a word also used to indicate a mixed lot of dates, but these trees are of a distinct long fruited dark sort. The trees are taller than those of the variety *Halawi,* and not so uniformly straight. This sort is most likely to succeed on sandy soils, or, at least, to do better on sandy than on ordinary adobe soil. It is inferior in quality to *Halawi* and *Khadrawi,* but, nevertheless, a good market date. It is grown here very extensively." (*Fairchild.*) (No. 897.)

8746 to 8752—Continued.

8749.

Gunnami. A male variety. "Considered by Hadji Abdulla Negem as the best pollen-producing male in this region. It holds its pollen best, and the latter is found to be 'stronger' than that of any other sort. One male tree suffices for 100 female trees." (*Fairchild.*) (No. 898.)

8750.

Halawi. "One of the standard sorts grown on the Shat-el-Arab River, of Arabia, and it is one of the principal dates shipped to the American market. There must be millions of trees of this variety along the river. A fairly light-colored date, short and thick, with a good-sized stone, and very little fiber about the seed. Grown under the same conditions as No. 8747, and ripens in September." (*Fairchild.*) (No. 899.)

8751.

Khadrawi. "A darker colored, longer date than the *Halawi*, and inferior to it. It is one of the standard sorts for shipment to America, but is not a delicate skinned variety; therefore an excellent packing date. It is a sticky date, and ripens in September or the first of October." (*Fairchild.*) (No. 900.)

8752.

Unnamed variety. "Sent without label from Abu Kassib, by Hadji Abdulla Negem, with Nos. 8746 to 8752, for all of which I am indebted to the kind assistance of Mr. H. P. Chalk, agent of Hills Bro. & Co., of New York." (*Fairchild.*) (No. 901.)

8753. PHOENIX DACTYLIFERA. **Date palm.**

From Hassa, Arabia. Received through Messrs. Lathrop and Fairchild (No. 905, March 17, 1902), June 7, 1902.

Khalasa or *Khalasi.* "This date is known all over the Persian Gulf as one of the three best dates. It certainly has few equals, and its only rivals are the *Maktum*, *Taberzal*, and *Berhi*, and probably also, though I have not tasted it, the *Mirhage*. Palgrave, author of 'Travels in Eastern Arabia,' 1863, says the literal translation of the name *Khalasi* is 'quintessence,' and that it 'is easily first of its kind.' The country in which it is grown is, according to Zwemer, a sandy one, with underground springs or water courses, water being reached only a few feet below the surface of the soil. This country of Hassa or El Hassa lies 60 miles or so inland from Bahrein Island, and these palms were brought by camels from that region. The climate in winter is hot in daytime, but cold at night, and in summer it is excessively hot. This variety matures its fruit, I presume, sometime in August or September, though I can not state this positively. It is a variety worthy the serious consideration of our date growers, as it will probably be better suited to our conditions than the Bassorah dates, which will require more water to bring them to full development. We are indebted to H. B. M. Vice-Consul J. C. Gaskin, of Bahrein, for securing these sets and for many other favors, and also to Mr. H. M. Zwemer for information about Hassa dates." (*Fairchild.*)

8754 to 8761. PHOENIX DACTYLIFERA. **Date palm.**

From Maskat, Arabia. Received through Messrs. Lathrop and Fairchild (Nos. 906 to 913, March 21, 1903), June 7, 1903.

8754.

Fard. "A long, large-sized, late date, of dark color but good flavor. About 1,000 tons of this date are exported from Maskat to America every year, it being the principal export date of the region of Maskat. These young palms were brought from Semail, 50 miles in the interior, where there are extensive plantations of this and other sorts. There are estimated by Vice-Consul Mackirdy, who very kindly secured these for the Department, to be half a million date trees in the Semail Valley. This date ripens in August and sells for $40 Mexican per 1,800 pounds. It is the best flavored soft packing date in the region. It is adapted to the hottest regions in America." (*Fairchild.*) (No. 906.)

8754 to 8761—Continued.

8755.

Burni. "This is a light-colored date about the same size as the *Fard*, but thinner, also from Semail. It ripens in Maskat in July. It was formerly shipped to America, but was found to be a poorer keeper than the *Fard*, and now it is no longer demanded. Because of its scarcity it sells for $50 Mexican per 1,800 pounds." (*Fairchild.*) (No. 907.)

8756.

Nagal. "An early variety from Semail, 50 miles in the interior, *ripening in June.* It is a light-colored date about 1¼ inches long and three-fourths inch in diameter. It is not as sweet as the *Fard*, but is highly prized because *it is the earliest date in the region.* It is consumed locally and only in a fresh condition. High prices are paid for it by the Arabs. It is a soft sort, resembling the *Fard.*" (*Fairchild.*) (No. 908.)

8757.

Mubsali. "From Semail, 50 miles inland from Maskat. This date is a long, large variety, which is picked before being ripe, boiled for an hour in salt water, and then spread out in the sun to dry. (See Nos. 8563 and 8564.) These dates, which are as hard as stick candy, and almost as sweet, are sold in India, where there is a big demand for them, and where higher prices are paid than for the ordinary *Fard* variety. They sell for $80 Mexican per 1,800 pounds. This belongs to the *Karak pokhta* class of dates, which are served in India at every wedding and festival. They are sometimes eaten fresh. It is the best paying date in Maskat. Suitable for dry, hot regions. It ripens in July." (*Fairchild.*) (No. 909.)

8758.

Khanezi. "From Semail, 50 miles inland from Maskat. An almost round, soft, very sweet sort, only consumed locally. It is a rare variety, ripening in July. It is eaten in the fresh state and considered one of the best of this kind in Maskat." (*Fairchild.*) (No. 910.)

8759.

Khassab. "From Semail, 50 miles inland from Maskat. A red variety when ripe, somewhat shorter in shape than the *Fard.* It ripens in August. It is a soft variety, therefore not a shipping date. It is reported to be the heaviest yielder of any, as much as 450 pounds being borne by a single tree. It is not as sweet as the *Fard*, but is still of good quality." (*Fairchild.*) (No. 911.)

8760.

Helladi. "From Semail, a date region 50 miles back of the town of Maskat. It is as round fruited as a walnut, light colored and soft. It is not a packing date but is used fresh. The bunches are exceedingly large. A rare sort even in Maskat." (*Fairchild.*) (No. 912.)

8761.

"*Fachl* or *Fahel*, meaning *male* date, from the valley of Semail, 50 miles in the interior behind Maskat. This is the variety used in this great valley, where half a million trees are grown, as the pollinator. It might be called simply *Semail Fahel*, to distinguish it from the Egyptian *Fahel* or male sent in 1900." (*Fairchild.*) (No. 913.)

8762 to 8785. PHOENIX DACTYLIFERA. **Date palm.**

From Kej, Baluchistan. Received through Messrs. Lathrop and Fairchild (Nos. 914 to 937, March 23, 1902), June 7, 1902.

A collection of date palms secured through the kindness of Lieutenants Grant and Maxwell, of the First Baluchistan Light Infantry, from Kej, a region six days by camel from Guadur, near the Pangh Ghur region. The soil is an adobe but mixed with small rocks. It is watered from artificial wells. The palms are as follows:

8762.

Mozati. One of the finest flavored dates in the world. It is sent in earthen jars, packed in the sirup of inferior sorts, to Kurrachee and Bombay. It is said to ripen in July. It is a large, round sort with small stone, golden brown flesh, and delicate skin. (No. 914.)

8763.

Gush. A male variety. (No. 915.)

8764.

Apdandon. (No. 916.)

8765.

Soont Gora. (No. 917.)

8766.

Hashna. (No. 918.)

8767.

Gonzelli. (No. 919.)

8768.

Jalghi. (No. 920.)

8769.

Bagum Jurghi. (No. 921.)

8770.

Shukkeri. (No. 922.)

8771.

Koroch. (No. 923.)

8772.

Hallani. (No. 924.)

8773.

Shapego. (No. 925.)

8774.

Dishtari. (No. 926.)

8775.

Chupshook. (No. 927.)

8776.

Korroo. (No. 928.)

8777.

Rogani. (No. 929.)

8778.

Churpan. (No. 930.)

8779.

Kharba. (No. 931.)

8780.

Dundari. (No. 932.)

8781.

Subzoo. (No. 933.)

8782.

Gond Gorbug. (No. 934.)

8783.

Washclout. (No. 935.)

8784.

Kalara. (No. 936.)

8785.

Hurshut. (No. 937.)

8786 to 8793. PHOENIX DACTYLIFERA. **Date.**

From the vicinity of the Persian Gulf. Received through Messrs. Lathrop and Fairchild, June 7, 1902. Samples of dried dates as follows:

8786.

Bedraihe. From Bagdad market. (No. 868.) (See No. 8740.)

8787.

A variety sold in the Kurrachee market in two-gallon earthen jars. It is said to come from the interior of Baluchistan. Its name is not known.

8788.

Kadrawi. (No. 900.) (See No. 8751.)

8786 to 8793—Continued.

8789.

Kustawi. From Bagdad market. (No. 866.) (See No. 8738.) A very fine date, though somewhat stringy.

8790.

Berhi. Dates as packed in paper cartons for European market. (No. 895.) (See No. 8746.)

8791.

Halawi. Dates as packed in paper cartons for export to all parts of the world. (No. 899.) (See No. 8750.)

8792.

Busser. From Bassorah, Arabia. An inferior variety.

8793.

Zehedi. "From Bagdad market." (*Fairchild.*) (No. 871.) (See No. 8743.)

8794. PHOENIX DACTYLIFERA. **Date.**

From Bagdad, Arabia. Received through Messrs. Lathrop and Fairchild (No. 885, March 10, 1903), June 7, 1902.

Taberzal. "Sample of dried dates. This is a rare date even at Bagdad, and I did not find it on the markets. Agha Mohammed, British consular agent at Kasimain, very kindly donated these to the Department. It is a small date $1\frac{1}{4}$ to $1\frac{3}{8}$ inches long by about seven-eighths inch in diameter. When dry it is of an amber color. The skin is a lighter shade than the flesh, is loose, rather papery in texture, and can be removed with the fingers from the dried flesh. The flesh is never dry in the sense of being hard, but has the consistency of a chocolate caramel and is sweet and of characteristic date flavor. The seed is of medium size and fits loosely in the dry flesh. There is scarcely any fiber about the seed. The stem has a trifle too large disk (involucre), but is easily removed with the fingers. When fresh it is considered one of the most delicate dates in Bagdad, though not so fine or so large as the *Berhi* (No. 8746), which it resembles. I have not seen the *Berhi*, but take this as the opinion of a date shipper. These dates, if not pressed into skins or cases, are dry enough to be handled with the fingers. This is a point of great importance. The *Deglet Noor* of Algiers would probably be quite as unappetizing if pressed into baskets or boxes. I secured these samples too late to make it possible to secure plants, but they can be had through Vice-Consul Hürner, of Bagdad, from Agha Mohammed, who donated these." (*Fairchild.*)

8795. PHOENIX DACTYLIFERA. **Date.**

From Bagdad, Arabia. Received through Messrs. Lathrop and Fairchild, June 7, 1902.

Ascherasi. Samples of dates. (See No. 8739, L. & F. No. 867.)

8796 and 8797. VITIS VINIFERA. **Grape.**

From Kandahar, India. Received through Messrs. Lathrop and Fairchild, June 7, 1902.

Samples of raisins bought in the Kurrachee market.

8796.

Seedless. Very sweet and thoroughly candied.

8797.

A large, light-colored raisin with seeds.

8798. Gossypium sp. **Cotton.**

From Arabia. Received through Messrs. Lathrop and Fairchild, June 7, 1902.

"Probably from the garden of Abdul Kader Kederry, on the Tigris River." (*Fairchild.*)

8799. Capsicum annuum. **Red pepper.**

From Bassorah, Arabia. Received through Messrs. Lathrop and Fairchild (No. 852, February 26, 1902), June 7, 1902.

"A lance-shaped variety of red pepper from the market of Bassorah. The fruits are not over 1 inch to $1\frac{1}{4}$ inches long." (*Fairchild.*)

8800. Pistacia vera × (?) **Butum.**

From Bagdad, Arabia. Received through Messrs. Lathrop and Fairchild (No. 874, March 9, 1902), June 7, 1902.

"A small packet of seeds from the market of Bagdad. These may be hardier than the European butum." (*Fairchild.*)

8801. Pistacia mutica. **Menengech.**

From Bagdad, Arabia. Received through Messrs. Lathrop and Fairchild (No. 874, March 9, 1902), June 7, 1902.

"Sample of seed from Bagdad market. These may prove hardier stocks than the European sorts." (*Fairchild.*)

8802. (Undetermined.) **Sissi.**

From Bagdad, Arabia. Received through Messrs. Lathrop and Fairchild (No. 875, March 11, 1902), June 7, 1902.

"Seeds brought from the mountains of Persia beyond Mosul. They are edible and are eaten by the Arabs as the Chinese eat melon seeds. The flesh is sweet, but there is little of it. The plant which produces these fruits is said to be a shrub and likely to withstand desert conditions." (*Fairchild.*)

8803. Amaranthus hypochondriacus (?) **Chagoggee.**

From Wönsau, Korea. Presented by Mr. C. F. S. Billbrough, of Wönsau, through Messrs. Lathrop and Fairchild (No. 773), June 10, 1902.

"Used in Korea as an ornamental, having masses of bright red foliage. The plant is an annual, 6 feet high. It is used by the natives for food, being boiled like cabbage. It is, further, much relished by stock. It should be grown for identification and may prove a new thing as an ornamental or may be of use as a fodder plant." (*Fairchild.*)

8804. Oryza sativa. **Rice.**

From Niuchwang, China. Presented by Hon. Henry B. Miller, United States consul, through the Department of State. Received June 10, 1902.

K'ien Tzu. "Dry land rice, sown the last of April or the first of May and harvested early in September. It grows best on low land or on rich yellow soil. It must not be flooded, but requires rain at the time the grain is forming. It will not grow on high, dry clay land." (*Miller.*)

8805. Panicum miliaceum. **Broom-corn millet.**

From Bassorah, Arabia. Received through Messrs. Lathrop and Fairchild (No. 853, February 25, 1902), June 7, 1902.

Dukkhn. "A kind of millet which is sown on the mud after flooding the soil with irrigation water and left to mature its crop without further watering. It is said to produce and ripen its heads in forty days, so that two crops are generally grown each year on the same soil. This is sent for trial in the Colorado Desert region and western Texas." (*Fairchild.*)

8806. MEDICAGO SATIVA. **Alfalfa.**

From Bassorah, Arabia. Received through Messrs. Lathrop and Fairchild (No. 904, March 15, 1902), June 7, 1902.

Djet. "This is treated like any alfalfa (see No. 8823). This is given a separate number as it comes from 500 miles south of the locality whence No. 8823 was sent. Secured through the assistance of Mr. Raphael Sayegh, of Bassorah." (*Fairchild.*)

8807. CICER ARIETINUM. **Chick-pea.**

From Bassorah, Arabia. Received through Messrs. Lathrop and Fairchild (No. 903, March 15, 1902), June 7, 1902.

Humus. "Sold everywhere on the markets of Mesopotamia. It is suited to very hot regions with little water. Sent for trials in California and Arizona." (*Fairchild.*)

8808. TRITICUM DURUM. **Wheat.**

From Bassorah, Arabia. Received through Messrs. Lathrop and Fairchild (No. 902, March 16, 1902), June 7, 1902.

Karun. "A hard wheat which is grown on the river Karun in Persia. It is reported to be the best wheat coming to the Bassorah market and is grown in a region where scant rains fall and which is exposed to excessive hot weather. Suited for our dry, hot Southwest." (*Fairchild.*)

8809. HORDEUM TETRASTICHUM. **Barley.**

From Bagdad, Arabia. Received through Messrs. Lathrop and Fairchild (No. 886, March 10, 1902), June 7, 1902.

Black. "The native barley of the Tigris Valley above Bagdad. It should be suited to culture in our dry Southwest, as it is a short season variety and depends on the scanty rains in January and February for its moisture. I understand that this barley is sometimes exported to Europe." (*Fairchild.*)

8810. LATHYRUS CICER. **Pea.**

From Bagdad, Arabia. Received through Messrs. Lathrop and Fairchild (No. 880, March 9, 1902), June 7, 1902.

Hortuman. "A species of the pea family, which in the market is called *Hortuman*, but, according to the dictionaries, *Hortuman* means *oat*, and this is evidently one of the Leguminosæ. It is cultivated by planting in hills or drills, and grows, according to the very unsatisfactory information which I could pick up, to a height of about 2 feet. The grains are produced in a pod and they form the valuable product of the plant. The straw is, however, also said to be fed to cattle, but has not any great value. The grain is exceedingly hard and requires grinding before it can be used. It is then cooked with rice or boiled and eaten alone. It is grown without much water, but generally on irrigated lands. It is suitable for trial in the extremely hot regions of the Colorado Desert. Its use as a soiling crop is quite unknown, but it may be of considerable value, nevertheless, for people here are evidently quite ignorant of soiling crops. Bought in the bazar at Bagdad, where it is not at this season a very common grain." (*Fairchild.*)

8811. TRITICUM DURUM. **Wheat.**

From Bagdad, Arabia. Received through Messrs. Lathrop and Fairchild (No. 879, March 9, 1902), June 7, 1902.

Hurma. "A large-grained, hard wheat which is called *Hurma*, meaning widow, because of the large size of the grains. This sample comes from the wheat-growing region of Mosul and is cultivated without irrigation. It deserves a trial in our arid-region experiments." (*Fairchild.*)

8812. TRITICUM VULGARE. **Wheat.**

From Bagdad, Arabia. Received through Messrs. Lathrop and Fairchild (No. 878, March 9, 1902), June 7, 1902.

Kermansha. "The finest looking soft wheat to be found on the Bagdad market. It comes from Kermansha, in Persia, where it is grown without irrigation. It brings a lower price than the *Kurdistan* and *Karoon* wheats, because it is soft and has not the 'strength' of the latter, which is necessary in the making of the Arabic 'Hubus' or pancake-like bread. It is worth a trial in dry regions." (*Fairchild.*)

8813. TRITICUM DURUM. **Wheat.**

From Bagdad, Arabia. Received through Messrs. Lathrop and Fairchild (No. 877, March 9, 1902), June 7, 1902.

Kurd. "A wheat grown in Kurdistan and brought down to the Bagdad market. It is used for bread making and brings good prices, being, in fact, one of the highest priced wheats in the Bagdad market. Bread from this wheat is made in thin sheets like German pancakes and has a decided mixture of the macaroni wheat flour in it. This wheat is harder than No. 8812. The *Kurd* wheats and the *Karun* or *Karoon* wheats are considered the best sorts sold in Bagdad and I understand they are grown without irrigation, depending only upon the scanty rains. They should be tested to show their resistance to rust and drought." (*Fairchild.*)

8814. PHASEOLUS VIRIDISSIMUS. **Bean.**

From Bassorah, Arabia. Received through Messrs. Lathrop and Fairchild (No. 864, March 3, 1902), June 7, 1902.

Maash. This is grown in Mesopotamia and used as food. It is employed with rice and even boiled and eaten alone. It is planted in drills or hills, like ordinary string beans, and grows to a height of 2 feet or more. This resembles, I am informed, the *Merjemek* of Turkey. I think this is the same species as No. 6430 sent in 1901 as *Phaseolus viridissimus*, secured in Athens, Greece. This bean should be tested in the irrigated lands of the Southwest, and as a vegetable throughout the Southern States of America." (*Fairchild.*)

8815. ANDROPOGON SORGHUM. **Sorghum.**

From Bassorah, Arabia. Received through Messrs. Lathrop and Fairchild (No. 863, February 25, 1902), June 7, 1902.

Edra. "A kind of sorghum like the *Dura* of the Egyptians. This is a white variety grown in this hot region where the temperature often goes to 117° F. and during the summer ranges between 85° and 99° F. day and night. No other irrigation than that of the rains is received by the plants, and yet it is said that it can be relied upon generally to give a fair crop. It is worth trying on the scorching deserts of California. The grain makes excellent second-class food." (*Fairchild.*)

8816 to 8819. TRITICUM. **Wheat.**

From Bassorah, Arabia. Received through Messrs. Lathrop and Fairchild (Nos. 857 to 861, February 25, 1902), June 7, 1902.

"A collection of wheats from the Euphrates, Tigris, and Karun river valleys, which are the three great wheat growing regions of Mesopotamia. These wheats are not generally grown by irrigation but depend upon the rains for their water, and as the climate is a dry and excessively hot one and the soil an adobe, inclined to be alkaline, these wheats deserve trial in similar excessively hot regions in America. Their rust-resisting qualities I know nothing about. With the exception of the Karun variety they are not especially fine wheats, but from their very long culture here in Mesopotamia they should be tried in the Colorado Desert region and on any stiff soil which is subject to droughts. Larger quantities may be had by corresponding with Mr. H. P. Chalk, of Bassorah, referring to the varieties by name. These are exposed two months to a summer shade temperature of 117° to 120° F. and stand it well. The wheats are as follows." (*Fairchild.*)

8816. TRITICUM DURUM.

Buelha. A hard wheat from Arag, on the Euphrates River. (No. 858.)

8817. TRITICUM VULGARE.

Bagdad. A soft variety from Bagdad. (No. 859.)

8816 to 8819 Continued.

8818. Triticum durum.

Koola. A hard wheat from Kurdistan; exact origin in doubt. (No. 860.)

8819. Triticum durum.

Humera. A hard sort of dark color, from Arag, on the Euphrates River.

8820. Triticum durum. **Wheat.**

From Bagdad, Arabia. Received through Messrs. Lathrop and Fairchild (No. 876, March 9, 1902), June 7, 1902.

Hurma. "A hard wheat grown at Desphuli, in Persia, near the Karun River. This sample was bought on the market in Bagdad. It is grown in a region noted for its extreme summer heat and scanty rains and should be suited to arid-land conditions. Exact data were unobtainable." (*Fairchild.*)

8821. Panicum miliaceum. **Broom-corn millet.**

From Kurrachee, India. Received through Messrs. Lathrop and Fairchild (No. 943, March 27, 1902), June 7, 1902.

San China. "Grown on the Sewage Farm at Kurrachee. It is an excellent forage crop, and should be tried, though not new to America, in the Colorado Desert region. The grain is fed to cattle and working bullocks. It is coarse, but is said to be a profitable crop. The yields are large. It is possibly a different strain from the ordinary." (*Fairchild.*)

8822. Zea mays. **Maize.**

From Bagdad, Arabia. Received through Messrs. Lathrop and Fairchild (No. 884, March 11, 1902), June 7, 1902.

"A Mesopotamian maize, given me by Agha Mohammed, of Kasimain. It is the variety commonly grown in the region and is sent as illustrating the low condition of agriculture in this wonderful region." (*Fairchild.*)

8823. Medicago sativa. **Alfalfa.**

From Bagdad, Arabia. Presented by Agha Mohammed, the Nawab at Kasimain and consular agent at that place for His British Majesty. Received through Messrs. Lathrop and Fairchild (No. 881, March 10, 1902), June 7, 1902.

Djet or *El-djet.* "A larger quantity of seed can be secured through arrangement with the American vice-consul at Bagdad, Mr. Rudolph Hürner. Although the Nawab admits this to be the best plant for horses he has ever grown, he says that he is the first in the region of Bagdad to grow it, and this, notwithstanding the fact that at Kerbella, only a day's journey away, large areas have been planted to it from ancient times. In the especially hot summers the fields are irrigated three times a month; in the cooler summers only twice. From 9 to 10 cuttings are taken each year, and the fields are manured with stable manure after each cutting. The life, i. e., profitable life, of a field of this *djet* is seven years. This variety should be admirably suited to our irrigated lands in California and Arizona, and deserves a trial in comparison with the Turkestan alfalfa. It should also be tested as to alkali resistance." (*Fairchild.*)

8824. Prunus sp. **Plum.**

From Kurrachee, India. Received through Messrs. Lathrop and Fairchild (No. 940, February 26, 1902), June 7, 1902.

Kandahar. "A peculiar dried plum sold on the market in Kurrachee and said to have come down from Kandahar. I have never eaten this plum stewed, so do not know of what quality it is. Sent for breeding purposes." (*Fairchild.*)

8825. PRUNUS ARMENIACA. **Apricot.**

From Kurrachee, India. Received through Messrs. Lathrop and Fairchild (No. 938, February 26, 1902), June 7, 1902.

"Dried apricots which were bought on the market in Kurrachee as coming from Kandahar. These apricots, when stewed and served as they are in India, have a really very delicious flavor. There is a bit of disagreeable fiber about the stone, but altogether they struck me as a novelty worthy of attention. Should they prove valuable, cuttings may be obtained by correspondence." (*Fairchild.*)

8826. PRUNUS sp. **Plum.**

From Arabia. Received through Messrs. Lathrop and Fairchild, June 7, 1902.

No data furnished.

8827. PRUNUS sp. **Plum.**

From Bassorah, Arabia. Received through Messrs. Lathrop and Fairchild (No. 865, February 26, 1902), June 7, 1902.

Aluche. "A variety sold on the markets of Bassorah as coming from Persia. A sour variety, which may be useful to breeders." (*Fairchild.*)

8828. ZIZYPHUS JUJUBA. **Jujube.**

From Bassorah, Arabia. Received through Messrs. Lathrop and Fairchild, June 7, 1902.

Samples of a variety similar to No. 8702.

8829 to 8847. FICUS CARICA. **Fig.**

From Italy. Received through Mr. W. T. Swingle (Nos. 101 to 119), June 13, 1902.

"The following collection of caprifig cuttings was obtained during the spring of 1902 at Naples, the classic ground for the study of caprifigs and caprification. Considerable attention was given to the study of the botanical characters of the caprifig trees, and detailed descriptions were drawn up of seven of the principal varieties of caprifigs occurring in this region. It was found possible to draw up a key for the determination of the different varieties of caprifig, based on these characters, which key is given below. It applies only to those of the caprifigs which were carefully studied, but it will doubtless prove useful to investigators who wish to study the caprifigs of Naples. This collection, like that included under numbers 6473 to 6491 and 6773 to 6823, has been introduced to this country in the hope of securing an assortment of caprifigs adapted to all the climatic and soil conditions occurring in California, where all of these caprifigs will be tested as soon as possible. A few varieties of figs are also included in this collection." (*Swingle.*)

KEY TO SEVEN PRINCIPAL VARIETIES OF NEAPOLITAN CAPRIFIGS.

Leaves *nearly entire* or but slightly lobed, small, short, covered with a golden pubescence; middle lobe obtuse and rounded. *Petioles short* and *very stout*, also pubescent. Veins reddish on drying. Profichi ovate with few male flowers; flower pedicels green. No. 8838.

Leaves decidedly lobed, or, if not, nearly smooth.

Leaves *velvety pubescent, petioles short and very stout*, also pubescent. Leaves many (5–7) *lobed.* Middle lobe with obtuse and rounded apex. Veins green on drying. Lamina yellow dotted. Profichi small *oval* with many male flowers. No. 8844.

Leaves not velvety, hairy; profichi ovate.

Petioles very long (reaching beyond sinuses when reflexed). Sinuses very deep and narrow. Middle lobe with rounded apex. Leaf long and narrow with U-shaped base. Veins reddish on drying. No. 8829.

Petioles short or medium in length (not reaching to sinuses if reflexed).

Profichi depressed at apex. Flower *cavity broader than long.* Leaves with *deep and narrow sinuses;* medium sized, regular in outline; 3-lobed, middle lobe with acute straight-sided apex. Lamina decurrent on petiole. Veins drying reddish; flower pedicels purplish. No. 8834.

Sinuses open, usually shallow. Profichi not depressed at apex. Flower cavity longer than broad.

Middle lobe rounded and obtuse. Leaf and petiole moderately hairy. Sinuses shallow and open. Veins drying reddish. Lamina not decurrent. No. 8832.

Middle lobe with acute, straight-sided apex.

Leaves large, irregularly 3–5 lobed. Sinus shallow, usually very open. Lamina decurrent. Veins drying reddish. Flower pedicels purplish. No. 8845.

Leaves medium sized. Lamina not decurrent. Veins green on drying. *Petioles and palmate veins very glabrous.* Flower pedicels green. No. 8837.

8829 to 8847—Continued.

8829.

From Naples. "A medium-sized tree in a garden on Posilipo hill on Strada Nuova di Posilipo, evidently a cultivated sort. It bore a fair number of *mamme;* full of *Blastophaga* on April 19, and still had a few *mamme* attached on May 14. The *profichi* are abundant. Apparently a valuable late sort. Its botanical characters are as follows: *Petioles very long*, when reflexed reaching beyond base of sinuses. Leaves small, long, and narrow, smoothish, 3-lobed, with deep and narrow sinuses, sometimes closed above. Middle lobe much expanded, with a blunt rounded apex; lateral lobes unusually narrow. Base U-shaped, with decurrent lamina. Veins drying reddish. Petioles very long and slender; slightly hairy. Profichi ovate, medium sized, 45 x 30 mm. Very unlike other sorts in leaf characters. Resembles most No. 8834, but has very much longer petioles, while No. 8834 has acute, straight-sided apex and profichi depressed at tip. No. 8832 has similar U-shaped base, but differs greatly in having shallow sinuses, shorter petioles, and abruptly attached lamina." (*Swingle.*) (No. 101.)

8830.

From Naples. "A large tree in the Botanic Garden, covered with *profichi*, but destitute of *mamme.* The *profichi* were far advanced and had abundant male flowers; but one that had been injured was soft, and this may indicate that this variety has the drawback of producing *profichi* which soften as they ripen. A valuable early sort." (*Swingle.*) (No. 102.)

8831.

From Naples. "A medium-sized tree, evidently of a cultivated sort, in a garden on Posilipo hill, near Villanova. Bore both *mamme* and *profichi.*" (*Swingle.*) (No. 103.)

8832.

From Naples. "A medium-sized tree, of a cultivated sort, in a garden on Posilipo hill. It had a few *mamme* still attached and many *profichi.* Its botanical characters are as follows: *Leaf U-shaped with shallow open sinuses and rounded apex.* Leaf medium sized, slightly hairy, 3-lobed, with shallow and rather open sinuses. Base U-shaped, with abruptly joined lamina. Apex of middle segment rounded. Veins slightly reddish on drying. Petiole medium length and not very slender; somewhat hairy. Profichi ovate, 58 x 37, with abundant male flowers. Near to No. 8837, but has a rounded instead of an acute apex and more hairy petioles. See under 8829. Differs from No. 8834 with U-shaped leaves in having open shallow sinuses and rounded apex." (*Swingle.*) (No. 104.)

8833.

From Naples. "A small seedling tree, growing from a wall retaining a roadway on Posilipo hill. Floral envelopes long and nearly hiding the flowers, which were still immature on May 9, 1902. Probably a seedling fig, but possibly a very large caprifig." (*Swingle.*) (No. 105.)

8834.

From Resina, near Naples. "A large tree in Villa Amelia, bearing a few *mamme* and abundant *profichi.* Evidently a cultivated sort. The tree had been caprified with *mamme*, in spite of the presence of a fair number of *mamme* attached to the branches. Its botanical characters are as follows: *Profichi depressed at apex.* Leaves small, rounded, regular in outline, 3-lobed, slightly hairy, with deep, narrow sinuses, often closed. Middle lobe with acute, straight-sided apex. Base U-shaped, with decurrent lamina. Veins drying reddish. Petiole medium or short, slender, slightly hairy. Profichi ovate, depressed at apex, 52 x 36. Some of the flower pedicels purplish. Differs from No. 8845 in smaller leaves, regular in outline, and narrower sinus, and from No. 8837 in having reddish veins on drying and a decurrent lamina. See also under No. 8829, which has longer petioles and rounded tip." (*Swingle.*) (No. 106.)

8829 to 8847 Continued.

8835.

From Resina, near Naples. "A medium-sized tree in Villa Amelia, probably the same as No. 8834." (*Swingle.*) (No. 107.)

8836.

From San Giovanni a Teduccio, near Naples. "A large tree, which had been cut back for grafting; growing in the garden of Dammann & Co. Owing to the presence of only young trees, there were no *mamme*, but a few *profichi* with very long pedicels were seen." (*Swingle.*) (No. 108.)

8837.

From Naples. "A medium-sized tree, evidently of a cultivated sort, growing in a garden on Posilipo hill. Had a few *mamme* and abundant, very large *profichi*, with numerous male flowers. A promising sort. Its botanical characters are as follows: *Petioles almost glabrous.* Leaves medium sized, slightly hairy, 3-lobed, with rather deep and narrow sinuses. Middle lobe narrow below and bulging above, with very acute, straight-sided apex, bulging moderately. Base cordate; lamina not decurrent, broad space between margin and first palmate vein. Veins drying green. Petioles *glabrous*, or nearly so; slender. Profichi very large ovate, 71 x 42, with very many male flowers. Flower pedicels green. Principal palmate vein glabrous. Skin marked with small reddish brown specks. Resembles No. 8834, but has not decurrent lamina and has flower pedicels and veins of dried leaves green, besides petioles which are less hairy. Very like No. 8845, q. v., and No. 8832." (*Swingle.*) (No. 109.)

8838.

From Naples. "A small tree growing in a garden. No *mamme* were seen, but there were numerous medium-sized *profichi*, which had only a few male flowers. Leaves nearly entire, with golden pubescence. Its botanical characters are as follows: *Leaves nearly entire*, small, short, pubescent, with golden hairs, as are the short, thick petioles; sinuses present, shallow and open, not extending one-third way to middle. Middle lobe blunt deltoid, nearly straight-sided, over 90 mm. long. Veins reddish on drying. Base cordate; lamina abruptly attached to petiole. Ultimate veinlets very fine and visible by transmitted light. Profichi ovate, 53 x 30 mm., with few male flowers. Skin with large, nearly white spots. Resembles No. 8844 in pubescence, which is, however, *less* marked, and in having short, stout petioles. No. 8844 differs in having lobed leaves and *oval* small profichi, and yellow spots on dried leaves. Slightly resembles the slightly lobed No. 8832, but has much shallower sinuses, and No. 8832 has rounded middle lobe and longer slender petiole and smoother leaf." (*Swingle.*) (No. 110.)

8839.

From Naples. "A large tree in a garden on the hill between Arenella and Capodimonte. May be a caprifig." (*Swingle.*) (No. 111.)

8840.

From Naples. "A cultivated sort, growing near No. 8831, in garden on Posilipo hill, near Villanova." (*Swingle.*)

8841.

From Naples. "A cultivated sort, growing in garden near No. 8831, on Posilipo hill, near Villanova." (*Swingle.*) (No. 113.)

8842.

From Vico Equense, near Castellamare. "A medium-sized tree, growing in a cliff by the road between Vico Equense and Sejano. It may be a caprifig." (*Swingle.*) (No. 114.)

8829 to 8847 Continued.

8843.

From Naples. "A good-sized tree, evidently of a cultivated sort, on Posilipo hill. Probably a *brebas* tree, i. e., a sort which matures the spring generation corresponding to the profico generation of a caprifig." (*Swingle.*) (No. 115.)

8844.

From Miseno, near Pozzuoli. "*Profico bianco*, white caprifig. A small tree in the garden on the top of Mount Miseno. It had a few *mamme* and some *profichi* which showed a large number of male flowers. Evidently a cultivated sort of value. Its botanical characters are as follows: *Leaves velvety hairy*, petioles thick and short; also velvety pubescent. Leaves medium sized, short and thick, decidedly 3–7-lobed. Sinuses rather open, usually less than one-half way to middle. Leaves (some at least) show numerous small yellowish dots on the upper surface. Apical lobe bluntly deltoid with nearly straight sides. Base strongly cordate. Lamina abruptly attached to midrib. Veins usually drying green. Lateral lobes bulge so sinus line cuts them. Profichi very small (possibly young?) 38 x 33 *oval*, with many male flowers. Skin marked with large, nearly white dots." (*Swingle.*) (No. 116.)

8845.

From Naples. "A large tree of a cultivated sort, growing in a garden on Posilipo hill. It had numerous *profichi* containing many male flowers. A promising caprifig. Its botanical characters are as follows: *Leaves large, irregular in outline, with very open sinuses.* Leaf large, irregular in outline, somewhat hairy; 3–5-lobed sinuses, rather shallow and very open. Lateral lobes very coarsely dentate. Middle lobe thick and bulging but slightly, with an acute straight-sided apex. Base U-shaped or slightly cordate. Lamina decurrent. Veins reddish on drying; palmate veins hairy. Petioles only slightly hairy, rather long and not very slender. Profichi very large, ovate, 62 x 40, with a good number of male flowers; pedicels of flowers purplish at base. Much resembles No. 8837, but differs in having large leaf, more decurrent lamina, and more hairy petioles and veins, and flower pedicels purplish at base. Most resembles No. 8834; differs in large irregular leaf, with more open sinuses and profichi not depressed at apex." (*Swingle.*) (No. 117.)

8846.

From Naples. "A large cultivated fig in a garden on Posilipo hill, bearing a few *brebas.*" (*Swingle.*) (No. 118.)

8847.

From Lago Averno, near Pozzuoli. "A large tree near the road from Arco Filice to Pozzuoli. It was covered with *brebas* figs. A promising sort of early fig." (*Swingle.*) (No. 119.)

8848 to 8886.

From Nice, France. Presented by A. Robertson-Proschowsky. Received June 13, 1902.

A collection of seeds as follows:

8848. Ageratum mexicanum.

8849. Amorpha fruticosa.

8850. Antholyza aethiopica.

8851. Araujia sericifera.

8852. Aristolochia elegans.

8853. Berberis nepalensis.

8848 to 8886—Continued.

8854. Carica quercifolia.

8855. Cassia corymbosa.

8856. Ceratonia siliqua.

"Sweet fruited." (*Proschowsky.*)

8857. Cercis siliquastrum.

8858. Cordyline banksii.

"This may be some hybrid." (*Proschowsky.*)

8859. Eupatorium sp.

"It has abundant white flowers in midwinter." (*Proschowsky.*)

8860. Eupatorium atrorubens.

"An evergreen bush with very beautiful foliage and flowers in midwinter." (*Proschowsky.*)

8861. Eupatorium atroviolaceum.

8862. Fatsia japonica.

8863. Freylinia cestroides.

8864. Franseria artemisioides.

8865. Glaucium flavum.

8866. Hedera helix var. aurantia .

8867. Hibiscus sp.

8868. Ipomoea ficifolia.

8869. Iris laevigata.

8870. Maytenus boaria.

8871. Melaleuca viridiflora.

8872. Olea europaea.

Nice. "Famous for oil. The fruit is very good for preserving in salt solution. The tree is of a very graceful weeping habit." (*Proschowsky.*)

8873. Olearia haastii.

8874. Oreopanax platanifolium.

"A very ornamental evergreen." (*Proschowsky.*)

8875. Oxalis corniculata var. atropurpurea.

8876. Salvia gesneraeflora.

"A very showy winter-blooming shrub. It produces very few seeds." (*Proschowsky.*)

8877. Senecio deltoides.

8878. Senecio petasites.

8879. Senecio grandifolius.

8880. Solanum pyracanthum.

8881. Solanum sodomaeum.

8848 to 8886—Continued.

8882. SOLLYA HETEROPHYLLA.

"A twining evergreen shrub with very beautiful blue flowers." (*Proschowsky.*)

8883. SOPHORA JAPONICA.

8884. STERCULIA PLATANIFOLIA.

8885. TACSONIA MOLLISSIMA.

"A very beautiful climbing plant, with large rose-colored flowers and abundant fruits of a pleasant, refreshing flavor." (*Proschowsky.*)

8886. TRIGLOCHIN MARITIMUM.

8887 to 8889.

From Erfurt, Germany. Purchased from Haage & Schmidt. Received June 21, 1902.

Palm seeds as follows:

8887. RHOPALOSTYLIS SAPIDA.

8888. HOWEA BELMOREANA.

8889. HOWEA FORSTERIANA.

8890. ERIOBOTRYA JAPONICA. **Loquat.**

From Tokyo, Japan. Received through Messrs. Lathrop and Fairchild (No. 954, June 2, 1902), June 23, 1902.

Tanaka. "The largest fruited loquat in Japan. This variety originated as a seedling in the yard of Mr. Ioshio Tanaka, at 72 Kinskecho, Tokyo. Mr. Tanaka is a noted Japanese authority on economic botany, and as originator of this remarkably large loquat, his own name has appropriately been given to it. A single fruit has weighed more than 97 grams, while the largest reported in Algiers, Malta, or Spain, so far as I am aware, was only 85, and the largest I have seen was only 56 grams. This is certainly a larger sort than any of these noted African or Spanish varieties. The scions were taken from the original seedling tree in Professor Tanaka's yard in Tokyo, and it is to be hoped can be used for budding. The fruit in formalin, which Professor Tanaka showed me, was egg-shaped, and the largest loquat I have ever seen. Quality is said to be very good. Professor Tanaka delivered an address on this loquat in 1897, at Nagasaki, in which he said the range of weight is between 40 and 80 grams only. The weight of 97 grams was exceptional." (*Fairchild.*)

8891. PANICUM CRUS-GALLI. **Japanese millet.**

From Niuchwang, China. Presented by Hon. Henry B. Miller, United States Consul, through the State Department. Received June 23, 1902.

8892. TRITICUM VULGARE. **Wheat.**

From Moscow, Russia. Received through E. Immer & Son, June 27, 1902.

Romanoff Spring.

8893. NICOTIANA TABACUM. **Tobacco.**

From Sumatra. Received through Messrs. Lathrop and Fairchild (No. 955), July 7, 1902.

Deli. "From one of the best plantations in Deli, East Sumatra. Secured by Mr. Barbour Lathrop personally. See special letter of explanation to Dr. Galloway, June 10, 1902." (*Fairchild.*)

8894. CITRUS BIGARADIA (?) **Bitter orange.**

From Shidzuoka, Japan. Received through Messrs. Lathrop and Fairchild (No. 956, June 16, 1902), July 8, 1902.

Natsu dai-dai. "A flat, broad, summer variety of the Japanese bitter orange, which is a remarkable citrous fruit and deserves the study of citrus growers. It is only of fair quality, but ripens at a time when our pomelos are over, and when the craving for a sour breakfast fruit is perhaps strongest, i. e., in May and June. These scions came from a noted old citrus grower near Shidzuoka, and are a gift to the United States Government. For fuller notes on this fruit see No. 8903. Tanaka gives in his 'Useful Plants of Japan' *Citrus bigaradia* as the species name for *Dai-dai*, but does not identify the *Natsu dai-dai*." (*Fairchild.*)

8895. CITRUS BIGARADIA (?). **Bitter orange.**

From Shidzuoka, Japan. Received through Messrs. Lathrop and Fairchild (No. 957, June 16, 1902), July 8, 1902.

Natsu dai-dai. "A globular formed, slightly different variety of summer bitter orange from No. 8894. Donated by a famous old citrus grower near Shidzuoka, where the government is going to start an experiment station for citrous and other fruits. For a fuller description on this fruit see Nos. 8894 and 8903." (*Fairchild.*)

8896. CITRUS JAPONICA. **Kumquat.**

From Shidzuoka, Japan. Received through Messrs. Lathrop and Fairchild (No. 958), July 8, 1902.

Nimpo. "Scions of one of the best varieties of kumquat in Japau; with large, round fruits. These kumquats, which are small oranges, eaten skin and all, are much more common in China and Japan than in America, and are worthy of being much better known on our markets. Donated by a veteran citrus grower in Shidzuoka." (*Fairchild.*)

8897 to 8899. TRITICUM DURUM. **Wheat.**

From Bombay, India. Received through Messrs. Lathrop and Fairchild (No. 945, April 2, 1902), July 14, 1902.

Three varieties of hard wheat from Ralli Brothers, in Bombay, suited for macaroni making. One sack of each forwarded by Latham & Co., of Bombay.

8897.

Khata. "This variety has been tested in Nag Pur, where it proved the most rust resistant of any kind experimented with. Nag Pur is one of the hottest regions in India, and any wheat which endures the heat of that region will be likely to do well in our desert regions of Arizona and California. This *Khata* is said by Ralli Brothers to be the best of all Indian hard wheats, and whenever they can buy it cheap enough and ship it to Genoa it brings as good a price as the hard Russian wheats. This deserves the serious attention of the hard-wheat experimenters, and may prove superior to the Algerian, Russian, or Spanish varieties for our conditions." (*Fairchild.*) (No. 945a.)

8898.

Khandwa. "This is not so good from the standpoint of such big firms as Ralli Brothers, and it does not have the reputation of being as rust resistant as the *Khata*." (*Fairchild.*) (No. 945b.)

8899.

Pila gheen. "This is not so good from the standpoint of such big firms as Ralli Brothers, and it does not have the reputation of being as rust resistant as the *Khata*." (*Fairchild.*) (No. 945c.)

8900. GLYCINE HISPIDA. **Soy bean.**

From Anjo, Japan. Received through Messrs. Lathrop and Fairchild (No. 963, June 29, 1902), July 24, 1902.

"Twenty-six numbered seeds of a giant soy bean presented to the Department by Mr. K. Obata, director of the Tokai branch agricultural experiment station at Anjo, Japan, on condition that should any of the seeds prove to have inherited the characteristics of its female parent he is to have returned to him a fair quantity of the beans which it produces. All the beans have been numbered, and it is desired especially that a record of each be kept for information. This most exceptional sport from which these beans are taken measured 12½ feet in length and had a stem 1 inch in diameter at the base. It yielded about one-fifth of a gallon of beans, while ordinary plants, I am assured by Mr. Obata, give from 50 to 60 seeds only. Its root system is well developed, but whether unusual it is impossible to say, as it was dug before Mr. Obata saw it. The history of this most remarkable sport is as follows: Mr. J. Miyazaki, a descendant of a Samurai and now a second-hand clothier in the village of Okasaki, found in his small back yard a soy bean which neither he nor his wife had planted purposely, but over which they quarreled, the wife wishing to pull it up because it grew to such unusual proportions and spread over the whole yard. Mr. Miyazaki, however, found in this abnormal plant something to interest him, and when the local district fair was held in Mukada in October he dug up the plant and exhibited it there, but he unfortunately and thoughtlessly ate up most of the beans. Mr. Obata, of the experiment station at Anjo, saw the plant at the fair, visited Mr. Miyazaki's place, and rescued the remaining handful of seed. He got samples of the soil where the plant grew and has sown about 20 seeds in this soil at the experiment station. I have seen and photographed this remarkable sport and think it worthy of the most careful attention." (*Fairchild.*)

8901 and 8901a. PYRUS COMMUNIS. **Pear.**

From Chios Island, Turkey in Asia. Presented by Mr. N. J. Pantelides, through Mr. D. G. Fairchild. Received July 29, 1902.

8901.

Chamogea.

8901a.

Kurania kirakia.

8902. CITRUS NOBILIS. **Mandarin orange.**

From Fukui, Japan. Received through Messrs. Lathrop and Fairchild (No. 959, June 24, 1902), July 21, 1902.

Unshu. "A large-fruited, thick, loose-skinned mandarin orange, which is generally quite seedless but sometimes has one or two seeds. In quality it is not quite so sweet as the common but smaller *Kishu Mikan*, which is the common mandarin orange of Japan. This seedless variety is known all over Japan, but these scions come from the coldest region in which oranges are grown in Japan, where the temperature sometimes goes down to −10° C.—i. e., 14° above zero F.—and where for fifty days or so a foot of snow lies on the ground. In this region, which is a very restricted one, called Sano, near Fukui, ice forms on the rice fields to the thickness of a quarter of an inch. However, the trees are covered by large bamboo mats during December, January, and February, and even with this covering the minimum of last year, 14° above zero, did them material injury. This sort has gradually driven the ordinary seed-bearing mandarin out of the market and is now, since ten years or more ago, the most popular mandarin in Japan." (*Fairchild.*)

8903. CITRUS DECUMANA (?) **Pomelo. (?)**

From Fukui, Japan. Received through Messrs. Lathrop and Fairchild (No. 960, June 24, 1902), July 21, 1902.

Natsu daidai. "Large summer orange. This fruit deserves the attention of all pomelo growers, as it is a variety to be had on the Japanese market *as late as the end of June.* I saw it as early as the close of April, so that the season is two months at least. It is not as fine and juicy as our best pomelo, but is nevertheless at this season eaten with relish by everyone, both European and Japanese. It is served with sugar, as pomelos are served in America, and would pass among all but connoisseurs as a tolerably good pomelo. Further than this, it ranks as one of the hardiest citrous fruits in Japan. These scions came from a tree that was exposed last winter, with a bamboo mat shelter, to a temperature of +14° F., and although it lost some of its leaves it was not killed by the low temperature. A foot of snow covered the ground about this plant for several weeks during the months of January and February." (*Fairchild.*) (See No. 8894.)

8904. CITRUS NOBILIS. **Mandarin orange.**

From Fukui, Japan. Received through Messrs. Lathrop and Fairchild (No. 961, June 24, 1902), July 21, 1902.

Koji. "A small-fruited variety with seeds. It is noted for its hardiness, being cultivated in a region where the thermometer drops to +14° F. and where the plants are surrounded by snow as late as February. It is not an especially fine variety, but is worthy of trial in the variety gardens. See Nos. 8902 and 8903 for further descriptions of climate where it is grown." (*Fairchild.*)

8905. Citrus nobilis. **Mandarin orange.**

From Fukui, Japan. Received through Messrs. Lathrop and Fairchild (No. 962, June 24, 1902), July 21, 1902.

Koji. "This is similar to No. 8904, but is said to bear larger, finer fruits. It was not the season for any of these fruits, so I can not say as to their excellence except from reports." (*Fairchild.*)

8906 to 8909.

From Nice, France. Presented by Mr. A. Robertson-Proschowsky. Received July 31, 1902.

Seeds as follows:

8906. Aristotelia macqui.

8907. Tacsonia mollissima.

"A variety with flowers of a darker color than the type." (*Proschowsky.*)

8908. Tacsonia mollissima.

8909. Olea europaea.

Nice. (See No. 8872.)

8910. Crotalaria juncea. **Sunn hemp.**

From Bombay, India. Received through Dr. S. A. Knapp, July 26, 1902.

8911 and 8912. Oryza sativa. **Rice.**

From Bombay, India. Received through Dr. S. A. Knapp, July 26, 1902.

8913. Prunus armeniaca. **Apricot.**

From Coahuila, Saltillo, Mexico. Received through Miss Lelia Roberts, July 20, 1902.

8914. Ceratonia siliqua. **Carob.**

From Marseille, France. Received through Hon. Robert P. Skinner, United States Consul-General, August 9, 1902.

8915. Voandzeia subterranea. **Woandsu (African goober).**

From Dar-es-Salam, German East Africa. Presented by Mr. D. Holtz. Received August 22, 1902.

8916 to 8975.

From Buenos Ayres, Argentina. Presented by Señor Carlos Thays, director of parks, through Mr. Frank W. Bicknell. Received August 20, 1902.

8916. Opuntia decumana.

8917. Sambucus australis.

8918. Cocos yatay.

8919. Solanum pocote.

8920. Cecropia palmata.

8921. Maytenus boaria.

8922. Psidium guajava.

8923. Enterolobium sp.

8924. Desmodium uncinatum.

8925. Terminalia triflora (?).

8926. Sesbania sanctipaulensis.

8927. Quillaja saponaria.

8916 to 8975—Continued.

8928. Xanthoxylon sp.

8929. Piptadenia cebil.

8930. Lippia turbinata.

8931. Parkinsonia aculeata.

8932. Tipuana speciosa.

8933. Cocos australis.

8934. Gleditsia amorphoides.

8935. Caesalpinia gilliesii.

8936. Bixa orellana.

8937. Eugenia sp. **Anacahuita.**

8938. Eugenia mato.

8939. Lithraea aroeirinha.

8940. Enterolobium timboüva.

8941. Dalbergia nigra.

8942. Sapindus trifoliatus.

8943. Schinus molle.

8944. Psidium cattleianum.

8945. Mimosa sensitiva arborea.

8946. Tricuspidaria dependens.

8947. Cestrum pseudo-quina.

8948. Acacia farnesiana.

8949. Colligua jabrasiliensis.

8950. Tecoma stans.

8951. Lucuma neriifolia.

8952. Lippia lycioides.

8953. Ilex paraguayensis.

8954. Bocconia frutescens.

8955. Lantana camara.

8956. Grabowskia glauca.

8957. Eugenia pungens.

8958. Heteropteris umbellata.

8959. Cestrum parqui.

8960. Carica quercifolia.

8961. Opuntia ficus-indica.

8962. Clematis hilarii.

8963. Eugenia michelii.

8964. Copernicia cerifera.

8965. Hibiscus argentinus.

8966. Psidium guajava var. pyriferum.

8967. Chorisia crispiflora.

8968. Morrenia odorata.

8969. Eugenia edulis.

8970. Scutia buxifolia.

8971. Bauhinia candicans.

8972. Celtis tala.

8973. Citharexylum barbinerve.

8974. Acacia moniliformis.

8975. Jacaranda chelonia.

8976. Garcinia mangostana. **Mangosteen.**

From Saigon, Cochin China. Received through Messrs. Lathrop and Fairchild from Mr. M. E. Haffner, director of agriculture of Cochin China, September 3, 1902.

8977 to 9013.

From Aburi, Gold Coast, Africa. Presented by the curator of the Botanic Gardens. Received September 5, 1902.

8977. Abrus precatorius.

8978. Achras sapota.

8979. Adenanthera pavonina.

8980. Anona muricata.

8977 to 9013—Continued.

8981. Anona squamosa.

8982. Arachis hypogaea.

8983. Artocarpus integrifolia.

8984. Bauhinia picta.

8985. Butyrospermum parkii.

8986. Cajanus indicus.

8987. Calotropis gigantea.

8988. Cassia alata.

8989. Chrysophyllum cainito.

8990. Coffea liberica.

8991. Crescentia cujete.

8992. Elaeis guineensis.

8993. Funtumia elastica.

8994. Garcinia hanburyi.

8995. Honckenya ficifolia.

8996. Hura crepitans.

8997. Labramia bojeri.

8998. Leucaena glauca.

8999. Michelia champaca.

9000. Palisota barteri.

9001. Persea gratissima.

9002. Pimenta acris.

9003. Pithecolobium saman.

9004. Poinciana regia.

9005. Raphia vinifera.

9006. Sideroxylon dulcificum.

9007. Spathodea campanulata.

9008. Spondias dulcis.

9009. Spondias lutea.

9010. Theobroma cacao. **Cacao.**

9011. Thevetia nereifolia. **Trumpet flower.**

9012. Thunbergia erecta.

9013. Voandzeia subterranea.

9014. Pyrus malus. **Apple.**

From Saltillo, Mexico. Received through Mr. G. Onderdonk, special agent of the Office of Seed and Plant Introduction, September 9, 1902.

Peron.

9015 and 9016. Frunus armeniaca. **Apricot.**

From Saltillo, Mexico. Received through Mr. G. Onderdonk, special agent, September 9, 1902.

9015.

Perry.

9016.

From a large tree at Chepultepec farm.

9017 to 9019. Citrus decumana. **Pomelo.**

From Bangkok, Siam. Secured by Dr. G. B. McFarland, and imported by Rev. G. R. Callender, at the request of Messrs. Lathrop and Fairchild. Received September 11, 1902.

"A seedless variety, or possibly three different varieties of pomelo, from the garden of Prince Mom Chow Rachawongse, of the lineage of the former Second King. The seedless pomelos, sold on the Hongkong market, which are supposed to be produced by trees of this variety, are the best pomelos in the Orient. The "seedless Bangkok" was the sort requested by us. The circumstances connected with the introduction of these pomelo plants, many months after Messrs. Lathrop and Fairchild visited Siam, were such that it is not possible to say definitely whether one single variety of the "Bangkok seedless" was represented by the three plants brought in, or whether the Prince sent one plant each of three kinds." (*Fairchild.*)

9020. Cucumis melo. **Muskmelon.**

From Valencia, Spain. Presented by Hon. R. M. Bartleman, United States Consul. Received September 20, 1902.

Bronze. One of the finest Spanish varieties.

9021. Trigonella foenum-graecum. **Fenugreek.**

From New York. Received through J. M. Thorburn & Co., September 29, 1902.

This seed was grown in southern Germany.

9022. Cucumis melo. **Muskmelon.**

From Valencia, Spain. Presented by Hon. R. M. Bartleman, United States Consul. Received October 2, 1902.

Bronze. (These seeds may be of the same variety as No. 9020, but as they are much lighter in color they have been given a separate number.)

9023. Psidium guajava. **Guava.**

From Merritt, Fla. Presented by Mr. L. H. Gurney. Received October 6, 1902.

9024. Anona squamosa. **Custard apple.**

From Mussoorie, united provinces of Agra and Oudh, India. Presented by Rev. H. Marston Andrews. Received October 6, 1902.

Sharifa or custard apple seed, grown in Dehra Dun, on the south side of a wall. The trees grow to a height of from 15 to 25 feet.

9025. Oenothera sinuata.

From Santa Rosa, Cal. Presented by Mr. Luther Burbank, through Mr. D. G. Fairchild. Received September 30, 1902.

"Mr. Burbank thinks this a valuable ornamental." (*Fairchild.*)

9026. Trifolium resupinatum. **Strawberry clover.**

From North Australia. Presented by Mr. Luther Burbank, of Santa Rosa, Cal., through Mr. D. G. Fairchild. Received September 30, 1902.

"Found in culture at Mr. Burbank's experimental gardens." (*Fairchild.*)

9027. Pyrethrum tchihatchewii.

From Santa Rosa, Cal. Presented by Mr. Luther Burbank, through Mr. D. G. Fairchild. Received September 30, 1902.

"Said to be from Asia Minor. Should be sown in pots and transplanted. Forms a pretty mat of foliage like a lawn, and could be used for lawn purposes." (*Fairchild.*)

9028. Musa textilis. **Manila hemp.**

From Manila, P. I. Presented by Mr. John W. Gilmore, of the Insular Bureau of Agriculture, through Mr. L. H. Dewey, Assistant Botanist of the Department of Agriculture. Received October 10, 1902.

9029. Prunus cerasus. **Cherry.**

From Vladimir, Russia. Received through Mr. E. A. Bessey (No. 101, July 22, 1902), October 9, 1902.

Vladimir. "Sun-dried cherries from the garden of Feodor Gontcheroff. These cherries, which will not be picked until about July 31, are from a garden typical as to the method of cultivation (or rather lack of cultivation). The trees are propagated by shoots from the roots regardless of any order. The trees are never pruned nor is the ground ever cultivated. The young shoots are allowed to grow up with the older trees. The result is a dense thicket or jungle, almost impenetrable, of trees from 8 to 12 feet high. In spite of this lack of care the trees bear rather freely. The cherries are usually fully ripe by the 20th of July, but this year being cold only part were ripe. The cherries are black, about five-eighths to three-fourths inch in diameter, with blood-red flesh and juice. They are sweet and juicy, but still retain a pleasant, acid flavor. The general idea that this variety is propagated, as a rule, from seeds is erroneous, that method being used only rarely. However, the variety is said to come fairly true to seed." (*Bessey.*)

9030. Prunus cerasus. **Cherry.**

From Dobrovka, near Vladimir, Russia. Received through Mr. E. A. Bessey (No. 103, July 22, 1902), October 9, 1902.

"From the garden of Vladimir cherries of Makar Kulikoff and Gregori Rezanoff. This tree differs from the others in being exceedingly prolific, the cherries nearly hiding the leaves. The tree is much more vigorous and less inclined to branch at the ground. The leaves are larger and darker green and more coarsely dentate. The leaves are shiny above while those of the neighboring Vladimir cherry trees are dull. The cherries are borne in clusters, those of the Vladimir being usually single or in pairs. They ripen ten days later than the Vladimir, i. e., normally about July 31, and are nearly black when ripe. The flesh is only slightly colored. The cherries are juicy and said to be sweeter than those of the true Vladimir variety. No trees were obtainable. Seeds (in the sun-dried cherries) were obtained in the hope that something valuable may be obtained. This is believed to be a seedling of the true Vladimir." (*Bessey.*)

9031 to 9039.

A miscellaneous collection of exotic plants growing in the Department grounds and greenhouses, which were turned over to the Office of Seed and Plant Introduction for distribution, October, 1902. The origin of most of them is unknown.

9031. Jacaranda chelonia.

From Argentina. Seed received May, 1901.

9032. Tectona grandis. **Teak.**

9033. Grabowskia glauca.

From Argentina. May be a good hedge plant.

9034. Sophora japonica. **Pagoda tree.**

9035. Rubus sp.

From Mexico. Presented by Dr. J. N. Rose (No. 194), assistant curator, U. S. National Museum. "The leaves have a metallic luster, making it a fine ornamental." (*Rose.*)

9036. Sterculia platanifolia.

9037. Nuytsia floribunda.

9038. Albizzia lebbek.

9039. Indigofera anil.

From Porto Rico. Received October, 1901.

9040. Citrus australica.

From Botanic Garden, Pisa, Italy. Received through Mr. W. T. Swingle (No. 120), October 16, 1902.

"A small tree, 12 feet high, with abundant foliage; trunk 4 feet high, 6 inches in diameter at base. Tree grows alongside *C. trifoliata* and, like it, seems to stand the cold at Pisa, which sometimes reaches 10° F. in winter and kills pistaches. Fruit is like a lime in Australia, and the species may prove very useful in breeding a hardy lime or lemon, or for a stock." (*Swingle.*)

9041. Phyllostachys castillonis. **Bamboo.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 983, July 28, 1902), November, 1902.

Kimmei-chiku. "Plants of the 'golden' or 'striped' bamboo of Japan. This species has the most decorative culms of any of the Japanese bamboos, being of a golden yellow color striped with green. When young these stems are brilliant in their freshness and a clump of them is a most beautiful sight. This bamboo is said to have been introduced into Japan from Korea. It is by no means a common sort, even in Japan. Owing to the fact that the green stripes fade after the culms are cut, its decorative value is confined to the living stems, especially those one year old. The plant grows to a height of 15 to 16 feet, even occasionally to 39 feet, and the culms attain 10 inches in circumference. If planted in a sheltered place on rich soil which is kept well mulched it will produce in a few years a handsome clump of the golden stems. The leaves are slightly variegated. It is exceedingly variable in the variegations, both of leaf and stem, the green stripes sometimes being scarcely visible. Sprouts appear in June in Japan and are said to be edible, though I have never heard of this variety being grown for food. It is essentially an ornamental plant." (*Fairchild.*)

9042. Phyllostachys nigra. **Bamboo.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 984, July 28, 1902), November, 1902.

Kuro-chiku, *Kurodaké*, or *Gomadaké.* "Plants of the Japanese black bamboo. This species is characterized by its dark brown to purple-black culms, which make it one of the handsomest species in Japan. It does not grow much over 20 feet in height, even under the best conditions of soil and climate. The shoots do not turn black until the second year, the first season being green with dark, freckle-like spots. The black bamboo formed at one time a considerable source of revenue to Japan, being largely exported to Europe and America, but of recent years the demand for it has fallen off. The growers say it is because the exporters have shipped immature culms. It is still extensively used for walking sticks, umbrella handles, etc. It grows largest on rich alluvial soil, needs plenty of phosphoric acid and potash, and the ground should be heavily mulched so that it will not dry out." (*Fairchild.*)

9043. Phyllostachys henonis, var. madaradake. **Bamboo.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 985, July 28, 1902), November, 1902.

Madaradake or *Unmon-chiku.* "Plants of the mottled bamboo from Hakone, province of Omi, arranged for through the assistance of Professor Hirase, a well-known Japanese botanist. This variety is characterized by having distinct blotches (possibly of fungus origin) on its culms. These blotches are of a dark-brown color, sometimes with concentric rings of a darker hue. The mottled culms are especially prized for fancy furniture making, as the mottling is permanent. The plant resembles *Phyllostachys henonis* in growth, and under favorable conditions attains a height of over 15 feet. The blotches on this bamboo do not make their appearance until the third or fourth year, and are more pronounced in the shady parts of the grove. If exposed to bright sunshine it is said the blotches fail to appear. This variety should be given especial attention, not planted in very small clumps, and grown on rich, well-drained soil in locations well sheltered from the wind. It is probably not so hardy as some other sorts and until well established should be protected with a heavy mulch of straw in the winter. The soil should not be allowed to dry out, but should be kept moist by an inch of good mulch during the summer as well." (*Fairchild.*)

9044. Phyllostachys bambusoides. **Bamboo.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 986, July 29, 1902), November, 1902.

Yadake. "The arrow bamboo, from whose culms the Japanese archers of feudal times had their shafts prepared. The culms are especially suited to this purpose, for they are straight, extremely hard, and of about the proper diameter. The arrows of present-day archers in Japan are also made of this bamboo. The sort was first introduced into England in 1894, Mitford says, and is consequently a comparatively new kind. In Japan it is not so common as many other types, being seen rarely in cultivated ground. It is pronounced hardy in England by Mitford, and a valuable acquisition. In habit it is cespitose, and its clumps are tall and closely set with the culms. Its broad leaves give it a very decorative appearance, individual leaves being as much as 11 inches long by $1\frac{3}{4}$ inches broad. It is sometimes used as a hedge plant in Japan, and its wood finds uses in the manufacture of tea sieves, baskets, etc. In general appearance it is quite unlike the ordinary bamboos, most of the leaves being borne only on the upper portion of the culms." (*Fairchild.*)

9045. PHYLLOSTACHYS MITIS. **Bamboo.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 987, July 29, 1902), November, 1902.

Moso-chiku or *Mouso-chiku.* "Plants of the edible bamboo of Japan. This variety, which Japanese historians say was introduced into Japan from China a century and a half ago, is not the species best suited for timber purposes, although the largest in size of any of the hardy sorts in Japan. Its culms are sold, it is true, and used in the manufacture of dippers, pots, vases, water troughs, etc., but the wood is softer and more brittle than that of the *Madake*, No. 9046. As a vegetable it is cultivated in small forests near the principal cities, and is given great care. Its young, tender shoots, like giant asparagus shoots, form one of the favorite spring vegetables of all classes in Japan. European and American residents in Japan are, many of them, fond of this vegetable, some even being passionately so. Its cultivation for the purpose of shoot production, therefore, is alone worthy the consideration of truck growers in the extreme South. A market can probably be created for the shoots as soon as a large enough supply can be insured to make the effort worth while. On the other hand, the value of the culms for use in fence making, basket making, and the production of a host of farm and garden conveniences, makes it worth a place in the back yard of every farmer in those regions suited to its growth. It is one of the hardy sorts, and so far as beauty is concerned it is, according to Mitford, 'the noblest of all the bamboos generally cultivated in England.' The severe winter of 1895 in England cut the culms down to the ground, but during that season the thermometer dropped below zero Fahrenheit. Even after this severe freeze the roots remained alive. It is not to be expected that this form will attain so large dimensions in the colder, drier climate of America, but the size of the culms of bamboos depends so much upon the richness of the soil and the methods of culture that, with proper nourishment, there is no reason why large-sized culms, over 2 inches in diameter, should not be produced in America. I have measured a shoot in Japan which was 1 foot $7\frac{3}{4}$ inches in circumference, and there are records of culms nearly 3 feet in circumference. These large culms were over 40 feet in height. A forest of these large bamboos forms one of the most beautiful sights in the world. In planting for its edible shoots about 120 plants are set out to the acre, but if for forest purposes at least 200 plants should be used. The balls of earth and roots should be more carefully set than those of deciduous trees, as the rhizomes, if injured, stop growing, and the spreading of the plant is checked. The fibrous roots are very brittle after planting and a heavy mulch of straw and loose earth should be kept on the field, so that the surface soil will not dry out. A sheltered situation is essential to the growth of this species, and rich, alluvial soil is what it likes best. Standing water beneath the soil kills it, and much gravel prevents its rapidly spreading. A sufficient number should be planted in a clump to enable the young plants, after a few years, to effectually shade the ground, otherwise, no tall, straight culms will be produced. Judicious thinning out of the small shoots, while still young, tends to make the plant produce larger culms." (*Fairchild.*)

9046. PHYLLOSTACHYS QUILIOI. **Bamboo.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 988, July 29, 1902), November, 1902.

Madake. "This is the great timber-producing bamboo of Japan. It is grown in large plantations or forests near the large cities of Japan, and its culture is said to be among the most profitable of any plant culture in the country. There are extensive wild forests south of Kobe, but the finest culms come from the cultivated forests; these culms are more regular in size and of better shape. The wood of this species is said to be superior in elasticity and durability to either that of the *Moso*, No. 9045, or *Hachiku*, No. 9047. Its extensive uses are too numerous to mention, for they would form a list as long as that of an enumeration of the uses of the white pine in America. The cultivation of this bamboo is not a difficult one, and forests of it should be started in all regions having a suitable climate. The species is one of the hardiest of the large-sized kinds in Japan and thrives in England, proving hardier than *Moso*, No. 9045. It never attains the same dimensions as this species, but often, however, grows to a height of 30 to 40 feet, and culms having a diameter of 2½ to 3 inches are not unusual. Even 4-inch culms are described by the books. The size of these culms depends largely upon the method of culture and how carefully the forests are thinned out and manured. About 300 plants should be set to an acre, in such a way that their spreading rhizomes will not interfere with each other at the start. The soil should be worked over to a depth of 18 inches several months before planting, and if of a heavy clay, should be lightened by working in straw and litter from the barnyard. After planting, the ground should be heavily mulched to prevent the top soil from drying out, and every means should be taken to insure that the ground is soon shaded by the growing shoots. The soil about the bases of the culms should be kept in semiobscurity. This object is only obtained by moderately thick planting and judicious thinning. Small clumps are not so likely to produce large stems as quickly as large patches, for the reason that the soil is more exposed to the drying effect of the sun. Only rich, alluvial, well-drained soil is likely to prove suitable for a bamboo forest of this species. The thickness of the pipes of this sort of bamboo is greater than that of any of the other common kinds, and this characteristic makes the culms more rigid and more serviceable for many purposes. It is of great importance that a young forest of bamboos be protected from the wind, for the young, tender shoots are easily injured. Wind-breaks of conifers are used in Japan even where the winds are anything but severe. A sheltered valley, or the base of a mountain slope, is sometimes chosen as offering such a sheltered situation. In setting young plants out great care should be taken not to injure the buds on the rhizomes or to break off the fibrous roots by packing down the soil too roughly about them. This species is likely to prove the most valuable of any of the Japanese hardy bamboos." (*Fairchild.*)

9047. PHYLLOSTACHYS HENONIS. **Bamboo.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 989, July 29, 1902), November, 1902.

Hachiku. "The second most important timber bamboo of Japan. Its method of culture is exactly similar to that of the *Madake*, No. 9046, and often it is cultivated side by side with this species. The brittleness of its joints, I am told, prevents its being used for many purposes, such as barrel hoops, for which the *Madake* is better adapted. On the other hand, the fine bamboo ribs of Japanese paper lanterns are generally made from this species. The height of this species is little inferior to that of the *Madake*, but it may be easily distinguished from it by the absence of dark spots on the sheath in young shoots. The sheaths are a solid light-straw color. The pseudophyll has a wavy outline. As an ornamental, this species is singled out by Mitford as the most beautiful of all the Japanese bamboos. In hardiness in Japan it ranks about the same as *Phyllostachys quilioi*. Mitford says it is one of the hardiest species in England, retaining its green color through the winter, the leaves not being injured by the cold. It should be given good soil and protection for the first few winters, or until thoroughly established." (*Fairchild.*)

9048. PHYLLOSTACHYS MARLIACEA. **Bamboo.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 990, August, 1902), November, 1902.

Shibo-chiku or *Shiwa-chiku.* "Plants of the wrinkled bamboo, perfectly hardy in England, characterized by having the base of the culm fluted or covered with longitudinal grooves and ridges. The stems of this species are especially prized for use in the woodwork of the special tea-ceremony rooms of old Japanese houses. An uncommon form in England and very decorative. Hard to get in quantity, even in Japan. It should be given the same treatment as that given to *Phyllostachys quilioi*." (*Fairchild.*)

9049. BAMBUSA QUADRANGULARIS. **Bamboo.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 991, August, 1902), November, 1902.

Shiho-chiku or *Shikaku-daké.* "Plants of the square bamboo. This is not considered as hardy as the previously mentioned species, *Phyllostachys quilioi*, and it will be advisable to give it especial care upon arrival. The plants should be potted and kept in a cool house over winter; not planted out at once. The culms of this species are square only when large. The small culms are round like any other kind. It produces its young shoots in Japan as early as February or March, I am told, and this feature may make it difficult to acclimate. Mitford says its rootstock is very vigorous, and, from clumps which I have seen near Yokohama, I judge it to be capable of producing small forests of culms 20 to 30 feet high. It is a beautiful form and its stems are much used for all classes of ornamental woodwork. It is not, however, very largely cultivated in Japan." (*Fairchild.*)

9050. ARUNDINARIA SIMONI. **Bamboo.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 992, August, 1902), November, 1902.

Narihiradaké. "One of the hardiest and tallest of the Japanese bamboos, perfectly hardy in England, where it is very commonly grown. It is mainly an ornamental and should be planted in small clumps. Its peculiar attraction lies in the large, persistent, or semipersistent sheaths, which do not fall off until the shoots are mature. It spreads rapidly, but for several years the young shoots are likely to be small. In Kew, Mitford says, this species has grown to a height of 18 feet, and I have seen specimens in Japan 20 feet high. It is a very showy form and one which is worthy a place in any collection of bamboos. It is not a forest type, and should be planted in clumps of three or four plants. So far as I know, little use is made of this species in Japan. It should be planted in sheltered locations, in fertile, mellow soil, and given especial care for the first two or three winters." (*Fairchild.*)

9051. PHYLLOSTACHYS RUSCIFOLIA. **Bamboo.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 994, August, 1902), November, 1902.

Bungozasa. "A small species of bamboo, not over 2 feet high. The plants sent are designed for trial along the banks of irrigation canals in California and elsewhere. The species is said to be an excellent sand binder and capable of forming a thick mat of pretty green foliage and an indestructible mass of interwoven roots and rhizomes. Plant 6 feet apart each way on the slopes of the canal bank and give attention until well established. This may prove of considerable value for making the banks of canals permanent. It will probably withstand considerable drought, and it forms a very pretty mat of foliage on slopes or under the shade of conifers in parks. It is not an uncommon species in England, and is also slightly known in America." (*Fairchild.*)

9052. PHYLLOSTACHYS AUREA. **Bamboo.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild. (No. 995, August, 1902), November, 1902.

Hotei-chiku or *Horai-chiku.* "The so-called 'golden' bamboo; a misnomer, as the culms are no more deep yellow in color than those of other sorts. It is distinguished by the short internodes at the base of the culm. It is an ornamental and the species most used for canes and fishing rods. It should be planted in clumps of not less than 15 plants for ornamental effect or for propagation. It is hardier than *Phyllostachys mitis* and probably one of the hardiest species in Japan. The sprouts are said to be of a better flavor than those of the real edible species, though this fact is not commonly known. In England this species grows to a height of 14 feet 6 inches, Mitford says. It is a much smaller species than *P. mitis*, *P. quilioi*, or *P. henonis*, but worthy of a place in every bamboo collection." (*Fairchild.*)

9053. BAMBUSA VEITCHII. **Bamboo.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 997, August, 1902), November, 1902.

Kuma-zasa. "A bamboo eminently suited for planting under conifers on lawns to form a dense mass of foliage. The edges of the leaves in this species die in winter and turn light yellow, giving them a striking landscape effect. Worth trying on embankments of canals in California. Not less than 50 plants should be planted in a place, say, 2 feet apart each way. For the slopes of embankments or roadways it produces remarkably pretty effects. It is used here in Japan very extensively for this purpose, and is also said to be a very good sand binder, but will probably not stand drought or salt water. It spreads very rapidly, but if it threatens to become troublesome by spreading, a ditch 2 feet wide by 2 feet deep, kept open by occasional redigging, will prevent its getting beyond control. A species whose value is in its decorative and sand-binding character. It is said to be quite hardy in England." (*Fairchild.*)

9054. **Bamboo.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 998, August, 1902), November, 1902.

Shakutan. "A broad-leaved species of bamboo which resembles in habit *Bambusa veitchii*, only the stems are much taller and the leaves are larger. It is suited for planting on embankments and under trees on a lawn to form a decorative mass of foliage. It is said to come from the Hokkaido and to be very hardy. It should be planted in lots of ten or more. In the Hokkaido the culms are used for pipe stems and a host of other objects where a small, hard, flinty pipe is desired. I can not find that this is commonly known in Europe under this name, though it comes near Mitford's description of *Bambusa palmata*, which he says is a striking ornamental species and evidently hardy; at least he says nothing to the contrary. It grows to a height of 5 feet." (*Fairchild.*)

9055. BAMBUSA VULGARIS. **Bamboo.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 999, August, 1902), November, 1902.

Taisau-chiku (?). "A tender variety of bamboo for Florida. This species comes from the hottest part of Japan and is the only species of the shipment not hardy. Its wood is said to be useful, though inferior to that of the hardy species. This may prove a different variety from those already in Florida under this specific name. Should be planted in lots of at least five." (*Fairchild.*)

9056. BAMBUSA ALPHONSE KARRI. **Bamboo.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1000, August 9, 1902), November, 1902.

Suwochiku, or *Suochiku.* "A species of striped bamboo which is considered by Mitford as tender in England. It is an exceedingly pretty species and worthy of trial in clumps in Florida and southern California, where it should grow to a height of 10 feet. When young the culms appear in autumn of a purplish color, traversed with green stripes. This should be distributed in lots of at least 10 plants." (*Fairchild.*)

9057. ARUNDINARIA HINDSII. **Bamboo.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1001, August, 1902), November, 1902.

Kanzan-chikú. "A species of bamboo which is commonly grown in clumps near the houses of the peasants in Japan. It forms a very pretty clump from 12 to 17 feet high and, although Mitford says his specimens were cut down to the ground by a severe winter, they grew up again, showing the species is not really tender. Should be tried in Florida, Arizona, or southern California. So far as I know, no use is made of this species except that of broom making." (*Fairchild.*)

9058. ARUNDINARIA HINDSII var. GRAMINEA. **Bamboo.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1010, August, 1902), November, 1902.

Taimin-chiku. "A very decorative, narrow-leaved species of bamboo which is used in Japan for hedges and ornamental clumps. It grows 10 to 12 feet high and forms a dense thicket of slender stems. The foliage is narrow and grasslike and resembles, though it is narrower, that of *Arundinaria hindsii*, No. 9057. It is a very common form and is used for making baskets used in pressing oil from various seeds. It is probably less hardy than other forms like *Phyllostachys quilioi*." (*Fairchild.*)

9059. Solanum tuberosum. **Potato.**

From Callao, Peru. Secured by Mr. Joseph C. Cree, United States vice-consul, October, 1902.

Papas amarillas. One-half bushel of native yellow potatoes.

9060. Myrica faya.

From Fayal, Azores Islands. Presented by Hon. Moyses Benarus, United States consular agent.

This shrub or small tree grows on the sandy shores of these and other subtropical islands.

9061 to 9082.

From Buenos Ayres, Argentina. Presented by Señor Carlos D. Girola, chief of the division of agriculture. Received September 15, 1902.

A collection of seeds, as follows:

9061. Carex darwinii.

9062. Carex decidua.

9063. Carex haematorrhynca.

9064. Carex macloviana.

9065. Carex pseudocyperus.

9066. Jacaranda cuspidifolia.

9067. Libocedrus chilensis.

9068. Schinus dentatus.

9069. Schinus dependens var. patagonica.

9070. Schinus montana.

9071. Tecoma sp.

9072. Aristotelia macqui.

9073. Chorisia insignis.

9074. Cocos australis.

9075. Cocos yatay.

9076. Enterolobium timbouva.

9077. Enterolobium timbouva.

9078. Feijoa sellowiana.

9079. Larrea nitida.

9080. Machaerium fertile.

9081. Prosopis denudans.

9082. Piptadenia macrocarpa.

9083 to 9122.

From Nice, France. Presented by Mr. A. Robertson-Proschowsky. Received October 24, 1902.

A collection of seeds, as follows:

9083. Acacia armata.

9084. Acacia cyanophylla.

9085. Acacia farnesiana.

9086. Albizzia moluccana.

9087. Albizzia odoratissima.

9088. Anchusa italica.

9089. Asystasia bella.

9090. Ceanothus azureus.

9091. Cobaea scandens.

9092. Commelina coelestis.

9093. Coronilla atlantica.

9094. Cuphea ignea.

9095. Cuphea selenoides.

9096. Cupressus sempervirens.

9097. Cyperus papyrus.

9098. Diotis candidissima.

9099. Eriobotrya japonica.

"From large fruits of very good quality." (*Proschowsky.*)

9100. Eryngium agavefolium.

9083 to 9122—Continued.

9101. Eupatorium atrorubens.

"Very remarkable leaves and flowers." (*Proschowsky.*)

9102. Genista monosperma.

"A very ornamental bush." (*Proschowsky.*)

9103. Iris germanica.

Varieties.

9104. Iris siberica.

Varieties.

9105. Kniphofia aloides var. nobilis.

9106. Lantana radula.

9107. Lespedeza bicolor.

9108. Linaria saxatilis (?).

9109. Malva sylvestris.

9110. Mariscus natalensis.

9111. Melaleuca leucadendron.

9112. Notochaete hamosa.

9113. Opuntia gymnocarpa.

"A very large and ornamental cactus with delicious fruit." (*Proschowsky.*)

9114. Osyris alba.

9115. Pelargonium zonale.

Varieties.

9116. Phormium tenax.

"Foliage variegated, very beautiful." (*Proschowsky.*)

9117. Phygelius capensis.

9118. Podachaenium paniculatum.

"Very ornamental." (*Proschowsky.*)

9119. Rivina humilis.

9120. Solanum erythrocarpum.

9121. Solanum sp.

9122. Sterculia acerifolia.

9123 and 9124.

From Paris, France. Received through Vilmorin-Andrieux & Co., November 3, 1902.

9123. Olea laurifolia.

9124. Olea verrucosa.

9125. Triticum vulgare. **Wheat.**

From Kharkof, in the Starobelsk district, Russia. Received through Mr. E. A. Bessey (No. 108, July 25, 1902), November 4, 1902.

Kharkof. "Red, bearded, hard winter wheat from the Starobelsk district of the government of Kharkof. This is similar to the *Kharkof* wheat obtained last year, but from a region where the winters are much drier." (*Bessey.*)

9126. Balsamorhiza sagittata.

From Bridges Peak, Mont. Received through Mr. V. K. Chesnut, of this Department, November 5, 1902.

9127 and 9128.

From Santiago, Chile. Presented by Señor Federico Albert, chief of the section of zoological and botanical investigations, department of industries and public works. Received November 12, 1902.

9127. Lithraea aroerinha.

9128. Persea lingue.

9129. TRITICUM VULGARE. **Wheat.**

From Padi, Saratov government, Russia. Received through Mr. E. A. Bessey (No. 109, July 25, 1902), November 15, 1902.

Winter wheat. "A softish, light-colored wheat, with smooth heads. Said to have been originally grown from the Hungarian Banat, but is somewhat darker colored and harder." (*Bessey.*)

9130. TRITICUM DURUM. **Wheat.**

From Naples, Italy. Received through Messrs. Lathrop and Fairchild (No. 1076). Sample received by mail November 28, 1902; 300 kilos received December 10, 1902.

Saragolla. "Wheat grown in the province of Apulia, along the Adriatic coast of southern Italy. This wheat is esteemed by the producers of the famous Gragnano macaroni as the best in the world for the production of a delicate, fine-flavored product. It has not the strength of the Taganrog varieties, which, owing to the small quantity of native wheat securable, are imported into Italy for semola-making purposes. It has, however, a better flavor, I am told, and the yield of semola from it is greater per weight of grain than from any of the imported hard wheats. It, therefore, sells from 1.25 to 1.75 lire per quintal (100 kilos) higher than imported wheats, which have to pay an import duty as well. Macaroni made from this variety of wheat will not keep as long as that made from Taganrog sorts and is more liable to the attacks of insects, but for quick consumption (three to six months) it is considered superior, and the gourmets of Naples order their macaroni made of the *Saragolla* wheat. The climate of the region about Foggia, where the best of this variety is said to be grown, is one of the driest in Italy—only 18 inches of rainfall in the year—and the soil is said to be stiff but impregnated with lime—i. e., calcareous. This variety deserves the attention of American macaroni-wheat growers. As it comes from a region where the winters are mild, it will probably not prove hardy as a winter wheat north of the thirty-fifth parallel of latitude. The summer temperature of Apulia is high, but not commonly over 100° F. The heavy rains occur in autumn, spring, and winter." (*Fairchild.*)

9131. TRITICUM VULGARE. **Wheat.**

From Dzhizak, a town about 100 miles northwest of Samarcand, on the railroad. Obtained through the Samarcand representatives of Mr. H. W. Dürrschmidt by Mr. E. A. Bessey (No. 118, August 30, 1902). Received December 1, 1902.

Chul bidai (or *bugdai*), meaning *steppe wheat.* "This grain is grown on the Steppes without irrigation. The grains are hard, but it is not *T. durum* (according to Mr. Schifron). This variety yields two harvests a year, for it can be sown as either a winter or spring wheat. If the former, the harvest comes in July; if the latter, the harvest comes in September. If sown in the spring, it is sown just as soon as the snow melts. The spring-sown is the most certain to yield a good crop, for the fall-sown must depend upon the rather uncertain snows. This seed, however, is from the fall-sown seed, being obtained in July. It is selected from over 1,000 poods offered for sale and is remarkably clean and free from foreign seeds for this region." (*Bessey.*)

9132. CITRUS NOBILIS × CITRUS BIGARADIA. **Tangerine.**

From Mustapha, Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist. Received December 3, 1902.

Clementine.

9133. HORDEUM DISTICHUM NUTANS. **Barley.**

From Fort Atkinson, Wis. Received through Ex-Governor W. D. Hoard, December 5, 1902.

Hanna. Grown from No. 5793.

9134. MUSA TEXTILIS. **Manila hemp.**

From Manila, P. I. Presented by Mr. W. S. Lyon, of the Insular Bureau of Agriculture, to Mr. L. H. Dewey, Assistant Botanist, United States Department of Agriculture. Received December 15, 1902.

9135 to 9146. Opuntia sp. Tuna.

From Mexico. Received through Dr. Edward Palmer (Nos. 1 to 12), December 19, 1902.

A collection of seeds as follows:

9135.

Amarillos. "One of the finest of the Mansa forms of tuna and well suited to the use of travelers, being large and containing sufficient water to quench the thirst. Outside it is amber-yellow in color; inside it is decidedly amber or with orange patches. Very productive fruit of this form will be found in the market up to December. The flesh is firm, with the flavor of boiled carrots with a large admixture of sugar." (*Palmer.*) (No. 1.)

9136.

Cardona. "Nine pears of this variety sold in the San Luis Potosi market for 1 cent. It is a small, rich, sweet fruit. The flesh is blotched with maroon and red. The commonest and most useful of all the tunas, yielding a fair supply in December. This fruit is much used in making a summer drink known as 'colonche,' which is largely in use. *Queso de tuna*, tuna cheese, is a round cake made from *Tuna cardo.* The fruit is divested of its jacket and then rubbed through an earthenware strainer and the resulting mass is cooked six hours, then worked (like candy) until all the heat is expelled, and then put into round frames to harden. This is a commercial article all over Mexico. The tuna *Cardona* contains sugar enough to preserve it." (*Palmer.*) (No. 2.)

9137.

Durasnillo Blanco (little white peach tuna). "Sold in the market of San Luis Potosi, 25 for 1 cent. This tuna is eaten entire, not having its rind removed. The seeds are compacted in a wad to resemble a peach stone. It is but a second class fruit. Inside it resembles a white freestone peach, firm, acid-sweet, with water-colored pulp. Its rind is canary-colored outside. I think this tuna would make a good pickle." (*Palmer.*) (No. 3.)

9138.

Durasnillo Colorado, or little red peach tuna. "Sold 25 for 1 cent in the market of San Luis Potosi. The fruit is eaten entire. Fine acid-sweet, much relished by some. Has the flavor of some late freestone peaches. It is rose-colored on the outside and a rose-pink inside (with a fleecy white spot near the base and also at the apex of the fruit). The seeds are compacted inside in a mass to resemble a peach stone. I think this would make a good pickle." (*Palmer.*) (No. 4.)

9139.

Cuejas. "Sold 30 for 1 cent in the market at San Luis Potosi. A remarkably juicy fruit, with a delightful acid taste, which might make it suitable for wine and a fine jelly. The fruit is first dark mauve, then rich maroon, a color fine for wine and jelly. It is considered but a second-class fruit; nevertheless all that come to the market are consumed." (*Palmer.*) (No. 5.)

9140.

Cameosa. "A Mansa form, sold in the market of San Luis Potosi 9 for 1 cent. A fine rich fruit with a watermelon flavor, and very juicy, making it fine for a breakfast fruit. Inside it has white patches intermixed with its mealy, tempting pulp, which is rich reddish crimson in color. The exterior is a pink crimson. This much prized fruit is abundant until the end of October." (*Palmer.*) (No. 6.)

9141.

Mansa Colorado. "Sold in the market of San Luis Potosi 4 for 1 cent. Old fruit is a dark mauve on the outside and bright maroon inside. A juicy, agreeable fruit which might make a good wine. At the base is a white patch, and at the apex under the skin is a circle of rose color. Many consider this equal in quality to any tuna. Disappears from market at the end of October." (*Palmer.*) (No. 7.)

9135 to 9146—Continued.

9142.

Blanca mansa. "Sold in the market of San Luis Potosi in piles of 7 for 1 cent. The fruit is greenish-white outside and a lighter white (with an icy look) inside. An agreeable juicy flavor renders it fine for early meals. It has rather a thin skin, and is one of the choicest tunas. Out of season at end of October." (*Palmer.*) (No. 8.)

9143.

Toconostle. "Fruit resembling a peach, with seed compacted in the center to represent the stone. The outside is a soft green when the fruit is young and of a salmon color when it is older. The flesh is solid and has an acid taste. Marmalade is made of it by removing the rind and seed core, boiling in water to remove the sourness, and cooking in sugar in the usual manner for marmalade. The fruit is also eaten chopped up and fried. Good pickles are said to be made of it. It is also cut into pieces and put into soups or boiled with vegetables and meats, and can be preserved in the ordinary way. It is also candied to represent white Smyrna figs, being first boiled in water (after the seeds have been removed from the apex) and then in sugar the usual way for candied fruit." (*Palmer.*) (No. 9.)

9144.

Chavaña. "Sold 10 for 1 cent in the market of San Luis Potosi. The fruit is a dark-mauve color outside and lighter colored inside. The rind is rather thick. The fleshy parts represent lines of white circles, which contain the seeds, and between which are lines of light mauve pulp. The core is decidedly white. The flesh has a rich, sweet, juicy taste like no other tuna; may be nearest to a rich, juicy apple. This is a wild variety. Can be used for preserves and marmalade. It seems to be next to *Cardona* in the amount of sugar it contains." (*Palmer.*) (No. 10.)

9145.

Castilla Colorado. "In the market of San Luis Potosi 10 of these large, magnificent fruits can be bought for 1 cent. Purple-mauve on the outside, rich crimson inside, but the two ends of the fruit are inclined to be carmine at first, but in the fully mature fruit of a rich claret hue. The juice might pass for claret wine. One of the largest, showiest, and richest flavored, and perhaps equal in flavor to the richest pear. It is one of the rarest tunas, and is soon out of the market." (*Palmer.*) (No. 11.)

9146.

Blanca Castalina. "Four sold in the market of San Luis Potosi for 1 cent. Yellow-white on the outside, but of an icy whiteness inside. Flesh solid, not as moist as some of the *Mansas*, and with a very agreeable watermelon taste. It is large, and has a rather thin skin. There seems to be considerable sugar in the fruit. Abundant in the market until the end of October, when it begins to disappear." (*Palmer.*) (No. 12.)

9147 to 9160. PHASEOLUS sp. **Bean.**

From San Luis Potosi, Mexico. Received through Dr. Edward Palmer, December 19, 1902.

A collection of selected "frijoles" as follows:

9147.

Amarillo. "A third-class bean, said to be of good flavor. For trial in New Mexico, Arizona, and southern California." (*Palmer.*)

9148.

Bailo. "A first-class bean, the leader in quality, and greatly admired, particularly by the rich. It is a good producer, fair sized, and light in color, which latter quality should warrant its trial in the United States. It should be tried in New Mexico, Arizona, and southern California." (*Palmer.*)

9147 to 9160—Continued.

9149.

Berendo. "A second-class bean; not without merit, however, as it has a large number of purchasers. When the beans are old they are much darker than when new. Plant just before a rain. For trial in New Mexico, Arizona, and southern California." (*Palmer.*)

9150.

Blanco bolador. "A third-class bean, but may improve with cultivation. Only two lots were seen on the markets. It is generally eaten when no better bean can be had. After being boiled it is sometimes fried in lard. It resembles our lima bean. It should be tried in New Mexico, Arizona, and southern California." (*Palmer.*)

9151.

Borado. "Rated as a second-class bean, though it is good when fried. It has many purchasers. The variations shown in the piles in the market prove that it crosses freely. For trial in New Mexico, Arizona, and southern California." (*Palmer.*)

9152.

Blanco. "A third-class bean which does not seem to be a favorite. It closely resembles the white bean of the United States, and I refused to eat it if any colored beans were on hand. Grows with a small amount of water. For trial in New Mexico, Arizona, and southern California." (*Palmer.*)

9153.

Ballo almo halla (*Cacaguate*, peanut bean). "This bean resembles the kernel of a peanut. It is a first-class bean, relished by many for its flavor, and as it is of a light color may be a good one to cultivate. Try in New Mexico, Arizona, and southern California." (*Palmer.*)

9154.

Color de Rosa. "A second-class bean, and yet there are many who prefer it. It seems to cross freely, judging from the 'half castes' in the piles of beans on the market. Should be tried in New Mexico, Arizona, and southern California." (*Palmer.*)

9155.

Garbansillo. "A first-class bean preferred by many, as it has a rich flavor. It is white, and on that account might claim recognition by those who like no other color, however high the quality. It grows freely on the table-lands of Mexico, and therefore might grow upon our plains and surpass our white bean in quality and productiveness. Should succeed in Utah." (*Palmer.*)

9156.

Grullito. "A first-class bean in every respect, and has only the *Ballo* as a rival according to most people. It is said to yield bountifully. It should be tried in New Mexico, Arizona, and southern California." (*Palmer.*)

9157.

Gruyo. "A second-class bean which seems to be a good producer. For trial in New Mexico, Arizona, and southern California." (*Palmer.*)

9158.

Guero de Vieja. "A second-class bean, not abundant in the market. For trial in New Mexico, Arizona, and southern California." (*Palmer.*)

9159.

Negro. "Rated as a third-class bean. It is grown only in the tropics, where no other bean thrives well. There it is appreciated. This sample came from Veracruz and was the purest in the market, either as regards adulteration or crossing. As a personal choice for permanent food, I should select this bean, as it has a satisfying quality to it. For trial in southern part of Florida." (*Palmer.*)

9147 to 9160—Continued.

9160.

Siguino. "A second-class bean, used a great deal. For trial in New Mexico, Arizona, and southern California." (*Palmer.*)

9161. Pyrus longipes.

From Mustapha, Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist. Received December 23, 1902.

9162. Edgeworthia gardneri. **Paper plant.**

From Shizuoka, Japan. Received through Messrs. Lathrop and Fairchild (No. 1008, August, 1902), January 6, 1903.

Mitsumata. "The paper plant, from which some of the finest Japanese paper is made. This fine paper is imported in large and increasing quantities into America, where it is used for legal paper, stocks and bonds, deeds, diplomas, etc. This plant requires especial attention, and a bulletin on its culture has appeared—B. P. I. Bulletin No. 42. In Japan the seeds are kept in bags of palm sheath fiber in a shallow hole in the floor of a house or shed, which is covered with boards to keep it dark. In planting in the spring, sow in rows in rich garden soil, and when several inches high transplant to nursery rows, and cultivate until large enough to plant out in permanent locations. It may, however, be planted out when only 8 to 9 inches high. The plant is semihardy, but is often given protection, even in Japan. A frost of 6 or more degrees will not kill it, as it is a deciduous plant. It seems to adapt itself to a variety of soils, and I believe it can be grown in arid regions by irrigation; at least it is worthy of trial in them. The paper pulp yielded by the bark is four times as valuable as ordinary wood pulp in Japan, and makes a quality of paper which for many uses is immeasurably superior to our wood pulp or even rag papers. This whole question of producing a bast paper in America is one worthy the serious consideration of our cultivators in the South. In Japan the cultivation of this species is increasing rapidly, I am told, and the consumption by foreigners of these fine *Mitsumata* papers is larger every year. The attempt to find out where the plant will grow should be made by the distribution of small potted plants rather than of seeds, and one of the main objects of this first importation of seeds is to discover how far north the plant will prove hardy. The bush grows about 6 feet high, is decorative, and is sometimes planted for its pretty yellow flowers." (*Fairchild.*)

9163. Edgeworthia gardneri. **Paper plant.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1011, August, 1902), January 6, 1903, and February 28, 1903.

(See No. 9162 for description.)

9164. Myrica nagi.

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1009, August, 1902), January 6, 1903.

Yama momo. "Plants of the best variety of this fruit species. (See No. 9314.) The best kind, i. e., that producing the largest fruit, has serrated leaves, I am informed. Entire leaved forms produce smaller, scarcely edible fruits. This is a very slow-growing tree, which will not produce fruit for six or seven years. Possibly a few fruits will be produced in four years from these trees." (*Fairchild.*)

9165. Wickstroemia canescens. **Paper plant.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1012, August, 1902), January 6, 1903.

Gampi. "A species of tree from which the noted *Gampi* paper is made. This plant has never been cultivated in Japan, but grows wild in the mountains of the provinces of Yamato, Ise, Mino, etc. The demand for the bark is so great that the plant is being killed out. The paper made from its bark is the toughest, finest, silkiest paper in the world, and is used for the manufacture of letter press-copying books, etc. In America many of these Japanese letter books are in use, and the export of this *Gampi* paper is an important one for Japan. The plant will probably do best in the mountains of the South, and the young plants should be distributed to such persons as can give them a trial by setting them out, a few in a place, to ascertain how hardy the species is. The plant is easily propagated by root cuttings, and this method should be used to secure a small forest of it. The species runs readily by means of shoots from the root, and trees 2 inches in diameter were not unusual before the big demand set up for this delicate *Gampi* paper. Now it is difficult, it is said, to find trees of more than a few feet in height. If this species can be brought into forest cultivation it will add to the market a paper pulp of the greatest value." (*Fairchild.*)

9166. ARALIA CORDATA. **Udo.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1013, August, 1902), February 28, 1903.

Kan Udo. "Seed of a new salad plant called *Udo*. This is described in B. P. I. Bulletin No. 42. It is a delicate, new salad which should find a most acceptable place on the tables of well-to-do Americans, for it comes into season in October and November. It is as crisp as celery, and has a refreshing flavor quite its own." (*Fairchild.*)

9167. ARALIA CORDATA. **Udo.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1014, August, 1902), January 6, 1903.

Kan Udo. "Roots of the same variety of *Udo* as No. 9166. For description see B. P. I. Bulletin No. 42. This variety should be given a different treatment from that given to No. 9168, *Moyashi Udo*." (*Fairchild.*)

9168. ARALIA CORDATA. **Udo.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1016, August, 1902), January 6, 1903.

Moyashi Udo. "Young roots of the forcing *Udo*, a new salad plant of great promise. These roots should be kept packed in straw, where they will not dry out nor mold, in a cool storage place until next spring, when they should be planted out in rows 2 by 3 feet apart, and cultivated all summer as potatoes are cultivated. In the autumn, after the leaves die, the old roots are dug and packed closely together in the bottom of a trench 2 feet deep, and covered with leaf-mold and rich loam to force them into growth. The blanched shoots, 2–3 feet long and as big as a man's thumb, are as tender as celery, and make a delicious salad if shaved and served with a French dressing. This forcing variety is likely to be useful throughout the South. See B. P. I. Bulletin No. 42." (*Fairchild.*)

9169. ARALIA CORDATA. **Udo.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1016a, August, 1902), January 6, 1903.

Moyashi Udo. "Old roots, which should be planted out next spring in rows 2 by 3 feet apart, cultivated all the season, and next winter forced by burying in a trench, as has been described for No. 9168. These old roots will produce good-sized shoots the first winter's forcing, while young roots will produce only a few small ones." (*Fairchild.*)

9170 to 9199. PRUNUS PSEUDO-CERASUS var. HORTENSIS. **Flowering cherries.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1017, August, 1902), January 6, 1903.

"A collection of the different varieties of flowering cherries from a noted grower in Tokyo—Mr. Takagi. There are hundreds of slightly different sorts of this flowering cherry, which is, as is well known, the favorite flower of the Japanese. It is inconceivable that Europeans and Americans have not followed the example of this race of flower lovers and planted long avenues or whole hillsides with this superbly beautiful plant. As an avenue tree in summer, the cherry would not be a success except when mingled with some other sort, but its beauty during the spring months warrants its being planted in big masses in our large parks instead of as single, isolated trees. The beauty of the cherry trees of Japan lies in the fact that there are miles of them or acres of them in bloom at once. Great care should be taken to keep the names of the varieties straight, to enable other plants to be ordered if desired later. These flowering cherries can be grafted on our wild cherry or on any good cherry stock. Single, double, and weeping sorts are included in this shipment. A list follows." (*Fairchild.*)

9170.

Nara Sakura.

9171.

Oshiogun.

9172.

Chioshiu hisakura.

9173.

Oyama fugin.

9174.

Yokihi.

9175.

Kuramayama.

9176.

Ito Kukuri.

9177.

Surugadai nioi.

9178.

Ogasa yama.

9179.

Gozanoma.

9180.

Ichio.

9181.

Daijen.

9182.

Botun sakura

9183.

Ochiochin.

9184.

Omanogawa.

9185.

Horinshi.

9186.

Amayadori.

9187.

Yedosakura.

9188.

Ouchisakura.

9189.

Shiogama.

9190.

Higurashi.

9191.

Bauriko.

9192.

Rui arashi.

9193.

Tamamari.

9194.

Ukon.

9195.

Kangosan.

9196.

Murasaki sakura.

9197.

Gayeakehono.

9198.

Shirofugin.

9199.

Sikigan.

9200. PRUNUS MUME. **Japanese plum.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1018, August, 1902), January 6, 1903.

Rinshiu. "The favorite variety used for stocks by the Japanese nurserymen. This is worthy of trial as a vigorous, resistant stock upon which to bud both European and American varieties of plum. It should be tried by nurserymen interested in the question of the influence of the stock on the scion. The fruit of the Japanese apricot is used principally for pickling purposes. The trees are unusually vigorous growers, heavy bearers, and are considered the best commercial plum trees of the *Ume* class in the nursery region of Ikeda, Japan." (*Fairchild.*)

9201. PRUNUS TOMENTOSA. **Japanese cherry.**

From Tokyo, Japan. Received through Messrs. Lathrop and Fairchild (No. 1015, August, 1902), February 28, 1903.

"A decorative cherry with fruits the size of a large pea and sessile, or nearly so, on the long, slender branches. The fruits are edible, but not of good quality. For breeders and as an ornamental species. The fruits have a considerable amount of pulp on them and are much more delicate than those of the American choke cherry." (*Fairchild.*)

9202 to 9210. PRUNUS TRIFLORA. **Japanese plum.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1019, August, 1902), January 6, 1903.

"Fruiting plums of the *Hatankyo* class. Great confusion exists in the nomenclature of these Japanese plums. The *Hatankyo* class is often confused with the *Botankyo*. The early ripening sorts are sometimes called *Hatankyo*; the late ripening kinds *Botankyo*. They are the largest of the true plums of Japan, and have a smooth skin like the European species. Said to be shy bearers and not as profitable for commercial purposes as the *Sumomo* class of small-sized, thin-skinned, soft-fleshed fruit. These *Hatankyos* or *Hatankios* are somewhat like the *Burbank* and *Wickson* in type. They are hard fleshed, and make the best stewed plums I have ever eaten. A list of the varieties follows." (*Fairchild.*) (See also Nos. 9222 and 9223.)

9202.

Okutsno.

9203.

Furugiya.

9204.

Nakatesumomo.

9205.

Hachioji.

9206.

Suikamomo.

9207.

Ohatankyo.

9208.

Ringotane.

9209.

Hakubotan.

9210.

Benibotan.

9211 to 9216. PRUNUS MUME. **Japanese plum.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1020, August, 1902), January 6, 1903.

"One-year-old plants of the *Ume* class of Japanese plums. These are quite different from European and American plum varieties, having a short but distinct pubescence. The fruit is exceedingly sour and is not designed for table use, except in the form of pickles. These pickles are the sourest things I have ever tasted, and are consumed in large quantities in Japan, being pickled with the leaves of a labiate, *Perilla arguta*, which give the plums a reddish color and aromatic taste. They are not much relished by Europeans, because of their intensely sour flavor. This class of plums is well known in America among breeders, but a collection of the different varieties will doubtless be acceptable for purposes of comparison. It is more like the apricot plum than anything else." (*Fairchild.*)

9217 to 9220. AMYGDALUS PERSICA. **Japanese peach.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1021, August, 1902), January 6, 1903.

"A collection of one-year-old plants of Japanese peach varieties. There are a number of distinct varieties of these Japanese peaches, and some are fairly sweet and many are unusually juicy. It is not possible for me to say how recently these sorts may have been introduced into Japan from China. A list of the varieties follows." (*Fairchild.*)

9217.

Hanbei.

9218.

Naschi maru.

9219.

Kintoki.

9220.

Mizumito.

9221. AMYGDALUS PERSICA. **Nectarine.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1022, August, 1902), January 6, 1903.

Chosen or Korean nectarine. "A freestone variety, with smooth, almost greasy skin, which is sold everywhere in the markets in July in Japan. It is a juicy, white-fleshed sort, bitter near the stone, but with a decided and agreeable peach flavor." (*Fairchild.*)

9222 and 9223. PRUNUS TRIFLORA. **Japanese plum.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1019, August, 1902), January 6, 1903.

(These two varieties were incorrectly labeled "L. & F., No. 1017," and packed with that lot.) (See Nos. 9202 to 9210.)

9222.

Kowase.

9223.

Yome momo.

9224. ARALIA CORDATA. **Udo.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1016, August, 1902), January 6, 1903.

Moyashi udo. A new salad plant of great promise. (See No. 9168.)

9225. VICIA GEMELLA.

From Yokohama, Japan. Secured by Messrs. Lathrop and Fairchild (not numbered) through the Yokohama Nursery Company. Received February 28, 1903.

9226. LAGENARIA sp. **Gourd.**

From Yokohama, Japan. Presented by the Yokohama Nursery Company. Packed with seeds secured by Messrs. Lathrop and Fairchild. Received February 28, 1903.

Kanpio gourd.

9227. PUERARIA THUNBERGIANA. **Kudzu.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1023, August, 1902), February 28, 1903.

Kudzu. "This broad-leaved, perennial, leguminous climber is well known in America, being often seen in private gardens where it is used as an arbor plant or to produce tropical effects by allowing it to grow over the tops of bushes or low-growing trees. For this purpose alone it is a valuable plant. In Japan the fleshy roots are used for starch making and the foliage is cut and fed to cattle for fodder. Whole hillsides are sometimes covered with this plant in Japan, where it grows wild, and in these regions its foliage is utilized for fodder purposes and a fine quality of starch is made from its roots. It should be tested as a fodder-producing plant in waste places. The seed should be sown in a seed bed and the young plants set out in rich soil. I am told it does not withstand much drought." (*Fairchild.*)

9228. Pueraria thunbergiana. **Kudzu.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1024, August, 1902), January 6, 1903.

"*Kudzu* roots for trial as a fodder plant. These roots should be planted in a single plat about 5 feet apart each way and the vines allowed to grow over the ground in all directions. It is possible that by repeatedly cutting the shoots back before they are too tough a continuous supply of fodder may be secured. The plant is a leguminous one and may be of service for breeders." (*Fairchild.*)

9229. Medicago denticulata.

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1025, August, 1902), January 6, 1903.

Uma goyashi. "A biennial wild-fodder *Medicago* with yellow flowers, which grows 2 feet in height. Its stems are said to be highly relished by horses, which eat them greedily in the spring. So far as I have observed the plant is not cultivated." (*Fairchild.*)

9230. Lespedeza buergeri.

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1026, August, 1902), February 28, 1903.

No Hagi. "The species of *Hagi* in Japan are especially prized for ornamental purposes and their summer and autumn flowers are used extensively for decoration. This species, the *No Hagi*, is said to be a good fodder plant, but how it is used I have been unable to discover. It is a low, bushy, hardy perennial." (*Fairchild.*)

9231. Juglans regia. **Walnut.**

From Shanghai, China Received through Messrs. Lathrop and Fairchild (No. 953, May 10, 1902), January 6, 1903.

"A variety of walnut bought on the market in Shanghai. This variety is said to be eaten all the year round by the Chinese. I could not find from which province it came." (*Fairchild.*)

9232. Juglans regia. **Walnut.**

From Hongkong, China. Received through Messrs. Lathrop and Fairchild, January 6, 1903.

These few nuts are from a lot secured by Mr. H. Suzuki, of the Yokohama Nursery Company, Yokohama, Japan, and may be slightly different from No. 9231.

9233. Prunus triflora. **Japanese plum.**

From Ikeda, Japan. Received through Messrs. Lathrop and Fairchild (No. 968), January 6, 1903.

Hatankyo. "A special sort of this common variety of plum. This fruit has a decided red blush upon it and is not of that translucent yellow which is said to characterize the sort in other parts of Japan. In flavor it leaves a good deal to be desired." (*Fairchild.*)

9234. Thermopsis fabacea.

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1030), from the Yokohama Nursery Company. Received February 28, 1903.

Sendai Hagi. "Seed of this yellow flowered variety, 1 foot high, perennial, said to be very showy." (*Fairchild.*)

9235. Prunus triflora? **Japanese plum.**

From Ikeda, Japan. Received through Messrs. Lathrop and Fairchild (No. 969), January 6, 1903.

Guanji. "A small fruited sort, 1 inch in diameter, bought in the orchard. Though differing little from No. 9236, it seems well to keep them apart. This is a vinous flavored variety, flattened in shape, with thin, sour skin, rich flavored flesh, and altogether the most delicate plum I have eaten in Japan, though not to be compared with a good variety of *Prunus domestica*. It is said to be the best paying plum in Ikeda, the plum-growing center of Japan." (*Fairchild.*)

9236. PRUNUS TRIFLORA? **Japanese plum.**

From Ikeda, Japan. Received through Messrs. Lathrop and Fairchild (No. 970, July 5, 1902), January 6, 1903.

Guanji. "Seeds bought on the market. This is essentially the same as No. 9235, though the fruit is somewhat larger and not quite so sweet. It is evidently one of the principal market plums, for one sees it everywhere, whether under this or some other name." (*Fairchild.*)

9237. VICIA HIRSUTA.

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1033, August, 1902), February 28, 1903.

Suzumeno yendo. "A leguminous plant worthy of investigation as a possible fodder plant or for breeding experiments, as it is said to be occasionally used in Japan for fodder. I was unable to see this species growing." (*Fairchild.*)

9238. DESMODIUM PODOCARPUM var. JAPONICUM.

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1034, August, 1902), February 28, 1903.

Nusubito Hagi. "A species of Leguminosæ of possible use in breeding experiments with leguminous fodder plants. I did not see the plant growing." (*Fairchild.*)

9239 to 9243. PYRUS SINENSIS. **Japanese pear.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1035, August, 1902), January 6, 1903.

"This collection will include, according to contract, some sorts which keep until July and even longer, and some very large-fruited kinds, which originated in the north of Japan. I have eaten many varieties of pear in Japan and, while none are as good as our pears, they are, nevertheless, refreshing fruits. I believe they should be advertised as a fruit for poor people, since the trees are heavy bearers and the fruit will keep well. In Japan nearly all the trees seen were trained upon overhead trellises, and it seems to be the popular idea that they will not bear well unless so trained. The selection of these varieties has been left to Mr. H. Suzuki, of the Yokohama Nursery Company, whose friend at Kawasaki is a specialist in Japan pears. A list follows." (*Fairchild.*)

9239.

Waseaka.

9240.

Ofurugawa.

9241. (Label missing.)

9242.

Tai haka.

9243.

Chiojuro.

9244 to 9247. ERIOBOTRYA JAPONICA. **Loquat.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1036, August, 1902), January 6, 1903.

Japanese loquats, called *Biwas* in Japan, as follows:

9244.

Tanaka. (See No. 8890.)

9245.

Long fruit.

9246.

Variegated.

9247.

Maruni.

9248 to 9267. NELUMBIUM SPECIOSUM. **Lotus.**

From Tokyo, Japan. Received through Messrs. Lathrop and Fairchild (No. 1039, August, 1902), January 6, 1903.

"A collection of pot lotuses for cultivation under water in large shallow pots of 2 feet in diameter and a foot deep. These plants are from a noted lotus grower in Tokyo, who claims to have hundreds of varieties and whose lotus show in late August is said to be unusually fine. The rhizomes of these pot lotuses are kept in a cool place over winter and in spring set out in 6 to 8 inches of rich mud at the bottom of the pots, which are kept filled to within an inch of the brim with water. The second year these rhizomes should bloom and produce a beautiful show of flowers. Judging from water-color sketches, which I saw in the Tokyo Botanic Gardens, the variety of form and color among these lotuses must be something quite unusual. All shades of pink, yellow, and green, and many variegated forms were represented. The pots should never be allowed to dry out, but the mud must be kept continually covered with water. The varieties are as follows." (*Fairchild.*)

9248.

Inazuma.

9249.

Shiro Shakuyaku.

9250.

Beni botan.

9251.

Sakuralen.

9252.

Kayo.

9253.

Tokalen.

9254.

Kinshi.

9255.

Nishikilen.

9256.

Mangitsu.

9257.

Itten kobai.

9258.

Tenjiku len.

9259.

Hakubotan.

9260.

Usuyo.

9261.

Shokan.

9262.

Giosan.

9263.

Nankin kuchibin.

9264.

Ashimaru.

9265.

Myiyo.

9266.

Beni Tinshi.

9267.

Tamausagi.

9268. CITRUS BIGARADIA? **Bitter orange.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1040, August, 1902), January 6, 1903.

Natsu Mikan or *Natsu Shiro.* "An especially fine variety of the bitter orange. This is a remarkable fruit and worthy the serious attention of citrus growers. It is not of such fine flavor as our pomelo, but still is sufficiently palatable to serve the same purpose, and it matures at a different time of the year. *This fruit is common on the market from April until the middle of August* in Japan and, although in August it is a poor fruit, it still serves very well as a morning appetizer. This is the commonest, often the only citrous fruit to be seen on the Japanese markets in July, and I judge the number of tons consumed every year is very large. The tree is said to be a vigorous-growing one and a good bearer. This variety is also one of the hardiest citrus sorts in Japan, withstanding a temperature of + 12° F. on the west coast of the main island. An important point in the culture of this variety is to leave the fruit hanging as long a time as possible on the trees, not picking it green and allowing it to ripen." (*Fairchild.*)

9269. CITRUS DECUMANA. **Pomelo.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1041, August, 1902), January 6, 1903.

Asa hikan. "I understand this is a summer-ripening pomelo." (*Fairchild.*)

9270. PRUNUS TRIFLORA. **Japanese plum.**

From Ikeda, Japan. Received through Messrs. Lathrop and Fairchild (No. 971, July 5, 1902), January 6, 1903.

Obeni. "A flattened variety, looking much like a large *Guanji* (see No. 9236), though lacking its flavor. The skin and flesh are intensely sour even when nearly ripe. Never sweet enough to be good eating. These fruits were bought on the market." (*Fairchild.*)

9271. CITRUS NOBILIS. **Mandarin orange.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1043, August, 1902), January 6, 1903.

Unshu or *Unshiu Mikan.* "This is the best Japanese mandarin orange. It is said to be quite seedless and very juicy. I do not believe it is the equal of our best mandarin oranges, but its seedless character makes it valuable. It is grown extensively all over middle Japan, especially in the Province of Kii. It is already known in America." (*Fairchild.*)

9272. CITRUS DECUMANA. **Pomelo.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1044, August, 1902), January 6, 1903.

Aya buntan. "A red-fleshed variety of pomelo which is eaten with great relish by the Japanese. It is doubtless inferior in flavor to our best pomelos, but its red flesh is a character of value." (*Fairchild.*)

9273. PRUNUS TRIFLORA. **Japanese plum.**

From Ikeda, Japan. Received through Messrs. Lathrop and Fairchild (No. 972, July 5, 1902), January 6, 1903.

Obeni. "These fruits came direct from orchard trees which are noted for producing especially fine fruits. They were certainly much larger and finer than those bought on the market, and I believe this is a different strain from No. 9270." (*Fairchild.*)

9274 and 9275. CITRUS JAPONICA. **Kumquat.**

Received through Messrs. Lathrop and Fairchild (Nos. 1046 and 1047, August, 1902), January 6, 1903.

Nagami-kinkan. "Two varieties of these kumquats were ordered, but the Yokohama Nursery Company sent only the one sort marked *Nagami-kinkan*, which is said to be an elliptical or obovate fruited kind." (*Fairchild.*)

9276. MYRICA FAYA.

From Madeira. Presented by Mr. J. B. Blandy, of Funchal. Received February 21, 1903.

9277. CELTIS SINENSIS.

From Yokohama, Japan, Received through Messrs. Lathrop and Fairchild (No. 1049, August, 1902), February 28, 1903.

"One of the prettiest shade trees in Japan, suitable for avenues or private gardens, parks, etc. It resembles *C. australis* which is so commonly used in Algiers and southern Spain, but does not attain the large size of this species, so far as I have observed. It should be tried in the Southwest as a shade tree." (*Fairchild.*)

9278. Corylus rostrata. **Hazelnut.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1050, August, 1902), February 28, 1903.

Hashibami. "Seeds of this wild species of hazelnut which may prove valuable for breeding purposes. The nut is not highly prized in Japan, and is nowhere given the attention that the hazelnut gets along the Black Sea or in Istria." (*Fairchild.*)

9279. Prunus triflora. **Japanese plum.**

From Kobe, Japan. Received through Messrs. Lathrop and Fairchild (No. 973), January 6, 1903.

Obeni. "Seed, originally from Ikeda, that was bought on the market in Kobe. It is very much like No. 9270. It is evidently one of the favorite market plums of this region. It resembles the American wild-goose plum. The trees are reported to be regular and heavy bearers." (*Fairchild.*")

9280. Juglans cordiformis. **Walnut.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1052, August, 1902), January 6, 1903.

Himegurumi. "A long, pointed walnut which is a narrower and slenderer type than that called in Japan *Otafuku.* Probably both seed variations of the same species." (*Fairchild.*)

9281. Prunus triflora. **Japanese plum.**

From Kobe, Japan. Received through Messrs. Lathrop and Fairchild (No. 974, July 7, 1902), January 6, 1903.

Sumomo of Awaji Island. "A delicate variety, like our wild-goose plums in quality. A thin-skinned, juicy, sour-fleshed, bright-red, translucent variety, with small stone, and a slightly bitter taste near the stone." (*Fairchild.*)

9282. Perilla ocymoides.

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1054, August, 1902), February 28, 1902.

"Seed of a labiate which is grown extensively in Japan for oil-producing purposes. The oil expressed from the seed is considered the best known for the manufacture of the remarkable oil and leather papers of Japan. It takes the place of linseed, which, I am informed, is not so good for this purpose. The plant can be grown very easily by irrigation or without it in regions where soil is cheap, and there is a possibility that it could be produced cheaply enough to make it a profitable article of export. It should be tried in the irrigated regions of the Southwest. I am informed that Australia imports the oil and the seed also from Japan. In Japan the seed is sown in a nursery bed in the middle of June, and the young plants are transplanted about the 1st of July into rows 2 to 3 feet apart and set 6 inches apart in the row. The ordinary methods of cultivation to keep down the weeds are all that are necessary. It is not grown here on irrigated land. The seed ripens in November. In America it could probably be planted earlier and harvested earlier. According to the owner of an oil mill in Yamada, 100 plants of Perilla yield 1 sho = 0.39 gallon of seed, 17 per cent of which by volume is oil. The price of this oil in Japan, as quoted by the oil mill owner, is 45 yen per koku (1 koku = 39.7 gallons; 1 yen = 50 cents). The seeds are likely to fall out of the dry calyx if left until overripe, and I am told the yield is therefore best in wet seasons. The crop is a variable one, and the price therefore quite variable. Land is so valuable in Japan that this crop does not rank as a good paying one, but if grown on cheap land, in Washington State, for example, it might be produced so cheaply as to pay very well. It is worth a trial at least in the wet regions of Washington." (*Fairchild.*)

9283. Ricinus communis. **Castor oil bean.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1055, August, 1902), January 7, 1903.

"For breeding purposes. By request." (*Fairchild.*)

9284. Amygdalus persica. **Japanese nectarine.**

From Kobe, Japan. Received through Messrs. Lathrop and Fairchild (No. 975, July 7, 1902), January 6, 1903.

Zumbai momo. "The only variety of nectarines said to be seen on the Kobe market." (*Fairchild.*)

9285. Amygdalus persica. **Japanese peach.**

From Kobe, Japan. Received through Messrs. Lathrop and Fairchild (No. 976, July 7, 1902), January 6, 1903.

Taruya. "A typical honey peach, an old variety on the Kobe market. Least valuable and least abundant here." (*Fairchild.*)

9286. Trichosanthes cucumeroides.

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1058, August, 1902), February 28, 1903.

"Seed of a wild perennial vine of the cucurbit family, which has large, dark-green leaves of unusually beautiful velvet texture. I have never seen such beautiful foliage except on some tropical aroids. This vine I have only seen growing in the shade or semishade of Cryptomeria trees, but I am assured it will grow well in the bright sunlight. If this is true it promises to be an interesting addition to our arbor plants, and deserves to be given the widest possible distribution. Its flowers are said to be very pretty, while its fruit, about the size of a duck's egg, is showy and useful, in Japan at least, where it takes the place of soap. The roots are used for starch production. The seed should be planted in the same way that cucumber seeds are planted. The roots will probably prove hardy all over the United States, but during the first winter some of them should be dug up and kept in a cold house." (*Fairchild.*)

9287. Trichosanthes cucumeroides.

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1059, August, 1902), February 28, 1902.

"Roots of No. 9286 for immediate trial. They should be planted out next spring after being kept like dahlia roots through the winter." (*Fairchild.*)

9288. Trichosanthes japonica.

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1060, August, 1902), February 28, 1903.

"Seed of a species of cucurbit, related to Nos. 9286 and 9287, but with broader, larger leaves, which have not such a velvety texture. It is said to have fruit twice the size of the latter. These fruits are eaten after preserving in soy or salt. Starch is made from the roots. For trial as an arbor plant." (*Fairchild.*)

9289. Solanum sp. (?) **"Kiswaheli" tomato.**

From Tanga, German East Africa. Received through Messrs. Lathrop and Fairchild (No. 1085, January 18, 1903), March 3, 1903.

Ngogwe or *Njanja.* "A native tomato grown by the Kiswahelis of the Tanga region. The fruit is 1½ inches in diameter, egg-shaped, brilliant light red, thick skinned, and with rough protuberances at its apex. The flesh is scanty and with little flavor, placentæ tough, and with many seeds. The negroes say it is a perennial plant, grown everywhere, about 4 feet high." (*Fairchild.*)

9290. Tamarix chinensis.

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1062, August, 1902), January 6, 1903.

"A species of *Tamarix* which has finer and more delicate foliage than *T. gallica.* It should be tried in Florida and California along the seashore drives in comparison with the ordinary species." (*Fairchild.*)

9291. XANTHOXYLON PIPERITUM. **Japanese pepper.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1063, August, 1902), February 28, 1903.

"A small shrub, the leaves of which are very agreeably aromatic and are used most effectively by Japanese housewives and by Europeans in Japan as a garniture. It would form a very acceptable variation from the conventional parsley. The small round fruits, flower buds, and leaves are boiled with meat dishes to give them a flavor, and the fruits are always served after eels as a digestive." (*Fairchild.*)

9292. TROCHODENDRON ARALIOIDES. **Birdlime tree.**

From Yokohama, Japan. Received through The Yokohama Nursery Company, February 28, 1903.

(This seed was apparently substituted by the Nursery Company for L. and F. No. 1064, *Ilex integra.*) (See 9293.)

9293. TROCHODENDRON ARALIOIDES. **Birdlime tree.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1065, August, 1902), January 6, 1903.

"A species of tree the bark of which is macerated and made into birdlime in Japan. This tree produces the best birdlime in the country, it is said, and there is an export of the article to Europe." (*Fairchild.*)

9294. FAGOPYRUM ESCULENTUM. **Buckwheat.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1066, August, 1902), January 6, 1903.

Sando Soba. From Nagano. "This Nagano buckwheat is famous in Japan, where all sorts of cakes, macaroni, and tarts are made from its flour. The question of the uses of buckwheat in Japan would form a very interesting and profitable study, for there are a hundred ways, I imagine, in which the buckwheat is employed, whereas we know of only a few." (*Fairchild.*)

9295. FAGOPYRUM ESCULENTUM. **Buckwheat.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1067, August, 1902), January 6, 1903.

"A species of *Fagopyrum* which is said to be inferior to *F. esculentum*, but is cultivated and may be of interest for breeding purposes." (*Fairchild.*)

9296. JUNIPERUS CHINENSIS var. PROCUMBENS.

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1068, August, 1902), January 6, 1903.

"A beautiful procumbent juniper which is used most effectively as a substitute for lawns on sloping embankments. It covers them with a mass of luxuriant foliage which is strikingly effective. In the Tokyo Botanic Gardens there is a very attractive lawn made in this way. The plants should be set about 3 feet apart each way and allowed to run freely in all directions until they completely cover the ground with a thick mat 12 to 18 inches deep. It will probably prove hardy about Washington." (*Fairchild.*)

9297 and 9298. SOLANUM MELONGENA. **Eggplant.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1069, August, 1902), January 6, 1903.

9297.

Naga nasu. "Considered the best variety in Japan, where eggplants are very largely eaten. They are even used for candying purposes. A candied eggplant is very delicate indeed, tasting something like a fig." (*Fairchild.*)

9298.

Maru nasu. "A round, black variety of eggplant, sold everywhere in the markets of Japan." (*Fairchild.*)

9299. Zoysia pungens. **Japanese lawn grass.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1071, August, 1902), January 6, 1903.

Birodoshiba. "A very fine-leaved lawn grass which forms a most beautiful velvet-like turf. The plant is said to have originated in southern Japan, to be sensitive to frost, but to be one of the prettiest lawn grasses in the country. It should be tested in California and Florida, where good lawn grasses are desired." (*Fairchild.*)

9300. Zoysia pungens. **Japanese lawn grass.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1072, August, 1902), January 6, 1903.

"A coarser leaved species of lawn grass than No. 9299, but otherwise of similar habit. These potted plants should be split up into a large number of small pieces and set out as is usually done with lawn grasses not grown from seed. It is said to be hardier than No. 9299." (*Fairchild.*)

9301. Allium fistulosum. **Forcing onion.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1073, August, 1902), January 6, 1903.

"The seed is sown in spring and the young onions are dug in July and inclined in long deep trenches, where they are gradually covered with earth almost to their tops. This covering of earth bleaches them and makes a length of about 14 inches of leaf edible. Sometimes the seed is sown in autumn and the transplanting to trenches done in the spring." (*Fairchild.*)

9302. Amygdalus persica. **Peach.**

From Kobe, Japan. Received through Messrs. Lathrop and Fairchild (No. 977, July 7, 1902), January 6, 1903.

Samomo. "This is the earliest ripening peach on the Kobe market. It is not very sweet but is of attractive color. It is an old sort in Kobe." (*Fairchild.*)

9303. Medicago sativa. **Alfalfa.**

From Limache, Peru. Presented by Mr. Adolfo Eastman Cox. Received October 20, 1903.

Seed of the native Peruvian alfalfa. Secured in Peru by Beéche, Duval & Co., and shipped through their house in New York.

"This variety has the following advantages over the Chilean: The stems are hollow and more succulent; the growth commences earlier in spring and continues later in the autumn, materially increasing the yield per acre, and it grows taller. On the other hand care has to be taken in feeding stock on it as it is apt to produce hoven (heaves)." (*Cox.*)

9304. Amygdalus persica. **Peach.**

From Kobe, Japan. Received through Messrs. Lathrop and Fairchild (No. 978, July 7, 1902), January 6, 1903.

Tinsin Suimitsuto. "One of the favorite sorts on the Kobe market, although too light in color to be very attractive. It is of large size and has been, it is said, recently introduced into southern Japan. According to nurserymen in Saitama Prefecture this can not be what they call the *Tinsin Suimitsuto* for that has *red* flesh, even before wholly ripe." (*Fairchild.*)

9305. Amygdalus persica. **Peach.**

From Kobe, Japan. Received through Messrs. Lathrop and Fairchild (No. 979, July 7, 1902), January 6, 1903.

Suimitsuto. "One of the earliest sorts and one of the sweetest of the peaches in the Kobe market. It differs in shape from the *Honey* type, being more like the *Persian.* It comes from the province of Sanuki, Japan." (*Fairchild.*)

9306. PRUNUS TRIFLORA. **Plum.**

From Kobe, Japan. Received through Messrs. Lathrop and Fairchild (No. 980, July 7, 1902), January 6, 1903.

Botankyo. "A light-colored variety of Hatankyo. A large-fruited plum, with very juicy flesh and thin skin." (*Fairchild.*) (See Nos. 9202–9210.)

9307. VICIA FABA. **Broad bean.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1031, August, 1902), January 6, 1903.

Otafuku. "Said to be remarkable for its size and good quality. The young beans of this variety are said to be especially delicious." (*Fairchild.*)

9308 to 9312. VICIA FABA. **Broad bean.**

From Yokohama, Japan. Received through Messrs. Lathrop and Fairchild (No. 1032, August, 1902), January 6, 1903.

"Five sorts of the Japanese broad bean or *Sora mame*, as follows:

9308.

Chiu otafuku.

9309.

Isun mame.

9310.

Kotsubu.

9311.

Yatanbusa.

9312.

Tsunashimam ame.

"The broad bean plays an important rôle in Japan, being grown extensively in ground which is later used for paddy rice. It is particularly abundant on the coast of the Japan Sea and in the colder parts of Japan. Almost exclusively used for human food." (*Fairchild.*)

9313. PRUNUS TRIFLORA **Plum.**

From Kobe, Japan. Received through Messrs. Lathrop and Fairchild (No. 981, July 7, 1902), January 6, 1903.

Hatankyo. "This is like the variety *Satsuma* in America and may be the same, though I am not familiar enough with the American type to say. The flesh is a blood or claret red color, very juicy, and not very sweet." (*Fairchild.*) (See No. 9202.)

9314. MYRICA NAGI.

From Kobe, Japan. Received through Messrs. Lathrop and Fairchild (No. 982, July 7, 1902), January 6, 1903.

Yama momo. "This fruit is said to be cultivated in the province of Kii. The beautiful fruits look something like raspberries, but resemble most in shape small fruits of *Arbutus unedo*, the strawberry tree of Italy. Their flesh is deep wine red, mildly acid, and refreshing. A very decorative fruit for fruit dishes, but not of great value for other purposes. Mr. Tanaka says it grows wild in the warm regions of Japan and forms a tree 20 feet high. The bark furnishes a tanning material." (*Fairchild.*)

9315. PANICUM TRYPHERON. **Guinea grass.**

From Sabana Grande, Porto Rico. Presented by Mr. Frank D. Gardner, special agent in charge of the Porto Rico Experiment Station. Received January 10, February 3, and February 9, 1903.

One of the best fodder grasses of the Tropics.

9316. MYRICA FAYA.

From St. Michael, Azores. Presented by Mr. F. S. Chaves. Received January 12, 1903.

9317. Opuntia ficus-indica. **Prickly pear.**

From Taormina, Sicily. Received through Messrs. Lathrop and Fairchild (No. 1079, November 24, 1902), January 17, 1903.

"A prickly pear which bears fruit containing comparatively few seeds. The variety is a white-fleshed one of medium size. The thallus is very spiny indeed, and the fruit is covered with small spines. This sort is considered more delicious than the ordinary kinds, and having but few seeds is in this respect entitled to the consideration of growers. A comparatively small number of plants of this variety are grown about Taormina, because the fruit is not a good market one, neither is it a very heavy cropper, but as the starting point for a seedless-fruited cactus it should appeal to any breeder of this very important and much neglected group of useful plants." (*Fairchild.*)

9318. Allium cepa. **Onion.**

From Valencia, Spain. Received through Hon. R. M. Bartleman, United States Consul, January 26, 1903.

"This large, mild-flavored onion is a native of Denia and the whole Valencia region. Attempts to grow these onions in other parts of Europe have not been successful, as they generally lose their mild flavor after the first season. The size of the onion is regulated by the farmers to suit the taste of the foreign buyers. Those shipped to the United States are the largest grown, and those intended for British markets the smallest. The seed is planted in beds from the middle of January until the first week in February, and transplanted when sufficiently developed. When large onions are desired, the plants are placed about 10 inches apart and plied with fertilizers and large quantities of water. When smaller ones are desired the plants are placed close together." (*Bartleman.*)

C. C. Morse & Co., of Santa Clara, Cal., state that this onion is without doubt the progenitor of Maule's "Prize Taker."

9319. Prunus armeniaca. **Apricot.**

From San Luis Potosi, Mexico. Received through Mr. G. Onderdonk, of Nursery, Tex., special agent of this Department, October, 1902.

9320. Amygdalus persica. **Peach.**

From San Luis Potosi, Mexico. Received through Mr. G. Onderdonk, of Nursery, Tex., special agent of this Department, October, 1902.

9321. Amygdalus persica. **Peach.**

From Saltillo, Mexico. Received through Mr. G. Onderdonk, of Nursery, Tex., special agent of this Department, October, 1902.

9322. Medicago sativa. **Alfalfa.**

From Tuggurt, Algeria. Received through Mr. Thomas H. Kearney, December 8, 1902.

An alkali-resistant variety. Crop of 1902.

9323. Medicago sativa. **Alfalfa.**

From Tuggurt, Algeria. Received through Mr. Thomas H. Kearney, December 8, 1902.

An alkali-resistant variety. Crop of 1901.

9324. Triticum durum. **Wheat.**

From Relizane, Algeria. Received through Mr. Thomas H. Kearney, December 8, 1902.

Marouani. An alkali-resistant variety.

9325. PISTACIA ATLANTICA. **Afsie or Betoom.**

From Duperré, Algeria. Received through Mr. W. T. Swingle (No. 122) from Dr. L. Trabut, Government Botanist of Algeria. Collected by Mr. Frank Joly. Received January 10, 1903.

"A large tree, reaching 40 to 50 feet in height and 4½ feet in diameter. The leaves produce a gall 'Afs-el-betoom,' which is an article of considerable commercial importance in Tripoli and Tunis. It is the only tree of any size growing in the northern Sahara, where it occupies the 'dayas' or depressions in the plateaus. Of much promise as a drought and alkali resistant stock for the pistache. A deciduous tree, not so resistant to cold as the Chicudia." (*Swingle.*)

9326 to 9341. ORYZA SATIVA. **Rice.**

From Lake Charles, La. Received through Dr. S. A. Knapp, January 19, 1903.

9326.

Shinriki. Grown from No. 8300. From Hyogo district, Japan. Doctor Knapp considers this the best early Japan rice.

9327.

Shiratama. Grown from No. 8301. From Fukuoka district, Japan. A very good early variety.

9328.

Komachi. Grown from No. 8302. From Kumamoto district, Japan. This is a medium late variety of no great value.

9329.

Omase. Grown from No. 8303. From Kumamoto district, Japan. One of the best medium varieties.

9330.

Miyako. Grown from No. 8304. From Yamaguchi district, Japan. A medium early variety that may be of value.

9331.

An unnamed variety. Grown from No. 8305. From Chiugoku district, Japan. This is not so early as No. 9326, but has many good qualities.

9332.

An unnamed variety. Grown from No. 8306. From Chikuzen district, Japan. One of the best medium varieties. Practically the same as *Kiushu.*

9333.

Fusakichi. Grown from No. 8508. From Bizen district, Japan. A medium early variety of remarkable quality. The seeds are exceptionally large, and on suitable land, with plenty of water, this will probably be one of the very best varieties.

9334.

Mansaku bozu. Grown from No. 8509. From Fukuoka district, Japan. This is one of the best medium varieties.

9335.

An unnamed variety. Grown from No. 8310. From Ise district, Japan. This is a medium variety and may become valuable.

9336.

An unnamed variety. Grown from No. 8511. From Buzen district, Japan. This is a medium variety and may prove valuable.

9326 to 9341—Continued.

9337.

An unnamed variety. Grown from No. 8512. From Iyo district, Japan. This is a medium late variety of extra vigor and fairly good yield.

9338.

An unnamed variety. Grown from No. 8513. From Higo district, Japan. This is one of the best late varieties.

9339.

An unnamed variety. Grown from No. 8514. From Bizen district, Japan. This is a late variety that may prove valuable.

9340.

An unnamed variety. Grown from No. 8515. From Banshu district, Japan. This is the best late variety.

9341.

Honduras rice. One of the standard varieties, grown for comparison.

9342. ORYZA SATIVA. **Rice.**

From Kin-hua, China. Secured by Dr. S. P. Barchet, of the United States consulate, Shanghai, China, at the request of Dr. S. A. Knapp. Received January 22, 1903.

A late variety sown in May.

9343. ORYZA SATIVA. **Rice.**

From Ki-ni, Kin-hua, China. Secured by Dr. S. P. Barchet, of the United States consulate, Shanghai, China, at the request of Dr. S. A. Knapp. Received January 22, 1903.

Glutinous rice. Sown in May.

9344. GLYCINE HISPIDA. **Soy bean.**

From Chiu-hua, China. Secured by Dr. S. P. Barchet, of the United States consulate, Shanghai, China, at the request of Dr. S. A. Knapp. Received January 22, 1903.

Chiu-hua. "In case of future reference to the bean, if you call this the *Chiu-hua* bean I shall know what is meant, in the absence of a botanical name, as I have not seen this bean anywhere else. It is sown broadcast in paddy fields before the rice is harvested. The moist ground favors the sprouting, and the standing grain shields the sprouting plant from the sun. By the time the rice is harvested the beans have taken firm roots and require no further care. Horses and cattle are very fond of them green or in the ripe state. The bean also makes a good food for man. This bean I think well worth a trial in the Southern States." (*Barchet.*)

9345. AMYGDALUS COMMUNIS. **Almond.**

From Mustapha, Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist. Received January 26, 1903.

Cuttings of the wild almond of the mountains of Algeria, said to be excellent for stock.

9346. PRUNUS DOMESTICA. **Plum.**

From Mustapha, Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist. Received January 26, 1903.

Reine Claude Rouge. Cuttings of this plum. Marked by Doctor Trabut "Glorion Vincent."

9347. LINUM USITATISSIMUM. **Flax.**

From Rotterdam, Holland. Received through F. Dutilh & Co., January 29, 1903.

Dutch Riga-Child. Extra picked. From crop of 1902.

9348 to 9351. AMYGDALUS COMMUNIS. **Almond**

From Alicante, Spain. Received through Mr. D. G. Fairchild (Nos. 740, 741, 745, 755a, July 19 and 20, 1901), January 30, 1903.

A collection of young almond trees budded on myrobalan stocks by Mr. Georges Boucher, Paris, France, with buds secured by Mr. Fairchild in Spain.

9348.

Mollar. (No. 740.)

9349.

Planeta. (No. 741.)

9350.

Castillet. (No. 745.)

9351.

Pastaneta. (No. 755a.)

(See Nos. 7985 to 7989 and 9458 to 9462.)

9352. OPUNTIA FICUS-INDICA. **Prickly pear.**

From Malta. Received through Messrs. Lathrop and Fairchild (No. 1082, December 27, 1902), January 31, 1903.

"Fruits from the plants of this variety contain less than 12 seeds, according to Dr. Giovanni Borg, of Malta, who kindly presents them to the Department. These seeds are very small and not at all objectionable. The fruit inside and out is yellowish orange in color, of good flavor, Doctor Borg says, and of the size of a goose egg. The thallus is nearly spineless. It is a rare plant even in Malta. These fruits came from plants growing in a garden in Siggiewi." (*Fairchild.*)

9353. OPUNTIA FICUS-INDICA. **Prickly pear.**

From Malta. Received through Messrs. Lathrop and Fairchild (No. 1083, December 27, 1902), January 31, 1903.

"This variety resembles No. 9352 closely, but the fruits are much smaller, being only the size of a hen's egg. Seedless or at least with very few seeds. The thallus is nearly spineless. The minute bristles on the fruit, according to Dr. Giovanni Borg, can be removed by washing the fruits in a basin of water with a whisk broom. The water loosens up the small cushions of bristles and they are easily brushed away into the water. This variety is not as promising as No. 9352, but is worthy a place in the breeder's collection. The fact of its seedlessness and spinelessness makes it a valuable variety of *Opuntia* for any economic studies on the subject. From Professor Pisani's villa at Maurisi, near Zeitun, Malta." (*Fairchild.*)

9354. FICUS CARICA. **Fig.**

From Malta. Received through Messrs. Lathrop and Fairchild (No. 1084, December 28, 1902), January 31, 1903.

St. Anthony. "Dr. Giovanni Borg, director of the botanic garden, says this is one of the most delicious figs he has ever eaten. It ripens one crop of figs in June and a second in September or October. The regular late crop is red in color. No caprification is deemed necessary for this sort, which Doctor Borg thinks could be used for drying purposes. It is an uncommon variety." (*Fairchild.*)

9355. ARACHIS HYPOGAEA. **Peanut.**

From Tanegashima, Japan. Presented by Mr. H. E. Amoore. Received February 2, 1903.

9356 and 9357. Zea mays. **Corn.**

From Forestburg, S. Dak. Presented by Mr. H. C. Warner. Grown from S. P. I. No. 13, which was found to be a mixture of types.

9356. *Malakoff* sugar corn. White type.

9357. Amber type.

9358. Triticum vulgare. **Wheat.**

From the estate of Mr. Bezouglov, near Byeloglinskaya, Don Territory, Russia. Obtained by Mr. E. A. Bessey (No. 110, August 4, 1902), through the Theodore N. Solodov Milling Company, Rostov-on-Don, Russia. Received February 3, 1903.

Beloglino. "A hard, red, winter wheat from the crop of 1902. This has just been harvested and thrashed at this date and is of very good quality, far exceeding that of last year." (*Bessey.*)

9359. Medicago sativa. **Alfalfa.**

From Erivan, Caucasia. Obtained by Mr. E. A. Bessey (No. 236, October 7, 1902), through Mr. N. P. Taratinoff, of Tiflis. Received February 3, 1903.

"Alfalfa from Erivan Province, the hottest and driest province in summer and coldest in winter (reaching −22° F.). It should prove valuable in cold regions." (*Bessey.*)

9360 to 9402.

From Tiflis, Russian Caucasus. Presented by Mr. A. Rolloff, director of the botanic garden, through Mr. E. A. Bessey. Received February 3, 1902.

9360. Pyrus communis. **Pear.**

Sini. (No. 209.)

9361. Pyrus communis. **Pear.**

Nana-armud. (No. 210.)

9362. Prunus domestica. **Plum.**

Vazirali. (No. 211.)

9363. Prunus domestica. **Plum.**

Tchantchuri. (No. 212.)

9364. Prunus armeniaca. **Apricot.**

Agdzhanabad. (No. 213.)

9365. Prunus armeniaca. **Apricot.**

Achverdi. (No. 214.)

9366. Prunus armeniaca. **Apricot.**

Badam-arik. (No. 215.)

9367. Prunus armeniaca. **Apricot.**

Norrast. (No. 216.)

9368. Prunus armeniaca. **Apricot.**

Tabarzei. (No. 217.)

9369. Prunus armeniaca. **Apricot.**

Bairam-ali. From Turkestan. (No. 218.)

9360 to 9402—Continued.

9370. PRUNUS ARMENIACA. Apricot.

Red Yusup-Khan. From Turkestan. (No. 219.)

9371. PRUNUS ARMENIACA. Apricot.

White Yusup-Khan. From Turkestan. (No. 220.)

9372. AMYGDALUS PERSICA. Peach.

Zafrani. (No. 221.)

9373. AMYGDALUS PERSICA. Peach.

Nazli. (No. 222.)

9374. AMYGDALUS PERSICA. Peach.

Norrast-huli. (No. 223.)

9375. AMYGDALUS PERSICA. Peach.

Salami. (No. 224.)

9376. AMYGDALUS PERSICA. Peach.

Narindzhi. (No. 225.)

9377. AMYGDALUS PERSICA. Peach.

Sachrari. (No. 226.)

9378. AMYGDALUS PERSICA. Peach.

Arabuli. (No. 227.)

9379. AMYGDALUS PERSICA. Peach.

Tibatrica. (No. 228.)

9380. AMYGDALUS PERSICA. Peach.

Gandzhari. (No. 229.)

9381. FICUS CARICA. Fig.

Tschapla. (No. 230.)

9382. ELAEAGNUS ANGUSTIFOLIA.

Matnu-pshat. (No. 231.)

9383. ELAEAGNUS ANGUSTIFOLIA.

Unab-pshat. (No. 232.)

9384. MORUS ALBA.

Gandzha. (No. 233.)

9385. PUNICA GRANATUM.

Krmzi-kabuck. (No. 234.)

9386. PUNICA GRANATUM.

Shirin-nar. (No. 235.)

9387. Mixture of seeds of PYRUS SALICIFOLIA and P. ELAEAGRIFOLIA. (Nos. 203 and 204.)

9388. PYRUS COMMUNIS. Pear.

Wild pear. (No. 202.)

9360 to 9402—Continued.

9389. AMYGDALUS PERSICA. **Peach.**

Wild peach.

9390. PRUNUS ARMENIACA. **Apricot.**

Wild apricot. (No. 205.)

Seeds of cultivated varieties of peaches as follows:

9391. AMYGDALUS PERSICA. **Peach.**

Narindschi. (No. 206.)

9392.

Guli. (No. 208.)

9393.

Zafrani. (No. 207.)

9394.

Norrast.

9395.

Spitak.

9396.

Lodz.

Seeds of cultivated sorts of apricots, as follows:

9397. PRUNUS ARMENIACA. **Apricot.**

Schalogi.

9398.

Agdschanabad.

9399.

Chosrof-schack.

9400.

Badam-arik.

9401.

Gerondi.

9402.

Gegdschanabad.

9403. STRYPHNODENDRON BARBATIMAO.

From São Paulo, Brazil. Presented by Dr. Alberto Löfgren, director of the Botanic Garden. Received February 2, 1903.

"The bark of this tree contains considerable tannin." (*Löfgren.*)

9404 and 9405. PHASEOLUS sp. **Bean.**

From São Paulo, Brazil. Presented by Dr. H. M. Lane. Received February 4, 1903.

9404. **Brown bean.**

Feijão mulato.

9405. **Black bean.**

Feijão preto.

9406. ARACHIS HYPOGAEA. **Peanut.**

From São Paulo, Brazil. Presented by Dr. H. M. Lane. Received February 4, 1903.

Ordinary variety.

9407 to 9418. GLYCINE HISPIDA. **Soy bean.**

A collection of soy beans grown by Mr. W. R. Beattie on the experimental grounds on the Potomac Flats, from introduced seed.

9407.

Grown in 1902 from S. P. I. No. 4912.

9408.

Grown in 1902 from S. P. I. No. 4913.

9409.

Grown in 1902 from S. P. I. No. 4914.

9410.

Grown in 1901 and 1902 from S. P. I. No. 6312.

9411.

Grown in 1901 and 1902 from S. P. I. No. 6333.

9412.

Grown in 1901 and 1902 from S. P. I. No. 6334.

9413.

Grown in 1901 and 1902 from S. P. I. No. 6336.

9414.

Grown in 1901 and 1902 from S. P. I. No. 6386.

9415.

Grown in 1901 and 1902 from S. P. I. No. 6396.

9416.

Grown in 1901 and 1902 from S. P. I. No. 6397.

9417.

Grown in 1901 and 1902 from S. P. I. No. 6414.

9418.

Grown in 1901 and 1902 from S. P. I. No. 6416.

9419. PHASEOLUS MUNGO-RADIATUS (?). **Gram.**

Grown on Potomac Flats in 1902 by Mr. W. R. Beattie from S. P. I. No. 6417.

9420. AMYGDALUS PERSICA. **Peach.**

From Pomoña, N. C. Presented by Mr. J. Van Lindley. Received February 6, 1903.

Natural peach seed from the seedling peach orchards, for growing as stocks in comparison with Mexican seed.

9421. LINUM USITATISSIMUM. **Flax.**

From Perwez, Belgium. Received through Emile Mathy, February 8, 1903.

First choice.

9422. AVENA SATIVA. **Oat.**

From Moscow, Russia. Received through Mr. E. A. Bessey, from Immer & Sons (No. 104, July 22, 1902), February 10, 1903.

Swedish Select. "This excellent variety has proven exceptionally good for the dry Steppe region. This is a selection made in Sweden of the Ligowo oat and bred up by Immer & Sons. It originally came from Ladoga, near St. Petersburg. This year's crop." (*Bessey.*)

9423 to 9425. PANICUM MILIACEUM. **Proso.**

From Moscow, Russia. Received through Mr. E. A. Bessey, from Immer & Sons. (Nos. 105 to 107, July 22, 1902.)

9423.

Red Orenburg. Crop of 1902. Received February 10, 1903. (No. 105.)

9424.

Red Vorónezh. Crop of 1902. Received May 22, 1903. (No. 106.)

9425.

Black Vorónezh. Crop of 1902. Received May 22, 1903. (No. 107.)

9426. PISTACIA LENTISCUS. **Mastic.**

From the rocky cliffs along the seashore, between Leghorn and Castiglioncello, Italy. Collected by Mr. W. T. Swingle (No. 123, January 14, 1903). Received February 17, 1903.

"The lentisk or mastic tree is found chiefly in the immediate vicinity of the sea in the Mediterranean region wherever the winters are not too severe (it is decidedly less hardy than the terebinth). Its northern limit is about the January isotherm of 42.8° to 46.4° F. It is a small evergreen tree (other species of *Pistacia* are deciduous) or more often a shrub, branching profusely from the ground. When growing in tree form it sometimes reaches a height of 20 to 25 feet, and a diameter of 8 inches to one foot. *It prefers silicious soils and avoids those decidedly calcareous* in nature, being just the opposite of the terebinth, so the two are very rarely seen growing together in a wild state. The leaves are rich in tannin (11.5 per cent), and are collected and sold in Tunis as a substitute for sumac for tanning. The seeds are much liked by pigs, goats, and wild boars in Tunis, and are an important source of food in dry years when the fruit is apt to be unusually abundant, while other forage is scarce. In Chios a grafted variety yields *mastic*, a soft resin much prized in the Orient for chewing gum and for flavoring liquors. This is a promising stock on which to graft the pistache, especially on silicious or slightly acid soils near the sea. It is said not to be so long lived as the terebinth, and the pistache, when grafted on the lentisk, is said to live only forty years, whereas it lives one or two centuries on the terebinth. It is probably a dwarf stock and pistaches grafted on it should be set out at smaller distances apart than on other stocks. On sandy soil with moderate bottom heat, there should be no difficulty in starting the cuttings." (*Swingle.*)

9427 to 9436.

From Nice, France. Presented by Mr. A. Robertson-Proschowsky. Received January 12, 1903.

A collection of seeds as follows:

9427. ARISTOLOCHIA ELEGANS.

9428. CESTRUM ELEGANS.

9429. CISTUS ALBIDUS.

9430. CLEOME ARBOREA (?)

9431. DOLICHOS LABLAB.

9432. ECHINOCACTUS SCHUMANNIANUS.

9433. PHLOMIS FRUTICOSA.

9434. SUTHERLANDIA FRUTESCENS.

9435. PITTOSPORUM UNDULATUM.

9436. TACSONIA MANICATA.

9437. CITRUS AURANTIUM. **Orange.**

From Mustapha, Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist. Received February 16, 1903.

Seeds of the *Condja* (?) orange. Fruit very large and sweet, four hundred grams or more, resembling the *Jaffna*. One or two seeds of each fruit. It reproduces true to seed.

9438 to 9444. PHASEOLUS sp. **Bean.**

From Mexico. Received through Dr. Edward Palmer, February 21, 1903. A collection of different varieties of beans, as follows:

9438.

Garbansillo. From Saltillo. "First-class bean and seems a little different from the one at San Luis Potosi of the same name (No. 9155). When the bean from San Luis Potosi is brought to Saltillo for sale it is objected to because it is said to take more fuel for cooking, and fuel is an object. This is probably due to the fact that the water at San Luis Potosi is hard, while that at Saltillo is soft. This bean is very prolific in this section of the table-lands and is the choice of all who can afford to purchase it. Bought from Jesus Santos Grande, Saltillo, Mexico." (*Palmer.*)

9439.

Vayo-gordo. From Saltillo. "A first-class bean and a great favorite with the rich. It is said to be very productive in this section, and as it is not very dark in color it might claim recognition in the United States." (*Palmer.*)

9440.

Frijol para la sopa. From San Luis Potosi. "Not of very good quality, but much used for soups. Apparently a poor quality of *Blanco bolador.*" (*Palmer.*)

9441.

Canelo Gordo. From Saltillo. "A first-class bean which can be had in large quantities at the markets." (*Palmer.*)

9442.

Canelo Chico. From Saltillo. "A first-class bean; plentiful in the markets. It is used extensively." (*Palmer.*)

9443.

Guadalupano. From Saltillo. "A bean not much seen on the markets, somewhat resembling the *Borrado*. It is a second-class bean." (*Palmer.*)

9444.

Bolador de Color. From Saltillo. "A third-class bean, and only eaten when others can not be obtained, and then only after boiling and frying in lard." (*Palmer.*)

9445. SOLANUM sp. **Pepper.**

From San Luis Potosi, Mexico. Received through Dr. Edward Palmer, February 21, 1903.

Chili guipin. "Sold in the markets of San Luis Potosi and commonly eaten by the well-to-do. A very hot pepper. Eaten before and with soups." (*Palmer.*)

9446. PISTACIA LENTISCUS. **Mastic.**

From rocky cliff near seashore, opposite Castello Sonnino, between Leghorn and Castiglioncella, Italy. Received through Mr. W. T. Swingle (No. 124), February 20, 1903.

9447. Anacardium occidentale. **Cashew.**

From Beira, East Africa. Presented by Mr. Arthur W. H. Glenny, United States consular agent at Beira, through Messrs. Lathrop and Fairchild (No. 1092, January 28, 1903), March, 1903.

"Seed of the West Indian cashew, which came from trees growing in Rhodesia that seem unusually hardy and grow at an altitude of several thousand feet, where occasional frosts are said to occur. Worthy of trial in Florida and Porto Rico." (*Fairchild.*)

9448. Physalis sp.

From Saltillo, Mexico. Received through Dr. Edward Palmer, February 21, 1903.

"A large, dark plum-colored variety, used in soups and stews. Also fried with beefsteak and sometimes used in dressings for fowls. Fruits secured in November, 1902, were sound February 6, 1903, when the seeds were removed." (*Palmer.*)

9449. Zea mays. **Corn.**

From Ravenna, Ohio. Presented by the Ford Seed Company. Received February 24, 1903.

Malakhoff sugar. Grown from S. P. I. No. 13.

9450. Medicago sativa. **Alfalfa.**

From Askhabad, Trans-Caspian Territory, Turkestan. Received through Mr. E. A. Bessey (No. 113, August 23, 1902), from Sadik-Bek Agabekov, acting governor of the district of Askhabad. February 28, 1903.

"The sort of alfalfa grown by the natives (*Tekins*) from time immemorial. Apparently well adapted to a very hot climate of low humidity and mild winters. This variety will probably not be suited for northern climates, but will thrive, when irrigated, in the very hottest, driest regions, as Askhabad is almost the hottest point in Turkestan." (*Bessey.*)

9451. Medicago sativa. **Alfalfa.**

From Sairam, near Chimkent, Russia. Received through Mr. E. A. Bessey, from Mr. H. W. Dürrschmidt, of Tashkent (No. 150, September 29, 1902), February 28, 1903.

"The alfalfa of this region (and also around Karabulák, 24 miles northwest of Sairam) is considered to be about the best in Turkestan. It is grown in considerable quantities throughout the whole region. This is probably the coldest region in Turkestan where alfalfa is grown in such large quantities. This ought to be good for cool regions." (*Bessey.*)

9452. Medicago sativa. **Alfalfa.**

From Karabulák, 25 miles north of Chimkent, Russia. Received through Mr. E. A. Bessey, from Mr. H. W. Dürrschmidt, of Tashkent (No. 151, September 29, 1902), February 28, 1903.

"The same methods of culture as in Sairam, only in slightly larger fields. As in Sairam, it is grown with the aid of irrigation. Sent for trial in cool regions." (*Bessey.*)

9453. Medicago sativa. **Alfalfa.**

From Bokhara, Turkestan. Received through Mr. E. A. Bessey, from Mr. H. W. Dürrschmidt, of Tashkent (No. 152, September 29, 1902), February 28, 1903.

"Bokhara is a region containing much alkali land; the soil has a white crust when dry. Large fields of various crops are destroyed by alkali. This seed is not especially resistant to cold. It is sent for trial in alkali regions." (*Bessey.*)

9454. MEDICAGO SATIVA. **Alfalfa.**

From Khiva, Turkestan. Received through Mr. E. A. Bessey, from Mr. H. W. Dürrschmidt, of Tashkent (No. 153a, November 6, 1902, numbered in sack 153), February 28, 1903.

"Khiva is one of the driest regions in Turkestan, the average rainfall being less than 3 inches a year. It is correspondingly hot in summer, but rather cold in winter; much colder than Bokhara, Askhabad, or Karshi. Alfalfa is grown only by irrigation. It is fertilized abundantly, at least with fresh soil if not with animal manure." (*Bessey.*)

9455. MEDICAGO SATIVA. **Alfalfa.**

From Karshi, Turkestan. Received through Mr. E. A. Bessey, from Mr. H. W. Dürrschmidt, of Tashkent (No. 154a, November 6, 1902, numbered in sacks 154), February 28, 1903.

"Karshi lies about 80 miles southwest of Samarcand and about as far southeast of Bokhara. It is in the edge of the mountains and much cooler than Bokhara." (*Bessey.*)

9456. QUERCUS SUBER. **Cork oak.**

From Paris, France. Received through Vilmorin-Andrieux & Co., March 5, 1903.

9457. LINUM USITATISSIMUM. **Flax.**

From Riga, Russia. Received through the United States consul, from A. Sellmar, March 6, 1903.

Best Riga.

9458 to 9462. AMYGDALUS COMMUNIS. **Almond.**

Received through Mr. J. W. Kerr, Denton, Md. Grown by Mr. Kerr from buds furnished by this Department. Received March 7, 1903.

9458.

Castillet. Grown from S. P. I. No. 7133.

9459.

Fabrica. Grown from S. P. I. No. 7135.

9460.

Jordan. Grown from S. P. I. Nos. 7398 and 7401, mixed.

9461.

Mollar. Grown from S. P. I. No. 7061.

9462.

Planeta. Grown from S. P. I. No. 7062.

See Nos. 7985 to 7989 and 9348 to 9351. Budded on peach stocks.

9463 and 9464. PRUNUS ARMENIACA. **Apricot.**

Received through Mr. J. W. Kerr, Denton, Md. Grown by Mr. Kerr from buds furnished by this Department. Received March 7, 1903.

9463.

Patriarca. Grown from S. P. I. 7136.

9464.

Grown from S. P. I. No. 6844.

9465. Rosa sp. **Rose.**

From Cannes, France. Received through Mr. J. B. Cognet, United States consular agent, March 9, 1903.

The true perfume rose.

9466. Anona cherimolia.

Plants grown in Department greenhouse from seed presented by Capt. J. J. Haden, Cocoanut Grove, Fla., April 16, 1902. Plants numbered March 11, 1903.

9467. Eriobotrya japonica. **Loquat.**

Seedling plants grown in Department greenhouse from seeds of large loquat tree in orange house. Plants numbered March 11, 1903.

9468. Eriodendron anfractuosum. **Kapok.**

From Marseille, France. Presented by the United States Consulate. Received February 14, 1903. Turned over to the Office of Seed and Plant Introduction by Mr. L. H. Dewey, Assistant Botanist.

9469 and 9470. Pyrus malus. **Apple.**

From Naples, Italy. Presented by Prof. L. Savastano through Messrs. Lathrop and Fairchild (Nos. 1077 and 1078). Received March 14, 1903.

9469.

Annurco. "The leading market apple of the region about Naples. It is a showy red apple, with yellow streaks, and has an unusually high flavor for a variety grown so far south. It should be tested in the Southern States. Obtained through the kindness of Professor Savastano, of the agricultural school at Portici." (*Fairchild.*)

9470.

Limoncelli. "A lemon-yellow fruited variety; one of the best market varieties of southern Italy. It has a hard, crisp, slightly tough flesh, subacid and highly flavored. It is not as good as No. 9469, but I believe is a better keeper. Obtained through the kindness of Professor Savastano, of the agricultural school at Portici." (*Fairchild.*)

9471. Pyrus malus. **Apple.**

From Portici (Naples), Italy. Presented by Prof. L. Savastano through Messrs. Lathrop and Fairchild. Received March 14, 1903.

Melo gelato. "Grows well in the warm region about Naples. In cold countries the yield is poor. It does best in calcareous soil." (*Fairchild.*)

9472. **Palm.**

From Black River, Honduras. Presented by Mr. Frank Dean through Dr. H. J. Webber of this Department. Received March 16, 1903.

Two ounces of seed of a small, pinnate-leaved palm 6 feet high. Foliage dark green. Fine for conservatories.

9473. Attalea cohune (?) **Palm.**

From Black River, Honduras. Presented by Mr. Frank Dean through Dr. H. J. Webber of this Department. Received March 16, 1903.

Coquito. A large pinnate-leaved palm.

9474. Pistacia mutica (?)

From Smyrna, Turkey in Asia. Purchased from Mr. B. J. Agadjanian, at the request of Mr. W. T. Swingle (No. 121). Received March 21, 1903.

"The celebrated turpentine tree of Chios, from which a kind of turpentine is extracted by making incisions in the bark. It grows to a large size, reaching a diameter of 5 feet 2½ inches and a height of 40 to 60 feet. The seeds yield an oil used for culinary purposes and in making toilet soaps. This tree is of great promise for use as a stock on which to graft the pistache, especially for semiarid regions in the Southwest, where this tree would be able to grow without irrigation. Worthy of trial as a shade and timber tree in warm dry regions. It is deciduous." (*Swingle.*)

9475. Capsicum annuum. **Red pepper.**

From Pasadena, Cal. Presented by Capt. C. W. Livermore. Received March 21, 1903.

Paprica.

9476. Myrica faya.

From St. Michaels, Azores Islands. Presented by Hon. George H. Pickerell, United States consul. Received March 21, 1903.

9477. Pistacia vera. **Pistache.**

From Catania, Italy. Presented by Hon. Alexander Heingartner, United States consul, at the request of Mr. W. T. Swingle. Received March 16, 1903.

Sicilian. "From grafted pistache trees at Bronte, on the slopes of Mount Etna. The only sort likely to succeed in America for commercial purposes. Not large, with a bright-green kernel." (*Swingle.*)

9478 and 9479. Triticum durum. **Wheat.**

From Brookings, S. Dak. Received through Mr. James H. Shepard, March 14, 1903. Grown from seed originally imported from Russia.

9478.

Kubanka.

9479.

Velvet Don.

9480. Citrus nobilis × citrus bigaradia. **Tangerine.**

From Mustapha, Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist. Received March 19, 1903.

Clementine.

9481. Cucurbita sp. **Squash.**

From Mustapha, Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist. Received March 21, 1903.

Courge bedouine.

9482. Trichilia dregei.

From Delagoa Bay, Portuguese East Africa. Received through Messrs. Lathrop and Fairchild (No. 1094, February 1, 1903), March 13 and 21, 1903.

Freda. "A handsome shade tree which is being used for avenue planting and which deserves trial as a shade tree in tropical gardens and also in Florida. It grows in almost pure sand, but requires water. Its seeds may be objectionable when they fall, as they are abundant and covered with a red arillus." (*Fairchild.*)

9483.

From Johannesburg, Transvaal. Received through Messrs. Lathrop and Fairchild (No. 1108, February 18, 1903), March 24, 1903.

"An undetermined species of the sunflower family which, according to Mr. R. W. Odlam, superintendent of the Municipal Garden at Johannesburg, bears very pretty pale-yellow flowers and is worthy of being brought into cultivation. These seeds were collected by him on the high veld for the purpose of planting in his garden. They should be sown immediately upon arrival." (*Fairchild.*)

9484. GERBERA JAMESONI. **Barberton or Transvaal daisy.**

From Johannesburg, Transvaal. Received through Messrs. Lathrop and Fairchild (No. 1106, February 18, 1903), March 24, 1903.

"This showy perennial is half hardy and can be grown in the open in California and the Southwest but will probably succeed as a potted plant, if set out in the summer time, even as far north as Chicago. Its flowers, which are daisy-like in shape and very large, are of a beautiful scarlet color. They are not borne in great abundance but are nevertheless very showy. The foliage, resembling slightly that of the dandelion in shape, is a deep, dark green, and the flower scapes, which rise out of a dense mass of it, are long and slender. The flower is a brilliant, attractive thing and well worthy of attention. The seeds are very short lived and should be planted at once in rich, sandy potting soil. Should germinate in ten to twelve days. The plants require plenty of water and sunshine." (*Fairchild.*)

9485. ANANAS SATIVUS. **Pineapple.**

From Durban, Natal. Received through Messrs. Lathrop and Fairchild (No. 1109, February 19, 1903). March 30, 1903.

Natal. "Sets taken from the tops of two most delicious pineapples of the common cultivated variety of Natal. More sets would be sent were it not for a disease which is prevalent among the Natal pines and which we fear to introduce into America. This disease is said to be fungous in character and to be caused by a species of Mucor which gets into the fruit through places attacked by a red mite. These two plants should be watched closely and the sets carefully examined before planting, for although they came from perfectly sound fruit they may harbor this Mucor. The Natal pineapple is a small sort of most unusual uniformity of flavor and texture and surpasses in sweetness, crispness, and freedom from fiber or seeds any other pineapple which we have ever eaten. Its small, convenient size and tenderness of flesh suit it better than any variety we have ever seen for general table use, and its excellent shipping qualities must recommend it to American growers. It has scarcely any core, and from the standpoint of the consumer it is a great pineapple. It is said to thrive with very little attention in Natal." (*Fairchild.*)

9486. MANGIFERA INDICA. **Mango.**

From Beira, Portuguese East Africa. Received through Messrs. Lathrop and Fairchild (No. 1091, January 28, 1903), April 2, 1903.

Lathrop. "The single fruit from which one of these two seeds came, and from which the following description is made, was the only one obtainable during our short stop in Beira. It was $15\frac{3}{16}$ inches in largest circumference and of a peculiar, characteristic shape; being in outline (seen from the stem end) very broadly elliptical (14 inches in circumference at base) while, seen in profile, it was heart shaped with a decided oblique tendency. It resembled in shape a Sour Sop and was nearly as large as a medium-sized specimen of this species of Anona. The skin was, when ripe, a light golden yellow and of a peculiar texture, not common to other varieties of mangoes that I have seen. It was not quite smooth but suggested the roughness of a pomelo skin. It was about one-eighth inch thick and quite tough, and on the inside it was lined with a number of long, strong fibers which did not penetrate into the flesh but adhered closely to the skin. The flesh, from this skin quite down to the short fibers attached to the seed, was entirely devoid of stringiness of any kind and had the texture of a firm custard and was of a deep golden color. In aroma it lacked very little of being as pronounced and agreeable as that of the best *Alphonse* variety of Bombay and its flesh had the indescribably rich flavor which characterizes the best varieties of this tropical fruit. The seed was small ($3\frac{3}{4}$ by $2\frac{3}{4}$ by $1\frac{1}{4}$) in proportion to the size of the fruit and the fibers attached to it are mostly about one-fourth inch long. A small bundle of fibers at one edge is 1 inch in length. This is one of the great mangoes of the world and would command fancy prices in America at any time of the year. It is fitting to name this after Mr. Barbour Lathrop, who first called it to the attention of the American public and who first introduced it into Florida. See No. 9669." (*Fairchild.*)

9487. RAPHANUS SATIVUS. **Radish.**

From Erfurt, Germany. Received through F. C. Heinemann, April 4, 1903.

Erfurt Crimson Giant. Heinemann's tender forcing radish.

9488. CITRUS HYBRIDA.

From Mustapha, Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist. Received April 11, 1903.

"Seed of a hybrid said to be of very good quality. Fruit nearly round, clear, yellow, sweet, and very juicy. Late." (*Trabut.*)

9489. CITRUS AURANTIUM × CITRUS BERGAMIA.

From Mustapha, Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist. Received April 11, 1903.

Seeds of a hybrid called by Doctor Trabut *Limorange.* A hybrid of the orange and mellarose. Said to be very good. Skin white. See No. 9554 for bud wood of same.

9490. PISTACIA VERA. **Pistache.**

From Baku, Trans-Caspian Province, Russia. Received through Mr. E. A. Bessey (October 9, 1902), April 13, 1903.

"The price of these nuts at retail in the market is 60 kopecks per pound; wholesale, 40 kopecks per pound." (*Bessey.*)

9491. PISTACIA VERA. **Pistache.**

From Tunis. Received through Mr. Walter T. Swingle (No. 125), February 21, 1903.

9492 to 9500.

From Japan. Presented by T. Tamura, of the agricultural experiment station at Okitsumachi, Shizuoka, Japan, through Messrs. Lathrop and Fairchild. Received April 16, 1903.

A collection of bud wood of Japanese fruits, as follows:

9492. PYRUS COMMUNIS. **Pear.**

9493. CITRUS JAPONICA. **Kumquat.**

Marukinkan.

9494. CITRUS JAPONICA. **Kumquat.**

Nagakinkan.

9495. CITRUS NOBILIS. **Mandarin orange.**

Aisomikan.

9496. CITRUS NOBILIS. **Mandarin orange.**

Kawahata Mikan.

9497. CITRUS sp.

Oshima Kunenbo or *Seedless Kunenbo.* "Grown on the island of Oshima, province of Osumi, prefecture Kagoshima. Fruit medium, flattened, but much larger than the common Kunenbo and very coarse. Rind thick, deep, brilliant reddish-orange color. Very fragrant. Pulp sweet, juicy, and delicious. Very good for table use and of good keeping quality." (*Tamura.*)

9492 to 9500—Continued.

9498. CITRUS AURANTIUM. **Orange.**

T. Tamura's summer orange. Originated by T. Tamura in the district of Shingai, province of Gosa, prefecture Kochi. "Fruit conical, weighing from 1½ to 2 pounds. Skin pale white and somewhat rough. Color bright yellow in the first year, changing to dull yellow the second. Fruit remains on the tree during July and August the second season. Pulp very sweet and juicy, melting and rich in fragrance, and is very palatable, although small in quantity. Contains 20 to 25 large seeds." (*Tamura.*)

9499. CITRUS NOBILIS. **Mandarin orange.**

Tamura Unshiu, or seedless mandarin orange, originated by T. Tamura, in the district of Shingai, province of Tosa. "Fruit roundish, oblate, rind thin, somewhat rough, of a bright reddish color. Pulp sweet, subacid, juicy, and seedless. This orange will not keep as well as the true sweet orange, but is one of the best for table use. The quality is very fine." (*Tamura.*)

9500. CITRUS DECUMANA. **Pomelo.**

Kawaguchi's Buntan, or seedless pomelo. Produced only in the district of Higashimorokata, in the province of Hiuga, Prefecture Miyazaki. "Fruit medium to large, very oblate, rind thin, smooth, and pale yellow. Pulp sweet, subacid, juicy, of a dull-purplish or light-reddish color, and seedless. Quality good. Excellent for table use and a good keeper." (*Tamura.*) (No. 967, July 5, 1902.)

9501 to 9503. MESEMBRYANTHEMUM sp.

From Cape Town, South Africa. Received through Messrs. Lathrop and Fairchild (Nos. 1140 to 1142, March 11, 1903), April 17, 1903.

A collection of plants presented by Mr. Eustace Pillans, of Rosebank, near Cape Town. The species were undetermined by Mr. Pillans.

9501.

"A strikingly ornamental variety with vivid orange flowers. From Mr. Eustace Pillan's garden at Rosebank." (*Fairchild.*)

9502.

"A variety with striking magenta-colored flowers. A very strong grower. Especially adapted for borders. Flowers in the early South African spring." (*Fairchild.*)

9503.

"A tricolored sort, orange, maroon, and red. Said to be very rare. It has a most striking dewlike sheen on plant and flowers. Is a strong grower." (*Fairchild.*)

9504 to 9553. MANGIFERA INDICA. **Mango.**

From Saharanpur, united provinces of Agra and Oudh, India. Received through Mr. W. Gollan, director of the Saharanpur Botanic Garden, April 17, 1903.

A collection of small grafted mango plants as follows, one plant of each variety:

9504.

Arbuthnot.

9505.

Bhabaurea.

9506.

Brindabani. (Dead on arrival.)

9507.

Bombay, green. (Dead on arrival.)

9508.

Bombay, yellow.

9509.

Gopalbhog. (Dead on arrival.)

9504 to 9553—Continued.

9510.

Khapariah.

9511.

Langra.

9512.

Malda.

9513.

Salibunda. (Dead on arrival.)

9514.

Stalkart.

9515.

Strawberry.

9516.

Sufaida.

9517.

Alfonso.

9518.

Bhurdas.

9519.

Bulbulchasm.

9520.

Calcuttia amin. (Dead on arrival.)

9521.

Chickna.

9522.

Davy's Favorite.

9523.

Faizan.

9524.

Fajri, long.

9525.

Fajri, round.

9526.

Faqirwala.

9527.

Gola.

9528.

Hatijhul.

9529.

Kachmahua.

9530.

Kakaria.

9531.

Kala.

9532.

Krishnabhog.

9533.

Khajya.

9534.

Samar Chisht.

9535.

Salamar.

9536.

Kistapal.

9537.

Lamba Bhadra.

9538.

Langra Hardoi.

9539.

Langra, large.

9540.

Machias.

9541.

Maradabadi amin.

9542.

Nijibabadi.

9543.

Nagale.

9544.

Nacha.

9545.

Pyasee.

9546.

Ramani. (Dead on arrival.)

9547.

Sanduria.

9504 to 9553—Continued.

9548.

Sharbati, brown.

9549.

Sharbati, black.

9550.

Singapur.

9551.

Sunahra.

9552.

Surkha.

9553.

Tamancha.

9554. CITRUS AURANTIUM × CITRUS BERGAMIA.

From Mustapha, Algiers, Algeria. Presented by Dr. L. Trabut, Government Botanist. Received April 18, 1903.

Scions of a white orange, a hybrid of the mellarose and orange, said by Dr. Trabut to be of excellent quality. A description of this is published in the "Revue Hort.," of Paris; exact reference not given.

9555 to 9558. BOUGAINVILLEA spp.

From Cape Town, South Africa. Received through Messrs. Lathrop and Fairchild (Nos. 1144 to 1147, March 11, 1903), April 20, 1903.

"Four different varieties of this superb creeper have been collected by Mr. Ardern and planted on his place called the 'Hill,' at Claremont. These differ in their habit of flowering, color of bracts, and vigor, and although probably not new to America, the set is sent for comparison with sorts already known in the gardens of California." (*Fairchild.*)

9555. BOUGAINVILLEA LATERESIA (?).

Has brick-red bracts and is a vigorous grower. No. 1144.

9556. BOUGAINVILLEA SPECTABILIS.

Has very dark purple bracts. A wonderfully vigorous grower, said to excel the others in its masses of bloom, which are borne for a short period only. No. 1145.

9557. BOUGAINVILLEA GLABRA.

Has very pale, purple bracts, much more so than the two other purple varieties.

9558. BOUGAINVILLEA SANDERIANA.

"A purple-flowered kind, remarkable for its free-flowering habit. It remains in flower much of the year, and although it is not so beautiful as *B. spectabilis* when the latter is in flower, it is preferable because of its constant blooming habit." (*Fairchild.*)

9559. OLEA VERRUCOSA (?). **Wild olive.**

From Cape Town, South Africa. Received through Messrs. Lathrop and Fairchild (No. 1148, March 11, 1903), April 20, 1903.

"The native wild olive of South Africa. These cuttings were taken from a tree growing in Mr. Ardern's garden at Claremont. It may be useful for breeding or as a stock in California." (*Fairchild.*)

9560 to 9568. VITIS VINIFERA. **Grape.**

From Khodjent, Russian Central Asia. Received through Mr. E. A. Bessey, from Mr. Valneff, April 20, 1903.

A collection of grape cuttings, as follows:

9560.

Khusaine.

9561.

Sheker-Angur.

9560 to 9568—Continued.

9562.

Kadu-Khusaine.

9563.

Darai.

9564.

Chelaki.

9565.

Shuravgani.

9566.

Tagobi.

9567.

Khusaine Surkh.

9568.

Bobaki.

9569. GARCINIA sp. (?).

From Delagoa Bay, East Africa. Received through Messrs. Lathrop and Fairchild (No. 1191, February, 1903), March 21, 1903.

"Seed of a large shade tree growing everywhere about and in the town of Delagoa Bay. The tree is a pretty shade tree, vigorous grower, and an enormous fruit producer. I have seldom seen any wild fruit tree which was so loaded down as the trees of this species are with their small egg-shaped green fruits. I was not able to determine the species of this tree, but according to the surmise of Mr. J. Medley Wood, of the Botanic Gardens of Durban, it is a *Garcinia*, and for that reason, as well as for its value as a shade tree, this is worth introducing into the tropical and subtropical gardens of America. It may be possible to cross this with the mangosteen, although the difference between the species seems very great. From the sour pulp of the fruit the Kaffirs prepare a variety of fermented liquor which they keenly relish. They also eat the fruit pulp fresh." (*Fairchild.*)

9570. SOLANUM MURICATUM. **Pepino.**

From Las Palmas, Canary Islands. Received through Messrs. Lathrop and Fairchild (No. 1166, April 6, 1903), April 24, 1903.

Pera Melone. "A seedless fruit plant which is grown on the terraces of Grand Canary and the other islands of the group and on Madeira as well. The fruit tastes like a canteloupe, is the shape of an egg, and when ripe is yellow, striped with splashes of purple. The texture of the yellow flesh resembles that of a ripe pear. The hotel visitors are very fond of this fruit, and it brings a good price in the markets of the island. Here the plants are grown by irrigation and bear in nine months after being planted as cuttings. Artificial fertilizers are used in their culture and the soil is a volcanic one. The fruit may be picked before it is ripe and ripened off the bush. Small shipments have been made to London, which arrived in good condition. This was introduced into California several years ago by Dr. Gustav Eisen and is now grown there." (*Fairchild.*)

9571. AVENA sp. **Mapstone oats.**

From Pietermaritzburg, South Africa. Received through Messrs. Lathrop and Fairchild (No. 1104), April 14, 1903.

"A variety of oat which has been a very prolific yielder in numerous trials at Mapstone farm in Natal." (*Fairchild.*)

9572 to 9574.

From Brookings, S. Dak. Presented by Prof. N. E. Hansen, horticulturist of the South Dakota Agricultural Experiment Station. Received April 17, 1903.

9572. CITRULLUS VULGARIS. **Watermelon.**

Grown from S. P. I. No. 23. Named *South Dakota* by Professor Hansen.

9573. ZEA MAYS. **Corn.**

Malakoff sugar corn. Grown from seed imported by Professor Hansen from Moscow, Russia, in 1902.

9574. DAUCUS CAROTA. **Carrot.**

Kuldja carrot. Grown from S. P. I. No. 1254.

9575. MUSA SAPIENTUM.

From Las Palmas, Canary Islands. Received through Messrs. Lathrop and Fairchild (No. 1168, April 12, 1903), April 27 and May 6, 1903.

Datile. "Young buds from the base of some banana plants in Mr. Nelson's garden in Las Palmas, which the gardener says came from Cuba several years ago. The fruit of this 'date' banana is very small, not over an inch or so long, it is said, but of unusual sweetness, though inclined to be dry. This may be of use for breeding purposes. The plants are small in size and do not seem very vigorous." (*Fairchild.*)

9576. VITIS VINIFERA. **Grape.**

From Old Bokhara, Turkestan. Received through Mr. E. A. Bessey from Mr. Voronov, the representative of Mr. H. W. Dürrschmidt (No. 114, August 27, 1902), April 29, 1903.

Kishmish. "A white (i. e., very light green) seedless grape, considered to be the best of the sorts grown near Bokhara. The berry is rather small, with a slight amount of bloom, short elliptical in outline, about one-half inch long and three-eighths inch wide, very thin skinned, with a moderately firm, juicy flesh and sweet taste, modified by the presence of sufficient acid to prevent its being insipid. The bunch is large, firm, and compact, and weighs one-half a pound to a pound. I fear that if once attacked by Anthracnose, *Plasmopara*, or Black Rot, the berries are so closely packed that the whole bunch would be destroyed, as without great care in spraying it would be impossible to properly reach the inner berries of the bunch. This variety was also seen in Ashkabad, where it is said to be of Persian origin. It s rather rare here." (*Bessey.*)

9577. VITIS VINIFERA. **Grape.**

From Old Bokhara, Turkestan. Received through Mr. E. A. Bessey from Mr. Voronov, the representative of Mr. H. W. Dürrschmidt (No. 115, August 27, 1902), April 29, 1903.

Khuśaini (Khoosá-eenee). "A light-green grape, considered to be one of the best, but inferior in quality to *Kishmish*, No. 9576, and *Ok Uzúm*, No. 9578. One of the most abundant varieties on the market. Very productive. Berries light green, without bloom, often tinged with a very faint red color on the sunny side, elongated elliptical in outline, an inch to $1\frac{1}{4}$ inches long by one-half to five-eighths inch in short diameter. Usually truncated at the base and shortly rounded at the apex. Often slightly larger near the base. Seeds usually only two, situated about one-third of the distance from the base to apex (rarely central). Skin thin and tender; flesh juicy and tender, but firm. Sweet and slightly acid—too little acid for some people's taste. Bunches large (three-fourths to 1 pound or more), loose, rather long; would be easy to spray." (*Bessey.*)

9578. VITIS VINIFERA. **Grape.**

From Old Bokhara, Turkestan. Received through Mr. E. A. Bessey from Mr. Voronov, the representative of Mr. H. W. Dürrschmidt (No. 116, August 27, 1902), April 29, 1903.

Ok Uzúm (meaning *White grape*). "A white (i. e., light green) grape, very abundant on the markets of Old Bokhara. Considered by some to be of better quality than *Khuśaini*, No. 9577, but I consider it inferior. Berries light green, with bloom, round, five-eighths to three-fourths inch in diameter, with usually three rather small seeds. Skin thin but tough, and with a slightly astringent taste, which makes it necessary to avoid chewing the skin much. Flesh firm but tender and juicy, sweet but with slight acid flavor, and superior in this respect to that of *Khuśaini*, if care is taken not to chew the skin. Bunches large (1 to $1\frac{1}{2}$ pounds), very compact, with a pronounced shoulder. Apparently would be difficult to spray properly, but not so difficult as *Kishmish*, No. 9576." (*Bessey.*)

9579. VITIS VINIFERA. **Grape.**

From Old Bokhara, Turkestan. Received through Mr. E. A. Bessey from Mr. Voronov, the representative of Mr. H. W. Dürrschmidt (No. 117, August 27, 1902), April 29, 1903.

Shuborgónyi. "An almost black grape with a faint bloom. Quite rare in the markets. Considered inferior to *Kishmish*, No. 9576, and *Ok Uzúm*, No. 9578. Berries elliptical, small to medium, usually one-half to five-eighths inch long by three-eighths inch thick, sometimes larger. Flesh actually almost colorless, but appearing dark on cutting open, because of the dark skin and colored layer immediately below it. Skin rather tender; only very slightly, or not at all, astringent. Flesh quite firm, juicy, and sweet. Seeds none or, if present, so tender that they are not noticeable on chewing, having no hard coat. Bunches rather small, not over one-half pound, with a pronounced shoulder, rather loose, and easy to spray. Except that it stains the fingers and mouth, I consider this variety superior to *Ok Uzüm*, No. 9578, and *Kishmish*, No. 9576." (*Bessey.*)

9580. Salsola arbuscula.

From Chardjui, Russian Central Asia. Received through Mr. E. A. Bessey from Mr. V. Paletzky, forester, of Chardjui (No. 194, October 3, 1902), May 1, 1903.

"This plant is one of the best sand binders in this region. It forms a large shrub, or even small tree, 15 to 20 feet high. It grows without irrigation in sand in a very hot region where no rain falls from April to November. In the winter it endures severe cold. This plant can be propagated either by seed (sown from January to March) or cuttings (also planted in early spring). In either case a stand of about 40 per cent is obtained. If grown along with *Aristida pennata* var. *Karelini*, No. 9582, it seeds itself in the tufts of the latter, and soon is able to take care of its own dissemination." (*Bessey.*)

9581. Haloxylon ammodendron.

From Chardjui, Russian Central Asia. Received through Mr. E. A. Bessey from Mr. V. Paletzky, forester, of Chardjui (No. 195, October 3, 1902), May 1, 1903.

"This plant often becomes a tree 20 to even 30 feet high, with a trunk 15 to 18 inches in diameter near the base. It requires a clay subsoil which holds some moisture. It is very hard to establish, but when once started is valuable as a sand binder. It will not endure salt." (*Bessey.*)

9582. Aristida pennata var. karelini.

From Chardjui, Russian Central Asia. Received through Mr. E. A. Bessey from Mr. V. Paletzky, forester, of Chardjui (No. 196, October 3, 1902), May 1, 1903.

"This grass, itself valuable as a sand binder, is especially valuable from the fact that its tufts act as shelters in which the seeds of *Salsola arbuscula* (No. 9580) and *Calligonum* sp. (Nos. 9583 to 9594) lodge and grow. Nearly every bunch of this grass will be found to have growing in it a young plant of Salsola or Calligonum. The seeds are sown in holes in the sand and covered with sand by the workman's foot, or are mixed at the rate of 1 pound to 200 or 300 pounds of sand and sown broadcast; the former method is, however, preferable. It is sown in the hollows between the sand dunes, and requires only one seeding, as the following year it reseeds itself." (*Bessey.*)

9583 to 9594. Calligonum sp.

From Chardjui, Russian Central Asia. Received through Mr. E. A. Bessey from Mr. V. Paletzky, forester, of Chardjui (No. 197, October 3, 1902), May 1, 1903.

9583. Calligonum arborescens and C. caput-medusae.

"A mixture of these two species. These two are the best of the Calligonums for sand-binding purposes. They form small trees. They are superior to *Salsola arbuscula* in that when planted from seeds or from cuttings 90 per cent grow, inferior in that they do not reseed themselves very well." (*Bessey.*) (No. 197, October 3, 1902.)

Additional species sent by Mr. Paletzky.

9584. Calligonum acanthopterum, Borsez. var. setosa.

9583 to 9594—Continued.

9584a. Calligonum acanthopterum, Borscz. var. setosa.

9584b. Calligonum acanthopterum, Borscz. var. setosa.

(These three packages were kept separate because of a slight variation in the appearance of the seeds.)

9585. Calligonum arborescens, sp. nov.

9586. Calligonum arborescens × C. acanthopterum.

9587. Calligonum calliphysa.

9588. Calligonum caput-medusae.

9588a. Calligonum caput-medusae var. rubicunda.

9589. Calligonum comosum.

9590. Calligonum densum.

9591. Calligonum eriopodum.

9592. Calligonum microcarpum.

9593. Calligonum pallasii.

9594. Calligonum rotula.

9595. Citrus aurantium. **Orange.**

From Las Palmas, Canary Islands. Received through Messrs. Lathrop and Fairchild (No. 1171, April 14, 1903), May 1, 1903.

Telde. "Considered the finest variety in Grand Canary and superior to those grown in the central part of the island. These latter, it may be remarked, are considered by Mr. Lathrop and myself some of the finest flavored oranges which we have ever eaten, being characterized by a freedom from fiber, a crisp texture of flesh, and an indescribably vinous flavor. The variety is medium in size, thin skinned and seeded. The color of the flesh varies, but in the best specimens is a shade of dark orange. The juiciness is phenomenal, and though the fruit varies greatly in flavor and color it is uniformly good and sweet. Any collection should be glad to get this variety. Its origin is unknown as far as I can discover. The name is that of the village where the fruit is grown, some 8 miles from Las Palmas." (*Fairchild.*)

9596. Citrus aurantium. **Orange.**

From Las Palmas, Canary Islands. Received through Messrs. Lathrop and Fairchild (No. 1172, April 14, 1903), May 1, 1903.

Canary seedless. "Scions from two trees which are growing on the estate of Don Juan Rodriguez, in the famous orange region along the *Barranco de la Higuera de Canaria*. These trees are reputed to produce only fruit that is absolutely seedless, and though they are very old trees they have never, so far as we could learn, produced fruits with more than the rudiments of seeds in them. No fruits were on the trees when these cuttings were taken, so the statement as to their seedlessness is that of the renter of the place, Sig. Rivero. If this orange is seedless, as claimed, and of a quality equal to the other varieties of the same locality, as is affirmed by the cultivator, the sort is well worth thorough investigation and comparison with the navel orange now grown in California. It is, I believe, a smaller sort, and may prove superior in flavor. The excellence of these oranges from this region, which is the most noted in the islands, is attested by Mr. Lathrop, who thinks them equal to the best." (*Fairchild.*)

9597. CITRUS AURANTIUM. **Orange.**

From Las Palmas, Canary Islands. Received through Messrs. Lathrop and Fairchild (No. 1172a, April 14, 1903), May 1, 1903.

Canary seedless. "Scions of a variety of seedless orange likely to prove the same as No. 9596, but taken from a much younger tree than the latter that grew a short distance away from the two old trees mentioned under No. 9596. We have taken the liberty of naming this and the previous variety the *Canary seedless.*" (*Fairchild.*)

9598. PLOCAMA PENDULA.

From Las Palmas, Grand Canary, Canary Islands. Received through Messrs. Lathrop and Fairchild (No. 1173, April 14, 1903), May 1, 1903.

"A species of low-growing shrub which occurs wild on the slopes of the arid hillside near the road from Las Palmas to Telde. It has a most beautiful weeping habit, giving the plants the appearance of tiny weeping willows. It is not over 2½ to 3 feet high. This would be very beautiful as a cover for dry hillsides overlooking the sea. It has already been brought into greenhouse culture. I believe it will withstand severe drought." (*Fairchild.*)

9599. MANGIFERA INDICA. **Mango.**

From the Philippine Islands. Received through Prof. W. S. Lyon, in charge of seed and plant introduction, Insular Bureau of Agriculture, Manila, May 4, 1903.

"One seed of mango No. 2. The fruit from which this seed was taken weighed 16 ounces. When still wet and fresh the seed weighed only 1 ounce, making more than 93 per cent of the flesh available, exclusive of a very thin and light rind." (*Lyon.*)

9600. PHOENIX DACTYLIFERA. **Date.**

From Marseille, France. Received through Champagne Bros., Ltd, May 4, 1903, 264 pounds dried Deglet Noor dates, purchased at the request of Mr. W. T. Swingle. (No. 130.)

"Dry Deglet Noor dates from the Sahara suitable for planting. Planting is best done after the ground gets warm in April or May on alkali-free soil with abundant irrigation. This superb variety can be propagated with certainty only by means of offshoots, but as these are now very difficult to obtain, it is desirable to grow seedlings in the hope of securing some that will prove equal to the parent sort in quality. About half the seedlings are generally males and one in ten can be counted on to yield good dates. It is not unreasonable to expect that some of the seedlings may be as good as the Deglet Noor, and ripen earlier, which will permit of their culture in the Salt River Valley, Arizona." (*Swingle.*)

9601. IRIS sp.

From Monte, Grand Canary, Canary Islands. Received through Messrs. Lathrop and Fairchild (No. 1174, April 17, 1903), May 4, 1903.

"A very beautiful white iris of unusual size (5 inches in diameter), which is fragrant. This grows wild in certain barrancos of Grand Canary, and Mr. Alaricus Delmard, of Monte, called it to our attention. He sent plants to English florists who declared it was new, but the plants failed to live. Its great size and the purity of its white color and its delicate perfume, like that of a lily, make it a desirable introduction, although specifically it may not be new to America." (*Fairchild.*)

9602. HEDERA HELIX var. CANARIENSIS. **Ivy.**

From Monte, Grand Canary, Canary Islands. Received through Messrs. Lathrop and Fairchild (No. 1175, April 17, 1903), May 4, 1903.

"An exceedingly vigorous, very large-leaved variety of ivy, which grows wild in the Canary Islands. The leaves are sometimes 6 to 8 inches across. It may not retain this character of large leaves, but it is worthy of trial or for breeding purposes." (*Fairchild.*)

9603. DRACUNCULUS CANARIENSIS.

From Monte, Grand Canary, Canary Islands. Received through Messrs. Lathrop and Fairchild (No. 1176, April 17, 1903), May 4, 1903.

"A giant aroid with spathes sometimes 14 to 16 inches long. Yellowish or greenish in color. Leaves deeply lobed and ornamental. Grows 6 to 8 feet in height in moist places in the mountains of Grand Canary. Might prove useful for breeders of the calla lily because of its large size. This was called to our attention by Mr. A. Delmard, of Monte." (*Fairchild.*)

9604. PORTULACARIA AFRA. **Spek-boom.**

From Cape Town, South Africa. Received through Messrs. Lathrop and Fairchild (No. 1130, March 8, 1903), May 6, 1903.

Spek-boom. "This bush, which grows sometimes 12 to 15 feet high, forms one of the most valuable fodder elements of the northeastern Karroo, in Cape Colony. It is a succulent-leaved species, greedily eaten by horned stock, and well worth thorough trial in the frostless, dry lands of our southwestern States. The cuttings should be placed in the hands of the gardeners of a few interested ranch owners and at the experiment stations in the States where the plant is likely to prove of value, with the understanding that they are to be grown and multiplied and small patches of mother plants started from which cuttings can be taken. The cuttings and young plants must be protected from gophers, rats, mice, or prairie dogs until several years old. At least the mother plantations should be so protected. This is not a desert plant, but simply a species which has the power to withstand a long, dry season, and because of the avidity with which live stock eat its leaves and stems it is worth acclimatizing in the frostless regions of America. It thrives best on rocky slopes and needs protection from the wind by wind-breaks. These cuttings were made from a tree growing in the grounds of the South African Museum, in Cape Town, which tree was planted many years ago by Professor MacOwan. They are a gift to the American ranchman from this veteran Cape botanist who has done so much to call attention to the good qualities of the *Spek-boom.* The climate of the region in which the tree lives is illustrated by these figures: Absolute maximum temperature for ten years (1881–1890), 108° F., absolute minimum, 21° F. Rainfall average for ten years, 18.76 inches per annum, occurring in the warm season." (*Fairchild.*)

9605. PORTULACARIA AFRA.

From Oatlands, South Africa. Received through Messrs. Lathrop and Fairchild (No. 1155, March 16, 1903), May 6, 1903.

Spek-boom. "These cuttings came from the typical Karroo, where the plant is highly prized for fodder purposes. It may prove slightly different from those taken from a tree in Cape Town, No. 9604. These cuttings were collected by Mr. Nash, of the Cape department of agriculture, and secured through Mr. Davison, chief sheep inspector of the department." (*Fairchild.*) (For description see No. 9604.)

9606. ANANAS SATIVUS. **Pineapple.**

From Lower Albany, Trapps Valley, South Africa. Received through Messrs. Lathrop and Fairchild (No. 1154, March 16, 1903), May 6, 1903.

Natal. "This is evidently the same variety of pineapple as No. 9485. Fresh pineapples from this region which we tested were not as fine flavored as those we ate in Natal, but the fact that they had been picked green should be taken into consideration. Should it grow as well in Florida as it does here it would prove a great success. Secured through the kindness of Mr. Eustace Pillans, agricultural assistant of Cape department of agriculture, from C. J. Ansley, Trapps Valley, Cape Colony." (*Fairchild.*)

9607. VITIS RUPESTRIS var. METALLICA. **Grape.**

From Cape Town, South Africa. Presented by the Cape department of agriculture through Messrs. Lathrop and Fairchild (No. 1137, March 10, 1903). Received May 6, 1903.

"A resistant American stock of South African origin, which has proved itself most admirably suited to the conditions at the Cape, and especially adapted to 'any loose soil, loam, gravel, or sand, and also in dry, open heavy soils; it can, besides, stand a fair amount of moisture in loose soils. It forms an excellent graft-bearer for all varieties of European vines, except *Hanepoot*, and possibly also other members of the *Muscat* family.' (cf. J. P. de Waal, in the Agricultural Journal, Cape of Good Hope, December 19, 1901, p. 838.) This variety, I am informed by Mr. Eustace Pillans, is the best of all the resistant stocks yet tried at the Cape, as its ease of grafting, great vigor, suitability to different kinds of soil, and grafting affinity for all but varieties of the *Muscat* type, make it a general stock of great value. Even those who do not claim that it exceeds in vigor any other sort, admit that it is the easiest grafted of any of the American stocks. The stock originated at Groot Constantia Wine Farm in a lot of seedlings from seed sown in 1886. It is uncertain whether the seed came direct from America or from France. This is entirely distinct, according to Mr. J. Bioletti (formerly of Berkeley University, California, now at Elsenburg Agricultural School), from the *Metallica* of French vineyardists. Its name applies to the luster of its foliage. The seedling was picked out in 1894, and by quick propagation in 1901 yielded 687,000 cuttings, and in 1902, 864,000 cuttings were distributed. It has been tested side by side with many French stocks, such as *Aramon rupestris*, *Riparia Gloire de Montpellier*, etc., and takes its place as their equal in all points and their superior as regards ease of propagation and suitability to the varieties of soil mentioned. Mr. Pillans goes so far as to predict that it will drive all other stocks out of South Africa, except for *Muscat* sorts. He claims for it a remarkable yield-giving power, extreme vigor, and resistance to the phylloxera. Mr. Bioletti admits its excellent qualities and practical growers are enthusiastic over it. This is well worth the serious consideration of Californian vine growers. The originators of this remarkable seedling are Messrs. J. P. de Waal and Eustace Pillans, of the Cape of Good Hope department of agriculture, and its trial in California should be made at once. We are indebted to Mr. Pillans for the plants sent." (*Fairchild.*)

9608. CHLORIS VIRGATA. **Rhodes grass.**

From Cape Town, South Africa. Received through Messrs. Lathrop and Fairchild (No. 1131, March 8, 1903), May 6, 1903.

"A species of pasture grass that, although scattered widely through the Tropics of both hemispheres (according to the books), has probably not before been brought into culture. Mr. Cecil Rhodes had the seed of this plant collected several years ago and sown in large patches on his place near Cape Town, called 'Groote Schur.' The grass has done well there, forming heavy sods of a good herbage, and the manager of Mr. Rhodes's farm has had the seed collected and distributed among the planters of the colony, by whom it is called 'Rhodes grass.' From what I saw of these patches on the slopes of a hillside, I do not believe this is a drought resistant form; at least it is not able to withstand very severe dry weather. It has the typical finger-like inflorescence of the genus and its strong, tough, creeping stems lie flat on the ground. When given sufficient moisture the grass is said to produce a mass of forage over 2 feet high, but what it would do if subjected to severe drought has yet to be found out. I saw a single patch which had been sown with the seed and had failed to take, and it was evident that the drought-resisting powers of the plant are quite limited. However, a grass which has attracted the attention of so keen a cultivator as Mr. Rhodes and is meeting with favorable comment from many practical men here at the Cape deserves a thorough trial in America. As the species is a perennial it need only be tested in frostless or nearly frostless regions. Its fodder value will be much inferior to alfalfa, but it will thrive on soil with little lime in it. This seed was given Mr. Lathrop for distribution in America by the steward of Mr. Rhodes's estate, and in case it succeeds, the Chartered South African Company, at Cape Town, should be notified of the success it attains." (*Fairchild.*)

9609. TRITICUM JUNCEUM.

From Cape Town, South Africa. Received through Messrs. Lathrop and Fairchild (No. 1136, March 9, 1903), May 6, 1903.

"A grass which is a native of North Africa and Europe, and is used as a sand binder here in Cape Colony. Mr. Hutchins, conservator of forests of the colony, to whom we are indebted for the seed, has found this species especially serviceable in experiments near the seashore. Von Müller remarks that it is one of the best grasses to keep rolling sand ridges together. Probably this has already been tried in America, but this South African seed may be of a different strain." (*Fairchild.*)

9610. MUSA SAPIENTUM. **Banana.**

From Las Palmas, Grand Canary, Canary Islands. Received through Messrs. Lathrop and Fairchild (No. 1169, April 12, 1903), May 6, 1903.

Manzana or *Silver*. "Young shoots from the base of a few plants of the *Silver* banana of Madeira, which variety is thought by the residents of this island to be a very superior sort and to have originated in Madeira. The fruits which we tasted were good, but not remarkable. They had an acid flavor, were juicy, had light-colored flesh, and though very refreshing as a change from the ordinary type of banana, were not especially to be recommended." (*Fairchild.*)

9611. STRYCHNOS SPINOSA (?) **Kafir orange.**

From Mozambique, East Africa. Received through Messrs. Lathrop and Fairchild (No. 1103, February 8, 1903), May 6, 1903.

"Seed (*poisonous*) of the Kafir orange, a native fruit of Portuguese East Africa. The tree is grown in Delagoa Bay only occasionally, and the Kafirs crack open the calabash-like fruit and eat the brown, plum-like flesh which surrounds the many flat angular seeds. These seeds are *said to be very poisonous*, but the flesh is quite refreshing. That of the specimen which we tasted was like a brandied peach into which cloves had been stuck. The spicy aroma of the fruit is perceptible before the hard shell has been broken open and forms one of its best characteristics. The fruits are cannon ball shaped and very heavy, and the green shell is so hard that it has to be broken with a heavy blow. It is in many ways a remarkable fruit, and although the data regarding it are meager it is well worth a place in Porto Rico, Florida, and Hawaiian gardens." (*Fairchild.*)

9612. CARISSA ARDUINA.

From Cape Town, South Africa. Received through Messrs. Lathrop and Fairchild (No. 1110, February 26, 1903), May 6, 1903.

"A beautiful, thorny, evergreen shrub, suited to frostless regions. It would be suited for hedge making and as an ornamental, for its white flowers and oblong, bright red fruits show off strikingly against its dark-green foliage. Like *Carissa grandiflora*, its fruits, resembling a large barberry fruit, are good to eat, having a sweet, fresh, but somewhat characterless taste. Standing alone this species produces a prettier shaped shrub than *C. grandiflora* and is well worth the attention of gardeners in California and Florida. These seeds are from fruit gathered in the municipal gardens in Cape Town. Breeders should be encouraged to try crossing these two species. There are other representatives of the genus in South Africa which might be used in breeding experiments. *C. acuminata*, A. D. C., is listed for Natal by J. Medley Wood in his 'Indigenous Plants of Natal;' von Mueller lists *C. brownii*, F. V. M., from East Australia, and *C. carandas* L., from India to China. All these species have edible fruits." (*Fairchild.*)

9613. MEDICAGO ARBOREA. **Tree lucern.**

From Cape Town, South Africa. Received through Messrs. Lathrop and Fairchild (No. 1111, March 3, 1903), May 6, 1903.

"Seed of the *Tree lucern*, which is said to occur in southern Europe, especially in Greece. It is, according to von Mueller in his 'Extra Tropical Plants,' page 300, the 'Cytisus' of the ancient Greeks and Romans. The plant forms a shrub 7 to 8 feet high with thick, woody stems 3 inches in diameter, which sprawl more or less over the ground. These seeds are from a single specimen in the Municipal Gardens at Cape Town, and Professor MacOwan informs me that the plant has not attracted much attention here as a fodder plant, though it grows well. For plant breeders only who are at work on the genus *Medicago*." (*Fairchild.*)

9614. SOLANUM sp.

From Cape Town, South Africa. Received through Messrs. Lathrop and Fairchild (No. 1112, March 3, 1903), May 6, 1903.

"Seed of a tree *Solanum*, of decided ornamental value, which is growing in the Municipal Gardens at Cape Town and which has never been specifically determined.

Its origin also is not known, according to Professor MacOwan. It should be sent for trial to the frostless regions of America and distributed among the superintendents of parks and public gardens and private ornamental plant growers. Its upright stem, spiny, broad leaves, and horizontal branches make it effective." (*Fairchild.*)

9615. PORTULACARIA AFRA.

From Cape Town, South Africa. Presented by Prof. P. MacOwan, Government Botanist, through Messrs. Lathrop and Fairchild (No. 1113. Received March 3, 1903), May 6, 1903.

Spek-boom. "Seed of this interesting fodder plant. (See Nos. 9604, 9605.)" (*Fairchild.*)

9616. HARPEPHYLLUM CAFFRUM. **Kafir plum.**

From Cape Town, South Africa. Presented by Prof. P. MacOwan, Government Botanist, through Messrs. Lathrop and Fairchild (No. 1114, March 5, 1903). Received May 6, 1903.

"One of the prettiest evergreen shade trees to be seen in the gardens of Cape Town. Prof. P. MacOwan has planted a row of these trees in a very windy situation near the parliament buildings in Cape Town and they are admirably suited to such a trying situation, where they are whipped by continuous winds which blow from various directions. Professor Sim remarks that its timber resembles mahogany and is used for wagon making, being called *escheuhout* by the Dutch. The red, showy drupes are suitable for preserves, but in the Cape they are apparently not popular though they have a pleasant acid taste, but little pulp. The branches are sometimes planted as fence poles and these large 'cuttings' take root and form trees. [*Sim.*] Professor MacOwan recommends this heartily as a shade tree for windy situations, where its beautiful dark green foliage forms a dense shade. The tree will thrive in the frostless belt of California and Florida and is sure to be appreciated by owners of parks as an avenue plant. The seeds should be sown in a seed bed and plants transplanted to situations desired. It is not a desert plant, but will stand some drought. This tree is worthy a prominent place in the gardens and parks of California and Florida." (*Fairchild.*)

9617. SOLANUM ACULEASTRUM. **Natal thorn.**

From Cape Town, South Africa. Presented by Prof. P. MacOwan, Government Botanist, through Messrs. Lathrop and Fairchild (No. 1115, March 8, 1903). Received May 6, 1903.

"An ornamental species with very large fruits, grows 6 feet high if grown singly or 4 to 4½ feet if in a hedge, for which latter purpose it is used by the farmers. Very acutely hook-thorned, rather disposed to use up too much space if left alone. The fruit is the size of a mandarin orange. It will not bear more than a short and slight frost. To be sent to Texas, Arizona, and California gardens." (*Fairchild.*)

9618. PASPALUM DIGITARIA.

From Cape Town, South Africa. Presented by Prof. P. MacOwan, Government Botanist, through Messrs. Lathrop and Fairchild (No. 1128, March 8, 1903). Received May 6, 1903.

"Seed of a grass, which, according to Prof. P. MacOwan, is promising for moist bottom land. It will not endure cold weather, but is suited to subtropical conditions." (*Fairchild.*)

9619. PENTZIA VIRGATA.

From Cape Town, South Africa. Presented by Prof. P. MacOwan, Government Botanist, through Messrs. Lathrop and Fairchild (No. 1129, March 9, 1903). Received May 6, 1903.

"Old seed of the fodder bush called the *Goed Karroo.* This is the best plant in the Karroo for sheep pasturage, for it furnishes good fodder, binds the sand, preventing gullying, and withstands drought. (*Fairchild.*)

9620. Euclea racemosa.

From Cape Town, South Africa. Presented by Prof. P. MacOwan, Government Botanist, through Messrs. Lathrop and Fairchild (No. 1132, March 9, 1903). Received May 6, 1903.

"A shrub with dense, dark-green foliage, of distinctly ornamental appearance, which is especially suited for plantings near the sea that are exposed to salt spray, with the purpose of lifting the wind from the surface of the soil and checking the shifting of the sands. In experiments of fixing sand dunes this plant may prove of decided value, not so much through the action of its roots as by the formation of a cover for the sand, which will lift the wind above its surface. Strongly recommended by Professor MacOwan in his recommendations to the Cape government on the rebushing of an overstocked island off the coast called Robbin Island. This seed should be planted in a seed bed and the young plants set out when of sufficient size to bear transplanting well." (*Fairchild.*)

9621. Myoporum insulare.

From Cape Town, South Africa. Presented by Prof. P. MacOwan, Government Botanist, through Messrs. Lathrop and Fairchild (No. 1133, March 8, 1903). Received May 6, 1903.

"An extra tropical Australian tree called in South Africa *Australian blueberry*, and used there as a hedge plant or as an ornamental tree. It is proof against sea breezes, can be propagated by cuttings, grows rapidly, and will thrive down to high-tide mark. It is one of the few trees which will grow in wet saline soil. The wood is close grained and good for cabinet making. (*Fairchild.*)

9622. Cotyledon teretifolia.

From Cape Town, South Africa. Presented by Prof. P. MacOwan, Government Botanist, through Messrs. Lathrop and Fairchild (No. 1134, March 8, 1903). Received May 6, 1903.

"Seeds of a *Cotyledon* from Grahamstown, Great Kirch River. This is a hothouse plant." (*Fairchild.*)

9623. Cephalandra quinquiloba.

From Cape Town, South Africa. Received through Messrs. Lathrop and Fairchild (No. 1135, March 8, 1903), May 6, 1903.

"A cucurbitaceous plant of ornamental value, running over the ground and bearing pretty yellow flowers and red fruits. It should be tried in southern California as an arbor plant mixed with other more dense shade-giving species. Probably a tender species." (*Fairchild.*)

9624. Eucalyptus ficifolia.

From Cape Town, South Africa. Received through Messrs. Lathrop and Fairchild (No. 1157, March 16, 1903), May 6, 1903.

"Seed from some trees growing on Cecil Rhodes's place, Groote Schur. I have never seen in any landscape more gorgeous dashes of color than those produced by these trees when in bloom. The colors vary from salmon or pale pink to deep scarlet. This tree is probably known in California, perhaps under another specific name." (*Fairchild.*)

9625. Pittosporum pendulum.

From Cape Town, South Africa. Received through Messrs. Lathrop and Fairchild (No. 1158, March 16, 1903), May 6, 1903.

"Seed of a remarkably grotesque tree growing in the municipal gardens at Cape Town. It has long slender branches which hang like those of a weeping willow. Its trunks are weird and irregular in form and give to the tree a most singular appearance. This is worthy of trial in such parks as the Golden Gate Park, of San Francisco." (*Fairchild.*)

9626. CUCURBITA MELANOSPERMA. **Squash.**

From San Antonio, Malta. Received through Messrs. Lathrop and Fairchild (No. 1159, December 27, 1902), May 6, 1903.

"Dr. Giovanni Borg, director of the gardens at San Antonio, called our attention to this squash as the best one for soups and as a vegetable which he had ever tested on the island. The plant also grows luxuriantly in Madeira, where it is highly prized as a vegetable. Doctor Grabham, of Funchal, remarked that it formed one of the principal foods of the native poor people. It should be given a good test by seedsmen." (*Fairchild.*)

9627. LUPINUS ALBUS (?).

From Tripoli or Tunis. Received through Messrs. Lathrop and Fairchild (No. 1160, December 1902), May 6, 1903.

"A few peculiar lupines picked up either in Tunis or Tripoli. They may be of interest to those experimenting with this plant as a green manure crop." (*Fairchild.*)

9628 to 9631. **Ornamentals.**

From Cape Town, South Africa. Received through Messrs. Lathrop and Fairchild (Nos. 1162 to 1165, March 16, 1903), May 6, 1903.

Seed of several ornamentals presented by Mr. H. J. Chalvin, superintendent of the municipal gardens at Cape Town, as follows:

9628. COTYLEDON sp.

Various species. Mixed seed. (No. 1162.)

9629. ASPARAGUS PLUMOSUS.

(No. 1163.)

9630. GASTERIA CROUCHERI.

(No. 1164.)

9631. MORAEA PAVONIA.

(No. 1165.)

9632 and 9633.

From Port Elizabeth district, South Africa. Received through Messrs. Lathrop and Fairchild, May 6, 1903.

9632. EUPHORBIA CORONATA.

A few seeds.

9633. LEUCADENDRON ARGENTEUM. **Silver tree.**

"Planted in a pot closely and allowed to grow up thickly, the silver tree is said to form a very pretty pot plant. Difficult to transplant." (*Fairchild.*)

9634. ANANAS SATIVUS. **Pineapple.**

From Trapps Valley, South Africa. Received through Messrs. Lathrop and Fairchild (No. 1156, March 16, 1903), May 15, 1903.

Natal. "These are probably in no way different from No. 9606, and were intended to be shipped with them, but arrived too late. Secured through the kindness of Prof. C. P. Lounsbury, entomologist of the Cape department of agriculture, from a plantation near Trapps Valley.

9635 to 9660. GOSSYPIUM BARBADENSE. **Egyptian cotton.**

From Egypt. Received through Mr. Thomas H. Kearney, May 16, 1903.

9635.

Extra Fine Mit Afifi. Purchased from Robin Carver, Kafr-el-Zayat.

9636.

Ashmuni. Purchased from Carver Brothers & Co., Beni-Suef.

9635 to 9660—Continued.

9637 to 9660.

Purchased from Choremi Benachi & Co., Alexandria.

9637.

Mit Afifi. First picking, from Behera Province.

9638.

Mit Afifi. Second picking, from Behera Province.

9639.

Mit Afifi. From Charkieh Province.

9640.

Mit Afifi. From Dakahlieh Province.

9641.

Mit Afifi. From Kalioubieh Province.

9642.

Mit Afifi. First picking, from Kalinobieh Province.

9643.

Mit Afifi. First picking, from Gharbieh Province.

9644.

Mit Afifi. Second picking, from Gharbieh Province.

9645.

Mit Afifi. First picking, from Menufieh Province.

9646.

Jannovitch. First picking, from Behera Province.

9647.

Jannovitch. From Charkieh Province.

9648.

Jannovitch. From Dakahlieh Province.

9649.

Jannovitch. First picking, from Gharbieh Province.

9650.

Jannovitch. Second picking, from Gharbieh Province.

9651.

Abbasi. First picking, from Behera Province.

9652.

Abbasi. Third picking, from Behera Province.

9653.

Abbasi. From Charkieh Province.

9654.

Abbasi. From Dakahlieh Province

9635 to 9660—Continued.

9637 to 9660—Continued.

9655.

Abbasi. Third picking, from Kalioubieh Province.

9656.

Abbasi. Second picking, from Kalioubieh Province.

9657.

Abbasi. First picking, from Gharbieh Province.

9658.

Abbasi. Second picking, from Gharbieh Province.

9659.

Abbasi. First picking, from Menufieh Province.

9660.

Abbasi. Second picking, from Menufieh Province.

9661 and 9662. **Ornamentals.**

From Funchal, Madeira. Received through Messrs. Lathrop and Fairchild (Nos. 1177 and 1178, April 21, 1903), May 18, 1903.

9661. STREPTOSOLON JAMESONII.

"This is one of the showiest flowering shrubs I have ever seen. It is a native of South Africa and there and in Madeira the bushes are covered with dense masses of yellow and orange colored blooms. Already known in California." (*Fairchild.*) (No. 1177.)

9662. BIGNONIA CHAMBERLAYNII.

"A beautiful lemon yellow flowering species, which grows to perfection here on walls and trellises. It is covered with masses of big trumpet-shaped flowers." (*Fairchild.*) (No. 1178.)

9663. PERESKIA ACULEATA.

From Funchal, Madeira. Received through Messrs. Lathrop and Fairchild (No. 1183, April, 1903), May 18, 1903.

"Cuttings of this member of the cactus family, which is used for a stock on which to graft cacti. As a stock it is well known, but as an ornamental climber probably less well known. In Funchal a single plant, 3 years old, had covered the front fence of a private house with a wealth of beautiful foliage. It was loaded with one-seeded fruits, which, though edible, had little taste. Already known in California." (*Fairchild.*)

9664. CANARINA CANARIENSIS (?).

From Funchal, Madeira. Received through Messrs. Lathrop and Fairchild (No. 1185, April, 1903), May 16, 1903.

"Seed of a pretty creeper, native of the Canaries and deriving its generic name from the islands. It has luxuriant light-green foliage and bears bell-shaped orange-red flowers which are quite showy. It requires much moisture and grows naturally in shaded valleys of the Canaries. These seed came from the villa of Mr. Reid, some distance above the town of Funchal, in Madeira. Should thrive in Florida and possibly in southern California. Sometimes grown as a hothouse plant." (*Fairchild.*)

9665. CANNABIS SATIVA. **Hemp.**

From Yokohama, Japan. Received through The Yokohama Nursery Company, 21-35 Nakamura, Yokohama, Japan, May 20, 1903.

Aizu.

9666 and 9667.

From Surat Government farm, India. Received May 11, 1903.

9666.

Unnamed seed.

9667. ORYZA SATIVA. **Rice.**

9668. HELIANTHUS ANNUUS. **Sunflower.**

From Moscow, Russia. Received through Mr. E. A. Bessey from E. Immer & Son, May 22, 1903.

White-seeded variety, grown for oil making.

9669. MANGIFERA INDICA. **Mango.**

From Beira, Portuguese East Africa. Received through Messrs. Lathrop and Fairchild (No. 1089, January 28, 1903), May 25, 1903.

Lathrop. "During a trip down this East African coast seven years ago, Mr. Lathrop found at Beira a few mangoes of such extraordinarily fine quality that he has often spoken of them as a possibly valuable present to the mango growers of America. We reached Beira at the end of the season for this mango and could only secure one fruit of it to test and one seed of another fruit. The fruit eaten, which was given us by the American consul, Mr. Glenny, was of exquisite flavor and as free from fiber as a firm custard. The seed of this fruit and the other seed of the same variety are labeled No. 1091, L. & F., S. P. I. No. 9486. The following scanty information was obtainable about this mango: On the island of Chiloane, some 60 miles south of Beira, a monastery was established by the Portuguese several centuries ago. This monastery has been abandoned for many years, a century or more, we are told. Long after that time some fishermen found mango trees growing in the abandoned garden of the once monastery and brought the fruit to Beira. Since then small lots of this fruit are brought from Chiloane by any fishing boat passing during the mango season. The repute of this mango has spread along the African coast as being far superior to any other variety grown there. So far as we could learn no effort has been made to introduce the plant to the mainland, except in the instance of a single young tree in Beira grown from a seed. The sample we ate was delicious in flavor, delicate in texture, and of large size. This variety was named after Mr. Barbour Lathrop, its discoverer and first introducer into America." (*Fairchild.*)

9670 to 9699. MANIHOT sp. **Cassava.**

From Robert Thomson, Half Way Tree, Jamaica. Purchased on the recommendation of Prof. P. H. Rolfs. Received May 7, 1903.

9670.

Pacho No. 1.

9671.

Pacho No. 2.

9672.

Pacho No. 3.

9673.

Pacho No. 4.

9674.

Heleda No. 1.

9675.

Heleda No. 2.

9676.

Heleda No. 3.

9677.

Heleda No. 4.

9678.

Heleda No. 5.

9679.

Heleda No. 6.

9680.

Heleda No. 7.

9681.

Rio (Pie?) de Paloma.

9682.

Negrita No. 1.

9683.

Negrita No. 2.

9670 to 9699—Continued.

9684.

Negrita No.

9685.

Negrita No. 4.

9686.

Blancita.

9687.

Cajon amarilla.

9688.

Notoscres.

9689.

Cabasa dura.

9690.

Pie de perdig.

9691.

Cenaguera.

9692.

Chingele.

9693.

Manteca.

9694.

Lingua de Venada.

9695.

Solita amarilla.

9696.

Mantera.

9697.

Cantabriera.

9698.

Solita blanca.

9699.

Bitter.

9700 to 9732.

From Jamaica. Received through Prof. P. H. Rolfs, May 7, 1903.

A collection of scions as follows:

9700. Citrus aurantium. **Tangerine.**

"A tangerine seedling, secured at Porus, Jamaica. An extra large variety, nearly as large and equally as good flavored as the *King*, ripening earlier, and of a much finer color." (*Rolfs.*)

9701. Citrus aurantium. **Tangerine.**

"A tangerine very similar to No. 9700, but ripening somewhat later." (*Rolfs.*)

9702. Citrus aurantium. **Navel tangerine.**

"Similar to No. 9700 in size, color, and general make-up of the fruit, but being seedless and producing a small accessory orange, as in the case of the Washington navel; otherwise being of the distinct tangerine type." (*Rolfs.*)

9703. Mangifera indica. **Mango.**

Alfoos. "This mango was introduced from India to Jamaica about fifteen years ago, and is considered to be one of the finest of the East Indian varieties." (*Rolfs.*)

9704. Mangifera indica. **Mango.**

Bombay. "The tree from which the scions were obtained was ripening fruit in winter. The fruit weighed about three-fourths of a pound. Very luscious and producing very little fiber. Altogether a superior mango." (*Rolfs.*)

Cuttings as follows:

9705. Hibiscus sinensis.

"A beautiful ornamental of unusual appearance, producing a rose-colored flower." (*Rolfs.*)

9700 to 9732—Continued.

9706. Hibiscus sinensis.

"Another beautiful *Hibiscus* with very dark center and yellow outer portions of the petal." (*Rolfs.*)

9707. Bougainvillea spectabilis var. lateritia (?).

"One of the most showy decorative plants for the lawn. The orange-colored bracts produce a very pleasing contrast with the dark-green background." (*Rolfs.*)

9708. Thunbergia grandiflora.

"A large flowering vine, very useful for arbor and house decoration." (*Rolfs.*)

9709. Thunbergia harrisii.

"A beautiful arbor plant." (*Rolfs.*)

9710. Thunbergia laurifolia.

"A beautiful plant for covering arbors and sides of houses." (*Rolfs.*)

9711. Ruppelia grata.

"An ornamental, producing very striking and pleasing effects on an arbor." (*Rolfs.*)

9712. Poinsettia sp.

"An especially fine extra double race of this variety." (*Rolfs.*)

9713. Passiflora quadrangularis.

"The granadilla of the Tropics, bearing large fruit the size of an ostrich egg, the inner pulp of which has a very pleasant subacid flavor." (*Rolfs.*)

9714. Petrea volubilis.

"An arbor ornamental of extra good qualities, making a dense shade and producing a profusion of flowers." (*Rolfs.*)

9715. Beaumontia grandiflora.

"A vine of large proportions, producing an immense white bloom, the tips of the corolla being pink. A valuable climbing plant for out-of-doors." (*Rolfs.*)

Seeds as follows:

9716. Coffea arabica.

"A variety of this species growing in a higher altitude and producing fruit of an extraordinarily good quality." (*Rolfs.*)

9717. Clitoria sp.

"A peculiarly crested form of this plant which makes an excellent plant for covering a lattice." (*Rolfs.*)

9718. Luffa aegyptica.

"A dishcloth gourd, the inner parts of which produce a fibrous material useful for various culinary purposes." (*Rolfs.*)

9719. Cananga odorata (?). **Ilang-Ilang.**

"Seed produced from tree growing in Jamaica." (*Rolfs.*)

9720. Hura crepitans. **Sand box.**

"Useful for shade and ornamental purposes." (*Rolfs.*)

9721. Acrocomia sp.

"This species produces nuts that are used like hickory nuts and are most excellent." (*Rolfs.*)

9700 to 9732—Continued.

9722. Oreodoxa oleracea. **Mountain palm of Jamaica.**

"A very handsome ornamental plant." (*Rolfs.*)

9723. Sabal sp. **Cuban sabal.**

"A very sturdy, big-trunked tree." (*Rolfs.*)

9724. Livistona hoogendorpii.

"An ornamental palm." (*Rolfs.*)

9725. Sabal adansoni.

"A dwarf palmetto." (*Rolfs.*)

9726. Pandanus vandermeschii.

9727. Areca alicae.

9728. Cocos botryophora.

9729. Livistona rotundifolia.

9730. Pandanus utilis.

9731. Roystonia regia.

"Is supposed to be distinct from the Porto Rico and Florida royal palm, making a tree of much grander stature." (*Rolfs.*)

9732. Ananas sativus. **Pineapple.**

"Seedling pineapple plants." (*Rolfs.*)

9733. Sechium edule. **Chayote.**

From San Juan, P. R. Presented by Miss Jennie H. Ericson. Received June 1, 1903.

9734 to 9749. Medicago spp.

From Madrid, Spain. Received through Messrs. Lathrop and Fairchild (No. 1189, a to p, May, 1903), June 1, 1903.

"The Botanic Gardens of Madrid have represented in their collection a large number of grasses and fodder plants, and the head gardener, Mr. Luis Aterido, has kindly furnished us with a collection of seeds of sixteen species of *Medicagos*, some of which may prove of value for breeding purposes. They are as follows:

9734. Medicago lupulina.

9735. Medicago rigidula.

9736. Medicago gerardi.

9737. Medicago laciniata.

9738. Medicago intertexta.

9739. Medicago disciformis.

9740. Medicago orbicularis.

9741. Medicago tenoreana.

9742. Medicago tuberculata.

9743. Medicago murex.

9744. Medicago praecox.

9745. Medicago suffruticosa.

9746. Medicago radiata.

9747. Medicago ciliaris.

9748. Medicago falcata.

9749. Medicago scutellata.

"Among these, several are indigenous to Spain and all of them have a greater or less value as fodder plants. They are mostly annuals, however, and are therefore limited in value for direct use." (*Fairchild.*)

9750 to 9774. TRIFOLIUM spp.

From Madrid, Spain. Received through Messrs. Lathrop and Fairchild (No. 1190, May, 1903), June 1, 1903.

"Small packets of seeds from the Botanic Gardens of Madrid (see Nos. 9734 to 9749). These are for the use of anyone who is especially interested in breeding *Trifoliums*." (*Fairchild.*) They are as follows:

9750. TRIFOLIUM ANGUSTIFOLIUM.

9751. TRIFOLIUM ARVENSE.

9752. TRIFOLIUM BONANII.

9753. TRIFOLIUM CHERLERI.

9754. TRIFOLIUM DIFFUSUM.

9755. TRIFOLIUM FRAGIFERUM.

9756. TRIFOLIUM GLOMERATUM.

9757. TRIFOLIUM HISPIDUM.

9758. TRIFOLIUM INCARNATUM.

9759. TRIFOLIUM LAPPACEUM.

9760. TRIFOLIUM MARITIMUM.

9761. TRIFOLIUM MEDIUM.

9762. TRIFOLIUM MONTANUM.

9763. TRIFOLIUM OCHROLEUCUM.

9764. TRIFOLIUM PANORMITANUM.

9765. TRIFOLIUM PRATENSE.

9766. TRIFOLIUM REPENS.

9767. TRIFOLIUM RESUPINATUM.

9768. TRIFOLIUM RUBENS.

9769. TRIFOLIUM SPUMOSUM.

9770. TRIFOLIUM STRIATUM.

9771. TRIFOLIUM STRICTUM.

9772. TRIFOLIUM SUBTERRANEUM.

9773. TRIFOLIUM TOMENTOSUM.

9774. TRIFOLIUM VESICULOSUM.

9775.

From Honduras. Presented by Mr. Frank Dean, Black River. Received June 1, 1903.

"One large seed of Oracco; a fine fruit, like the Maumee sapota." (*Dean.*)

9776. **Palm.**

From Honduras. Presented by Mr. Frank Dean, Black River. Received June 1, 1903.

"Seeds of the Coyol palm. A large variety, growing to a height of 40 feet. Produces wine and vinegar. Seeds good for cattle and hogs." (*Dean.*)

9777.

From Honduras. Presented by Mr. Frank Dean, Black River. Received June 1, 1903.

"A climber, with flowers like the *Allamanda;* yellow, with red center. Fine plant. Name unknown." (*Dean.*)

9778 to 9789.

From Khojend, Russian Central Asia. Presented by Mr. E. M. Valneff, of Khojend, through Mr. E. A. Bessey. Received June 17, 1903.

A collection of seeds, as follows:

9778. PISTACIA VERA. **Pistache.**

From Hissar, Bokhara. Crop of 1902.

9779. ANDROPOGON SORGHUM. **Sorghum.**

Djougara.

9778 to 9789—Continued.

9780. SESAMUM INDICUM. **Sesame.**

Seed of mixed colors.

9781. TRITICUM VULGARE. **Wheat.**

Winter wheat.

9782. TRITICUM VULGARE. **Wheat.**

Spring wheat.

9783. HORDEUM VULGARE. **Barley.**

Spring barley.

9784. CHAETOCHLOA ITALICA. **Millet.**

9785. PANICUM MILIACEUM. **Broom-corn millet.**

9786. PHASEOLUS MUNGO. **Mung bean.**

9787. CARTHAMUS TINCTORIUS. **Safflower.**

9788. MEDICAGO SATIVA. **Alfalfa.**

9789. LINUM USITATISSIMUM. **Flax.**

Grown for oil making.

9790 to 9800.

From Tashkent, Russian Central Asia. Presented by Mr. H. W. Dürrschmidt, seedsman, of Tashkent, through Mr. E. A. Bessey. Received June 17, 1903.

A collection of seeds, as follows:

9790. TRITICUM VULGARE. **Wheat.**

Alabjurag winter wheat.

9791. TRITICUM VULGARE. **Wheat.**

Iantagbay or *Yantagbay.*

9792. TRITICUM VULGARE. **Wheat.**

Kisilbugday.

9793. TRITICUM VULGARE. **Wheat.**

Tschulbugday. Grown in winter on irrigated land.

9794. TRITICUM VULGARE. **Wheat.**

Aulieata. Grown in winter on unirrigated land.

9795. ZEA MAYS. **Corn.**

Kukurusa.

9796. ANDROPOGON SORGHUM. **Sorghum.**

Dshugara Balchá.

9797. SESAMUM INDICUM. **Sesame.**

Mixed brown and white.

9798. PANICUM MILIACEUM. **Broom-corn millet.**

9790 to 9800 Continued.

9799. Chaetochloa italica. **Millet.**

Kunak.

9800. Carthamus tinctorius. **Safflower.**

9801. Eriobotrya japonica. **Loquat.**

From Yokohama, Japan. Presented by the Yokohama Nursery Company at the request of Messrs. Lathrop and Fairchild. Received June 5, 1903.

Formosa. Seed of the Formosan loquat.

9802. Nephelium litchi. **Leitchee.**

From Canton, China. Received through Messrs. Lathrop and Fairchild (No. 792, December 20, 1901), January 30, 1902.

Hak Ip, black leaved. "This is one of the best varieties grown about Canton, China. It is said to be a large-fruited sort, of excellent flavor, but with medium-sized stone. The dried leitchees of the market here are mostly of this form. The plant is not reproduced from seed but is grafted or inarched." (*Fairchild.*)

9803. Nephelium litchi. **Leitchee.**

From Canton, China. Received through Messrs. Lathrop and Fairchild (No. 793, December 20, 1901), January 30, 1902.

No Mai, "tender rice" leitchee. "This is a small-seeded, very superior sort, one of the favorites on the Canton market where four or five different varieties are known and where the sale of this fruit is a very important one. Dr. J. M. Swan, of the Canton Hospital, pronounces this one of the two or three best varieties known to him." (*Fairchild.*)

9804. Diospyros kaki. **Japanese persimmon.**

From Canton, China. Received through Messrs. Lathrop and Fairchild (No. 794, December 20, 1901), January 30, 1902.

Hung tsz, large red persimmon. "This is a soft variety of medium to large size, round to oblate spheroid, dark in color, and reported to be very sweet in flavor. It is imported as being probably a Chinese variety and worthy of trial in comparison with the Japanese sorts." (*Fairchild.*)

9805. Amygdalus persica. **Peach.**

From Canton, China. Received through Messrs. Lathrop and Fairchild (No. 795, December 20, 1901), January 30, 1902.

Hung Wat tim. "A variety of the 'Honey' type, reported to be good for preserves and not so sweet as the *Ying tsui* or Eagle Beak variety. It is medium early. Worthy of trial as coming from the south China region, though probably not of superior excellence." (*Fairchild.*)

9806. Prunus sp. **Plum.**

From Canton, China. Received through Messrs. Lathrop and Fairchild (No. 796, December 20, 1901), January 30, 1902.

Hung Mui. "A large red plum, fairly sweet, but of the hard-fleshed type. Like the other Chinese plums about Canton it is said to have a somewhat bitter taste when cooked and allowed to stand for an hour or so. Europeans in Canton do not prize these Chinese plums very highly. This variety blooms in February or March." (*Fairchild.*)

9807. Bambusa sp. **Bamboo.**

From Canton, China. Received through Messrs. Lathrop and Fairchild (No. 797, December 20, 1901), January 30, 1902.

Kam Chuk, golden bamboo. "The most beautiful of all the bamboos about Canton, a golden-stemmed sort, with stripes of green. It is rather rare on the island of Hongkong, I am told by Mr. Ford, and it is not very common about Canton. It is worthy of trial in Florida and southern California." (*Fairchild.*)

9808. MANGIFERA INDICA. **Mango.**

From Mussorie, India. Presented by Rev. H. Marston Andrews, principal of Woodstock College. Received August 8, 1903.

Malda. Said to be of very large size and spicy flavor.

9809. VITIS RUPESTRIS var. METALLICA. **Grape.**

From Cape Town, South Africa. Presented by the Cape Colony department of agriculture, through Messrs. Lathrop and Fairchild (No. 1137, March 10, 1903). Received August 10, 1903.

"Plants of a South African originated variety of resistant American stock, which has proved itself most admirably suited to the conditions at the Cape and especially adapted to 'any loose soil, loam, gravel, or sand, and also in dry, open, heavy soils. It can, besides, stand a fair amount of moisture in loose soils. It forms an excellent graft bearer for all varieties of European vines except *Hanepoot* and possibly also the members of the Muscat family.' (Cf. J. P. de Waal, in the Ag. Jour. Cape of Good Hope, December 19, 1901, p. 838.) This variety, Mr. Pillans says, is the best of all the resistant stocks yet tried at the Cape, as its ease of grafting, great vigor, suitability to different kinds of soil, and grafting affinity for all but varieties of the Muscat type make it a general stock of great value. Even those who do not claim that it exceeds in vigor any other sort, admit that *it is the easiest grafted of any of the American stocks.* The stock originated at Great Constantia Wine Farm, in a lot of seedlings from seed sown in 1886. It is uncertain whether the seed came direct from America or from France. This is entirely distinct, according to F. J. Bioletti (formerly of the experiment station at Berkeley, Cal., now at the Elsenburg Agricultural School), from the *metallica* of French vineyardists. Its name applies to the luster of its foliage. The seedling was picked out in 1894, and by quick propagation in 1901 yielded 687,000 cuttings. In 1902, 864,000 cuttings were distributed. It has been tested side by side with many French stocks, such as *Aramon rupestris*, *Riparia Gloire de Montpellier*, and takes its place as their equals in all points and their superior as regards ease of propagation and suitability to the varieties of soils mentioned. Mr. Pillans goes so far as to predict that it will drive all other sorts out except for Muscat sorts. He claims for it a remarkable yield-giving power, extreme vigor, and resistance to the phylloxera. Mr. Bioletti admits its excellent qualities, and practical growers are enthusiastic about it. This is well worth the serious consideration of California vine growers. The originators of this remarkable seedling are Messrs. J. P. de Waal and Eustace Pillans, of the Cape of Good Hope department of agriculture, and its trial in California should be made at once. We are indebted to Mr. Pillans for the plants sent. See No. 9607, the identical variety." (*Fairchild.*)

9810 to 9814. VITIS sp. **Grape.**

From Cape Town, South Africa. Presented by the Cape Colony department of agriculture, through Messrs. Lathrop and Fairchild (No. 1149 to 1151, and 1153, March, 1903). Received August 10, 1903.

9810. VITIS VINIFERA.

Red Hanepoot. "A variety of table grape that is believed to have originated in South Africa and which, according to Mr. Bioletti, formerly vine expert of the California Experiment Station, at Berkeley, is not known in America. The variety belongs to the *Muscat* type and may be described as a *Muscat* with the red color of the *Flaming Tokay.* It is one of the most popular of the South African varieties and is exported to England. It is an excellent shipper and a showy table sort. Sent by Mr. Eustace Pillans, from the Government vineyard at Constantia." (*Fairchild.*) (No. 1149.)

9811. VITIS VINIFERA.

Hermitage. "This is the grape from which the Cape claret is made. It is said by experts to rank high as a claret maker and not to have been tested in California. Mr. Bioletti, formerly of the California Experiment Station at Berkeley, Cal., remarks (in the Cape Journal of Agriculture, Vol. XX, No. 12, p. 696), that the Cape *Hermitage* is distinct from the sort grown in the Hermitage vineyards of France and is not so good as the *Shiraz* or *Sirah* grape, which is well known to Californians." (*Fairchild.*) (No. 1150.)

9810 to 9814—Continued.

9812. VITIS RUPESTRIS.

Le Roux. "A variety of American phylloxera-resistant stock which, according to de Waal (in the Cape Agricultural Journal, Vol. XIX, No. 13, p. 839), originated from a seedling, selected by Mr. J. G. Le Roux, of Klein, Drakenstein, Paarl. It requires a loose loam, gravel, or sand, and also grows in dry, open, heavy soils as well. *It is especially suitable as a stock for the Hanepoot and very likely also for the other Muscat varieties*, and is a good general grafting stock. Mr. Bioletti, formerly of the California Experiment Station at Berkeley, Cal., thinks this sort will be keenly appreciated in California for a stock for Muscat varieties." (*Fairchild.*) (No. 1151.)

9813. VITIS RUPESTRIS.

Pillans. "A variety of resistant American stock which has been selected by Mr. Eustace Pillans, agricultural assistant in charge of the Government wine farm at Constantia. Mr. Pillans thinks this will prove an excellent stock for the Muscat varieties of grape and, although it has not yet been thoroughly tested, he predicts its general use for this class of vines. The *Hanepoot*, which is of the *Muscat* type, does well on it. These cuttings are sent by Mr. Pillans himself." (*Fairchild.*) (No. 1153.)

9814. VITIS VINIFERA.

White Hanepoot. "Probably descended from the *White Muscat.*" (*Fairchild.*)

9815. AMYGDALUS PERSICA. **Peach.**

From Constantia, South Africa. Presented by the Cape Colony department of agriculture through Messrs. Lathrop and Fairchild (No. 1152, March 16, 1903). Received August 10, 1903.

Constantia. "A variety of peach which originated at Constantia. It is said by Mr. Eustace Pillans to be an excellent shipping variety, of good quality and one of the best sorts grown in Cape Colony. It deserves a trial in the collections of California and Georgia, but may not prove hardy enough for Maryland, Delaware, or Michigan. Sent by the Cape department of agriculture." (*Fairchild.*)

9816. MEDICAGO SATIVA. **Alfalfa.**

From Willard, Utah. Received through Mr. P. A. Nebeker, June 9, 1903.

Turkestan alfalfa seed grown by Mr. Nebeker under agreement with the Department of Agriculture from imported seed (S. P. I. No. 991), furnished him in 1900.

9817. TRIFOLIUM PANNONICUM.

From Erfurt, Germany. Received through Haage & Schmidt, July 17, 1903.

Seed from the 1902 crop.

9818 to 9823.

From Heneratgoda, Ceylon. Received through J. P. William & Bros., July 31, 1903.

Seeds of trees for arid regions, as follows:

9818. CASUARINA EQUISETIFOLIA.

9819. DALBERGIA SISSOO.

9820. ALBIZZIA PROCERA.

9821. ALBIZZIA LUCIDA.

9822. ALBIZZIA JULIBRISSIN.

9823. EUCALYPTUS GLOBULUS.

9824 to 9826.

From Santiago, Chile. Presented by Federico Albert, of the ministry of industry and public works. Received July 9, 1903.

Seeds as follows:

9824. ARAUCARIA IMBRICATA.

9825. JUBAEA SPECTABILIS.

9826. BELLOTA MIERSII.

9827. PINUS PINEA. **Umbrella pine.**

From Rome, Italy. Presented by Hon. Hector de Castro, United States Consul-General. Received August 7, 1903.

9828 to 9830.

From Monte, Grand Canary, Canary Islands. Presented by Mr. Alaricus Delmard, through Messrs. Lathrop and Fairchild. Received August 14, 1903.

Seeds as follows:

9828. CANARINA CAMPANULA var. CANARIENSIS.

9829. PAPAVER sp.

9830. PINUS CANARIENSIS.

9831 to 9850.

From Mexico. Secured by Mr. G. Onderdonk, special agent of this Department, and sent to G. L. Taber, Glen St. Mary, Fla., for propagation.

9831 to 9846. PRUNUS ARMENIACA. **Apricot.**

9831. Onderdonk's No. 1, Taber's No. 1.

From garden of Crispin Mariscal, Coyoacan, Distrito Federal. Freestone; 4 inches in circumference; blush; rich; sweet; season, May.

9832. Onderdonk's No. 2, Taber's No. 2.

From garden of Crispin Mariscal, Coyoacan, Distrito Federal. Freestone; $4\frac{1}{2}$ inches in circumference; blush; rich; sweet; season, May.

9833. Onderdonk's No. 3, Taber's No. 3.

From garden of Crispin Mariscal, Coyoacan, Distrito Federal. Freestone; $4\frac{1}{2}$ inches in circumference; blush; rich; sweet; season, May.

9834. Onderdonk's No. 4, Taber's No. 4.

From garden of Crispin Mariscal, Coyoacan, Distrito Federal. Clingstone; $3\frac{3}{4}$ inches in circumference; blush; rich; sweet; season, May.

9835. Onderdonk's No. 5, Taber's No. 5.

From garden of Crispin Mariscal, Coyoacan, Distrito Federal. Freestone; $4\frac{1}{2}$ inches in circumference; blush; rich; sweet; season, May.

9836. Onderdonk's No. 6, Taber's No. 6.

From garden of Crispin Mariscal, Coyoacan, Distrito Federal. Fruit not yet grown. Season, August 1.

9837. Onderdonk's No. 7, Taber's No. 7.

From garden of Carlos Ortero, San Angel, Distrito Federal. Fruits not fully grown; 5 inches in circumference; fine; season, June. Twelve buds inserted, all dead July 15, 1903. Mr. Onderdonk states that the trees do not make a vigorous growth, literally bearing themselves to death. He promised to furnish Mr. Ortero a tree if any lived, as he was permitted to take all the bud wood there was on the tree. Wood altogether too young when taken. Freestone; yellow; blush.

9831 to 9850—Continued.

9831 to 9846—Continued.

9838. Onderdonk's No. 8, Taber's No. 8.

From garden of Martin Velasco, San Angel, Distrito Federal. Freestone; $4\frac{1}{2}$ inches in circumference; cream yellow; blush; season, June 1.

9839. Onderdonk's No. 9, Taber's No. 9.

From garden of Hilario Abilo, Contreras, Distrito Federal. Freestone; $6\frac{3}{4}$ inches in circumference; cream colored; blush; sweet; season, May 25 to June 1.

9840. Onderdonk's No. 10, Taber's No. "A."

From J. R. Silliman, Saltillo, Coahuila. Variety, *Perry*. Unripe fruit six inches in circumference; cream colored; blush.

9841. Onderdonk's No. 11, Taber's No. "B."

From Santa Anita gardens, near Saltillo. Fruit $4\frac{1}{2}$ inches in circumference; yellow; blush; sweet; season, May.

9842. Onderdonk's No. 12 (or 13), Taber's No. "C."

From Santa Anita gardens, near Saltillo. Fruit $5\frac{1}{2}$ inches in circumference when not fully grown; yellow; blush; season, June 5.

9843. Onderdonk's No. 13 (or 12), Taber's No. "D."

From J. R. Silliman, Saltillo, Coahuila. Unripe, $4\frac{1}{2}$ inches in diameter; highly recommended by Mr. Silliman; season, July. Mr. Taber writes that the packages containing these last two numbers were both marked 12, so that it is not possible to tell which should be 12 and which 13.

9844. Onderdonk's No. 15, Taber's No. 15.

Probably from garden of J. R. Silliman, Saltillo, Coahuila. A very fine apricot, $5\frac{1}{2}$ inches in circumference; yellow; blush; season, May 25; named *Nellie* for owner's daughter.

9845. Onderdonk's No. 16, Taber's No. 16.

Probably from garden of J. R. Silliman, Saltillo, Coahuila. A very fine apricot; $5\frac{1}{2}$ inches in circumference; yellow; blush; season, June 1; named *Dorah* for owner's daughter.

9846. Onderdonk's No. 17, Taber's No. 17.

From garden of Henrique Maas, Saltillo, Coahuila. Said to be a very fine large variety. Season about July 5.

9847. PRUNUS CERASUS. **Cherry.**

Onderdonk's No. 14, Taber's No. 14. Mr. Onderdonk writes that this is the Capulin cherry but does not state where the buds were secured.

9848 to 9850. AMYGDALUS PERSICA. **Peach.**

9848. Onderdonk's No. 11, Taber's No. 11.

From garden of Carlos Ortero, San Angel, Distrito Federal. A large, yellow, blush, clingstone.

9849. Onderdonk's No. 12, Taber's No. 12.

From garden of Carlos Ortero, San Angel, Distrito Federal. A yellow, blush, freestone.

9850. Onderdonk's No. 13, Taber's No. 13.

From garden of Martin Velasco, San Angel, Distrito Federal. A large, white, blush, clingstone.

9851. Prunus cerasus (?). **Cherry.**

From Mexico. Received through Mr. G. Onderdonk, June 29, 1903, by Mr. W. A. Taylor, pomologist in charge of field investigations.

Capulin.

9852. Andropogon sorghum. **Kafir corn.**

From Durban, Natal. Presented by Mr. Claude Fuller, Government Entomologist, through Messrs. Lathrop and Fairchild (No. 1193a, August 5, 1903). Received August 31, 1903.

Mahele or *Mapele.* "This variety has proved more resistant than any other to a species of aphis which injures all the common sorts." (*Fairchild.*)

9853 and 9854. Triticum durum. **Wheat.**

From Poona Farm, Kirki, India. Sent by the superintendent through Latham & Co., Bombay, India, addressed to Dr. S. A. Knapp. Received July 23, 1903.

9853.

Piola Karte. From Shuedrager (?).

9854.

Shet Gahu. From Poona.

9855 and 9856. Andropogon sorghum. **Sorghum.**

From Poona Farm, Kirki, India. Sent by the superintendent through Latham & Co., Bombay, India, addressed to Dr. S. A. Knapp. Received July 13, 1903.

9855.

Gidgep Jowar.

9856.

Dagdi Jowar.

9857. Castilla sp. nov.

From Costa Rica. Presented by Mr. Guy N. Collins, of the Department of Agriculture, June 16, 1903.

Seed of a new species of great promise as a rubber producer.

9858. Theobroma sp. nov. **Cacao.**

From Costa Rica. Presented by Mr. Guy N. Collins, of the Department of Agriculture, June 16, 1903.

Seeds of a new species.

9859. Cassia auriculata. **Avaram.**

From Manamadura, South India. Presented by Rev. Edward P. Holton, through Miss Nina G. Holton, of this Department. Received September 5, 1903.

Grown and used extensively in South India; the bark for tanning, the leaves, twigs, and seed pods as a fertilizer for salt lands, wet cultivation. Habit, low and brushy like a blueberry bush on rocky, sandy, dry, waste lands.

9860. Cyperus nutans. **Matting rush.**

From Japan. Received through Mr. R. H. Sawyer, Kennebunk, Me., July 23, 1903.

Cultivated in the rice fields of Japan. Straw dried and used in the manufacture of the coarser, cheaper grades of Japanese matting.

9861. Cyperus tegetiformis. **Matting rush.**

From China. Received through Mr. R. H. Sawyer, Kennebunk, Me., July 23, 1903.

Native in salt marshes along the coast of China. Three-cornered rush split, dried, and used in manufacture of Chinese floor matting.

9862. Andropogon sorghum. **Sorghum.**

From the Sudan, Africa. Presented by Dr. L. Trabut, Government Botanist, 7 Rue des Fontaines, Mustapha, Algiers, Algeria. Received September 14, 1903.

A few seeds of a strain originated in the Sudan. Recommended by Doctor Trabut as of extraordinary size and quality.

9863. Pyrus malus. **Apple.**

From Stockholm, Sweden. Presented by Mr. Axel Pihl, secretary of the Swedish Pomological Society, through Messrs. Lathrop and Fairchild. Received September 22, 1903.

Salems. "A newly-discovered variety, promising because of its hardiness and ability to live on poor soils." (*Fairchild.*)

9864. Trifolium pannonicum.

From Erfurt, Germany. Received through Haage & Schmidt September 26, 1903.

9865. Secale cereale. **Rye.**

From Stockholm, Sweden. Received through Mr. J. E. W. Tracy, of this Department, August 17, 1903.

Wasa. Three small samples, from different seed houses. As the bags containing two of the samples were broken and the seed mixed, it was decided to give but one number to the three samples. (1 sample from Sellberg & Co., Stockholm; 1 sample from Öhmans, Söner & Co., Stockholm; 1 sample from another seed house.)

9866. Euphorbia pulcherrima var. plenissima. **Poinsettia.**

From Hope Gardens, Kingston, Jamaica. Presented by Prof. William Fawcett, director, through Messrs. Lathrop and Fairchild. Received October 8, 1903.

"In 1898 Mr. Barbour Lathrop noticed a single plant of this variety growing in the Hope Botanic Gardens, of Kingston, Jamaica. Although he had seen the double variety of this plant in many places in the Tropics and in greenhouses, nowhere had he observed a plant with such unusually full whorls of colored bracts. The plant in its full glory was a perfect blaze of color, forming one of the handsomest decorative shrubs for landscape purposes that we have ever seen. The writer is inclined to believe that this is a strain from the ordinary double poinsettia, and that it can be propagated from cuttings. Its special beauty may possibly have been, however, produced by specially favorable soil conditions in Jamaica. If the former presumption is true, this will probably prove a very valuable strain for park use in those regions of the South where it will grow, and it may even prove superior to the ordinary type for greenhouse culture. It is worthy of a serious trial, both out of doors and under glass. Under notes L. and F., No. 56, in 1898, the Department's attention was called to this variety." (*Fairchild.*)

9867. Prunus lauro-cerasus. **Cherry laurel.**

From Trebizond, Turkey. Presented by Mrs. Julia F. Parmelee. Received October 9, 1903.

Kara yemish. Five plants brought by Mrs. Parmelee from Trebizond to Dunkirk, N. Y. Given to the Department through Mr. W. A. Taylor, pomologist in charge of field investigations.

9868. Ocimum viride.

From Kew, England. Presented by the director of the Royal Botanic Gardens, Kew. Received October 9, 1903.

Obtained at the request of Dr. L. O. Howard, Entomologist of this Department, for experiments on the effect of this plant upon mosquitoes.

9869. GARCINIA MANGOSTANA. **Mangosteen.**

From Heneratgoda, Ceylon. Received through J. P. William & Bros., October 19, 1903.

"One thousand seeds of this most delicious of tropical fruits, which, it is believed, will prove of great commercial value to the fruit-growing interests of Porto Rico." (*Fairchild.*)

9870. PERSEA INDICA.

From Madeira. Presented by Mr. J. B. Blandy, through Mr. D. G. Fairchild. Received October 15, 1903.

"This tree is a native of the Canary Islands, and is hardier than the alligator pear. It is introduced for the purpose of testing it as a stock upon which to graft *Persea gratissima*. According to the statement of one of the principal growers in Florida, such a stock is especially desired, because the trunk of the young alligator pear is its weakest part." (*Fairchild.*)

9871. TRITICUM VULGARE. **Wheat.**

From Erivan, Caucasus, Asiatic Russia. Received through Mr. E. A. Bessey (No. 300, August 24, 1903), October 21, 1903.

"Red wheat from the mountains near Erivan. It is grown without irrigation and is sown in March. It should be tried in dry mountain regions." (*Bessey.*)

9872. TRITICUM DURUM. **Wheat.**

From Erivan, Caucasus, Asiatic Russia Received through Mr. E. A. Bessey (No. 301, August 24, 1903), October 21, 1903.

Galgalos. "A variety of macaroni wheat which is said to be very good. It is prized for flour. It brings 30 kopecks a pood more than No. 9871. It is also grown without irrigation in the mountains. It is mostly grown as a winter wheat, being sown in October. It is also sown early in March." (*Bessey.*)

9873. JUNCUS EFFUSUS. **Matting rush.**

From Kobe, Japan. Presented by Dr. A. G. Boyer, of the United States consulate at Kobe. Received October 25, 1903.

Seed of the round Japanese matting rush. This seed was picked from the plants which are growing for next year's crop of matting grass, i. e., from roots that are 2 years old. The seed ripens in July.

9874 to 9876. TRIFOLIUM ALEXANDRINUM. **Berseem.**

From Cairo, Egypt. Secured through the courtesy of Mr. George P. Foaden, of the Khedivial Agricultural Society. Received November 7, 1903.

9874.

Muscowi.

9875.

Fachl.

9876.

Saida.

9877. HORDEUM VULGARE. **Barley.**

From Cairo, Egypt. Secured through the courtesy of Mr. George P. Foaden, of the Khedivial Agricultural Society. Received November 7, 1903.

Mariut.

9878. AVENA SATIVA. **Oat.**

From Paris, France. Received through Vilmorin-Andrieux & Co., November 9, 1903.

Belgian winter.

9879. Garcinia cochinchinensis.

From Saigon, Cochin China. Presented by M. E. Haffner, director of agriculture of Cochin China, through Messrs. Lathrop and Fairchild. Received November 11, 1903.

"A species of *Garcinia* which is closely related to the mangosteen, and upon which it is hoped this delicious fruit tree can be grafted. This species is said to be much less limited in its range of soil and climatic conditions, and it may prove a valuable stock for the mangosteen." (*Fairchild.*)

9880. Garcinia ferrea.

From Saigon, Cochin China. Presented by M. E. Haffner, director of agriculture of Cochin China. Received November 11, 1903.

"A species of *Garcinia* introduced for the same purpose as No. 9879, as a stock for the mangosteen." (*Fairchild.*)

9881. Garcinia mangostana. **Mangosteen.**

From Heneratgoda, Ceylon. Received through J. P. William & Bros., November 11, 1903. Shipped from Ceylon August 31, 1903. A wardian case full of plants of this delicious tropical fruit.

9882. Amygdalus persica var. nectarina. **Nectarine.**

From Marplan, Turkestan. Presented by Prof. Ralph Pumpelly. Received November 11, 1903.

Five seeds of a variety of nectarine which Professor Pumpelly describes as a very delicious, large sort, which was abundant in that portion of Turkestan. Professor Pumpelly's first impression was that this was a smooth-skinned peach, thinking that the nectarine would not be likely to occur in that portion of Turkestan.

9883. Clerodendron foetidum.

From Cape Town, South Africa. Presented by Prof. P. MacOwan, of the Cape department of agriculture. Received November 9, 1903.

A hardy, ornamental bush 3 to 6 feet in height, said to be hardy in the Middle and Southern States and not new to this country.

9884 to 9886.

From Guadalajara, Mexico. Presented by Mr. Federico Chisolm. Received November 16, 1903.

Seeds of native Mexican plants as follows:

9884. Dahlia sp. **Wild dahlia.**

Dwarf, leaves very thickly covered with fine prickly hairs, flowers on stem 24 to 48 inches tall, have a diameter of $1\frac{1}{2}$ to 2 inches, petals blood red, with very high glaze, center yellow.

9885. **Tuberose (?)**

Chicalam. Small bulb, one or two slender, round leaves 12 to 36 inches long. Flowers exquisite, colored like a fuchsia, in clusters on slender, round stem 12 to 40 inches high. Blooms July, August, and September. (Doctor Rose says this is probably a tuberose.)

9886.

Bulb with leathery leaves splotched with brown. Flowers green, not valuable, August. Leaves sometimes 12 inches long by 4 inches broad. May be useful for foliage. Doctor Rose says probably *Amole* (*Chlorogalum pomeridianum* or *Agave americanum*).

9887. SECALE CEREALE. **Rye.**

From North Watergap, Pa. Received through Mr. M. L. Michael, November 14, 1903.

Winter Ivanof. Grown in 1903 from S. P. I. No. 1342.

9888. TRICHOLAENA ROSEA.

From Honolulu, Hawaii. Presented by Mr. Jared G. Smith, special agent in charge of the Hawaiian agricultural experiment station. Received November 23, 1903.

9889 and 9890. PHASEOLUS VIRIDISSIMUS. **Bean.**

Grown from S. P. I. No. 6430, in 1903.

9889. Received through Mrs. Hattie L. Asseltine, Fruithurst, Ala., November 28, 1903.

9890. Received through Mr. John J. Dean, Moneta, Cal., December 4, 1903.

The California grown seed is noticeably larger than that grown in Alabama.

9891. EUTREMA WASABI. **Japanese horse-radish.**

From Yokohama, Japan. Presented by Mr. H. Suzuki, of the Yokohama Nursery Company, through Messrs. Lathrop and Fairchild. Received December 7, 1903.

"Described in B. P. I. Bulletin No. 42. The Japanese horse-radish, which is eaten with raw fish as commonly in Japan as ordinary horse-radish is eaten in America with raw oysters." (*Fairchild.*)

9892. ATRIPLEX LEPTOCARPA. **Saltbush.**

From Sydney, Australia. Received through Anderson & Co., December 5, 1903.

9893. DESMODIUM TRIFLORA.

From Mayaguez, Porto Rico. Sent by Mr. G. N. Collins, of the Department of Agriculture, through Mr. D. G. Fairchild. Received December 14, 1903.

This plant is used as a soil covering on the coffee plantations in Porto Rico.

9894 to 9896.

From Tanegashima, Japan. Presented by Mr. R. Chester, through Mr. R. B. Handy, of this Department. Received December 12, 1903.

Native Japanese seeds, as follows:

9894. **Red jessamine.**

One-half ounce of seed that looks like four-o'clocks.

9895. **Lily.**

Very decorative.

9896.

A few seeds, without name or other data.

INDEX OF COMMON AND SCIENTIFIC NAMES.

O

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 67.

B. T. GALLOWAY, *Chief of Bureau.*

RANGE INVESTIGATIONS IN ARIZONA.

BY

DAVID GRIFFITHS,

ASSISTANT IN CHARGE OF RANGE INVESTIGATIONS.

GRASS AND FORAGE PLANT INVESTIGATIONS.

ISSUED OCTOBER 6, 1904.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1904.

BULLETINS OF THE BUREAU OF PLANT INDUSTRY.

The Bureau of Plant Industry, which was organized July 1, 1901, includes Vegetable Pathological and Physiological Investigations, Botanical Investigations and Experiments, Grass and Forage Plant Investigations, Pomological Investigations, and Experimental Gardens and Grounds, all of which were formerly separate Divisions, and also Seed and Plant Introduction and Distribution, the Arlington Experimental Farm, Tea Culture Investigations, and Domestic Sugar Investigations.

Beginning with the date of organization of the Bureau, the several series of bulletins of the various Divisions were discontinued, and all are now published as one series of the Bureau. A list of the bulletins issued in the present series follows.

Attention is directed to the fact that "the serial, scientific, and technical publications of the United States Department of Agriculture are not for general distribution. All copies not required for official use are by law turned over to the Superintendent of Documents, who is empowered to sell them at cost." All applications for such publications should, therefore, be made to the Superintendent of Documents, Government Printing Office, Washington, D. C.

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26. Spanish Almonds and Their Introduction into America. 1902. Price, 15 cents.
27. Letters on Agriculture in the West Indies, Spain, and the Orient. 1902. Price, 15 cents.

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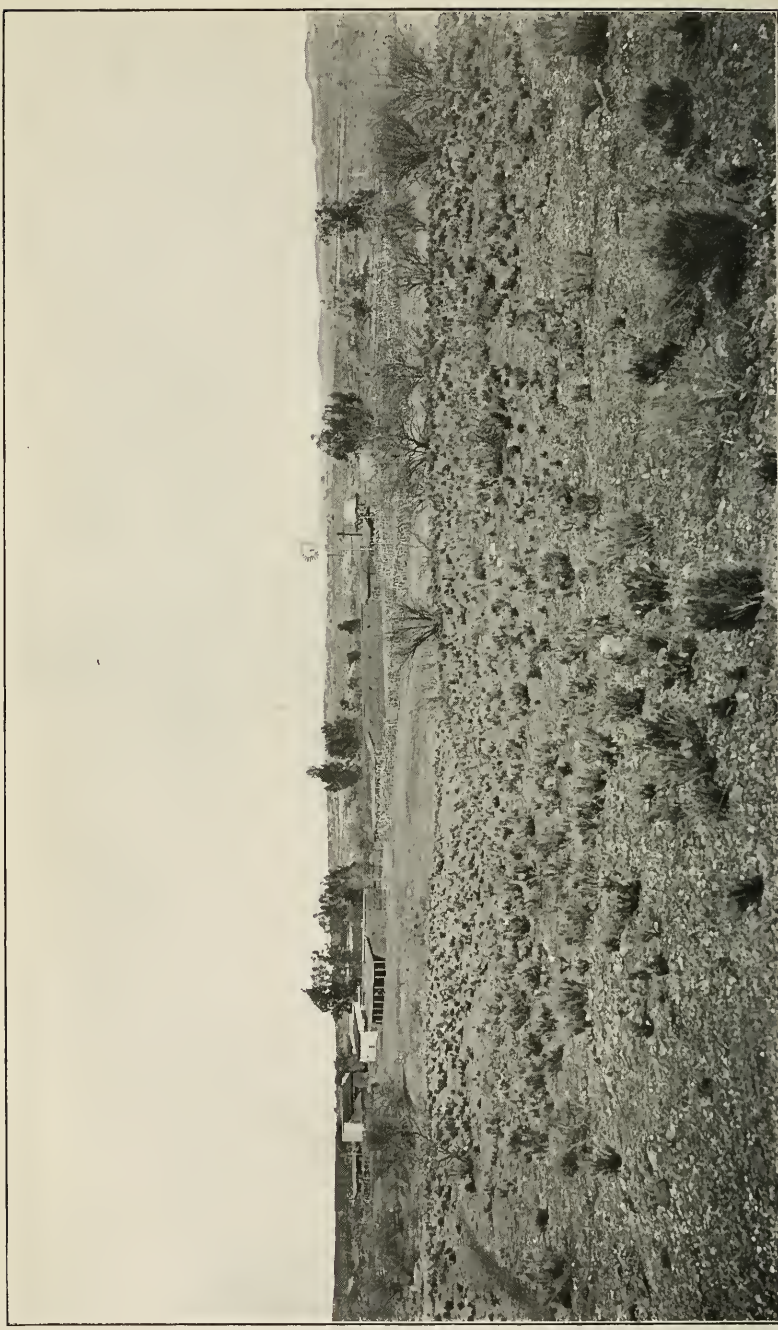

LAOSA, A TYPICAL SOUTHERN ARIZONA RANCH.

U. S. DEPARTMENT OF AGRICULTURE.

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BUREAU OF PLANT INDUSTRY.

B. T. GALLOWAY, *Chief.*

J. E. ROCKWELL, *Editor.*

GRASS AND FORAGE PLANT INVESTIGATIONS.

SCIENTIFIC STAFF.

W. J. SPILLMAN, *Agrostologist.*

A. S. HITCHCOCK, *Assistant Agrostologist in Charge of Alfalfa and Clover Investigations.*
C. V. PIPER, *Systematic Agrostologist in Charge of Herbarium.*
DAVID GRIFFITHS, *Assistant Agrostologist in Charge of Range Investigations.*
C. R. BALL, *Assistant Agrostologist in Charge of Work on Arlington Farm.*
S. M. TRACY, *Special Agent in Charge of Gulf Coast Investigations.*
D. A. BRODIE, *Assistant Agrostologist in Charge of Cooperative Work.*
P. L. RICKER, *Assistant in Herbarium.*
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BYRON HUNTER, *Assistant in Charge of Pacific Coast Investigations.*
R. A. OAKLEY, *Assistant in Domestication of Wild Grasses.*
C. W. WARBURTON, *Assistant in Fodder Plant and Millet Investigations.*
M. A. CROSBY, *'ssistant in Southern Forage Plant Investigations.*
J. S. COTTON, *Assistant in Range Investigations.*
LESLIE F. PAULL, *Assistant in Investigations at Arlington Farm.*
HAROLD T. NIELSEN, *Assistant in Alfalfa and Clover Investigations.*
AGNES CHASE, *Agrostological Artist.*

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., July 1, 1904.

SIR: I have the honor to transmit herewith the manuscript of a paper on Range Investigations in Arizona, which embodies a report upon investigations conducted in cooperation with the experiment station of the University of Arizona.

The paper is a valuable contribution to our knowledge of improvement of range lands, and I respectfully recommend that it be issued as Bulletin No. 67 of the regular Bureau series.

Respectfully,

B. T. GALLOWAY,
Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

PREFACE.

The main features of the range problem have been reduced to two: The carrying capacity of the range, and the best methods of managing the range so as to secure the largest amount of feed from it without permanent injury to the food plants that furnish the covering of the soil. The principles of management may be reduced to the following: A proper control of the amount of stock upon a given range and the time of the year at which they are allowed upon the various subdivisions of it; the protection of such native plants as are of value, and, particularly, the saving of seeds of such plants and scattering them upon the range; lastly, the introduction upon the range of such new forage plants as experience has shown can be thus introduced.

A knowledge of the carrying capacity of the ranges is of the utmost importance, for it must form the basis of any intelligent legislation relating to the range question. This knowledge determines the rental and sale value of range lands and should also determine the size of the minimum lease or homestead for range purposes in case laws are passed providing for such disposal of the public ranges.

The present report includes a general study of range problems in southern Arizona, but is devoted more particularly to the investigations conducted in cooperation between the United States Department of Agriculture and the Arizona Experiment Station on two tracts of land situated on the Santa Rita Forest Reserve in the Territory of Arizona. The work upon one of these tracts, consisting of a fenced area of 58 square miles, has been conducted under the immediate supervision of Dr. David Griffiths, of this Office. The work upon the other area, which is also fenced and consists of some 240 acres of land, has been conducted under the supervision of Prof. R. H. Forbes, Director of the Arizona Experiment Station, by Prof. J. J. Thornbur of that station, since August, 1901. Previous to that time Doctor Griffiths was a member of the station staff at Tucson, and conducted the work on the small tract also. Once each year the Department has furnished the Arizona Experiment Station with a report of the work done by its officers upon the large tract, while the officers of the station have furnished to the Department a similar report of the work on the small tract. Particular attention is called to the study of the amount of vegetation produced upon the large tract since it was fenced nearly two years ago. It will be noted that deductions concerning the carrying capacity of this range made from this study agree in a most satisfactory manner with actual practice. It is proposed in the near future to determine by actual trial the amount of stock this fenced area will carry without deteriorating.

Acknowledgments are due to Mr. Howell Jones, of the Santa Fe railway system, for much assistance in prosecuting the investigations reported in this bulletin.

W. J. Spillman, *Agrostologist.*

Office of Grass and Forage Plant Investigations,

Washington, D. C., June 29, 1904.

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RANGE INVESTIGATIONS IN ARIZONA.

INTRODUCTION.

The discussions of the following pages are based upon experimental work and observations made in the Territory of Arizona between the months of August, 1900, and November, 1903, in cooperation with the Arizona Experiment Station. The experimental work thus far has been conducted upon the small inclosure near Tucson, a discussion of which was the main feature of Bulletin 4 of this series. Such data regarding this work as were not included in that publication are discussed here. The opportunities of the writer for observation of the conditions obtaining throughout the main grazing areas have been very good, especially during a residence of an academic year at Tucson in 1900–1901 and during the spring, summer, and autumn of 1903.

Besides visiting the region within 60 miles of Tucson at all seasons of the year, the following list of trips over the different portions of the range country is appended for the purpose of fixing more definitely the time at which these observations were made, as well as to make the data accompanying the rather large collections of forage and other plants secured upon these several journeys and afterwards deposited in various herbaria more complete:

October 6 to 19, 1900. Tucson to Wilcox via Benson, and return via Pearce and Tombstone.

December 6 to 23, 1900. Maricopa to Tempe, and return to Picacho via Mesa and Florence.

March 17 to 22, 1903. Tucson to Laosa via Sopori and Arivaca, and return via Babuquivari Mountains and Robles.

March 24 to 30, 1903. Tucson to Dudleyville via Willow Spring Mountains, and return via San Pedro and across the Rincon Mountains to Tanque Verde.

April 7 to 15, 1903. Tucson to Nogales, and return to Phoenix via Arivaca, Coyote, Santa Rosa, and Casagrande.

May 15 to 18, 1903. Williams to Bright Angel and return.

June 29 to July 8, 1903. Huachuca Mountains to Cannanea, Sonora, Mexico.

July 16 to 17, 1903. Prescott to Mayer.

July 18 to 19, 1903. Ash Fork and Williams.

July 20 to 23, 1903. Flagstaff and south to Mogollon Mountains.

July 25 to 26. 1903. Winslow and Holbrook.

August 8 to 17, 1903. Adamana to Fort Apache via Long H ranch and St. Johns, returning via Showlow.

September 12 to 22, 1903. Adamana to Chin Lee, and return via Navajo.

September 24 to 25, 1903. Prescott to Mayer.

October 6 to 11, 1903. Tucson to Patagonia via Greaterville and Cottonwood, and return via Sopori, Arivaca, Babuquivari Mountains, and Robles.

This rather formal list takes no cognizance of the work done between trains and on short stops at various places along the lines of railroad, especially on the main line of the Santa Fe system, the Santa Fe, Prescott and Phoenix, and the Santa Fe, Prescott and Eastern railways, between Needles and Gallup and between Phoenix and Ash Fork.

Arizona has a total area of 72,332,800 acres, of which only 254,521 acres are improved; but there are reserved 19,724,717 acres, according to Governor Brodie's report to the Secretary of the Interior in 1902. A part of this reserve land is available for grazing purposes under certain restrictions, grazing being allowed upon all the forest reserves excepting the Grand Canyon, and of course the Indians raise a great deal of stock upon their reservations. Taking everything into consideration, there are probably upward of 65,000,000 acres available for stock raising.

According to the Twelfth Census (1900), there were in the Territory 1,033,634 units of stock, sheep and goats being calculated at the rate of 6 to 1 bovine animal in relation to pasture consumption. Unfortunately no distinction was made in these Census reports between range and farm stock, so that it is impossible to determine from the lists the number of stock supported on native pastures. All that can be said is that there was in the Territory in 1900 one animal unit to approximately every 65 acres of land available for stock purposes. This includes farm animals as well as range stock. It is interesting to compare these figures with those given by Mr. C. W. Gordon in the statistics of the Tenth Census. Here Mr. Gordon, who made an elaborate report upon the conditions, as well as the number of animals, estimated that in 1880 there were 229,062 units of stock, occupying 43,750 square miles of range lands, or 1 unit to 122.24 acres.

THE SMALL INCLOSURE.

A full description of the small inclosure was given in Bulletin No. 4 of this series, after the first planting was made in the winter of 1901. It will not be necessary, therefore, to enter into the details of the work on this area any further than to discuss briefly the results which have been secured by the experiments which were suggested at that time, and which have been carried on since with such modifications and changes as further light and experience have shown to be necessary.

As stated in Bulletin No. 4, some sixty species of forage plants were sown, the work being begun on the 10th and finished on the 23d of January, 1901. These plants were given various forms of treatment, the seed of some being covered by a disk harrow and of others by a smoothing harrow; in some cases the ground was harrowed or disked before planting, and in others the seed was sown on the uncultivated mesa. Besides the seed sown, *Lippia repens*, recommended as a soil binder for arid situations, was planted on one of the embankments. This plant is still living and has covered the spaces between the hills in a few places; but it can hardly be considered promising for situations which do not receive more rainfall than these mesas. Plantings of this species subsequently made have failed entirely.

The vast majority of the plantings of grasses made the first year were a failure from the start; that is, the seed did not germinate at all. There were some good rains following closely upon the completion of the seeding, furnishing ideal conditions for the germination of such grasses and other forage plants as are adapted to the prevailing conditions at that season. The following are the mean temperatures for the early months of 1901 at the university, 5 miles distant: January, 51° F.; February, 52° F.; March, 55.6° F.; April, 61.7° F.

As will be seen from an examination of the lists published in Bulletin No. 4 of the Bureau of Plant Industry, some of the seed planted was from the Northwestern States, but the greater part of it was native seed gathered the previous autumn. A considerable quantity which might be considered native was nevertheless from a very different situation from that in which it was planted upon the mesas surrounding Tucson. As examples may be mentioned the seed secured in Sulphur Spring Valley, Arizona, and in Silver City, N. Mex., all of which grew at high elevations. A comparison of the northern and southern seed during the two following months was very interesting indeed. It was the seed from the northwest which gave promise of success during February and early March. Several species from the north germinated remarkably well, while the vast majority of the native species did nothing, as was to be expected, for they make their growth during the hot, moist weather from July to September. To this general rule, however, there were some marked exceptions. *Bouteloua oligostachya*, for instance, germinated well and there was a good stand of it on plots 43 and 69 in March. Upon these plots native seed was sown, but it was secured from an altitude of about 5,000 feet. Seed of this species received from the north did not germinate, possibly owing to its being old or poorly matured. Many of the native species which did nothing upon the range germinated in the grass garden a few days later in the season, as discussed in the text and tables given below. Rescue grass (*Bromus unioloides*) purchased from seedsmen and of unknown origin germinated well enough to make a good stand had it been able to combat the drought of spring and early summer. It would have succeeded much better, no doubt, if it had been planted in early autumn.

The following tabular statement in connection with Bulletin No. 4

will serve to emphasize the fact that it was the northern-grown seed which germinated to best advantage upon the range plots during the cool weather of spring:

Record of germination upon range plots, spring of 1901.

Name of plant.	Number of plot.[a]	Origin of the seed.	Date of germination.	Condition.
Agropyron spicatum	6	Walla Walla, Wash	Feb. 9	Good stand.
Agropyron occidentale	7 and 68	.....do	....do...	Thin stand.
Atriplex canescens	33	Tucson, Ariz	Mar. 4	Good stand.
Atriplex halimoides	40	California	Mar. 8	Very thin stand.
Atriplex semibaccata	43	.....do	Feb. 9	Good stand.
Bouteloua oligostachya	43 and 69	Cochise, Ariz	Mar. 8	Do.
Elymus canadensis	61	Silver City, N. Mex	....do...	Thin stand.
Elymus ambiguus ?	63	Walla Walla, Wash	Feb. 21	Very thin stand.
Elymus condensatus	64	Washington	Mar. 8	Thin stand.
Elymus virginicus submuticus.	65	Walla Walla, Wash	....do...	Very thin stand.
Agropyron tenerum	66	.....do	....do...	Thin stand.
Agropyron spicatum	67	.....do	Feb. 9	Good stand.
Bromus polyanthus paniculatus.	74	Silver City, N. Mex	Mar. 8	Do.
Phleum asperum	75	Walla Walla, Wash	....do...	Do.

[a] For information as to the location of the plots and methods of culture, see Bul. No. 4, Bureau of Plant Industry, 1901.

Shortly after completing the seeding on the range plots, a small grass garden was established on the university campus in rather a protected place behind the main building. This was designed for purely scientific study, but it served nevertheless as a very instructive check upon the species planted on the range. The planting was done here on the 13th and 14th of February and the plots were irrigated by well water when they needed it. The saltbushes were planted in a plot by themselves at some distance from the building, and consequently in a more exposed place.

The following tabular statement lists all the plants sown upon the range which germinated under irrigation and did not do so under the natural mesa conditions. The two tables, therefore, include all species, the seed of which was of known origin, planted on the mesa, which germinated in the spring; but the last table does not give a complete record of the grass-garden germinations, for there were many things planted in the grass garden that were not at hand in sufficient quantity to be sown upon the mesa:

Record of germination upon irrigated grass garden, spring of 1901.

Name.	Number of plot.[a]	Date of germination.	Source of seed.	Condition.
Sporobolus cryptandrus	6	Nov. 15	Tucson, Ariz	Thin stand.
Sporobolus wrightii	7	Mar. 4	....do	Good stand.
Chloris elegans	11	Mar. 22	....do	Very thin stand.
Muhlenbergia gracilis	13	Mar. 1	Cochise, Ariz	Thin stand.
Hilaria cenchroides	17	Mar 22	New Mexico	Very thin stand.
Poa fendleriana	31	Mar. 15	Silver City, N. Mex	Good stand.
Phaseolus retusus	38	Mar. 22	New Mexico	Do.
Andropogon saccharoides	39	Mar. 6	Cochise, Ariz	Thin stand.
Bouteloua rothrockii[b]	40	Apr. 13	.... do	Very thin stand.
Atriplex lentiformis	62	Mar. 15	Tempe, Ariz	Thin stand.
Atriplex polycarpa	69	....do	....do	Do.

[a] These are numbers of plots in the grass garden and have no reference to previously published numbers.

[b] This was incorrectly called *B. polystachya* in Bul. No. 4 of the Bureau of Plant Industry in referring to plots 26, 31, and 70. Throughout that publication these two species were not segregated.

By the middle of May there was nothing which had been planted upon the range plots alive, except a little *Lippia repens*, which had been placed upon one of the embankments thrown up across an old roadway, and a few scattered plants of shad scale (*Atriplex canescens*) on area F. Everything else had succumbed to the drought which invariably prevails in this region from March to June.

During the rainy season of the following August several plants which were sown in the winter germinated and made some growth. The most conspicuous of these was Metcalfe's bean (*Phaseolus retusus*), which germinated and grew beautifully through August, but died out completely by the middle of September. *Andropogon saccharoides* and *Chloris elegans* made a very small growth, but nothing commensurate with the quantity of seed sown and the labor involved.

During the autumn of 1903 there was nothing to show for the plantings of 1901 except a few stray plants of *Andropogon saccharoides* in the southeastern corner of the field, a similar growth of shad scale on portions of area F, and a small strip of *Lippia repens* on one of the embankments. None of these, however, gave promise of success.

In June, 1901, the writer discontinued his connection with the Arizona Experiment Station to accept his present position in the United States Department of Agriculture. The work upon the small tract was placed under the immediate supervision of Prof. J. J. Thornbur, of that station. During the summer of 1902 cooperative arrangements were entered into by the Department of Agriculture and the Arizona station whereby the investigations on the small tract were to be continued and those upon the large tract, discussed later, were to be instituted. Since that time Professor Thornbur has had charge of the work upon the small tract and the writer that upon the large tract.

The following paragraphs relating to the work upon the small tract are based upon data obtained from reports furnished this office by Professor Thornbur.

Since the winter of 1900–1901 considerable work has been performed on this area in an attempt to conserve storm waters by the erection of embankments and by the introduction of forage plants which will thrive under the advantages afforded by the dams. It is believed that the perennial plants which have been sown thus far can not be successfully established upon these mesas without careful attention to the soil and conservation of the waters, both of which entail considerable expense.

The dams built were thrown up across the water courses as in the winter of 1901, but their forms have been slightly changed because it was found that the diversion of the water did not suffice to spread it out very much nor to check its flow sufficiently to allow it to penetrate the ground as much as necessary. This is especially true with reference to the summer rains. The precipitation during the winter months, although causing considerable run-off, is much more gentle and penetrates the ground more readily.

The work done thus far seems to indicate that the most efficient dam for a gently sloping mesa is one which is so constructed that it will spill around the ends when the water has reached a height of not more than 12 inches. This requirement demands that the dam be constructed nearly on contour lines,[a] except at the ends, which are turned so as to retain water up to the desired depth and spread it over as much ground as possible. Besides the two dams mentioned in Bulletin No. 4, seven additional ones were built in January, 1902. These vary in length from 270 to 600 feet and in height from 12 to 24 inches, and are built at an average cost of a little more than $13.

In January, 1902, some seeding was done, but only in favored places, mostly above the embankments. Fewer species were planted than the previous year, and only two made any growth at all. Egyptian clover (*Trifolium alexandrinum*) and *Panicum texanum* were sown in the same dam, the first in the lower situation. The Egyptian clover germinated beautifully early in August, but all died in a very short time. *Panicum texanum* produced only a few plants, which made no seed.

Besides the above, seeds of the following species were planted: *Hilaria mutica*, *Bouteloua rothrockii*, *Atriplex coronata*, *A. elegans*, *A. nuttallii*, *A. canescens*, *A. bracteosa*, *A. polycarpa*, *A. nummularia*, *A. halimoides*, *A. leptocarpa*, *A. semibaccata*, *A. eremicola*, *Rhagodia inermis*, and *R. linifolia*. No seedlings of any of these species were observed.

During the last week in June, 1903, a third seeding was done. As in the second operation, the seed was sown in the vicinity of the dams

[a] This form of dam was first suggested by Prof. S. M. Woodward.

and the ground was prepared to receive it. In some cases, however, seed was sown below the dams, as well as above them. The following species were planted: *Panicum texanum*, *Andropogon saccharoides*, *Bouteloua curtipendula*, *B. rothrockii*, *B. oligostachya*, *B. hirsuta*, *B. aristidoides*, *Eriochloa punctata*, *Sporobolus wrightii*, *S. stricta*, *S. cryptandrus*, *Phaseolus retusus*, *Astragalus nuttallianus*, *Chætochloa composita*, *Pappophorum apertum*, *Chloris elegans*, *Elymus glabrifolius*, *Epicampes rigens*, and *Leptochloa dubia*.

In all cases the seed was sown very thick. Had all grown, the plants would have been entirely too numerous upon the ground. In many cases four times as much seed was sown as would produce a good stand if it all grew. Experience has shown that a good deal of the native seed is of very low germinating quality, and must often be sown excessively thick in order to even approximate a stand.

Many of the seeds of plants sown this time made considerable growth, but only in two or three cases was there anything like a stand secured. *Andropogon saccharoides*, *Bouteloua curtipendula*, *B. oligostachya*, *B. hirsuta*, and *Leptochloa dubia* all made thin stands. *Bouteloua rothrockii* made a scattering growth in one situation and quite a fair stand in another, but nowhere was there a better stand where it was sown than on favorable situations upon the uncultivated and undisturbed mesa in the immediate vicinity. The best stands and the best growth were secured with *Panicum texanum* and *Chloris elegans*. The former was especially good in places, but very uneven on account of having been sown partially in the depressions in the dams where the surface soil had been removed for the construction of the embankments and partially upon ordinary weathered soil. The lower depressions doubtless held water a little too long after the summer rains for the best development of the grass. In one of the dams there was considerably less than one-half acre which would cut at the rate of 1 ton of dry feed per acre. There was about a quarter of an acre of *Chloris elegans* in one of the dams which would yield at the rate of one-fourth ton of dry feed per acre. *Panicum texanum* has yielded by far the most promising results of anything tried thus far. It is an annual, however, and can not be used except in some such way as the common cultivated millets. There is little doubt that this grass is capable of considerable application in forage-plant culture in this region. If the seed could be secured at reasonable prices it might be sown upon barley fields for the production of summer and fall grazing and possibly for a small crop of hay in October. It matured this year in about ninety days after being sown.

The behavior of some of the native grasses was very interesting this year, especially when considered from the standpoint of seed habits. Usually perennial grasses do not mature much seed the year they are planted. The case is very different with species from this region. Some of them, although distinctly perennial in habit, mature seed in abundance in three months after being sown. This was especially the case with *Andropogon saccharoides*, *Bouteloua hirsuta*, and *B. oligostachya*, and less conspicuously true of *B. curtipendula*. *Bouteloua rothrockii* and *Leptochloa dubia* produced mature heads from practically every plant which grew. *Bouteloua rothrockii* produced fine, large bunches, with an abundance of mature seed. It should be noted that the latter is but a short-lived perennial at best. It is therefore not so surprising that it should produce an abundance of seed the first season. *Trichloris fasciculata* often produces two crops of seed—one in May and the other in September—in neglected spots and fence corners in the Salt River Valley.

THE LARGE INCLOSURE.

During the spring of 1903 arrangements were made for enlarging the work begun upon the mesas near Tucson in 1900. Permission having been granted by the Department of the Interior, an irregular tract of land upon the Santa Rita Forest Reserve, containing 49.2 square miles, or 31,488 acres, in the four townships Nos. 18 and 19, in ranges 14 and 15 east, Gila and Salt River meridian, was inclosed by a four-wire fence, completed early in June (fig. 1). Practically all stock was excluded from the tract by the 10th of June. This area differs very materially from the desert mesas upon which the small inclosure is situated, as will be seen from the descriptions given below. Much of it is situated within the altitude where perennial grasses are produced, and it is therefore capable of sustaining much more stock tnan the small inclosure upon the mesa.

TOPOGRAPHY.

The portion of the Santa Rita Forest Reserve which, after a preliminary survey, it was decided to fence is located in the northern foothills of the Santa Rita Mountains. It has a general northwesterly slope toward the Santa Cruz River (Pl. III, fig. 2). All of the region is well drained and there is consequently no accumulation of alkali at any point. Considerable quantities of water flow over portions of the area at certain seasons of the year. The presence of *Atriplex canescens* in the northwestern portion does not necessarily indicate that there are accumulations of soluble salts in the soil at this point.

The field, as a whole, contains typical foothill pasture lands of the region at this altitude. Along the eastern side there are rocky, steep bluffs rising 500 to 800 feet above the general level of the area. To the west and south of this point there are gently sloping areas free from brush. On the west half of the north side there occurs a considerable area of "washed country," while the east half of this side is a typical arid, creosote-bush area where no grass of any consequence ever grows. None of the higher mountain areas has been included on account of the difficulty and expense of fencing. Neither are any bottom lands included, for none of the typical river bottoms lies within the reserve. The bluffs spoken of above, however, answer very well for the mountain area, for they have upon them some of the more valuable mountain grasses; but they possess the disadvantage of not

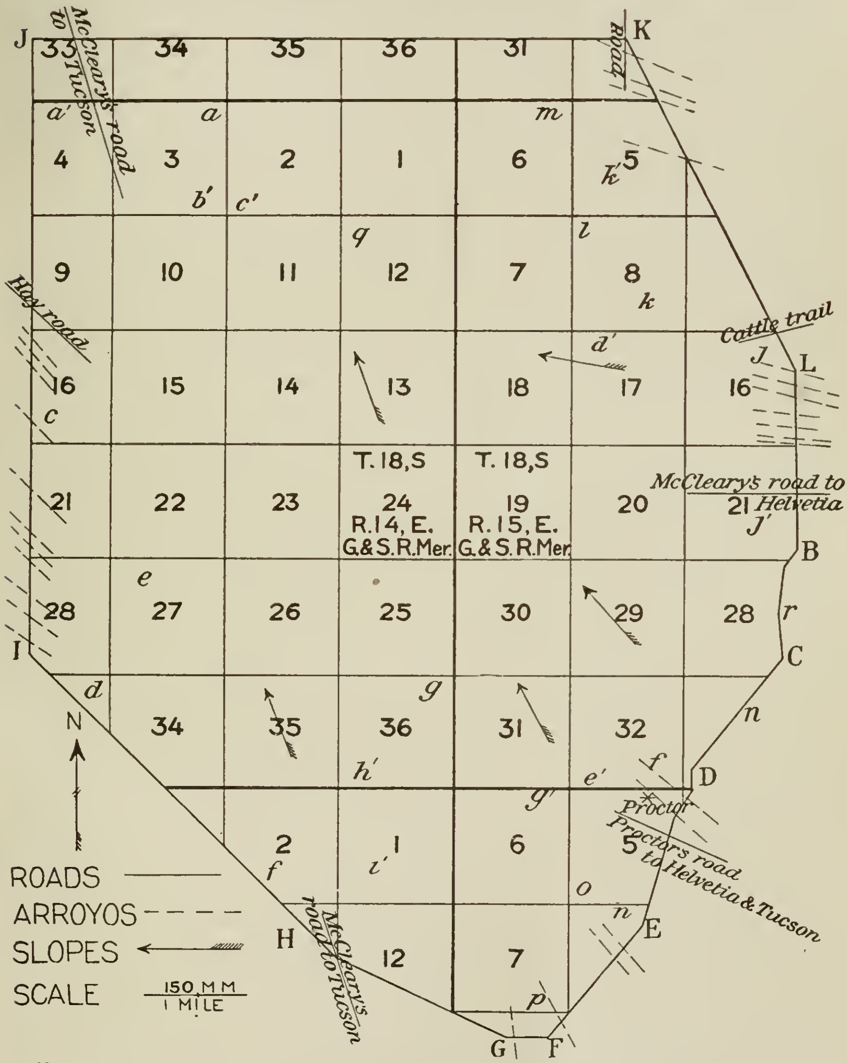

FIG. 1.—Diagram of the large inclosure in the northern foothills of the Santa Rita Mountains.

getting the rainfall of the higher mountains. It is to be regretted that no bottom land could have been fenced; but after all, in some respects, this would not be very much of an advantage, because the vacant river bottom lands in this vicinity are not, as a rule, productive, and do not figure at all conspicuously in the range feed supply.

The entire tract is more or less cut up by arroyos. These are usually steep, rugged, and rocky close to the mountains, but become wider and more shallow northward. The water which they carry during flood time is consequently spread over larger areas on the north side of the field. The surface water which goes down to the north side, however, is small in quantity and of short duration, but the sands of the arroyos carry an underground supply of water for several days after a rain. This supply of moisture to the shrubby vegetation is very considerable along these temporary water courses, but the areas between them receive only such moisture as happens to fall at those points. During the violent summer showers much of this runs off.

As stated above, the southern portion of the area is a comparatively open region, being cut by frequent arroyos, as indicated on fig. 1 between points L and G. The largest of these is the one which runs close to Proctor. At this point it is from 150 to 200 feet deep and 800 feet wide from bank to bank. Here the bottom of the arroyo is on solid rock, which accounts for the appearance of water at the surface. In general, however, it, like the others, is of coarse sand and like them widens out to the northward, its banks becoming lower and less rocky. Between the points L and B on fig. 1 on the fence line there are a number of small steep arroyos, and the same condition exists on the southern half of the west line, but the latter are less pronounced than the former. All of the arroyos are more rocky close to the mountains, and gradually spread out to the northwest, making the whole area a sloping plain, cut at frequent intervals by usually shallow washes to the northward and by deeper arroyos and canyons to the south. Besides the above water courses there are numerous gullies cut by the flood waters. These usually occur as laterals to the main arroyos, and extend into the broad gentle slopes which exist between the main water courses. The condition is a difficult one to portray, for the cuts are made by the flood waters, whose action is explained only when considered in connection with a surveyor's level and with the chemical and physical conditions of the soil. One can drive with a light rig over the entire field by picking his way slowly, but in many places he is obliged to travel considerable distances in order to get around the arroyos. This is especially true of the southern half of the field.

SOIL.

But little discussion of the subject of soil can or need be entered into. In general it may be said that the soil is of a light-brown color and composed of very fine particles intermixed with a large amount of coarse sand and gravel. On the south side it is much looser in texture, has more gravel in its composition, and packs less firmly upon drying than on the north side. On this account the sloping areas between the arroyos are not so badly washed, which condition, together with a more abundant supply of moisture, accounts for the more luxuriant vegetation and evenly distributed grassy covering. On the whole the soil does not differ from that which obtains throughout the entire region in similar situations. The area is well drained, but the soil softens very much more upon being moistened than would be expected. It is true, however, that it is very seldom that the moisture penetrates to great depths. In October, 1902, it was with great difficulty that 1-inch stakes of redwood or Oregon pine could be driven into the ground to a depth of 6 inches with an ax, yet, when the heavy rains of November came, these fell down of their own weight and could be driven into the ground their entire length by the pressure of the hand.

When the fence was built a peculiar condition of soil was observed along the middle of the northern fence line. The post-hole work was purposely done at a time when the ground was wet, and consequently, easily dug over the greater portion of the tract. In the above locality, however, to our astonishment, a heavy rainfall had not penetrated more than 2 or 3 inches, although the soil received the drainage of the entire Box Canyon region. On the greater part of the fence line, however, the winter and spring rains had penetrated to a depth of 2 feet or more. This area is known here as "washed country," which simply signifies that the upper strata of sandy loam has been removed, leaving the very closely packed, nonabsorbent subsoil exposed.

Underlying portions of the ground is a deposit of caliche, a calcareous hardpan, of variable thickness. All the arroyos, canyons, and washes are covered with a clean, coarse sand, while the steeper areas are coarse gravel and rocks. The soil particles are only slightly washed, as would be expected. Prof. W. P. Blake[a] considers the caliche to be derived from long-continued evaporations of subterranean waters raised by capillary action.

The soil of the general area is derived for the most part from the disintegration of the granitic rocks of the Santa Rita Mountain upheaval.

BRUSH AND TIMBER.

The greater part of the area is covered with a scattering growth of various shrubs and small trees. The northern and western portions contain much more shrubbery than the southern and eastern parts. A line drawn from corner L to corner I, figure 1, represents approximately the dividing line between the heavier and lighter brush. Upon the southern half there are large stretches which have practically no brush at all. Along the washes and arroyos, however, there are invariably found numerous shrubs, some of which attain to the dignity of trees, although very scraggy. A close examination of the broad,

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[a] Transactions American Institute of Mining Engineers, Richmond meeting, February, 1901.

gentle, grassy slopes between the arroyos in this vicinity reveals a very scattering growth of mesquite (*Prosopis velutina*), which is in the form of twigs 2 to 3 feet high, with an occasional larger shrub in some of the more favorable localities. Without more critical data regarding the previous history of the region than it is possible to secure at the present time, one can not tell whether this growth indicates that this shrub is spreading or not. The present condition rather suggests this possibility. It would not be at all surprising, for there appears to be abundant evidence that such is the case under the influence of stock grazing in portions of Texas, where a closely related mesquite grows in abundance.

By far the most important shrub is the mesquite, which, like the majority of the other shrubs, is especially at home from the line LI, figure 1, northward and along the arroyos in the southern half of the inclosure. In many localities in the southern half cat-claw (*Acacia greggii*) is nearly as abundant as the mesquite at the present time. This, however, is better protected than the mesquite, and the wood choppers have generally avoided it on this account. The other smaller species of acacia (*A. constricta*) is less abundant, but is also confined to the arroyos. The blue palo verde (*Parkinsonia torreyana*), which rivals the mesquite in size, grows in similar localities. The desert willow (*Chilopsis linearis*), cottonwood (*Populus fremontii*), hackberry (*Celtis reticulata*), soapberry (*Sapindus marginatus*), and walnut (*Juglans californica*) grow sparingly in some of the upper canyons. A large part of the northwestern portion of the field is badly infested with *Isocoma coronopifolia*. The line LI, figure 1, passes through a very conspicuous growth of large bunches of *Ziziphus lycioides*, which is of as little value as the creosote bush (*Covillea tridentata*), which occupies some of the southeastern portion of the field. The greater part of the latter was avoided, however, in the final fencing, a very large area being found immediately north of the eastern portion of the inclosure. The upper edges of it are included in the northeastern portion of the field and in places along the northern portion of the McCleary road to Tucson. The line LI also represents the most profuse growth of the Cactaceæ, the main species of which are prickly pear (*Opuntia engelmanni*), cholla (*Opuntia fulgida*), and *Opuntia spinosior*. These, together with the sewarah (*Cereus giganteus*), are the most conspicuous of the cacti within the inclosure. The biznaga (*Echinocactus wislizeni*) occurs in scattering individuals over the entire tract.

Of the other cacti little need be said. *Opuntia arbuscula* grows scatteringly on the northern portion, while *Cereus fendleriana* and *C. greggii* are occasionally found in the same region. On the rocky banks and higher bluffs are numerous other inconspicuous species, such as *Mammillaria grahami*, *M. arizonica*, *Cereus rigidissimus*, and

C. caespitosus. Upon the higher elevations there are scattered plants of *Yucca baccata*, *Agave applanata*, and *A. schottii*, while *Yucca radiosa* is scattered along the northeastern fence line in rather limited numbers. *Nolina microcarpa* and *Dasylirion wheeleri* are conspicuous, especially on the northern slopes of the hills, while thickets of ocotilla (*Fouquiera splendens*) are frequent on the southern slopes. Scattered at rather frequent intervals all over the brushy area are to be found clumps of Brigham's tea (*Ephedra trifurca*). Besides these there are a great many other usually smaller shrubs scattered over various portions of the inclosure, some of them of considerable economic importance. They will be discussed under another head.

The area contains typical foothills, and does not differ materially from similar regions in the foothills of the Huachuca, Santa Catalina, and Babuquivari mountains in this same general region. As a rule, there are large, gently sloping, grassy areas comparatively free from brush between the brushy mesas and the sparsely timbered mountains, not only in southern Arizona, but in New Mexico as well.

FORAGE PLANTS.

This inclosed area contains three typical and natural subdivisions of the grazing lands of this portion of the Southwest, and the cattleman would look upon it as an average grazing proposition, not the best, nor yet by far the poorest. The first subdivision may be described as an arid desert mesa; the second, adjoining the first, may very properly be designated as open, gently sloping foothills, comparatively free from rocks; and the third, as rough, rocky bluffs and arroyo banks.

The arid mesa portion of the inclosure occupies approximately half of the field, and we may accept a line drawn from corner L to corner I, figure 1, as the division between this region and the open foothills. This division line would in all probability be more accurate if it were described as extending from L to a point about $1\frac{1}{2}$ miles north of I on the west fence line. It will be seen that the upper edge of the heavy brush (*heavy* is used in a purely relative sense) corresponds roughly with the lower edge of the grassy area. North of this line there is but little grass, the main forage plants being various desert herbs and shrubs to be described later. In a favorable season there are areas of considerable magnitude of six weeks' grass (*Bouteloua aristidoides*) along the arroyos and on the higher levels of the west side, as far north as section 9, township 18, range 14; and there is usually more or less *Triodia pulchella* and six weeks' grass upon the rocky ridges in the northwest part of the pasture. These two grasses, however, are of little forage value here. They never, so far as experience since 1890 teaches, occur here except scatteringly. At times there are tufts of such perennial grasses as *Leptochloa dubia*, *Chætochloa composita*, *Andropogon saccharoides*, and *Bouteloua rothrockii*, together with the annual *Bouteloua polystachya*.

By far the greater part of the feed here is produced by the winter and spring annuals and the browse plants. The first of these are mainly Indian wheat (*Plantago fastigiata*), *Pectocarya linearis*, *Sophia pinnata*, *S. incisa*, *Thelypodium lasiophyllum*, *Monolepis nuttalliana*, *Phacelia arizonica*, *Ellisia chrysanthemifolia*, *Sphærostigma chamænerioides*, and several species of Gilia and Linanthus. There are also extensive areas of *Atriplex elegans*, often growing to the exclusion of all else and producing from 200 to 500 or more pounds of dry herbage per acre. This plant, although an annual, usually germinates in the spring and matures in autumn, passing through the dry season in the vegetative state.

The list of shrubby plants which occur here and which are of more or less forage value is quite large. The majority of them have been mentioned under another heading. The mesquite is by far the most important. Cat-claw (*Acacia greggii*), *A. constricta*, *Parkinsonia torreyana*, and *Ephedra trifurca* are also abundant. *Baccharis brachyphylla*, *B. bigelovii*, and *Anisacanthus thurberi*, while common in the shrubby mesa region, are much more abundant along the arroyos in the southern half of the field. During late spring the annual groundsel (*Senecio longilobus*), is a very conspicuous plant upon portions of the lower areas, and purslane (*Portulaca retusa*), forms a loose cover in many places in the fall. The former is probably of no forage value, while the latter furnishes good feed. In places in autumn two other species of purslane (*P. stelliformis* and *P. pilosa*) are of some value on the east side of the field.

It is to the open foothills that the greatest interest attaches, for it is here that the perennial grasses become numerous enough to be reckoned with in the range ration. The six weeks' grama (*Bouteloua aristidoides*) is by far the most abundant grass over the greater portion of this area, being especially abundant in the *Ziziphus lycioides* areas in the neighborhood of the line LI, fig. 1. In the same locality are also to be found large quantities of *Aristida americana* and its variety *humboldtiana*, the latter being usually found surrounding ant hills. *Bouteloua rothrockii* makes a tall, thin stand on the better portions of the gently sloping stretches between the arroyos, where in favorable years it makes a very conspicuous growth, but can not be said ever to take possession, for mixed with it are invariably found much six weeks' grama and *Aristida americana*. Growing in similar situations, and in some seasons covering large areas, are to be found *Bouteloua bromoides*, *B. eriopoda*, and *B. havardii*, which, however, are the main grasses on the majority of the rocky banks and bluffs along the arroyos. In the latter situations are also to be found *Andropogon contortus*, either in solid patches or scattering bunches, and *Andropogon saccha-*

roides at slightly lower levels. Confined mainly to the loose sands in the vicinity of the washes, but also at times extending over portions of the rocky hillsides, is a scattering growth of *Bouteloua vestita*, while *Muhlenbergia porteri*, the black grama of this region, is invariably limited to the protection of cat-claw and other spiny or thorny shrubs. The rough grama (*Bouteloua hirsuta*) is usually found upon all of the rocky banks, but it is at home in the higher bluffs and mountains beyond the inclosure. The same may be said of the side-oat grama (*Bouteloua curtipendula*). Growing under the protection of bushes along the arroyos in this section is always to be found more or less *Panicum lachnanthum*.

In the spring these open, grassy foothills are a veritable flower garden of magnificent proportions, so conspicuous in the neighborhood of section 24, township 18, range 15, as to be plainly visible from Tucson, a distance of from twenty-five to thirty miles away. The poppies (*Eschscholtzia mexicana*) in this place develop a little later than upon the mesa near Tucson or in the foothills of the Tucson Mountains. This is explained by the difference in altitude and exposure, and at times may be influenced by variation in rainfall as well, although the rainfall of the winter is more evenly distributed than that of the summer season. Other plants which are abundant enough to influence the vernal landscape by their floral colors are *Linanthus aurea*, *Phacelia arizonica*, *P. crenulata*, *Orthocarpus purpurascens palmeri*, *Baileya multiradiata*, *Lupinus leptophyllus*, *Eriophyllum lanosum*, and *Baeria gracilis*. None of these are altogether without forage value, although the poppies and one or two of the other species mentioned are not eaten when there are other plants of greater palatability. The other vernal vegetation consists of such small plants as "patota" (*Pectocarya linearis*), *Plagiobothrys arizonicus*, *Eremocarya micrantha*, *Lotus humistratus*, *L. humilis*, *Astragalus nuttallii*, Indian wheat (*Plantago fastigiata* and *P. ignota*), all of which are of forage value. To these should also be added covena (*Brodiæa capitata*) and the mustards (*Lesquerella gordonii*, *Sophia pinnata*, *S. incisa*, and *Thelypodium lasiophyllum*).

The spring grasses on the open foothills amount to little in the average season. The perennials mentioned above, especially the gramas, make a slight growth of root leaves in a favorable season, and *Aristida americana* sometimes develops to the point of seed production. *Festuca octoflora* is common throughout the area, but it is never abundant enough to make any feed. *Poa bigelovii* often furnishes quite a little grazing around the bases of bushes and in other protected areas in the arroyos, where *Chætochloa grisebachii* is of some value in the fall. In autumn there is usually considerable feed produced by lamb's-quarters (*Chenopodium fremontii*).

An enumeration of the main forage plants upon the rougher portion of the inclosure has necessarily been made in the previous paragraphs. All of the perennial species mentioned above grow here in scattering clumps. Besides those mentioned, of which the gramas (*Bouteloua bromoides*, *B. eriopoda*, *B. curtipendula*, and *B. hirsuta*), *Andropogon saccharoides* and *A. contortus* are the most important, *Muhlenbergia vaseyana*, *Hilaria cenchroides*, *Aristida divergens*, *A. schiedeana*, *Eragrostis lugens*, *Chætochloa composita*, *Trachypogon montufari*, *Leptochloa dubia*, *Epicampes rigens*, together with a little *Hilaria mutica* in a few places, are of importance. *Panicum lachnanthum* usually grows under the protection of shrubs, as stated above, but it sometimes covers considerable areas of open land, as shown in Pl. II, fig. 2. In 1902 and 1903, *Pappophorum apertum* made a very conspicuous growth upon the top of Pyramid Hill, where it and *Nicotiana trigonophylla* were the only conspicuous plants.

The blue grama (*Bouteloua oligostachya*), although of great importance on the opposite side of the mountains, does not occur here, at least not in sufficient quantities to be of any consequence. The same is true of *Chloris elegans*.

A part of the forage upon the inclosure is produced by the Eriogonums, which are not distantly related botanically to the docks, one of which, the canaigre (*Rumex hymenosepalus*), is very common along all of the arroyos. The most important species is *Eriogonum microthecum*, which grows to best advantage on some of the rougher foothills of the regions south and west of Proctor. It makes its best development here upon the higher lands beyond the fence line. Many of the annual species are also grazed by stock, and *E. thurberi*, *E. trichopodium*, *E. cernuum*, *E. abertianum*, and *E. divaricatum* are abundant enough to influence the general aspect of portions of the field at certain seasons of the year. Besides the above species, *E. polycladon*, *E. thomasii*, *E. pharnaceoides*, and *E. watsoni* (?) are common in some localities. *Eriogonum trichopodium* is so abundant at times in the region between the bushy and open foothills and farther north as to give its characteristic yellow color to large areas of ground.

AMOUNT OF FEED PRODUCED.

It seems highly desirable to secure as accurate an estimate as possible of the amount of herbaceous feed produced upon this inclosure at the present time. This is desirable not only for an estimate of the amount of stock that can be carried upon these lands, but also as a basis for comparison as to the value of protection and systematic grazing when observations shall have been made and data secured upon such points. In view of this fact an attempt was made to secure at the most opportune times during the two vegetative seasons as accurate an estimate as possible of the amount of growth which occurred upon the inclosure during the seasons of 1903. The estimate was secured by measuring the yield of all vegetation excepting the shrubs upon representative areas carefully selected from the different divisions of the tract. The positions of the plots measured are indicated by letters upon the diagram (fig. 1). A to Q represent those areas measured between the 1st and 20th of April, and A′ to K′ between the 29th of September and 2d of October, 1903.

It will be noticed that but few perennials, aside from the grasses included in the fall reckoning, are listed. It was the intention to estimate only the grasses and other annual plants, but it was decided after the work was begun to include a few perennial species other than the grasses. It might appear better to have made quantitative measurements upon those plants of forage value only; but it is exceedingly difficult to decide which species are and which are not forage plants. It often happens that nearly all plants that grow are eaten. What is grazed depends largely upon what is available for stock to eat within walking distance of water. It was deemed better, therefore, to measure the entire growth exclusive of the shrubbery, and to estimate the nonforage plants by deducting from the totals thus obtained such a percentage as seems justifiable, based upon personal observations as well as the testimony of stockmen.

In these measurements a unit area 3 feet by 7 feet was adopted, and in the majority of cases the areas were measured by a frame of the dimensions stated constructed for this purpose. In a few cases the areas were measured with a tapeline. All plants within the frame were pulled up, counted, cleaned, the roots cut off at the surface of the ground, and the plants thoroughly dried and subsequently weighed. In some instances where the number of plants was very large and the distribution uniform, one-half of the plot only was used for the estimate, although the tables given below are based upon areas of 3 feet by 7 feet for the sake of uniformity in tabulation. In four instances plants were discarded—that is, no records of them are made in these tables. They were so small and of such insignificant weight that they would amount to only about 1 pound per acre. The annotations in the last column of the tables mention these.

While making the measurements in the spring it was found that in some of the plots there was a number of very small seedlings which it was decided not to include at that time on account of the fact that they would necessarily have to be included in the autumnal measurements. This avoided counting the same plants twice. It was decided to include *Atriplex elegans* in both spring and autumnal measurements, because of the better growth made by it than by the others, and on account of the great loss which the plant would sustain during the long dry season from April to the first of July. This loss, it is thought, will in a large measure correct the error incurred by the double estimate of this plant. The measurements were made when it was believed the maximum yield for the season would be secured. It was impossible, of course, to select a time when the maximum for each plant could be obtained on account of the difference in the date of maturity and the difference in the resistance to the drought of late spring.

Tabular statement of plot measurements.

[Each plot contains 21 square feet.]

Name of plant.	Number of plants.	Height of plants.	Condition of plants.	Weight.	Condition of plot.
PLOT A.		*Inches.*		*Grains.*	
Eschscholtzia mexicana	4	5	In bloom	26	A broad, nearly level area from which some surface soil has been removed by erosion. Sparsely covered with shrubbery.
Atriplex elegans	9	3	Very young	76	
Gilia floccosa	9	4	Under bloom	20	
Lotus humilis	1	2	In fruit	2	
Pectocarya linearis	10	2	....do	104	
Sphærostigma chamæneri-oides.	4	5	In bloom	2	
Lepidium montanum	5	7	....do	80	
Filago californica	1	1	....do	3	
Triodia pulchella	1	2	....do	2	
Phacelia arizonica	5	4	In fruit	28	
Lotus humistratus	4	2	In bloom	21	
Caucalis microcarpa	9	4	....do	6	
PLOT B.					
Monolepis nuttalliana	57	3½	In fruit	1,631	A broad, shallow depression, from which nearly all brush has been cut and the surface soil removed by erosion.
Atriplex elegans	5	5	Very young	94	
Onagra trichocalyx	1	1	In bloom	10	
PLOT C.					
Filago californica	2	1½	In bloom	1	On a stony ridge in an area cut with steep, shallow ravines.
Lotus humistratus	1	1½	....do	2	
Sphærostigma chamæneri-oides.	1	3½	....do	4	
Gilia floccosa	1	3	Under bloom	2	
Eriogonum abertianum	1	3	In bloom	10	
PLOT D.					
Aristida americana	24	6	Under bloom	297	On the southern exposure of a stony knoll containing an unusually good growth of Aristida. Besides the list there are 223 seedling *Eriocarpum gracilis* less than 1 inch high.
Lupinus leptophyllus	3	5	Early bloom	56	
Lotus humistratus	20	2	In bloom	63	
PLOT E.					
Lotus humistratus	183	3 to 4	In fruit	555	A gently sloping, grassy area at the upper edge of the heavier mesquite brush. Besides the plants listed there are two small seedlings of *Gærtneria tenuifolia*, and ten plants of *Bouteloua rothrockii* beginning to grow.
Pectocarya linearis	116	2½	....do	611	
Astragalus nuttallii	7	2 to 4	In bloom	11	
Plantago ignota	26	4	Early bloom	53	
Gilia floccosa	8	5	....do	11	
Plagiobothrys sp	71	3 to 4	In fruit	469	
PLOT F.					
Plantago ignota	595	1 to 4	Early bloom	245	Very similar to E. No brush excepting an occasional mesquite from 2 to 3 feet in height. There is considerable old grass of *Bouteloua rothrockii*, *B. aristidoides*, and *Aristida americana* from last season.
Lotus humistratus	189	1	Full bloom	126	
Plagiobothrys arizonicus	35	6	Late bloom	147	
Pectocarya linearis	374	1 to 3	In fruit	318	
Orthocarpus purpurascens palmeri.	37	5	In bloom	93	
Gilia floccosa	38	2 to 3½	Early bloom	56	

Tabular statement of plot measurements—Continued.

Name of plant.	Number of plants.	Height of plants.	Condition of plants.	Weight.	Condition of plot.
PLOT G.		*Inches.*		*Grains.*	
Plagiobothrys sp	14	4	In fruit	101	Differing but little from Plot F. Besides the plants listed there are 12 small seedlings of *Eriocarpum gracilis* to be included in the autumnal reckoning.
Lupinus concinnus	190	1 to 8	Early bloom	999	
Calandrinia menziesii	276	1½	In fruit	700	
Plagiobothrys arizonicus	17	3 to 12	....do	116	
Lotus humistratus	94	1 to 1½	In bloom	56	
Baeria gracilis	53	3 to 4	Full bloom	53	
Linanthus aureus	4	3 to 4	....do	2	
Plantago ignota	49	2 to 4	Under bloom	35	
Festuca octoflora	84	1½ to 4	....do	14	
Filago californica	35	1 to 3	In bloom	14	
Phacelia arizonica	6	2	Early bloom	15	
Eremocarya micrantha	49	1 to 1½	In fruit	21	
PLOT H.					
Eriogonum thurberi	97	1 to 2	In bloom	77	In the bottom of Box Canyon, upon a coarse, sandy alluvium, which has not been disturbed for several years.
Eremocarya micrantha	21	1 to 2	....do	8	
Lupinus leptophyllus	21	4 to 8	....do	102	
PLOT I.					
Lotus humistratus	67	1 to 5	In fruit	56	Upon a stony, southern exposure bordering Box Canyon. Besides the plants listed there are 30 plants of perennial grasses just beginning to develop. *Opuntia engelmanni* is very conspicuous here.
Plantago ignota	38	1 to 3	Early bloom	57	
Erodium texanum	7	3	In fruit	78	
Eriophyllum lanosum	19	1 to 2	Full bloom	9	
Phacelia crenulata	10	2 to 6	In bloom	23	
Astragalus nuttallii	34	3	In fruit	259	
PLOT J.					
Eschscholtzia mexicana	343	1 to 9	In fruit	542½	Broad, open, gently sloping foothill region which produced a large crop of *Bouteloua aristidoides* last year.
Plantago ignota	291	1 to 2	Early bloom	70	
Lotus humistratus	32	(*a*)	Full bloom	101	
Eremocarya micrantha	115	1 to 2	....do	14	
Erodium cicutarium	3	2	Early fruit	6	
Eriophyllum lanosum	5	1 to 2	Full bloom	4	
Stylocline micropodes	35	1 to 2	In bloom	7	
Pectocarya linearis	24	1 to 2	In fruit	5	
PLOT K.					
Pectocarya linearis	310	1 to 4	In fruit	878	On a rocky hillside among steep, stony, bare arroyos. *Zizyphus lycioides* is conspicuous here. *Bouteloua aristidoides* was the chief crop last fall.
Lotus humistratus	2	1½	In bloom	10	
Lotus humilis	8	1½	In fruit	36	
Erodium texanum	3	3 to 4	....do	6	
Lepidium lasiocarpum	1	4	....do	18	
Eriophyllum lanosum	80	2 to 3	In bloom	105	
PLOT L.					
Lotus humilis	226	1	In bloom	180	Similar to K, but farther from arroyo. Besides the list, there is one plant each of *Plagiobothrys arizonicus*, *Baeria gracilis*, *Filago californica*, and *Eremocarya micrantha*. All would weigh less than 2 grains.
Linanthus bigelovii	13	2 to 3	....do	6	
Linanthus aureus	2	3½	....do	4	
Gilia floccosa	5	2 to 3	Under bloom	3	
Caucalis microcarpa	5	5	In bloom	6	

a Prostrate.

Tabular statement of plot measurements—Continued.

Name of plant.	Number of plants.	Height of plant.	Condition of plants.	Weight.	Condition of plot.
PLOT M.		*Inches.*		*Grains.*	
Thelypodium lasiophyllum.	7	10 to 18	In fruit	79	About one-third of plot situated under a Zizyphus bush, where the vegetation is much more abundant than in the remainder of the area, but it represents an average for this kind of situation.
Cryptanthe intermedia	5	5 to 8	In bloom	31	
Pectocarya linearis	6	1 to 3	do	20	
Caucalis microcarpa	6	2 to 3	In fruit	2	
Sphærostigma chamænerioides.	4	3 to 12	Early bloom	18	
Ellisia chrysanthemifolia.	1	6	Late bloom	6	
Sophia pinnata	12	10 to 14	do	95	
PLOT N.					
Lotus humistratus	490	1 to 3	Full fruit	1,053½	Gently sloping open foothills. *Eschscholtzia mexicana* very abundant a short distance away, but comparatively few plants within 20 rods of the plot. Besides the plants listed there are 31 seedlings of *Gærtneria tenuifolia* and 10 bunches of perennial grasses.
Plagiobothrys sp	2	1 to 2	In fruit	4	
Plagiobothrys arizonicus	9	3 to 5	Late fruit	22	
Linanthus aureus	8	1 to 3	Late bloom	2	
Pectocarya linearis	8	2 to 4	Late fruit	8	
Eremocarya micrantha	32	1 to 1½	do	5⅗	
Plantago ignota	374	1 to 3	In fruit	283	
PLOT O.					
Mentzelia albicaulis	1	6	In fruit	3	On a sandy, gravelly wash which has not been disturbed for about two years. The plants in situations like this habitually grow much larger than in other places. They are, however, much fewer in number.
Phacelia crenulata	2	4	In bloom	4	
Lupinus leptophyllus	1	4	In fruit	27	
Gilia inconspicua	6	8 to 12	do	92	
Gilia floccosa	3	3 to 4	do	27	
Eschscholtzia mexicana	1	5	Late bloom	2	
Plantago ignota	1	5	In fruit	26	
Eremocarya micrantha	2	2 to 4	do	10	
Lupinus concinnus	2	3 to 5	do	101	
Pectocarya linearis	1	3	do	8	
PLOT P.					
Plagiobothrys arizonicus	56	5 to 10	In fruit	1,905	Typical representation of the uneroded lands just above the washes and below the rocky bluffs on either side. It is between areas of this nature and the sandy washes that trees and shrubs grow in this part of the inclosure.
Lupinus concinnus	4	3 to 4	Late bloom	116	
Malacothrix fendleri	1	4	In bloom	8	
Gilia floccosa	2	3½	do	21	
Linanthus aureus	2	3	Full bloom	6	
Gilia inconspicua?	11	7 to 11	In fruit	81	
Phacelia arizonica	1	3½	Late bloom	10	
Astragalus nuttallii	1	3	In fruit	2	
Eremocarya micrantha	11	1 to 2	do	18	
PLOT Q.					
Ellisia chrysanthemifolia	4,612	3 to 7	In bloom	1,008	Typical development in the protection of bushes.
PLOT A′.					
Atriplex elegans	10	12	Mature	968	Uneroded. In other respects not different from Plot A.
PLOT B′.					
Atriplex elegans	72	4 to 6	do	1,614	Surface soil partially removed by erosion.
Portulaca retusa	106	3	In bloom	126	
Bouteloua aristidoides	2	4	Mature	1	
PLOT C′.					
Atriplex elegans	82	14	Mature	4,479	Surface soil largely removed by flood waters.

Tabular statement of plot measurements—Continued.

Name of plant.	Number of plants.	Height of plants.	Condition of plants.	Weight.	Condition of plot.
PLOT D′.		*Inches.*		*Grains.*	
Bouteloua rothrockii	82	18 to 24	Mature	1,560	In the upper end of a small stony arroyo.
Allionia incarnata	1	1 to 2	In fruit	31	
Bouteloua havardii	1	12	Mature	106	
Machaeranthera sp.	22	3 to 7	Late bloom	201	
Aristida americana	2,604	4 to 9	Mature	501	
Eriocarpum gracilis	10	7	Late fruit	36	
Gærtneria tenuifolia	5	16	In fruit	136	
PLOT E′.					
Bouteloua bromoides	130	5 to 8	Mature	1,910	On the bank of a small stony arroyo.
Aristida americana	15	4	do	1	
Bouteloua havardii	26	5 to 9	do	172	
Eriocarpum gracilis	18	3 to 5	Overmature	42	
PLOT F′.					
Bouteloua aristidoides	1,148	6 to 8	Mature	2,305	On a sandy alluvial bank about 8 feet above the shifting sands.
Tribulus grandiflorus	30	4	Overmature	128	
Amaranthus palmeri	4	6	Mature	22	
PLOT G′.					
Bouteloua bromoides	158	6 to 10	Mature	1,326	On the broad upper end of a shallow wash west of Proctor.
Aristida americana	903	2 to 4	Overmature	84	
Aristida americana bromoides.	3	12 to 18	Mature	82	
Eriocarpum gracilis	6	3 to 5	Late bloom	60	
Eriogonum polycladon	15	7 to 24	Full bloom	450	
PLOT H′.					
Bouteloua bromoides	4	6 to 7	Mature	38	On a rocky western exposure. *Calliandra eriophylla* very abundant, there being 15 small plants upon the plot.
Bouteloua eriopoda	20	8 to 12	do	154	
Bouteloua havardii	16	6 to 10	do	120	
Eriocarpum gracilis	72	3	Overmature	122	
Bouteloua hirsuta	5	8 to 12	Mature	70	
PLOT I′.					
Panicum arizonicum	1	3	Overmature	1	On a sandy wash. The soil has been undisturbed for about one year.
Bouteloua aristidoides	88	1½ to 5	do	28	
Eriocarpum gracilis	2	10 to 12	do	33	
Bouteloua rothrockii	1	18	Mature	33	
Eriogonum polycladon	1	24	Full bloom	139	
PLOT J′.					
Bouteloua artistidoides	7,854	3 to 4	Mature	1,890	A distinctly six weeks' grass (*Bouteloua aristidoides*) area.
Aristida americana	168	6 to 8	do	42	
Bouteloua eriopoda	1	10 to 12	do	32	
Eriocarpum gracilis	42	6	Overmature	336	
PLOT K′.					
Machaeranthera sp.	3	4	Late bloom	173	Upon a gravelly knoll where it requires an exceptionally favorable year to produce any feed.
Bahia absinthifolia	1	5	Early bloom	1,467	

The following table giving totals computed from the preceding tables is more convenient of reference and shows in connection with figure 1 the relative productivity of different portions of the field:

Totals compiled from previous tables.

Plot.	Total number of plants on 21 square feet.	Weight of plants on 21 square feet.	Average weight of plants.	Computed dry weight upon 1 acre.
		Grains.	*Grains.*	*Pounds.*
A	62	370	5.97	109
B	63	1,815	28.81	537
C	9	51	5.66	15
D	47	416	8.85	123
E	411	1,710	4.16	507
F	390	985	2.53	291
G	442	2,126	4.81	629
H	139	187	1.35	55
I	175	482	2.75	143
J	303	749	2.47	221
K	347	1,053	3.03	312
L	251	199	.79	58
M	41	251	6.12	74
N	297	1,378	4.64	408
O	20	300	15.00	88
P	42	2,455	58.45	727
Q	172	1,008	5.86	298
A′	10	968	96.80	286
B′	91	1,741	19.13	515
C′	82	4,479	54.62	1,327
D′	188	2,577	13.71	763
E′	102	5,155	50.54	1,529
F′	142	2,695	18.98	798
G′	146	1,902	13.03	562
H′	81	504	6.22	149
I′	49	234	4.78	69
J′	385	2,300	5.97	1,150
K′	4	1,640	410.00	486

The last column of this table is of special interest. It shows a wide variation in the quantity of vegetation which is produced even in areas situated near each other. It must be borne in mind that the most productive plots represent comparatively small areas. The tables also show a greater average of summer growth, the average for the spring being 270 pounds per acre and for the summer season 799 pounds, or an average for the entire year of 1,069 pounds per acre.

In interpreting these figures it must be remembered that they represent very closely the total herbaceous growth and that some of the plants listed are not eaten by stock when there is more palatable feed to be had, while others are eaten only in part. In estimating the amount of stock feed, therefore, it is necessary to make a liberal deduction from the above figures. The method of making the estimate must also be taken into account. Every plant upon the plots was pulled up and the roots cut off at the surface of the ground. The weights given, therefore, include all of the plant which grows above ground. It is needless to say that it would be impracticable, indeed impossible, to take the vegetation off the ground as closely as this by grazing. Furthermore, the method practiced in obtaining these estimates removes all vegetation, leaving no seed for annual species and no cover for the roots of the perennials. Another very important factor to be considered is the fact that so many of the annuals which make good feed while green are of practically no value when once they are dried. As an example of this may be mentioned *Pectocarya linearis* and the majority of the other borages. Even if it were possible to utilize the entire development of vegetation except what should remain for seed, it would have to be done to a very large extent, especially in the case of the spring annuals, before they ripened. Attention is called especially to the fact that it would be impossible for cattle to secure the same amount of feed that is indicated in the above totals. The above apparent large yields must be considered in connection with what is actually secured from pastures under proper grazing methods in more productive parts of the country. Where blue-grass pastures are properly grazed, and upon closely cut lawns, there is not less than 1,500 to 2,000 pounds of material left upon the ground continually, and a timothy meadow from which 2 tons of hay per acre has been removed has not less than this number of pounds remaining in the stubble. It will be seen from these measurements, therefore, that the entire herbaceous development upon this tract is not over two-thirds of what remains upon the ground, ungrazed and uncut, in good pastures and meadows.

To carry the computations and comparisons still farther, we can say that as a general rule one-third of the hay and pasture plants are left in the stubble. From the yields obtained here for the plants which are not eaten by stock, or only eaten in part, 50 per cent should probably be deducted. Deducting therefore 50 per cent for plants not eaten, and an additional $33\frac{1}{3}$ per cent for the quantity which should be left upon the ground for the protection of the roots mainly, in the case of perennials and for reseeding in the case of annuals, we have left in round numbers an average of 350 pounds per acre as the total herbaceous production available for stock feed. From this 350 pounds per acre another large deduction must be made for plants which are of forage value for only a short time during the season and therefore are capable of only partial consumption. The borages have been mentioned in this connection, and a score of others might be enumerated. Even Indian wheat is of little value after it has dried up, for the seed falls to the ground very soon after maturity, and the remainder of the plant is not eaten in the dry condition. In the same category belong the annual grasses *Bouteloua aristidoides* and *Aristida americana*, which without doubt produce as many pounds of growth upon the inclosure as all other grasses combined. It is very doubtful if these are eaten except under enforced conditions after the seed begins to ripen. Their period of usefulness as stock feed is therefore very short. Fifty per cent more should be deducted from the total available for stock feed for plants of this kind which are of little or no value when dry and therefore are not capable of complete consumption. The two species of lotus enumerated in the record of plot measurements and Pectocarya are from their habits of growth not grazed to any extent, by cattle especially, until they begin to fruit, on account of their lying flat on the ground until this time. Their period of usefulness is therefore very short. When this deduction is made, and it is believed that all of these deductions are conservative, we have left 176 pounds of dry feed per acre to be utilized under necessarily wasteful pasture practices, where green feed is present for about five months, and the season of grass production in July to September is often closely followed by a few light showers of rain, which greatly decrease the value of the cured forage. This remainder of 176 pounds is increased somewhat by the browse plants, which have not entered into our calculation.

If we consider 18 pounds per day of well-cured hay sufficient for the maintenance of a mature idle animal without adding anything to its weight, it will require 37 acres to support such an animal one year. This calculation considers the native feed equivalent to well-cured hay and allows nothing for increase in weight. Neither does it allow anything for labor performed by the animal in gathering its food and walking a distance of 5 to 10 miles for water. When additional allowances are made for these factors, the number of acres required to pasture one animal is very materially increased and approaches very closely the 50-acre estimate given upon a previous page.

CARRYING CAPACITY.

Before any rational adjustment for the proper control of public grazing lands to meet the evident pressing demands for a change in this direction can be made, much should be definitely known regarding the amount of stock that these lands will carry profitably year after year. This must form the basis of all equitable allotments. To secure such information is a most difficult task in a region where the seasons, the altitude, the slope, and the rainfall are so variable. It can be determined very easily in the Great Plains region, where conditions are uniform and reasonably constant, and indeed it is very definitely known there; but here the case is very different. There is in the Territory comparatively little native pasture land under fence, and that which is fenced is usually the better land, representing a much higher carrying capacity than the average. Even in cases where the land is fenced the areas are irregular, and therefore of uncertain acreage, with no record of the amount of grazing secured from them. The estimates below are given, therefore, reservedly, but with a feeling that they are approximately accurate for the specific areas mentioned.

Mr. W. B. McCleary has 200 acres fenced at the base of Mount Wrightson, at an altitude of approximately 4,000 feet. The conditions are approximately the same as those in the southernmost part of the area recently inclosed by the Department, except that a portion of Mr. McCleary's holding is occupied by a large wash heavily covered with brush and trees. When first fenced, it was necessary to feed some hay to the four head of stock which are carried on the land, but at the present time the area furnishes sufficient feed for this number. Mesquite beans and browse furnish no small part of the feed, and in general the area represents about an average carrying capacity for the foothill-mountain areas. It furnishes rather more browse and mesquite beans but less grass than some of the neighboring localities. In the estimate of this pasture, if the data which it furnishes be correct, the carrying capacity for the best pasture lands in the foothill-mountain areas of this region is about 1 head to 50 acres. This is probably not far from the proportion which should govern grazing upon these lands. It should be stated that this estimate is based upon the better lands, which are proportionally smaller in area than desert mesas and unproductive lands at lower altitudes.

Much effort was made to get an estimate of the carrying capacity of the land in the northern part of the Territory, where the task is even more difficult than it is farther south. The figures given for this region are purely estimates based upon the judgment of ranchers who operate in the region. A great many ranchers were consulted and their opinions secured, but the two or three quoted below seem to be based upon the most definite data.

Some information received from Mr. George L. Brooks, manager for a cattle company, shows the extent to which the country has been overgrazed in past years. The lands of this company are located from Aztec west to Angel and south to the limit of the old Atlantic and Pacific grant. This strip of country contains a little more than 1,500,000 acres. Mr. Brooks, who necessarily made a very careful study of the matter, estimates that there were upon this area for a number of years an equivalent of upward of 44,000 bovine animals, or about 1 steer to 34 acres. The loss of cattle through starvation was tremendous for several winters, and the country became so badly damaged as to compel the company to go out of the cattle business. Their losses from theft, no doubt, were considerable, but the land could not maintain stock at the above ratio. At the present time there is very little grazing on this territory except by sheep during the winter season.

A rancher near Ashfork, who pastures 1,000 head of cattle, this number of stock now having the entire run of land composing nearly eight townships, thinks that they could be carried with perfect safety on four townships. This gives 92 acres to 1 head, which seems to be a liberal allowance, and the lands would probably carry stock at the ratio of 1 bovine animal to 100 acres indefinitely.

The higher lands in the San Francisco Mountains of course produce much more abundantly than the bench lands at lower altitudes or in the valleys of the Colorado and the Little Colorado. Practically no grazing is done here, however, except in the summer season, and an estimate of the carrying capacity must, therefore, be made on an entirely different basis. The better lands here would probably support 1 sheep to 5 acres during the grazing season from May to November. This, according to the usual method of calculation, would mean 1 steer to 30 acres for the same season.

Twice during the past season the goat ranch of Mr. Joe Mayer, at Mayer, Yavapai County, Ariz. (Pl. VII, fig. 1), was visited. Mr. Mayer has run goats for a number of years on the same territory, and his estimate of the carrying capacity of this ranch is probably as accurate as can be obtained at the present time. During the course of a conversation in July Mr. Mayer stated that, as nearly as he could judge, he is using between 3 and 4 acres of land for each animal. The estimate obtained from one of the herders of the area grazed during the season gives a somewhat higher allowance for each animal. It should be borne in mind that this estimate can not be reduced to terms of bovine animals very safely, because goats thrive upon vegetation which is not eaten by cattle or, if eaten, upon which they can subsist but a short time. The ranch is located in the mountains where scrub live oak abounds, upon which the animals live exclusively for a large part of the year.

WATER FOR STOCK.

One of the most perplexing problems of the ranchmen throughout the Territory is that of the proper distribution of water for stock purposes, and every contrivance known is employed to secure this most important adjunct of the stock business. Besides the natural supplies of springs and streams, wells and surface tanks are commonly used. Many regions are so remote from available water supplies that they are not grazed except during the cooler or more moist portions of the year, when stock can endure long periods without water, or when there is temporary water in the rivers, arroyos, and natural tanks. Water is so difficult to secure in many places that the lands can not be grazed even during this season. This condition is especially true of the higher mesas remote from both mountain ranges and river valleys where neither short streams nor small springs of the mountain valleys nor the underground water supply are available.

Central Pima County, embracing Avra, Altar, Santa Rosa, and Babuquivari valleys, is especially noted for its deep wells furnished with steam pumps. The ranches in this region are very sparse, and consequently these always furnish water for the pasturing of very large areas. Some of these wells are upward of 800 feet in depth. The fuel used for pumping is almost entirely mesquite from the immediate vicinity. The supply of water at these depths appears to be inexhaustible.

The ranches situated higher in the foothills and mountains depend upon springs and shallow wells operated by windmills. The supply of water from these shallow wells, however, often varies greatly from season to season, the difference sometimes being as high as 30 feet between the level of the water in moist and dry seasons. Upon the river bottoms the natural flow of the rivers is supplemented by wells during the dry season. These are operated by steam, horse, or wind power. On account of the absence of streams and the great difficulty of obtaining well water, a large part of the northern portion of the Territory is obliged to resort to surface tanks built of earth as the only available means of supplying water to stock. Upon the higher areas in the San Francisco and contiguous mountain ranges water is abundant enough in the average season for all purposes, but upon the lower plateaus the case is very different. Here the prospective rancher is often deterred from entering the stock business on account of the great expense involved in securing water. Under a system of more stable tenure the expense might not be prohibitive, for it is estimated that tanks which hold water for one year can be built for about $500. The clay soils so common here are admirably adapted to the construction of tanks of this kind, for they hold water almost perfectly when once thoroughly tramped and compacted. In some places natural tanks are found which need only to be filled by having water conducted into them by ditches or embankments.

Another consideration which renders water relatively expensive is the low carrying capacity of the land, which decreases the number of stock which can be profitably watered in one place, making the returns for outlays much smaller than they would be under more productive conditions of soil and rainfall. Every rancher who develops water here in any form of course owns the land upon which the water is situated, but even this ownership counts for but little under the present uncertain tenure of the surrounding areas. In short, water development being expensive and the carrying capacity of the land low at best, a large acreage is necessary to furnish a livelihood.

So far as cattle especially are concerned, Arizona is essentially a breeding ground for animals which are fattened elsewhere. It would seem, however, that this would not be the case long, for the present irrigation projects, when developed, will greatly increase the feeding facilities of the Salt and other river valleys, so that many more cattle can be matured. At present, and for a long time past, practically no cattle leave the Territory in condition for the markets. This, however, is true at the present time of nearly all the native pasture regions in the United States.

Throughout the Territory, excepting in the vicinity of the irrigated regions of the Salt and Gila valleys, no hay or other feed is furnished stock. They live upon the native vegetation, consisting of grass, weeds, or browse, depending upon the locality or the season of the year. The main concern of the rancher is with branding, preventing theft, and furnishing water. It will not be long, however, under the present management of the live stock sanitary board, before thieving, which has obtained so commonly and has been the means of ruining a great many stockmen, will be a thing of the past. The scarcity of water, coupled with the small carrying capacity of the ranges, compels cattle to travel long distances. These distances would be considered prohibitive upon the native pasture lands of the Great Plains; but the development of water at intervals of 2 or 3 miles, such as is advocated and practiced there, could not be thought of here on account of the great expense and proportionally small returns.

The readiness with which stock of all kinds adapt themselves to the enforced conditions of shortage of water is remarkable. It is not, however, without great loss at certain seasons, and it is those who make the best provision for watering who are the most successful in the business. The influence of a good supply of wholesome water is very noticeable during the dry season from April to July. Abundant opportunity was had during the past year for observation on this point, inasmuch as the greater part of the dry season was spent in the southern portion of the Territory. It was evident that cattle having plenty of water and living upon mesquite and cat-claw browse were able to live through this period in better condition than those upon better pastures but with inconvenient water supply.

It is not to be supposed that cattle go to water even once a day when feeding grounds are so remote. Indeed, the habits of cattle have been so often observed by so many people that it is well known that they very often, even during the hottest weather of summer, go to water regularly only every second or sometimes every third day, if the distance is very great between water and feed. Mr. Truax, foreman of a cattle company of Apache County, relates some of his experiences in this matter. A few days before arrival at his ranch, on the 9th of August, he followed a bunch of cattle which watered at the corral at daylight in the morning. About the middle of the afternoon they were 8 miles from the ranch. He further states that his cattle often go 10 or 15 miles away from water. It hardly seems probable, however, that cattle can accustom themselves to living over twenty-four hours without suffering in the extreme heat of summer, although they thrive for a much longer period, as shown by the following signed statement, which was recently furnished at my request:

HELVETIA, ARIZ., *July 13, 1903.*

In the month of July, 1900, in building a fence for a pasture, we inclosed a 3-year-old steer. The fence was completed on the 5th of July, and the steer to our knowledge was in our pasture thirteen days without water. We will state further that there was no grass in the pasture, but there was plenty of mesquite and cat-claw browse.

W. B. MCCLEARY.
J. MARTIN.

Mr. Truax relates a still more remarkable instance than this one, in which he states that his men accidentally inclosed a cow and calf in a dry pasture in the month of July, where they remained for a period of fifteen days before being discovered. The calf at the end of the period was in apparently good condition, but the cow could not have lived much longer. These extreme cases are quoted to show that it is not at all impossible for stock to live regularly even under this subtropical heat with but two or three waterings per week, although the practice can not be upheld where there is any possibility of supplying water at shorter intervals and more convenient distances.

In many countries where sheep are extensively raised they are almost never watered, but in dry regions water must be supplied, although at rather less frequent intervals than is the case with cattle. Upon the high plateau of the Ash Fork and Seligman regions herders informed the writer during the past season that they do not water more often than once every eighty hours in the hottest weather. They remain three nights away from water with both sheep and pack burros. In this way they are able to graze an area around the water supply with a radius of about 6 miles, or about 72,000 acres. Even with this remarkable utility of water there are large areas where grazing can not be done except during the rainy season or in winter when there is snow upon the higher elevations. During a large part of the winter, when grazing is done upon alfilerilla and Indian wheat, sheep live without water for months. Little or no water is needed even in summer when feed is green.

Goats need water more often than sheep, and it is usually claimed that they can not get along without water once every twenty-four hours. They are much better travelers than sheep, however, and on this account fully as large an area can be grazed from one watering place as with sheep. Mr. J. F. Burns reports that his 500 Angoras traveled 14 miles each day for about two weeks one year with no apparent inconvenience. This means that nearly 150,000 acres could be grazed from one watering place. This amount of travel, however, is excessive, and without doubt could not be profitably continued. Mr. Mayer's herders report that their flocks do not travel over 5 miles per day, but they think that there would be no evil effect from driving them farther than this. Considering the necessity of watering more often, it is probable that no greater area can be grazed with goats than with sheep.

Horses have no difficulty in traveling 20 miles to water, it is claimed. Some portions of Arizona are overrun with cayuses of little value, a large number of which are unbranded and badly inbred. They are claimed, of course, and, being upon public range, can not be gotten rid of. Horses and burros have a decided advantage over cattle, not only from the fact that they are better travelers, but because they are able to dig for water in the sands of the arroyos. It is a novel sight to the uninitiated to see a horse or burro up to its knees in the loose sand pawing for water. During the summer rains the water level is high in the arroyo sand for some time after a shower, although there may be no running or standing water for miles around. Horses and burros very commonly supply themselves with water during the summer season in this way, and are, therefore, able to graze upon lands that cattle or even sheep can not reach. Plate III, figure 1, shows horses digging for water in a small arroyo at the western base of Pyramid Hill, within the present inclosed area on the Santa Rita Forest Reserve.

By far the greater number of sheep and goats are summered in the great highland region of the San Francisco, Mogollon, and White mountains, and wintered upon the deserts of the Salt, Colorado, and Little Colorado river valleys. This statement should be modified by the assertion that the Navajo and Moqui sheep are not included. The rainfall is so variable, however, that there is no regularity in the migrations. The exact locality where a man winters depends entirely upon the distribution of the rainfall of the late autumn of that particular season.

THE SEASONS.

There are in southern Arizona two distinct seasons of feed production; in other words, two seasons of plant growth. They are totally different in the class of plants which they produce; indeed, one can almost recognize three seasons of growth if he takes into consideration those plants which grow well during the hot weather of May and June upon the moisture which they have stored up during the winter.

The first season draws to a close with the advent of the April drought, which continues to the first of July. The second begins with the summer rains of July and terminates early in October. The spring season is largely dependent upon fall rains to start the vegetation, which grows very slowly during the winter and matures in the spring. Of course not all of the spring plants germinate in the autumn, but there is a large class of very conspicuous and important things which do germinate as early as the latter part of September, make a good growth before the cold weather sets in, grow very slowly during the cold weather, and mature in the spring. This cycle is entirely dependent, however, upon the distribution of moisture. If the months of September and October are dry no germination takes place until moisture comes in late winter. If this continues long enough in the spring a crop matures; but if not, as is usually the case, these plants dry up and there is no more feed produced until the summer rains come again.

From April to June, although it is very dry, there is a considerable development of plants which have some special provision for retaining or securing a supply of moisture. The development of these is usually not perceptible until the season of drought. Indeed, it is after the dry hot season begins that they begin their growth. Attention should be called here to the fact that it is only those plants which have means of supplying themselves with water that grow during the dry season. Those plants protected by varnish, or by having power to discard their leaves, etc., use these contrivances to enable them to live, not grow, during the dry season. The case is very different with the majority of the cacti, which store vast quantities of water in their tissues. They grow without apparent hindrance through the dry season of early summer. They are of value as food for stock, and would be closely grazed were it not for their offensive spines. The native gourds, devil's claw, the native night-blooming cereus (*Cereus greggii*), one of the ground plums (*Physalis* sp.), birthwort (*Aristolochia brevipes*), and numerous others that might be enumerated, have storage reservoirs in the form of enlarged roots. These plants, however, are of little forage value. The mesquite, on the contrary, is able to thrive through a long period of drought with no appreciable storage of water, but it is a very deep-rooted plant, and growing to best advantage along river courses and arroyos it gets water from the deeper strata there much longer than the shallow-rooted plants, and is therefore able to grow well into the summer dry season, if not fully through it into the moist summer season without being checked. During the past year this tree was in full bloom about the middle of May upon the northwestern part of the large inclosure, and it was almost completely defoliated by a lepidopterous larva by the last of the month. On the 26th of June it was again in full bloom and had nearly recovered from the effects of the defoliation. During the period from April to June there had been 2.9 inches of rain at McCleary's camp, and but 0.42 inch at Tucson. The rainfall in the mountains at

McCleary's did not reach the area in question, and as nearly as can be judged the rainfall here at this period was little if any greater than at Tucson. The effect upon the deep sands of the washes, however, was considerable, no doubt, and the deep roots of the shrubs were able to profit by it.

The winter season is characterized by an abundant (relative) growth of short-lived annuals. Some of these, as before stated, start their growth in October, or even September, at the close of the summer rainy season. Among these may be mentioned *Pectocarya linearis*, alfilerilla, Indian wheat, and a large number of boraginaceous plants which furnish a great deal of feed. Between this time and the 1st of February (it is not definitely known at what time, and, indeed, the time varies owing to the variation in precipitation) there appear a host of other short-lived plants, a large number of which are of some forage value. These are ephemeral, especially in their effect upon the landscape and in their forage utility, although they are really in the vegetative state a considerable period. The time of maturity of these winter and spring annuals in the same season is very variable, there being from two to three weeks' difference between the mesas about Tucson and the northern slope of the Santa Rita Mountains or the eastern slope of the Babuquivaris. This vernal development is mostly confined to altitudes below 4,000 feet in southern Arizona, the regions above this having really but one prominent vegetative season. The cause of this is mainly the lower temperatures of the higher altitudes, there being too low a temperature for the growth of the annuals at a time when the winter and early spring moisture is present. By the time the temperature is high enough for plant growth the moist conditions have disappeared, and there is practically no growth of vegetation, except during the summer rainy season. A very large part of the best pasture lands of this section, therefore, has but one season of plant growth.

The summer season is characterized by the production of grasses of a great variety of species. Upon the lowlands the greatest development is upon the flooded areas, which were much more abundant formerly than they are now, owing to the excessive erosion which has taken place during recent years. Upon the mesas there is but little development of perennial grasses as a usual thing, unless these mesas be high. In favorable places and in favorable seasons there are a few perennials which make considerable feed. Upon the mesa swales galleta (*Hilaria mutica*) is an important grass, while upon the less favorable situations species of grama grass sometimes make a thin growth. It is on the foothills and mountains that the grasses make their best and most pronounced growth. Here the rainfall is more abundant during the summer season than upon the lower areas, although there may not be such a difference in the winter rainy season, and the growth of grasses is proportionately larger. Nearly all grasses are in bunches and often grow 2 or 3 feet high, but always scattering. It is only in favorable depressions, where the land gets an increased quantity of moisture that there is a sufficient amount of development to produce a complete ground cover. The summer season of growth depends not only on the amount of rainfall, but upon its distribution during the period from July to September.

The following table of rainfall, prepared from Weather Bureau observations at Tuscon during the years 1902 and 1903, illustrates very nicely the difference between what are considered years of plenty and years of famine in the range business in this region:

Table showing difference in amount and distribution of precipitation in a good and in a poor season.

[Precipitation expressed in inches.]

Month.	Year.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
January...	1902	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	1903	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
February..	1902	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	1903	.....	0.20	0.11	.....	0.11	0.31	.....	.....	0.02	.....	.....	.....	.....	0.08	0.25	.....
March.....	1902	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.01	.....	.....	.....	.....	.....	.....
	1903	.....	.03	.01	0.01	T.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
April......	1902	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	1903	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
May.......	1902	.....	.....	.....	.....	.....	.....	T.	.....	.....	.....	.....	.....	.....	T.	.....	.....
	1903	.....	.....	T.	.07	.....	.....	.....	T.	.....	.....	.....	.....	.....	T.	.13	T.
June.......	1902	.....	.....	.....	.....	.....	.....	.....	.....	T.	.....	.....	.....	.....	.....	.....	.....
	1903	.....	.....	.....	.....	.....	.....	.....	.....	T.	T.	0.22	.....	.....	.....	.....	.....
July.......	1902	.....	.....	.....	.....	.....	.....	.....	.....	.....	.01	.....	.....	.....	.10	.01	.....
	1903	.....	.....	.....	.....	.....	.16	.....	0.23	.....	T.	T.	T.	0.01	.08	.11	0.67
August....	1902	.....	T.	.....	.46	.....	T.	0.07	.05	T.	.....	.53	.....	.....	.....	.....	.....
	1903	.....	.....	T.	.04	T.	.11	.97	.03	.20	.....	.07	.....	.....	.....	.....	.....
September.	1902	.....	.....	.....	T.	.....	.06	T.	.....	.....	.17	.....	.....	.....	T.	.16	.....
	1903	.....	.....	.....	.....	.05	.14	.....	.01	.....	.....	.....	.....	.....	.....	.....	.....
October....	1902	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	1903	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
November.	1902	.....	.....	.....	.....	.....	.....	.....	.....	.....	.21	.29	.....	.....	.....	.....	.....
	1903	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
December.	1902	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.50	.91	.42	T.	.....
	1903	.....	.....	.....	.....	.....	.10	.14	.03	.....	.....	.01	.....	.....	.....	.....	.....

Table showing difference in amount and distribution of precipitation in a good and in a poor season—Continued.

Month.	Year.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	Total.
January	1902	.....	.....	.....	.....	.....	.....	.....	.....	0.10	0.09	T.	.....	0.20	0.14	.....	0.53
	1903	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....
February	1902	.....	.....	.....	.....	.....	.....	.....	.....	.....	T.	.....	.....	.....	.....	.....	....
	1903	.....	.....	.....	.....	.....	.....	.....	.....	.....	T.	.....	.....	.....	.....	.....	1.11
March	1902	.....	.....	0.02	.....	.....	.....	.....	0.41	.....	.....	T.	.....	.....	.....	.....	.44
	1903	.....	.....	.....	.....	.....	.....	.....	.03	1.42	.13	T.	.....	.....	.....	.....	1.63
April	1902	.....	.....	.....	.....	T.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	T.
	1903	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....
May	1902	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	T
	1903	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.20
June	1902	.....	.....	.....	.....	T.	.....	.....	.....	.....	.....	.....	0.09	.03	.07	.....	.19
	1903	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.22
July	1902	.....	.....	.....	.....	0.05	0.21	0.01	.....	.....	T.	.....	.....	.....	.....	.....	.42
	1903	.....	.....	.....	0.04	.01	.....	.02	.....	.15	.04	.....	.....	.....	....	.....	1.52
August	1902	0.05	.....	.....	T.	.....	T.	.15	.....	.....	.....	T.	.....	T.	....	.....	1.31
	1903	.....	.....	.....	.....	.....	.....	.....	.....	.01	.99	.....	.....	.25	....	.....	2.67
September	1902	.....	0.09	.01	.09	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.58
	1903	.....	.....	.....	.....	T.	T.	.....	.....	T.	.....	0.96	.01	.....	....	.....	1.17
October	1902	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.64	....	.....	1.64
	1903	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	.....	....
November	1902	.....	.....	.....	T.	.46	.02	T.	.....	.....	.....	.....	.....	.40	....	.....	1.34
	1903	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	.....	....
December	1902	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.32	2.15
	1903	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.28

Several important points should be noted in connection with this table of rainfall. Although arranged by calendar years, it should not be studied according to this division, although this might be done in other regions. The total rainfall of these two years was practically the same, but the good rains of October and November, 1902, with the rainfall of March and April, 1903, were the means of producing good feed during the early part of the latter year, while the rainfall of the latter half of the year 1902, although above normal, produced very poor summer feed on account of its improper distribution. It fell mainly between the 29th of October and the 14th of December, too late for the proper development of the grasses, which thrive here only under intense heat and considerable moisture. The precipitation during July, August, and September, 1903, was good and well distributed, but the fall during the last three months of the year was too light to augur very auspiciously for the winter of 1904, although the good rainfall of September was sufficient to start the annuals beautifully. It should be stated that these conditions do not bear much generalization, they apply locally where the observations on precipitation were made very well, but they may not apply at all in localities somewhat removed. For instance, the feed upon the inclosure in the Santa Rita Mountains was much better in the summer of 1902 than in the same season of 1903. This, of course, was due to a difference in conditions, which is shown by the following table, in which it will be seen that the rainfall of July was just twice as great at McCleary's camp as at Tucson, slightly less in August, but still a good amount, and decidedly more in September:

Comparison of monthly totals of precipitation at Tucson and McCleary's camp.[a]

Month.	Tucson.			McCleary's camp.		
	1902.	1903.	Average.	1902.	1903.	Average.
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
January	0.53	0.00	0.21	0.67	0.10	0.38
February	.00	1.11	.55	.00	1.48	.74
March	.41	1.63	1.02	.85	1.59	1.22
April	.00	.00	.00	.11	.00	.05
May	.00	.20	.10	.15	.99	.57
June	.19	.22	.20	.50	1.10	.80
July	.42	1.52	.99	.90	3.04	1.97
August	1.31	2.67	1.96	3.07	2.45	2.76
September	.58	1.17	.70	3.45	1.99	2.72
October	1.61	.00	.82	.15	.00	.07
November	1.31	.00	.71	2.72	.00	1.36
December	2.15	.28	.71	1.05	.12	.58
Yearly total	8.60	8.88	8.74	13.62	12.86	13.24

[a] Observations at Tucson from U. S. Weather Bureau records, and at McCleary's camp by Mr. W. B. McCleary.

The unproductive condition of the present public lands is often attributed to drought during recent years. It is a very common thing to hear ranchers speak of the prolonged droughts during the last few years, and attribute to these the shortage in feed and the consequent decrease in the cattle industry. The majority of ranchers, however, agree that the carrying capacity of the lands is necessarily small and always has been, but that they were led to believe in the early history of the cattle business and at a time when the old vegetation upon the ground was an accumulation of long standing that the carrying capacity was much greater than it really is. This old vegetation having been eaten off and tramped out by more stock than ever should have been placed upon the land, coupled with the evil effects of erosion, described elsewhere, account for the present conditions.

The following table shows that the precipitation during the past five years has been somewhat less than during the previous four years, and that the average for the past five years has been but 0.95 inch less than the average for the past fourteen years. This table, prepared from Weather Bureau observations at Tucson, shows the total of precipitation by months and years for the past fourteen years.

Monthly totals of precipitation at Tucson, Ariz., for fourteen years.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
	In.	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
1890	0.53	0.52	0.62	0.59	0.75	0.83	0.88	0.83	0.77	0.86	0.60	0.52	8.30
1891	.12	2.08	.17	.00	.18	.22	.70	2.26	.65	.00	.00	.23	6.61
1892	1.52	2.63	.98	.18	.17	.10	1.00	2.14	.37	.27	T.	.25	9.61
1893	.27	.82	1.16	T.	.75	.00	2.78	5.40	1.02	.00	.43	.49	13.12
1894	.11	1.04	1.17	T.	.05	T.	1.60	1.01	.12	.31	.00	1.88	7.29
1895	.56	T.	.00	T.	.09	.02	.11	4.48	.75	.68	4.30	.08	11.07
1896	.53	.08	.27	.12	T.	.19	3.45	1.25	1.13	3.31	.30	.76	11.39
1897	1.79	.08	.13	.00	.00	.00	1.98	3.12	2.71	.54	.00	.11	10.96
1898	1.10	T.	.63	1.05	.00	.20	3.22	3.94	.10	.00	.85	1.63	12.72
1899	.78	.39	.37	.62	T.	1.27	1.87	1.82	.03	.67	.56	T.	8.38
1900	.16	.49	.54	1.12	T.	.17	.65	.95	.85	.41	2.45	T.	7.79
1901	1.15	1.38	.64	.01	.41	.00	2.57	1.99	.28	1.18	.08	.00	9.72
1902	.53	T.	.44	T.	T.	.19	.42	1.31	.58	1.61	1.34	2.15	8.60
1903	.00	1.11	1.63	.00	.20	.22	1.52	2.67	1.17	.00	.08	.28	8.80
Mean	9.15	10.62	8.75	3.72	2.60	3.41	22.75	2.39	.75	.71	.78	.60	9.60

EROSION.

The entire absence of a sod, a soil very slowly permeable when once thoroughly dried, steep grades, violent windstorms, and torrential rainfalls of short duration are the elements which are calculated to produce erosion in its most violent forms. Coupled with these natural conditions, excessive stocking, with scarcity of water, compelling cattle to travel long distances to feeding grounds over surfaces easily pulverized, enhances very much the erosive action of the natural elements. There always were deep gorges, cuts, arroyos, and washes in the foothills, mesas, and other sections having steep grades; but the cutting of the river channels into deep gorges which effectually drain the bottoms instead of allowing the water to spread over the broad, fertile lands is a distinctly modern condition, directly traceable to the effect of the white man's operations. (Pl. V, fig. 2.)

One of the most serious questions which confronts the rancher to-day is how to prevent this gullying. While the loss of the land itself is not, the loss of the water is a serious matter. The flood waters which once spread over the river bottoms with practically no channel are now sunken from a few feet to 20 feet below the surface, and are carried off, together with all the rich sediment which they contain.

Several ranchers whom the writer has met have been obliged, within recent years, to devise means to mitigate this evil. It is often impossible or impracticable to do anything in those cases where the cutting has progressed very far, but on the other hand it is not at all impossible nor impracticable to prevent further depredation by attacking the matter at the most advantageous point. The difficulty with work of this kind is its expense compared with the productivity of the land when no water is present for irrigation.

Two general processes are in vogue for counteracting the effect of the sinking of the water channels. The first consists in planting some soil-binding grass in such situations for the purpose of preventing further difficulty. This is usually a remedial measure which does not get at the root of the matter and is capable of but limited application after the destruction is well under way. It can be applied in this region in situations which receive flood waters from higher localities. The soils where it is attempted must already be reasonably stable in order to allow the grass to get a foothold. Mr. Harry L. Heffner, manager of the Empire Cattle Company, has experimented a great deal in this matter. The plan which he has adopted has been to establish plantations of Johnson grass upon the lands near the ends of the deep, narrow gorges and washes which approach the Pantano Wash, between the Santa Rita and Whetstone mountains. In these situations considerable areas of comparatively level lands are flooded one to three times during the year. Were three irrigations certain each year, the establishment of Johnson grass on such areas would be a comparatively easy matter. Indeed, two thorough floodings, together with the light showers that normally occur, would insure the establishment of this grass. It has been found that the most successful method of establishing a wash-resistant covering of this grass in such situations is by planting cuttings. Sections of the underground stems, from 8 to 12 inches in length, are inserted in the ground in rows across the wash, about 3 feet apart. In planting, a spade or bar is used to prepare the opening in the soil, and simply the pressure of the foot completes the operation when the cutting has been inserted. This operation is not so slow and tedious as would seem. The cuttings are easily dug or plowed up from fields which are in reasonably good tilth, and the planting is accomplished very expeditiously. Bermuda grass has also been tried in the more moist situations, but with very indifferent success thus far. This grass requires more moisture than it is possible to secure for it here, except where irrigation is practiced.

The second method in vogue to check and repair the damage done by flood waters is by the erection of embankments across the cuts, the object in all cases being to turn the water from its course on to higher lands and compel it to spread out over them instead of following the regular channel. Brush, stone, and earth are used in the formation of these embankments, which must be strong enough to withstand a great pressure until the course of the waters is once turned. When once the flow has been checked the filling up and leveling off of the gullies for some distance above the dams is quickly accomplished by the waters, which contain large volumes of sediment. The filling up process below the dam is a slow one, but the turning of the water from its course prevents further erosive action. Several small works of this nature have been observed in the valleys of the Little Colorado and White rivers and some are under contemplation by Messrs. Vail & Wakefield in the Altar Valley near the Mexican border.

THE PRAIRIE DOG.

This little animal, which has caused such devastation throughout the plains region since its enemies have been killed by the rancher and his herdsmen, is without doubt migrating into new territory. The destruction wrought by it is more pronounced east and north of the divide of the San Francisco and White mountains than anywhere else in Arizona. Large areas have been completely overrun in the vicinity of Flagstaff. In August a trip was taken through a very badly infested area between Adamana and the White Mountains. Pl. X, fig. 2, shows an infested area on the northern slope of the White Mountains, which represents in some respects the greatest injury that has been observed in any region in the Territory. It is seldom that one can secure a photographic representation of the work of the prairie dog, but here the lime pebbles—or rather the lime-covered malpais rocks and pebbles—thrown out of the burrows furnish a sufficient contrast to the black malpais rocks and bare ground to give a fairly good representation of the extent of the operations carried on by these animals. There were no perennial grasses in the infested area, and but little vegetation of any kind. No area which has been visited within the Territory is so badly overrun by these animals as that in the vicinity of the old Twenty-four Ranch and southward to the base of these mountains.

RANGE FEED.

There is without doubt no part of the country where the character of the native feed is so variable as it is in the Southwest; and this in spite of the fact that the aggregate yield per acre is very low, and that two crops are produced each year upon a large part of the range country. We have a carrying capacity here varying from one animal to 40 or 50 acres to one animal to 100 acres, as compared with one to 15 acres in portions of the Great Plains. At the same time, the grasses, which are practically the only forage plants in the latter region, are much less numerous there than in the Southwest—much less numerous in point of species. Some of the most important groups of forage plants are discussed below.

THE GRASSES.

While it may be stated in general that of the forage production of the Territory as a whole the grasses form the most important part, yet the grass production is confined to the summer season of rain, and consequently there is a large part of the year during which all stock is obliged to subsist on other things. The grasses furnish good feed from July to the 1st of January, but after that date, if the normal winter precipitation occurs, what is left of them is quite well bleached out. The value of grass for winter feeding always depends upon its being dry cured. When the winter rains come, therefore, stock begin to shun the old grass in proportion as the succulent annual stuff develops. During this cold winter and spring moist season there are, however, a few grasses which are of some importance in the forage ration upon the range. The most important of these are *Bromus carinatus*, *Poa longipedunculata*, *P. fendleriana*, *P. bigelovii*, and *Festuca octoflora*. Occasionally, however, the winter rains are prolonged into the warm spring season sufficiently to allow the perennial grasses, of which the gramas upon the open foothills are the most important, to get a start. In such a season there is some good feed produced by these in the spring, but this condition is an exceptional one, and we may say that as a general rule the perennial grasses which furnish the feed of midsummer to winter season do not grow at all in the spring. There is abundant evidence, however, that they would furnish two crops if the moisture and temperature conditions were favorable.

The most important of the grasses belong to the group known popularly as gramas (*Bouteloua* spp.), some of which are perennial and some annual. The perennials grow in the higher altitudes, and are mainly *Bouteloua oligostachya*, *B. curtipendula*, *B. bromoides*, *B. rothrockii*, *B. hirsuta*, *B. eriopoda*, and *B. havardii*, with considerable areas of *B. trifida* upon some stony, bare, high foothills. These furnish the best and most important range feed. *Bouteloua rothrockii* extends to lower altitudes than the others, and at times is strictly a mesa plant, furnishing upon favorable places and in favorable seasons a thin stand of large bunches. It is in the open foothills, however, that this species reaches its best development. Here, together with other species of lesser importance, it often makes sufficient growth for hay. The open foothills of the Whetstone, Huachuca, Santa Rita, and Babuquivari mountains, the Sulphur Spring Valley, and the high mesas between the Santa Catalina and Willow Spring mountains furnish extensive areas of this grass in favorable seasons. It is interesting to compare this distribution with similar situations in the Mesilla Valley of New Mexico, where Professor Wooton states that *Bouteloua eriopoda*, which is never an exclusive crop in southern Arizona, is often cut for hay. All of these species occur in the southern part of Arizona, but it is the blue grama (*Bouteloua oligostachya*) that is of the greatest importance in the northern part. Here it is by far the most important grass upon the high plateau surrounding the San Francisco and contiguous divides. Many of the juniper ridges so characteristic here have practically no other grass, and even this makes only a thin, short growth very different from its habit in the southern part of the Territory, where it assumes a more erect and robust character. The northeastern part of Arizona, especially from Navajo to Chin Lee, and southward to the Long H Ranch and St. Johns does not differ materially in the higher elevations from the lower juniper areas of the plateau region. The three annual species of grama (*Bouteloua aristidoides*, *B. polystachya*, and *B. prostrata*) furnish feed of a poorer quality and shorter duration than the perennial ones. The first two species are found most abundantly from the lower areas to the higher foothills in the southern part of the Territory, *Bouteloua polystachya* furnishing much the better feed of the two, but the quantity is smaller. The third or prostrate grama is an important forage plant all through the pine region in the general highland of the White, Mogollon, and San Francisco mountains. At times it also reaches favorable situations along the Little Colorado.

The main grass in the lower areas in the valley of the Little Colorado is *Sporobolus airoides*. This valley has much in common, so far as its vegetation is concerned, with the valley of the Rio Grande farther east. *Sporobolus airoides* and salt grass (*Distichlis spicata*) furnish the greatest amount of feed here, but they never yield so abundantly as they do in the Rio Grande Valley. The former is known here as saccaton, but is very different from *Sporobolus wrightii*, which makes such a magnificent growth on some of the river bottoms in the southern part of the Territory.

Galleta (*Hilaria mutica*) is an important grass throughout Arizona, although not by any means so palatable as the gramas. It nearly always occupies swales or depressions in the mesas, and for its best development gets one or more irrigations by flood water during the year. In the past season there were small areas upon the mesas south and east of Tucson that would cut one-fourth of a ton of hay to the acre of this grass. In the northern portion of the Territory, especially near Ashfork, upon the Navajo Reservation, and along the main line of the Santa Fe from the plateau region east, except in the lower areas along the Little Colorado, this must be considered one of the most important grasses. It is often grazed to the ground continuously. Curly mesquite (*Hilaria cenchroides*), a closely related species, is of great importance upon the high, open foothills, and *Hilaria rigida* is characteristic on some of the deserts along the Gila and Salt rivers.

The great highland region of the San Francisco and White mountains furnish as good summer feed as any in the Territory, and where properly pastured the parks and open places are quite productive. Here a fescue (*Festuca arizonica*) is probably the most abundant grass, although sheep men sometimes claim that it is inferior in quality to *Sporobolus interruptus*, which also grows to the exclusion of all other vegetation over quite extensive areas upon thinly wooded plateaus. Indeed, *Festuca arizonica* and *Muhlenbergia gracilis*, which occupy large areas, are not considered such good sheep feed as *Spo-*

robolus interruptus. However, they are all grazed, and thousands of sheep live on practically nothing else for a large part of the summer. Sheep fescue (*Festuca ovina* var.) is common in portions of the mountains, but it is not so abundant nor so valuable as the other species. Strange as it may seem, the bluestem of the great plains region (*Agropyron occidentale*) produces a very important part of the range feed here. In open depressions there are often pure stands of it, which, during the past season, would cut as high as one-half ton to the acre. *Aristida purpurea* is another grass which, though not considered the best of feed, is very abundant in places, and furnishes fairly good grazing when young. Among other grasses of importance here should be mentioned *Kœleria cristata*, *Sporobolus depauperatus*, *S. pringlei*, *Schedonnardus texanus*, *Agrostis hyemalis*, *Sitanion longifolium*, *S. molle*, *Blepharoneuron tricholepis*, and *Epicampes ligulata*. As would be expected the grass flora here is varied, but the species mentioned, together with the blue grama, are the most important from the stockman's standpoint.

Upon the bottom lands in the southern part of the Territory sacaton (*Sporobolus wrightii*) is without doubt the most important, and it was much more abundant formerly than now. Its place is taken on the saltier bottoms in the Salt, Gila, Little Colorado, and Sulphur Spring valleys by *Sporobolus airoides*.

The bluejoint grasses are of special importance in the southern part of Arizona, and furnish a great deal of the summer feed in the foothills and mountains. They are usually grazed to the ground. The most important species are *Andropogon saccharoides*, *A. contortus*, and *A. hirtiflorus feënsis*. The first of these often makes a good crop on usually limited highland depressions. The other two are common on rocky hillsides.

There are a number of annuals aside from those noted above which are of much value and often make comparatively large yields on limited areas. Without doubt the most important of these is *Chloris elegans*, which in favorable seasons will sometimes cut a ton of hay to the acre in situations which receive an overflow. It is also an important constituent of the foothills range feed in some localities. It was especially abundant in the Sulphur Spring Valley in 1900, and upon the eastern slope of the Santa Rita Mountains in 1902 and 1903. *Eriochloa punctata* is also an important annual, with about the same habits as the former species, and in the same connection should be mentioned *Eragrostis neo-mexicana*. The triple-awn grass (*Aristida americana*) is abundant in similar situations to the six weeks' grama. While the awns render this of little value after maturity, it nevertheless furnishes some grazing early in the rainy season upon the lower foothills throughout the southern part of the Territory.

Of the perennial species not previously mentioned there is a large number which, although not of great importance in themselves, in the aggregate furnish considerable feed. *Pappophorum wrightii* occurs in places in the open foothills and is of a great deal of importance, and the closely related species *P. vaginatum* is generally found in depressions where water accumulates. In the protection of bushes almost exclusively at the present time is to be found the so-called black grama of this region (*Muhlenbergia porteri*), which is said to have been very plentiful at one time upon open ground. This is a very interesting species, inasmuch as it is one of the few grasses of the region which has perennial culms. Confined as it is to the protection of shrubbery, it, together with a large amount of other vegetation, is left unmolested during the fall, while the grasses on the open ground are grazed off. During the winter, however, this, as well as *Panicum lachnanthum* and other grasses which tend to seek this protection, are grazed off clean, even when they form a tangled mass with cat-claw, mesquite, and cacti. It is very interesting to note that the grasses are not injured by this form of grazing nearly so much as in the open spaces. These protected areas under shrubbery, concerning which considerable has been said during recent years, are often grazed as closely as any other, but the grazing comes after the maturity of the grasses. Vegetation growing in these protected areas has several advantages. The ground is not trampled by stock, and is kept in better condition by the gophers, which almost invariably burrow here. The leaves and twigs of the bushes and joints of the cacti also furnish some protection to them. Upon the sandy bottom *Chætochloa composita* and *Sporobolus strictus* furnish some feed, while *Trichloris fasciculata* makes a thin growth on moist areas and heavier soil. It is the mountain areas that furnish the greatest quantity of valuable feed in southern Arizona. The most important grasses are the perennial gramas, bluejoints, *Leptochloa dubia*, *Lycurus phleoides*, and several species of *Muhlenbergia*. All of these are well mixed and produce a very tall growth, ranging from one-half foot to 3 feet high, but the stand is always very thin, except in the most favorable situations where water and sediment are deposited in the more gently sloping ravines where the steep mountains break off into open foothills.

Upon the sand hills in the valley of the Little Colorado there are several characteristic grasses, of which sand grass (*Calamovilfa longifolia*), drop-seed, (*Sporobolus giganteus*), and *Muhlenbergia pungens* are the most important.

PIGWEED FAMILY.

A large quantity of feed is produced by the different plants which belong to the large natural group of pigweeds. While much of it is browse, there is nevertheless some herbaceous feed furnished by the common pigweeds, several of which are closely related to the lamb's-quarters.

Without doubt the saltbushes furnish the largest amount of feed in this natural order and are abundantly distributed in many situations, some upon alkaline soil and some upon land with but little or no salt content. In the southern part of Arizona shad scale (*Atriplex canescens*), *A. polycarpa*, *A. lentiformis*, and *A. linearis* are the most abundant of the shrubby species. These are all known to the Mexicans as chamiso. The first is not so prominently a salt-loving plant as the others, although it often occurs upon somewhat alkaline soils. In the Tucson region all but the third of these occur abundantly and are invariably grazed.[a] Shad scale occurs in the valleys throughout the Territory, but the other three mentioned above are of most importance in the alkaline valleys north and west of the Tucson region. They are especially abundant in the valleys of the Gila and Salt rivers and their tributaries. *Atriplex lentiformis* is the most rapidly growing species of this genus with which the writer is familiar. Its remarkable development is well illustrated by observations made in the vicinity of Tempe in 1900, where plants which had sprung up on newly subdued land after the removal of the first crop of wheat were 5½ feet high by the 1st of December. This growth had been made between the month of June and that date.[b] Near Tempe and Phoenix it does not appear to be grazed very much, but upon the ranges along the Gila River it is not uncommon to see canes one-fourth of an inch in diameter grazed off. Having about the same range as the above are two annual species, *Atriplex elegans*, growing almost exclusively upon nonalkaline soil, and the salt-loving species, *A. bracteosa*. Both of these are grazed when feed is scarce. During the past season they were quite closely cropped along the Santa Cruz River south of Tucson. *Atriplex elegans* is a very interesting species in many ways on account of its habit of maturing seed at the close of the winter rainy season and again in midsummer. It therefore, although an annual, lives through the hot dry weather of early summer in the vegetative condition. It should be noted that there are some slight differences between the spring and summer forms, and the collections of the writer, although extensive, fail to show one of the common autumnal fruit forms at all in the spring.

The valley of the Little Colorado is especially noted for its abundance of saltbushes, some of which do not grow elsewhere in the Territory, so far as known. The saltbush flora of this region resembles that of the valley of the Rio Grande in many respects. Here that most valuable species, the spiny saltbush (*Atriplex confertifolia*), so

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[a] See Bul. 25, Division of Agrostology, U. S. Department of Agriculture, 1891, Pl. XXVI.

[b] See Pl. IV, fig. 1.

abundant in the Great Basin, is perfectly adapted; and *Atriplex greggii* covers very extensive areas on many of the saline bottoms with an almost pure growth, especially from Corn Creek southeastward through the Holbrook, Adamana, and St. Johns regions. Upon the Navajo and Moqui Reservation, and indeed throughout the valley of the Little Colorado, shad scale fills a very important place upon both mesas and bottom lands. In the petrified forest areas there occurs a shrubby species of *Atriplex* (No. 5085), which appears to be undescribed. This is said to be grazed during the winter. In this same region *Atriplex powelli*, an annual species, covers many areas of washed lands, while *Atriplex expansa* is abundant in some localities.

Next in importance to the saltbushes should be mentioned the white sage (*Eurotia lanata*), which occupies very extensive areas upon the highlands in the northern part of the Territory. It is especially important, as a winter feed only, in the great highland region north and east of the main divide of the San Francisco and contiguous mountains. It is common in places in the higher situations in the southern part of the Territory also, but never abundant enough to be seriously considered in the range ration. It is common in the Sulphur Spring Valley and has been collected upon the Santa Rita Forest Reserve. Greasewood (*Sarcobatus vermiculatus*) makes much winter feed in all the alkaline bottoms of the Gila, Salt, and Little Colorado valleys. Red sage (*Kochia americana*) is abundant enough to furnish some winter feed in the valley of the Little Colorado.

The common lamb's-quarters of the East is represented in Arizona by several species, which are of economic importance. In southern Arizona they are of more importance in the upper foothills than elsewhere, but in the northern higher altitudes they occupy the areas under the junipers upon the mesas and ridges, and sometimes cover large depressions with an almost pure growth. They furnish good summer feed, for sheep and goats especially. The species which grow here are *Chenopodium leptophyllum*, *C. incanum*, *C. fremontii*, and *C. olidum*? (No. 5841). A small annual, *Monolepis nuttalliana*, belonging to this natural group makes a carpet in shallow depressions in the southern part of the Territory during the spring season. This is one of the plants to which the Mexicans apply the name *patota*. It is considered good feed for cattle.

THE CLOVERS.

There are but few situations in Arizona where the clovers are of much importance, but there are suggestions that they may become more abundant as time goes on. In the northern mountains *Trifolium involucratum* and *T. longipes* cover small areas in moist situations. In the canyon bottoms of the southern mountains, which are devoid of meadows in the ordinary acceptance, there grows a species which, although limited in quantity, makes dense mats over small areas. It is to two small annual species, *Trifolium gracilentum* and *T. tridentatum*, that the greatest interest attaches, for there are indications that these are introduced species which are just beginning to assert themselves in the southern part of Arizona. In March, 1903, there was good feed produced by these species in several localities in the Willow Spring Mountains. Being associated here with alfilerilla and in the direct path of the early sheep migrations from California, it is quite probable that these have been introduced in wool from California and western Great Basin points, where they occur in considerable profusion. It is interesting to note that the maturity of these two species occurs about two months earlier in these mountains than in the Sierra Nevada Mountains east of Fresno, Cal. There is a bare possibility that a systematic effort to distribute these to other mountain ranges, either by securing the seed from the situations where it is produced most abundantly or by systematic herding in the season when the clovers are ripening, may result in establishing them, thereby increasing the feed in the foothills and lower mountains. It is quite certain that they will be of value only in the foothills, below the limit of winter annuals.

ALFILERILLA.[a]

Upon the areas where the alfilerilla is thoroughly established there is no other plant, unless it be Indian wheat, which can compare with it in the quantity of feed which it produces upon the desert mesas for winter and spring grazing. There appears to be no doubt that it was introduced into Arizona by sheep from California points. It is now well distributed as far south as the northern slope of the Santa Catalina Mountains and up the San Pedro Valley as far as Benson. It has not spread very much east of the San Pedro River. From here it extends northward and westward through the desert areas and high into the plateau regions on the north and west sides of the Prescott highlands; thence westward into California. There are scattering plants of it all over the Territory, but it is in the region indicated that it is of importance. It even occurs commonly upon the San Francisco Mountains at an altitude of 7,000 feet, but it is never abundant enough to be of any importance. It is much more abundant in the vicinity of Prescott (5,320 feet), but does not produce as much feed as upon the west side of the Prescott highlands, where it extends up to Iron Springs (6,032 feet). In this region it is well established all the way from Wickenburg (2,067 feet) to Iron Springs, in the edge of the pines. It appears to be perfectly at home in the scrub-oak area below the pines, where it remained green during the season of 1903 as late as the last of May.

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[a] See Plate VI.

According to the opinions of stockmen, it is spreading slowly, and is said to have been first observed near Willow Springs. There is a popular belief that it will thrive only on granitic soils. But this does not account for its peculiar distribution in the Tucson region. Here, as stated above, it makes a good crop in an average year on the northern slope of the Santa Catalina Mountains; but while distributed in scattering individuals all over the Santa Cruz Valley, it is never abundant enough to be of any consequence. There are a few small areas upon the northern slope of the Santa Ritas, where it is as thick upon the ground as it is upon the northern slope of the Santa Catalinas, but these areas are very limited, and therefore do not figure conspicuously in the total feed production. There is a good stand of it upon the east side of the Santa Catalina Mountains, and it is well distributed over the San Pedro Valley as far west as the top of the Rincon Mountains on the Tanque Verde road, but it does not extend in any quantity into the Santa Cruz Valley.

Some systematic attempts have been made to spread the plant. Messrs. Maish & Driscol some years ago sent a force of men to the Canyon del Oro district to gather large quantities of it, to be scattered on their Canoa property. They raked up the plant when the seed was ripening and scattered it upon their land. They have not been able to observe any material benefit. Mr. C. H. Bayless believes that it can be scattered most successfully by systematic herding of sheep at the time that the plant is maturing its seed. His plan is to herd sheep first upon land well seeded, and then upon contiguous unseeded areas. It is thought by those who have observed it that it is gradually spreading southward, and that it will eventually be as abundant in the valley south of Tucson as it is in the Oracle and Willow Springs region now. There certainly appears to be no good reason for holding a contrary view.

MISCELLANEOUS WINTER AND SPRING ANNUALS.

Under the designation "Indian wheat" the ranchers recognizes a group of important forage plants belonging to the botanical genus Plantago. There are two important species, both of which make their first appearance in the autumn and mature in the spring. *Plantago fastigiata* occurs mainly upon the mesas and lower areas, and *Plantago ignota* upon the foothills. The mesas in the Tucson and Phoenix region are especially noted for the magnificent growths of *Plantago fastigiata*, which, together with alfilerilla in the latter locality, feeds the largest number of sheep in the Territory during the winter and spring seasons. Next in importance to Indian wheat should be noted patota (*Pectocarya linearis*, *P. setosa*, and *P. pencillata*), the first being much the most abundant, and indeed the only one that need be considered from a forage standpoint. These plants furnish feed up to the time of ripening, but are of no value after that date, because of their extreme harshness. Belonging to the same family as the latter is a very large group of borages, which are of importance as sheep feed. The most abundant of these are *Plagiobothrys arizonicus*, *P. tenellus*, *Amsinkia tessulata*, *Cryptanthe cylloptera*, *C. intermedia*, *C. angustifolia*, and *Eremocarya micrantha*. The water-leaf family is represented by a large number of very conspicuous plants which are of more or less forage value for a short time. The most numerous of these belong to the genus Phacelia (*Phacelia arizonica*, *P. crenulata*, *P. tanacetifolia*, and *P. ramosa*), which will seem rather peculiar forage plants to many, but they, as well as *Ellisia chrysanthemifolia*, must be listed here as of some forage value, although not grazed except when feed is scarce. Of somewhat more value than the above are numerous plants related to the cultivated phlox, of which the most important are *Linanthus bigelovii*, *L. aurea*, and *Gilia inconspicua* (?). Mexican poppy (*Eschscholtzia mexicana*) is reported by many to be of some value. Mr. Ed. Vail and others assert that their vaqueros report that stock live largely upon this poppy, Indian wheat, and jojoba (*Simondsia californica*), during winter and spring on the west side of the Babuquivari Mountains. The observations of the writer do not entirely confirm these views, but it should be stated that wherever observed other feed has been abundant enough, so that it has not been necessary for stock to graze poppies. *Malvastrum exile* makes a large amount of feed on many of the river bottoms. During the past season it was abundant and extensively grazed in the lower San Pedro, Gila, and Santa Rosa valleys.

The native mustards, *Sophia incisa*, *S. pinnata*, *Lesquerella gordonii*, *Thelypodium lasiophyllum* and pepperwort (*Lepidium lasiocarpum*) form a small but important and interesting group of forage plants in the southern part of Arizona. With the exception of *Lesquerella gordonii* they are not grazed much while green, but after they are ripe the pods and oily seeds are greatly relished, by range horses especially. Horses have never been observed in better condition upon the range than they were upon the mesas south of Tucson in May, 1903. An abundant opportunity was had to observe what they were feeding upon. They appeared to be subsisting entirely upon seeds of these cruciferous plants, which grew mainly in the protection of shrubs, where they are scarcely molested until they are ripe. During the early part of the dry season, however, they were cleaned up about as completely as the grasses in similar situations in autumn.

Quite a number of leguminous annuals are of importance in the southern part of the Territory. Upon the mesas and foothills two species of lotus (*Lotus humistratus* and *L. humilis*) and vetch (*Astragalus nuttallii*) are the most important. A glance at the tables (pp. 26–29) will show the relative importance of these to the other vernal forage plants upon the northern slope of the Santa Rita Mountains. The lupines are very conspicuous upon the higher mesas and foothills, and are often grazed a little, but they are not relished like the species of lotus. Two species are very common. *Lupinus leptophyllus* often gives its characteristic purple to large areas in steep ravines and hillsides, while *L. concinnus* is fully as abundant in places.

Miscellaneous species such as *Baeria gracilis* and *Baileya multiradiata* are abundant enough to impart their characteristic golden color to the landscape at times. *Calyptridium monandrum* and *Sphærostigma chamænerioides* both contribute to the forage ration. The two first mentioned in this paragraph are composites, and are grazed by horses, especially when they are in bloom. Very little aside from the heads is eaten. *Chænactis stevioides*, another composite annual, is much more abundant in many places than these, but it is seldom eaten. In the spring of 1903 cattle in the vicinity of Santa Rosa, where the country was white with it, were grazing upon it a little. Mr. Charles Howard, of Ashfork, reports that his flocks subsist for weeks upon *Gymnolomia annua*, which is a particularly conspicuous thing upon these highlands.

MISCELLANEOUS BROWSE PLANTS.

Besides the saltbushes and their relatives, the majority of which are browse plants, a large number of other shrubs furnish feed for stock. These plants are especially valuable during the two seasons of short feed. The value of the mesquite is proverbial, on account of the large quantity of beans which it furnishes for winter and fall feed; but it is also grazed during the summer dry season. The cat-claw (*Acacia greggii*) and *Acacia constricta* are second in importance only to the mesquite as browse plants, but their fruit is of practically no value to stock. The twigs of the blue palo verde (*Parkinsonia torreyana*) and bigota (*P. aculeata*) also make winter feed of considerable importance. Jojoba (*Simondsia californica*), abundant in the foothills and lower mountain areas, appears to be the most important browse plant in these situations. The central foreground of Plate VI, figure 1, shows how this shrub, which is normally 4 or more feet high, was grazed during the past season near Dudleyville. Mr. Ed. Vail reports this one of the most important browse plants in the valleys west of the Babuquivari Mountains. *Eriogonum microthecum* and *Calliandra eriophylla* are also of much importance in the higher foothills and lower mountains. There are large areas on the east and southeast of the Huachuca Mountains, where the first has practically taken possession. It appears to spread with excessive grazing in this locality, and it is therefore very fortunate that it is of some forage value. These shrubs are especially characteristic of the southern regions.

The scrub live oaks of the entire Territory of Arizona form a class by themselves, and deserve more attention as forage plants than is usually accorded them. White oak (*Quercus arizonicus*) is probably the most important species in the southern part of Arizona, where it has even been known to be cut and fed to cattle. The black oak (*Quercus emoryi*) is said not to be touched by cattle, a statement which it has not been possible to verify. *Quercus turbinella* furnishes more feed in places in the Prescott and Bradshaw mountains than all other forage plants combined, goats and even sheep having little else to eat at some seasons.

Brigham's tea (*Ephedra trifurca*, *E. nevadensis*, and *E. torreyana*) is very commonly grazed. The first species is confined to southern Arizona mesas and foothills, while the other two are most common in the central and northern portions of the Territory. The three-leaved sumacs (*Rhus trilobata* and *R. emoryi*) are commonly browsed. Upon the highlands of the central portion of the Territory *Cowania mexicana* and *Falugia paradoxa* are grazed wherever found. Upon the mesas and foothills in the Tucson region there are two species of composite shrubs, *Baccharis brachyphylla* and *B. bigelovii*, which are invariably grazed.

Upon all the sandy ridges in the valley of the Little Colorado there is more or less sage (*Artemisia filifolia*), which is said to make valuable winter feed.

HAY CROPS.

No more than a very brief mention of the cultivated forage crops is necessary here. Alfalfa is of course the staple wherever water for irrigation is obtainable, and there is no region where more profitable returns are obtained than in the river valleys of the Territory. It is a common practice to cut a crop of barley with the first crop of hay each year upon poorly established meadows; but strange as it may seem, the bearded variety is usually sown, although the objectionable feature of this could be very easily dispensed with by sowing the beardless form instead. It is a common practice where alfalfa meadows are pastured to cut the first crop, for two purposes. One is to get rid of the weeds and the other is to give the plants a chance to recuperate from the close pasturage by this season of growth.

Barley and wheat are very largely grown for hay as winter crops, and are frequently sown for pasturage also. The Mexican population cut a large amount of this winter grain crop, bind it up in small sheaves 6 to 10 inches in diameter, and sell it in the green state in the cities and mining camps, where there is a small market for this class of roughage. These sheaves sell at the rate of about 20 for 25 cents. Sorghum is commonly grown in the summer rainy season, supplemented by light irrigations, upon the lands which produce the winter crop of barley.

Mention has been made in previous pages of the use of *Bouteloua rothrockii* as a hay plant, but with it are always cut a large variety of other species, a specific mention of which is not necessary. Sometimes saccaton (*Sporobolus wrightii*) is cut, along with such other species as grow upon the lowlands. Upon the east side of the Santa Rita Mountains blue grama (*Bouteloua oligostachya*) and bluejoint (*Andropogon saccharoides*) together with *Chloris elegans*, often make a small crop of hay. In many situations Johnson grass makes an important addition to the native hay plants upon overflowed areas.

The Mexican population makes use of a number of weedy plants, the most important of which is *Amaranthus palmeri*. In the vicinity of Tumacacori and Sopori during the past season there were large quantities of this plant put up for winter use. The crop was invariably obtained upon land from which a crop of barley had been removed in the late spring or early summer. The barley crop in this region is often the only one grown. The lands therefore lie idle from May to October, when they are plowed again for the fall seeding. During the summer they furnish some weedy pasturage, and from favorable situations a large volunteer crop of this weed is obtained. Plate VIII, figure 1, shows Mexicans stacking a large volunteer crop of this plant about the 1st of October. The yield was not far from 3 tons per acre in the field which was being harvested. These men report it to be good hay for horses, but rather poor for cattle.

WEEDS.

In a region of such small production it is not to be expected that weeds have a very detrimental influence upon native pasture lands. The weeds, as a general rule, furnish feed when other things fail. The use that is made of alfilerilla is a striking example of this.

In a few instances, however, absolutely worthless weeds flourish upon the most productive of the range lands. The alluvial bottoms which were once covered with either annual or perennial grasses have suffered great injury during recent years on account of the establishment of the cockle bur (*Xanthium canadense*). Hundreds of acres of the very best and most productive lands in the higher valleys of southern Arizona have been absolutely taken possession of by this plant during recent years. It is hoped that Johnson grass will be the means of reclaiming these areas. It is the only plant known which can compete successfully with this weed.

Along the main line of the Santa Fe Railway, for a distance of 20 or more miles on each side of the road, the Russian thistle is well established. In the valley of the Little Colorado it appears to be quite at home upon the dry mesa land, and will doubtless become more conspicuous as time goes on. While it will cause trouble upon the cultivated areas, it is not thought that it will ever injure the range lands; indeed, it may be a decided benefit. So far as known, it does not occur in the southern part of Arizona at all.

Cleome serrata has become very conspicuous upon the poorly grassed areas of overflowed depressions throughout the northern highlands. By some this plant is said to be relished by sheep, but evidences of this have not been seen. It is especially abundant in the vicinity of Flagstaff and upon the northern slope of the White Mountains.

In the southern portion of Arizona there are two perennial weeds related to the golden rods which it is claimed are spreading rapidly. These are *Isocoma coronopifolia* and *Gutierrezia microcephala*. They are very abundant in portions of the Santa Cruz and Altar valleys.

Upon the cultivated meadows the squirrel-tail grass is very troublesome and unsightly in irrigated districts. In pastures, however, it is of little or no detriment, for it is usually prevented from becoming conspicuous by the close grazing which is usually practiced upon the alfalfa pastures. It is interesting to note that in the Salt and Gila valleys *Hordeum murinum* is the prevalent species, while *H. jubatum*, which has such a bad record in the Plains region, has not been observed. In the valley of the Little Colorado, however, this species is nearly if not quite absent, while *Hordeum jubatum* is very common and even troublesome in the cultivated fields.

PLANTS INJURIOUS TO STOCK.

There are times during years of short feed when the creosote bush (*Covillea tridentata*) causes a good deal of injury to sheep. No stock of any kind eat this shrub ordinarily, but when feed is scarce sheep are sometimes forced to feed upon it. According to a recent report from Mr. E. S. Gosney, of Flagstaff, the animals, after feeding upon this shrub for a time, run about in an unsteady fashion, and are very likely to run into any obstacle which happens to be in their way. They are said to very often run toward the herder, or even his dogs, as though seeking protection. Mr. W. H. Campbell, also of Flagstaff, who has had a good deal of experience upon the deserts north of Phoenix, states that the greatest mortality occurs among pregnant ewes.

Upon the San Francisco and contiguous highlands there occurs a great deal of loco (*Aragallus lambertii*), and in some cases in the same region areas are said to have been abandoned as sheep grazing grounds on account of the preponderance of *Asclepiodora decumbens*.

Mechanical injury is sometimes done by six weeks' grass (*Bouteloua aristidoides*) and triple-awned grass (*Aristida americana*). When matured the seeds of these two species are very annoying, to say the least, to both men and animals. The sharp-pointed seeds work into both the fleece and the feet of sheep, but are more especially injurious to the latter. They accumulate between the hoofs of the animals to such an extent as to disable them. The areas of these grasses are avoided during the time of their ripening until the seed has fallen off and partially disappeared into the soil.

SUMMARY.

The carrying capacity of the lands in Arizona varies from the rate of one bovine animal to 50 acres to one to 100 acres.

Johnson grass appears to be the best adapted for preventing erosion, and will thrive in favorable situations which receive two or more irrigations by flood waters during the year. Bermuda grass does not appear to be promising without irrigation.

The valley of the Little Colorado, so far as much of its vegetation is concerned, resembles the valley of the Rio Grande, but the yield of feed is very much smaller.

From the stockman's point of view, the seasons upon the lower southern areas are four in number, each differing from the others in the character of the feed which is available. The two seasons of feed production alternate with two seasons of short feed.

(1) Middle of February to middle of April or first of May, characterized by a growth of annual weedy plants, which furnish feed for a short time.

(2) First of May to middle of July or first of August, having little growth except of shrubby plants, upon which stock largely subsist.

(3) Middle of July to first of December, which is the season of the best feed, being characterized by growth of perennial grasses and many other forage plants.

(4) First of December to middle of February, which is the hardest season of the year upon all stock.

The growth of winter and spring annuals occurs mainly below an altitude of 4,000 feet. The best pasture lands are located principally above an altitude of 3,000 feet.

In southern Arizona a large part of the feed upon the lower unoccupied lands is furnished by shrubby plants. The remainder of the feed upon these areas, as well as upon the mesas below 3,000 or 3,500 feet, is furnished by annual weedy plants in the spring, together with annual and a few perennial grasses in the summer, and in the higher foothills and mountains by perennial grasses.

Goat raising is on the increase, and it is believed that this industry will continue to develop.

The total annual precipitation can not serve as an index of the character of the feed upon the range, its distribution during the hot summer season being of paramount importance.

It is common for cattle to travel 10 miles from water to feeding grounds, and sheep are often herded 6 miles away, making a total travel between waterings of 20 miles for cattle and 12 miles for sheep. Horses travel a much greater distance.

The prairie dog is doing a large amount of damage in the north and northeastern portions of the Territory.

Beardless barley should be more extensively substituted for the bearded form for supplementing the first cutting of alfalfa.

The Russian thistle, while widely distributed in the northern part of Arizona, has not yet appeared in the southern part to any extent at least.

There appears to be abundant evidence that the creosote bush is injurious to sheep, which are sometimes forced to eat it on account of a scarcity of feed.

The average total available feed which it is practicable to utilize upon the large inclosure is believed to be between 150 and 200 pounds of air-dry substance per acre.

Alfilerilla, one of the most important forage plants of the Territory, which was probably introduced from California in the wool of sheep, is spreading. It is believed that two species of clover were introduced in the same way.

Experimental work carried on thus far in attempting to introduce perennial forage plants upon the mesas has given very little encouragement. *Panicum texanum*, an annual, has given the best results of anything thus far introduced, and it is believed that more success will be secured with annuals than with perennials. They are not as good feed, but short-lived plants with good seed habits now furnish the main feed upon the mesas.

The following tabulation showing the relative weight of desert annuals and certain of their reproductive portions will be of interest in this connection:

Plant.	Number of plants.	Fruit or seed.	Weight of seed or fruit.	Weight of plant less seed or fruit	Condition of plants.
			Grains.	*Grains.*	
Pectocarya linearis	2	Seed	15½	20	Fully mature.
Lotus humilis	1	Pods	19	12	Half of pods mature.
Monolepis nuttalliana	1	Seed	49	40	10 per cent of seed not mature.

This table shows, so far as this amount of data can show, that the seed production of these three characteristic desert annuals is large when compared with the total weight of the plants. *Lotus humilis* produced, in the condition indicated, 7 grains of clean seed. Two plants of *Bouteloua aristidoides*, weighing 48 grains, produced 27 grains of spikelets. It is believed that there is a suggestion here regarding the nature of the plants which will be most successful upon these arid mesa lands. Alfilerilla is already widely introduced. It has good seed habits and special provision for burying its seed. Of course perennial forage plants would furnish better feed than the annuals, but there is little hope of establishing them without greater expense than the economic benefit seems to warrant. It may be possible to establish some of the hardier perennial species upon the foothills. This, however, is a matter for experimental work to determine.

DESCRIPTION OF PLATES.

Plate I. (*Frontispiece.*) Laosa, a typical southern Arizona ranch.

Plate II. Contrast between dry and wet seasons in foothills range. Fig. 1.—Live-oak belt, upper foothills, eastern slope of Huachuca Mountains, July 1, 1903, before the rainy season began. Last year's crop of grass has all been eaten off. Fig. 2.—Upper foothills, northern slope, Santa Rita Mountains, just below the oak belt, showing *Panicum lachnanthum*, grama, and mesquite at the close of the rainy season.

Plate III. The large inclosure. Fig. 1.—Pyramid Hill, section 18, township 18, range 15. Horses digging for water in the sands of an arroyo. September, 1902. Fig. 2.—Looking south from the top of Pyramid Hill, showing the general character of the fenced area. October, 1902.

Plate IV. Saltbushes. Fig. 1.—*Atriplex lentiformis*, the largest of our native saltbushes. Tempe, Ariz., November, 1902. Fig. 2.—*Atriplex elegans* in large inclosure, northern foothills, Santa Rita Mountains, September, 1903.

Plate V. Fig. 1.—Hay meadow, Salt River Valley. First crop of alfalfa with winter barley, which greatly increases the yield. Phoenix, April, 1903. Fig. 2.—Erosion along Pantano Wash, east of Santa Rita Mountains, October, 1902.

Plate VI. Alfilerilla range. Fig. 1.—Alfilerilla and Indian wheat near Dudleyville. In the central foreground are shown closely grazed bushes of "jojoba" (*Simondsia californica*). Fig. 2.—Alfilerilla and Indian wheat near Oracle. *Opuntia engelmanni*, *Yucca radiosa*, and mesquite are the conspicuous plants.

Plate VII. Two phases of the range question. Fig. 1.—Goats and the oak brush upon which they live. Mayer, September, 1903. Fig. 2.—The remains of thirteen head of cattle in a space of 30 feet along a small arroyo near Arivaca, as the result of too great distance between feed and water. April, 1903.

Plate VIII. Haying scenes in southern Arizona. Fig. 1.—Mexicans at Sopori stacking "celite" (*Amaranthus palmeri*), which makes a large volunteer crop after the winter crop of grain hay has been removed. October, 1903. Fig. 2.—A Mexican packing hay from the mountains. Santa Rita Mountains, July, 1903.

Plate IX. Native pasture lands in southern Arizona. Fig. 1.—Galleta (*Hilaria mutica*) in a swale south of Vail Station. September, 1902. Old grass, there being practically no growth this year. Fig. 2.—A round-up in the northern foothills of the Santa Rita Mountains, April, 1903, when the large area was being inclosed.

Plate X. Fig. 1.—An ocotilla forest about 4 miles northeast of the large inclosure. September, 1902. Practically no feed is produced here. Fig. 2.—The work of prairie dogs upon the northern slope of the White Mountains. Large areas of grass are destroyed by these animals. July, 1903.

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FIG. 1.—LIVE-OAK BELT, UPPER FOOTHILLS, EASTERN SLOPE OF HUACHUCA MOUNTAINS, FIRST OF JULY, 1903, BEFORE THE RAINY SEASON BEGAN; LAST YEAR'S CROP OF GRASS ALL EATEN OFF.

FIG. 2.—UPPER FOOTHILLS, NORTHERN SLOPE, SANTA RITA MOUNTAINS, JUST BELOW THE OAK BELT, SHOWING PANICUM MACHNANTHUM, GRAMA, AND MESQUITE AT THE CLOSE OF THE RAINY SEASON.

CONTRAST BETWEEN DRY AND WET SEASONS IN FOOTHILLS RANGE.

FIG. 1.—PYRAMID HILL, SEC. 18, T. 18, R. 15. HORSES DIGGING FOR WATER IN THE SANDS OF AN ARROYO, SEPTEMBER, 1902.

FIG. 2.—LOOKING SOUTH FROM THE TOP OF PYRAMID HILL, SHOWING GENERAL CHARACTER OF FENCED AREA, OCTOBER, 1902.

THE LARGE INCLOSURE.

FIG. 1.—ATRIPLEX LENTIFORMIS, THE LARGEST OF OUR NATIVE SALTBUSHES, TEMPE, ARIZ., NOVEMBER, 1902.

FIG. 2.—ATRIPLEX ELEGANS. LARGE INCLOSURE, NORTHERN FOOTHILLS, SANTA RITA MOUNTAINS, SEPTEMBER, 1903.

SALTBUSHES.

FIG. 1.—HAY MEADOW, SALT RIVER VALLEY. FIRST CROP OF ALFALFA WITH WINTER BARLEY, WHICH GREATLY INCREASES THE YIELD. PHOENIX, APRIL, 1903.

FIG. 2.—EROSION ALONG PANTANO WASH, EAST OF SANTA RITA MOUNTAINS, OCTOBER, 1902.

FIG. 1.—ALFILERILLA AND INDIAN WHEAT NEAR DUDLEYVILLE. IN THE CENTRAL FOREGROUND IS SHOWN CLOSELY GRAZED BUSHES OF "JOJOBA" (SIMONDSIA CALIFORNICA).

FIG. 2.—ALFILERILLA AND INDIAN WHEAT NEAR ORACLE. OPUNTIA ENGELMANNI, YUCCA RADIOSA, AND MESQUITE (PROSOPIS VELUTINA) ARE THE CONSPICUOUS PLANTS.

ALFILERILLA RANGE.

FIG. 1.—GOATS AND THE OAK BRUSH UPON WHICH THEY LIVE, MAYER, ARIZ., SEPTEMBER, 1903.

FIG. 2.—THE REMAINS OF 13 HEAD OF CATTLE IN A SPACE OF 30 FEET ALONG A SMALL ARROYO NEAR ARIVACA, THE RESULT OF TOO GREAT DISTANCE BETWEEN FEED AND WATER. APRIL, 1903.

TWO PHASES OF THE RANGE QUESTION.

FIG. 1.—MEXICANS AT SOPORI STACKING "CELITE" (AMARANTHUS PALMERI), WHICH MAKES A LARGE VOLUNTEER CROP AFTER THE WINTER CROP OF GRAIN HAY HAS BEEN REMOVED. OCTOBER, 1903.

FIG. 2.—A MEXICAN PACKING HAY FROM THE MOUNTAINS, SANTA RITA MOUNTAINS, JULY, 1903.

HAYING SCENES IN SOUTHERN ARIZONA.

FIG. 1.—GALLETA (HILARIA MUTICA) IN A SWALE SOUTH OF VAIL STATION, SEPTEMBER, 1902. OLD GRASS, THERE BEING PRACTICALLY NO GROWTH.

FIG. 2.—A ROUND-UP IN THE NORTHERN FOOTHILLS OF THE SANTA RITA MOUNTAINS, APRIL, 1903, WHEN THE LARGE AREA WAS BEING INCLOSED.

NATIVE PASTURE LANDS IN SOUTHERN ARIZONA.

FIG. 1.—AN OCOTILLA FOREST ABOUT 4 MILES NORTHEAST OF THE LARGE INCLOSURE, SEPTEMBER, 1902. PRACTICALLY NO FEED PRODUCED HERE.

FIG. 2.—THE WORK OF PRAIRIE DOGS UPON THE NORTHERN SLOPE OF THE WHITE MOUNTAINS, JULY, 1903. LARGE AREAS OF GRASS LANDS ARE DESTROYED BY THIS ANIMAL.

[Continued from page 2 of cover.]

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