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U. S. DEPARTMENT OF AGRICULTURE.

PAPERS

ON

HORTICULTURAL AND KINDRED SUBJECTS,

BY

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
Washington, D. C., June 5, 1891.

SIR: I have the honor to submit herewith for republication a series of papers on horticultural and kindred topics previously published in various Annual Reports of this Department, which are no longer available for distribution. These papers have been brought together, in accordance with your suggestion, to afford a convenient means of replying to many requests for information on these topics.

WILLIAM SAUNDERS,
Superintendent of Gardens and Grounds.

Hon. J. M. RUSK,
Secretary of Agriculture.

TABLE OF CONTENTS.

	Page.
Landscape gardening	7
On draining lands.....	37
Sowing seeds and raising young plants of forest trees	38 ✓
Making and keeping lawns.....	40
Spring and fall planting of trees	42
Keeping hedges	44
Cultivation	44 ✓
Mechanical preparation of soil	46 ✓
Mulching	47
Situations for orchards.....	49
Orchard planting	49
Management of orchards.....	50
Pruning	51
Remarks on pear culture	53
Native grapes.....	60
Grapes—mildew	63
Propagating native grapes	66
Foreign grapes in glass structures	67
Inside borders for graperies	70
Thrips on grapes.....	70
Propagating by cuttings	71
Sowing seeds	73 ✓
Seed saving.....	74
Rotation in cropping.....	75
Expedients for promoting fruitfulness in plants	79
Importance of a uniform supply of water in plant culture	80 ✓
Liquid manure for plants in pot culture	82
Flower pots.....	83
Night temperature in glass structures.....	83
Watering plants in pots.....	85 ✓
Water plants	86
Glazing greenhouse roofs.....	87
Raspberry culture	88
Figs	89
Vanilla.....	89
India-rubber plants.....	90
Citron.....	90
Special inquiries and answers	92
Well-ripened wood.....	111
Notes on orange culture and the pineapple.....	114

PAPERS ON HORTICULTURAL AND KINDRED SUBJECTS.

LANDSCAPE GARDENING.

Landscape gardening is a comprehensive art, combining the genius of the landscape painter with the art of the practical gardener; the exact knowledge of the engineer with the poetical imagination of the artist. The professor of this art should also possess a competent knowledge of the general principles of botany, architecture, geology, hydraulics, hydrostatics, mechanics, laws of heat and ventilation, horticulture, and vegetable physiology. This may seem rather a formidable array of acquirements, but in the multifarious details of selecting and arranging the style and location of rural residences and their accompanying domestic auxiliary structures; the drainage of lands; the location and construction of roads; the preparation of garden sites and the erection of horticultural buildings; the decoration of grounds for the purposes of beautifying the surroundings of rural homesteads, the more ambitious suburban villas, and public buildings of every description; and the artistic disposition of arborescent growths, so as to produce the most varied yet distinct beauties of which the scenery is susceptible, necessitate a knowledge more or less intimate and extensive with these as well as with other branches of science.

During the last twenty years much attention has been given to landscape gardening, both in the laying out of private grounds and in the design and construction of public parks. Some of the latter are deserving of the highest commendation, both in design and execution, and have been the means of instructing and familiarizing the public with the capabilities and beauties of the art, and in educating the popular taste to an appreciation of the development of rural improvements and their beneficial effects upon the moral and physical condition of society.

It can not be too forcibly urged upon the attention of those who are intrusted with educational institutions that one of the most certain means of encouraging a desire for studies in natural history, and forming correct principles of taste in young minds, is that of landscape embellishments of school houses and college grounds. This has become one of the greatest wants in existing systems of education and can not long remain neglected.

It is not proposed to offer a treatise on landscape gardening, but rather to allude briefly to some of the more prominent points and subjects that will naturally arise for consideration in the location of residences and public buildings, and in the arrangement of the principal accessories and the execution of various details connected with rural improvements.

GARDENING AND CIVILIZATION.

Gardens are of the most remote antiquity. Our first parents were placed in a garden, and the writings of the oldest historians and poets contain various descriptions and traditions concerning the extraordinary beauty of the gardens. History proves that a taste for gardening has kept pace with the progress of civilization, and that it has always exerted a powerful influence upon the passions and feelings of mankind. Much of the decorative beauty of architecture has resulted from study of the combinations and graceful lines of the vegetable kingdom. Two thousand years before the Christian era Lydia was famed for its gardens. The gardens of Babylon are traditionally ranked among the greatest successful combinations of skill and wealth. The Persian kings were very partial to gardens, which were cultivated as much for their beauty as for their fruit, and even in gardens of limited extent the trees were arranged in regular lines and figures, and the walks bordered with tufts of roses, violets, and other odoriferous plants. The Greeks copied from the Persians, both in their gardening and their architecture. Epicurus took great delight in his garden, and there taught his philosophy. The Greeks excelled in architecture more than in gardening, although a public park or garden was planted by Cimon, the general, at Athens, furnished with streams of water and supplied with shady groves, with gymnasia and places for exercise. They had flower markets which were well patronized, and learned or distinguished men wore crowns of flowers, and successful warriors were decorated with wreaths and garlands. Their garden decorations partook largely of statuary and other architectural appendages.

The Romans devoted much of their wealth to the adornment of their gardens and pleasure parks. Lucullus seems to have had large ideas of magnificent expenditures in this direction, being represented as having sumptuous villas in different parts of Italy, so that he could enjoy an agreeable climate every month in the year. Cicero had fine plantations at his Arpinum villa. Sallust, who made a fortune in the government of Numidia, devoted largely of his means to the laying out of gardens which were for a long period the pride of Rome. Pliny's villa appears to have been laid out with more taste and less of ostentatious display than some others, since the pastoral beauty of his grounds is highly praised. It is apparent, however, that the principal features of ornamentation were derived from vases, fountains, and similar works of art that bore the resemblance of wealth, and were at once objects that con-

veyed impressions of grandeur and magnificence, without necessitating patient waiting for effects produced by artificial plantations, which require time for their development and a higher appreciative taste for their enjoyment.

The Romans also devoted much attention to culinary vegetation, and carried their knowledge of science and the arts into such countries as they colonized, so that a great degree of wealth and enlightened prosperity accompanied their footsteps to an extent that the world has rarely seen equaled.

With the reign of the emperors commenced the decline of the empire. The reign of barbarism was triumphant, and the finest palaces, country houses, and gardens were destroyed. For five centuries the monks were almost the only class who cultivated gardens and kept alive the culture of fruits, vegetables, flowers, and medicinal herbs during the dark ages. To them we are indebted for the preserving and handing down of the arts of gardening and architecture.

It was not until the middle of the fifteenth century that the arts of peace and commerce were so prosperous as to awaken a love for the fine arts; and the examples of former grandeur that still remained, together with traditions of ancient magnificence, stirred up a desire of imitation, and Italian gardening attained a perfection and standing that are still recognized and distinguished among rural improvements.

STYLES OF LANDSCAPE GARDENING.

There are two very distinct modes of laying out grounds, known as the geometrical and the natural. Various terms have been used from time to time by descriptive writers on these subjects to designate styles, but they are all easily referred to one or the other of these modes. Under the geometrical may be placed the formal, Roman, architectural, and ancient, as well as the Italian, French, and Dutch varieties of this style. Under the natural we may, in a similar manner, place the gardenesque, modern, irregular, English, and graceful.

A third style is commonly included, but has never been very successfully defined, either practically or hypothetically; that is, the picturesque. The former two are sufficiently comprehensive for the present purpose.

THE GEOMETRICAL STYLE.

In the earlier ages of the world the possessor of wealth exhibited his riches by surrounding his residence with such improvements as were most distinctive from the common scenery of the country. Hence gardens were ornamented with ballustraded terraces of massive masonry, magnificent flights of steps, elaborately decorated arcades, costly fountains, architectural grottoes, and lofty, clipped hedges arranged with niches and recesses for the display of statuary. His less wealthy neighbor contented himself by substituting a sloped grass bank for the

stone terrace, shaped his small lake in a square or circular form, and clipped his trees and shrubs into fantastic shapes, aiming at ostentation without regard either to propriety or good taste.

Such a style is well fitted for immediately producing startling if not grand effects; and during early stages of society, and in countries abounding with the irregular and natural forms of uncultivated scenery, distinction is at once imparted by introducing perfectly level or regularly sloping surfaces of ground, trees planted at uniform distances apart, and lakes or ponds bounded by geometrical lines, so as to leave no chance of mistaking any portion of the scene as having been the result of unassisted arrangement, but unmistakably conveying the impression of a display of wealth and refinement, and to indicate ownership by distinguishing the country residence from the natural, uninclosed, rude scenery of the neighborhood.

In the strictly geometrical style everything is architecturally accurate in its lines, perfect symmetry pervades the whole, and all parts are equally balanced. Statuary of all kinds, fountains, steps, balustrades, and pediments, broad walks, straight-planted avenues, formal-shaped flower beds, all belong to this species of garden and landscape decoration.

THE NATURAL STYLE.

In the geometrical style the hand of the artist is evident in every detail; but in the natural style artificial interference is not so conspicuously apparent. In the disposition of the material used for the development of landscape views and scenic effects there is nothing, so far as general impressions are concerned, to indicate where the hand of the improver has been operating, or anything appearing beyond a natural production, or what may be indigenous to the locality. All natural beauties are carefully preserved so far as is consistent with objects of use or convenience, and the element of utility enters more largely, perhaps, into our ideas of the beautiful in this than in the geometrical style; and while there is no desire to avoid the appearance of art in operative details, it is not rendered obtrusive, and the effects produced need not suggest the idea of painful and laborious operations.

The perception of the beauty ought to be the first impression, and not that of the art by which it has been produced. The beauties of nature are imitated in the disposition of trees and shrubs, and, so far as general scenic effect is concerned, the arrangement might be taken for a natural group; yet a close examination of details will lead to the discovery that the plants employed are not indigenous to the locality, and thus art and design will be recognized. So also in a district where evergreen trees do not exist in the surrounding natural woods their introduction in the scenery will at once convey the impression of an artificial plantation, so far as regards the materials of which it is composed. While therefore the general effects produced in this style are

similar to those with which we are familiar in natural scenery, the details are dictated by convenience, utility, and adaptability to the end in view.

A neglected footpath seen in the distance, curving gracefully around the sides of a hill or on the banks of a stream, now embracing a thicket of trees and undergrowth, and lost in a maze of tangled vines, then emerging and tracing across the meadow, alternately widening and narrowing, and at times altogether lost in the massive foliage of grasses and other natural growths, is what might truly be termed a natural path. Let it be trimmed and widened, however, its surface neatly adjusted and covered with gravel, its curves well defined, and its sides made perfectly parallel, and it will have lost much of its beauty as a natural woodland path, although the contiguous scenery has not been disturbed nor in any degree impaired. It is now invested with the beauty of utility, and however much we may have admired it in its original condition, yet for comfort as a dry and convenient walk we greatly prefer its improved condition; and in addition to the charms associated with its position, it has those of adaptability and fitness to the end in view.

CHOOSING A LOCATION FOR BUILDINGS AND GROUNDS.

In choosing a location one of the first considerations is that of access to and egress from a city, and if daily intercourse is contemplated, it becomes a question of special interest. The time, trouble, and expense of travel on bad roads are a severe tax upon country pleasures. A drive of half an hour on a hard road during a fine summer evening is a recreative pleasure which may not be appreciated when an hour and a half are spent on the same distance during a stormy winter morning. A good road in dry weather may become very indifferent after rains, and be impassable for three-fourths of the year.

In these days of railroads and steamboats it is difficult to indicate what might be considered a convenient distance from the city. Upon a well-managed railroad a distance of 20 miles may be more accessible than 2 miles upon a common road. Proximity to a railroad station will always secure a certainty of convenient transit, even allowing the distance to be within an easy carriage drive. This facility should not be overlooked when it can be secured.

Healthiness of locality is of paramount importance. Low, flat lands are generally damp and cold, and should never be selected for the habitation of man or beast, if there is any choice in the matter. Valleys, or even depressions, are equally unsuitable. The air after sunset is always dense in such places, dews are heavier and more frequent, and, as a consequence, frosts are more prevalent than on elevations. Fogs are more frequent on low lands. The extremes of temperature are also greater, especially if surrounded by forests, which prevent the free circulation and equalizing influence of winds. Wide and long valleys,

between uniform hills are frequently subjected to sweeping blasts. Even the vicinity of such localities ought to be avoided. A person may drain, cultivate, and otherwise improve his property, and still be subjected to the injurious influences of unimproved lands over which he has no control.

An elevated situation is generally healthy. The extent of prospect it secures is also an advantage; yet it is not well to place too great a value on distant views. For permanent residence the exposure of elevation is a disadvantage. Though cool, airy, and agreeable in summer, they may be bleak, chilly, and exceedingly uncomfortable during winter. The tender and delicate varieties of flowers and shrubbery, as well as fruits and culinary products, are less likely to flourish when fully exposed to cold and unbroken winds.

SELECTING A BUILDING SITE.

This is too commonly settled by selecting the highest point of the ground, but not always wisely. A modern house set up on a sharp knoll has an isolated appearance which is not readily altered or improved by trees, and it is with difficulty approached by roads, if the grounds slope suddenly from it.

A somewhat level plateau, partially surrounded by higher ground, forms a good position for a dwelling house. The ground should fall from it in all directions, more rapidly in front than back, where the descent may be merely sufficient for drainage. Back of the house, positions should be selected for the vegetable garden, stables, and other buildings, such as greenhouses and graperies, all of which will be sheltered and protected by the higher ground beyond.

The nature of the soil should receive attention in selecting a spot for a house. Clay soils are retentive of water, and, even when artificially drained, the surface is disagreeable after rains. Clay, in contact with foundation walls, keeps them damp and cold. The expansion of clay when wet, and shrinkage when dry, unfit it for a safe foundation. If every other condition is secured in a site, art can do much towards ameliorating the physical qualities of the soil; but, for all the purposes of human comfort and enjoyment, in the immediate vicinity of a house, a light, open, porous soil is decidedly the best.

It is always desirable to secure the beauty and utility of a natural plantation; but to select the site for a mansion in the center of a grove of old trees, with the intention of making them a nucleus for future landscape effect, will generally prove unsatisfactory. In natural forests the trees grow too closely together; their trunks are long, slender, and destitute of branches; and if thinning is attempted, those that are left seldom flourish for any length of time. If the thinning out is gradual, and the best of the remaining trees are judiciously pruned, they may ultimately recover and make a satisfactory appearance.

Where old trees abound it is difficult to prepare or keep a good lawn or introduce new shrubs or flowers. The roots of the trees prevent thorough renovation of the soil and the shade of their branches interferes with the growth of plants. There is a steady antagonism between the old and the new, both with regard to individual growth and landscape effect, until either the one or the other predominates. It is no matter of doubt or uncertainty, but a settled question with all who have any experience in remodeling or adapting old woods or groves to modern improvements, that it is measurably better to commence on a treeless, naked field ; as a judicious selection and intermixture of fast-growing trees, properly planted in good soil, will in a few years serve all useful purposes, produce such effects as are contemplated, and give far more satisfaction than can be derived from the accidental position and growth of natural forests, at least so far as relates to improvements in the immediate vicinity of a rural residence.

PLAN OF IMPROVEMENTS.

The grounds being secured and the site fixed upon for the house, the next step is to prepare a well-defined working plan for contemplated improvements, and this is of equal importance whether the grounds are extensive or quite limited. To strike out the rude and simple outlines of an arrangement for the various accessories and conveniences of a country residence requires a mind thoroughly imbued with the principles of taste and conversant with the application of art to the development of beauty ; and, although we admit that every individual best knows what will meet his ideas of comfort and convenience in the abstract, there are few who can tell all the details or satisfactorily introduce and fit all the disjointed parts so as to produce a complete whole.

As it is wisdom on the part of those who are about building a house to enlist the services of a competent architect, so it is essential to consult with a landscape artist in the preparation of a plan for the improvement of the grounds ; as to what trees to plant and where to plant them ; the proper introduction and construction of roads and walks ; locating and erecting barns, stables, glass houses, and other buildings ; selecting and preparing the soil for vegetable and fruit gardens ; making lawns, and the numerous details that are involved in perfecting all the indispensable, useful, and ornamental adjuncts to a suburban house and grounds.

All plans should be definite and simple as possible, and not overloaded with mechanical embellishments, as an excess in this respect generally indicates a deficiency in more important particulars. They should be accompanied with ample references, where each tree and the most important shrubs should be distinctly named and referred to numbers on the plan. Intelligible reasons should be given for everything proposed, both with reference to immediate and to future effect,

with clear instructions and suggestions with regard to the operations proposed, and the relative order in which they should be conducted. It may be taken as a rule that no proprietor should undertake improvements until he sees clearly the objects and intentions of the design or plan; and if this information can not be conveyed by inspection and explanation, it is a strong presumptive evidence of defect either in the design or in the explanation, or in both.

In transferring designs to the ground, the most correct and speedy method is to divide the plan into squares by lines drawn on it in both directions, the side of the square being of any length that will best serve the purposes of accuracy. Squares of 60 feet for the side will be found a convenient length; but in intricate designs, such as those for flower gardens, squares of 30 feet, or even shorter, may be necessary. The ground, or space to be operated upon, is to be divided into squares of the same size, and a stake set firmly at each point of intersection of the lines, and numbered to correspond with the numbers on the plan. A still more distinctive method is to use numbers for one direction and letters for the other; each stake will then be marked with a number and a letter. The plan and grounds being thus prepared, the placing of a tree, or the laying down of a walk, or any other object, can be executed with the greatest facility. It also enables the work to be commenced at any point, and a short practice will enable any one, by looking at its position in the square on the plan, to place a tree in its relative position in the square on the ground, without having recourse to exact measurements. A plan carefully prepared with references, and accurate to a scale, may thus be transferred to the ground by any person capable of reading letters and figures.

ARRANGEMENT OF OUTBUILDINGS, STABLES, ETC.

The selection of sites for the various buildings required near a country or suburban residence is second in importance only to the selection of a site for the mansion. Convenience dictates that these buildings should be as near the house as is practically consistent with their objects and character. The dwelling house will, of course, occupy the best and most advantageous position, and its superior size and style of architecture will always be such as to render all other necessary structures of secondary and subordinate appearance. Such buildings as stables and icehouses are so obviously necessary to domestic comfort that their presence is not only expected, but their absence conveys an impression of poverty or incompleteness altogether inconsistent with our ideas of what a country home should be.

Instead, therefore, of endeavoring to entirely conceal these structures by plantations and other expedients, as is frequently advised, they should be located on the most eligible sites, and display in their architectural details and ornaments an expression of the purposes for which

they are intended, and be judiciously exposed to view without rendering conspicuous the operations necessarily connected with the structure.

The best location for these buildings will be governed to some extent by local circumstances; but, where there are no grades, views, or other exceptional features to interfere with the selection, a point in a north-east direction from the house will combine the greatest number of advantages.

While the stables and other farm buildings should not be entirely hidden from view at certain points, at the same time it will be obvious that a due amount of privacy in and about the buildings themselves, as well as in the line of view from the dwelling house, will be essential, and can readily be effected by the introduction of trees and shrubs at the points indicated.

LAYING OUT ROADS AND WALKS.

The guiding principle in designing the position of roads and walks is utility. Nature forms no roads. They are works of men and animals, and would undoubtedly always proceed in straight lines from point to point if obstructions of various kinds did not interfere and cause deviations. Necessity will therefore suggest where and how they should be introduced. So far as regards approaches and walks to and from buildings, the object of their introduction is sufficiently apparent; but, in laying out pleasure grounds and lawn fronts, it is a common practice to introduce walks for the mere purpose of variety. This is a very questionable reason at the best, and not always successfully accomplished; but even in cases of this kind they should appear to aim for some definite object, or lead to points of sufficient importance to suggest their utility.

Unnecessary roads and walks should be carefully avoided. They are expensive in their construction, if properly made, and require constant attention to keep them clean and in repair. Nothing looks so woebegone and poverty-stricken as a weedy, neglected road to a house, or walks through pleasure-grounds or garden. They detract much from the beauty of the surroundings, no matter how elaborate or intrinsically worthy they may be. An oversupply of roads and walks is always a serious infliction.

The beauty of curved lines sometimes prompts to a deviation from the more available direct course; and, where it can be done without too great sacrifice of utility, it is not objectionable. But no walk should be turned from its obvious direct course without an apparently sufficient reason. A change of level in the grounds, a tree, or a group of plants or other similar obstruction will induce, and seemingly demand, a change of line.

There are many locations where the straight line should be preferred as a matter of taste in design. As a connecting link between the strictly horizontal and perpendicular lines of a building, and the irreg-

ular surfaces surrounding it, a perfectly straight walk is in the best taste and adds greatly to the effect of the architecture, while a frequently curving walk detracts from it. So also a walk along the side of a straight boundary fence should not curve if both lines are visible at the same time. Most persons are aware of the great beauty of straight walks and avenues of trees; and for public parks of lesser order, inclosed by formal outlines, they can always be introduced with great effect, as well as convenience, where curving walks would be the reverse. In this case beauty depends upon harmony rather than contrast, and more than either upon utility.

When roads or walks are carried over irregular surfaces the natural turns and windings necessary to follow an easy or uniform grade and keep as near the original surface of the ground as possible will usually develop pleasing curves. A little studied attention in this matter of the course of a road will not only increase the beauty of curves by adding to them the grace of utility, but also deep and expensive cuttings, as well as heavy embankments, will be avoided, and easy grades and economical construction be more certainly secured.

When it is necessary to branch a second road from the main line it should leave the latter at as nearly a right angle as convenient, and at the same time be somewhat narrower, so that its appearance may convey the proper idea of it being subordinate, and to avoid confusion and mistake; otherwise the roads leading to the stable, ice house, or garden may be mistaken for the road to the mansion. Under no circumstances should walks be made conspicuous in views of natural scenery. If it is essentially necessary that a walk should cross a lawn where it would interrupt a continuity of view and destroy breadth of effect it should be sunk beneath the line of vision by placing it in a slight excavation, which may be further assisted by throwing up a small mound on the side nearest the point of view. These expedients, as also that of planting thick groups of low-growing shrubs, will be effective and satisfactory if properly executed.

In laying out curving roads it is not advisable to closely follow geometrical rules, or to set the curves out to any regular radius. This plan may occasionally prove perfectly satisfactory on a strictly level surface, but it will have quite an opposite effect where the ground is greatly undulating. The curves, to be pleasing, must be "eye-sweet"—not too sudden or abrupt—and properly blended at their points of junction.

CONSTRUCTION OF ROADS AND WALKS.

Very much of personal comfort and pleasure in rural residences depends upon good roads. A smooth, firm, dry road is one of the greatest conveniences and enjoyments, while a rough, soft, muddy road is one of the greatest drawbacks and annoyances of country life. Bad-roads form the greatest obstacles to progress and permanent improve-

ments in all the neighborhoods that are blasted with their presence; they have a demoralizing effect upon the inhabitants, and are a sure sign either of poverty or mismanagement, or both.

Water is the worst enemy to good roads. It is therefore a leading principle in road-making so to construct them that they may be kept dry. In absence of a timely recognition of this principle many costly roads have proved to be failures; but where it has had prominent recognition and its value has been properly appreciated good roads have been made at a trifling expense.

After locating the road and marking out its course, the sides should be brought to the proper grade and finished by a layer of sod as a guide to further operations. In crossing a sloping surface it is not necessary to have both sides perfectly level, but the nearer this can be secured, with due regard to getting rid of surface water, the better it will admit of a neat finish and the more easily will it be kept in repair.

The roadbed is then formed by excavating and removing the soil to a depth of 6 inches at the sides, curving slightly higher in the center, and made perfectly smooth by rolling, producing a uniform surface upon which the material of the road is to be placed.

The best stone for road metal is tough granite. Hard, brittle stone is more readily reduced by pressure, but in a well-kept road this difference is not important. It is, however, all important that the stones should be broken small. The largest should pass easily through a 2-inch ring, and if one-half of them are small enough to pass through a ring of only 1 inch diameter the road will ultimately become all the more compact.

The road should be filled with this broken stone to a level with the sides, increasing in depth towards the center at the rate of 1 inch to the yard. Thus a road 16 feet in width would have a depth of about 9 inches in the center. The utmost care should be applied to regulating the surface, and the smaller stones should be used on top, in order to secure an even, compact, carefully molded grade, which should be compressed by repeatedly passing a heavy roller over it, wedging every stone and making the surface almost as smooth and solid as a pavement. A thin layer, not more than 1 inch in thickness, of fine clayey gravel should then be evenly distributed over the stones and the roller again applied until the surface becomes homogeneous, firm, and close.

The surface of the road will thus be higher than the sodded edgings; water will therefore pass readily from it, and one of the main points of keeping a good road will be secured.

This will form a first-class road for ordinary carriage drives, or for all purposes required in public parks or private grounds; and if kept in good surface by frequent rolling, so as to prevent the forming of ruts while it is settling, and if a facing of gravel is applied when necessary, it will permanently fulfill all requirements of a good road.

The quality of the gravel deserves notice. Wash gravel, consisting

only of sand and rounded pebbles, should never be used. No amount of pressure will render it firm, and it is the most disagreeable material to walk upon. The best gravel is that to be found in banks composed of pebbles mixed with reddish clay, and the stones must be small. No detail in road-making is of so much importance as this. If a wagon wheel or the foot of a horse press on one extremity of a stone the other end of it will probably be slightly raised, allowing small particles of sand to fall into the crevice when the stone is loosened, and will roll on the surface; hence the necessity of using only very finely divided stones on top, so that they will be smaller than the pressing point, and not become deranged from leverage or compound action.

Where stone can not be conveniently obtained the roadbed may be filled with refuse matters of many kinds, such as coal ashes, clinkers from furnaces, and shells. Oyster shells are plentiful in many places near the seaboard, and form an admirable road; but the permanency as well as the efficiency of these materials in a roadbed will depend altogether upon the care of surfacing with proper gravel. Where it is impracticable to procure or deemed inexpedient to use any of the foregoing materials, an earth road may be rendered very serviceable by proper attention to the leading principle; that is, to keep it dry. In this case, instead of excavating the road bed, slight excavations should be made at the sides and the material spread over the center; and that surface water may pass to the sides more rapidly and thoroughly a greater convexity may be given to the curve. In some sections of the country good roads are kept up in this manner, but they are carefully repaired whenever necessary, and all ruts and tracks are filled up as soon as they are formed. The same general principles apply to the formation of walks and footpaths. The depth of material, however, need not exceed a few inches. It is certain that much unnecessary expense is frequently laid out upon mere foot-paths. A porous, gravelly, or sandy soil is in itself a good walk if properly shaped. Such walks admit of greater convexity than carriage roads, which is equivalent to a saving of material. Walks should be well filled up. There is no more disagreeable object, or one that conveys so meager an expression, as deep, raw edgings to a walk, looking as if they had been trimmed with a plow. Walks in this condition may be serviceable as water courses, but they are not comfortable footpaths.

FORMATION AND MANAGEMENT OF LAWNS.

A fine lawn is the most beautiful of external ornaments. Soft, velvety, elastic turf, smoothly shorn and of fine color, is always pleasing, but not always attained. Formerly the emerald lawns of European pleasure grounds were considered to be unequalled, and it was thought that nothing approaching to their beauty could be realized in this climate of scorching sun and summer droughts; but it has been demonstrated beyond any doubt that lawns may be produced and maintained here as fine as those to be found in any country.

The primary requisite is thorough preparation of the soil. Without this failure is probable; but if properly done at the outset, success is certain, with subsequent intelligent management. First of all a good foundation must be laid by draining and subsoiling, trenching, manuring, or otherwise loosening and enriching the soil. With limited lawns spade-trenching will be at once thorough and permanent; but where a plow and other implements can be used, the work may be executed much more economically, and by using the subsoil plow in connection with the common surface-turning, a depth of 18 inches will be reached, which on ordinary good corn-producing lands will be ample preparation for a good lawn. Previous to the final plowing a heavy dressing of manure should be applied. This should be well decomposed, more especially if the soil is partially of a gravelly or sandy character.

The surface must be rendered smooth and regular. Careful plowing can accomplish much towards making a smooth surface; but whatever the expense may be, the finish should be made perfect before sowing the grasses. There are two seasons for sowing—autumn and spring—either of them appropriate; and the choice will depend upon circumstances, and is of secondary consideration compared to the preparation of the land. To get rid of weeds and clean the ground before laying it down in grass it is a commendable practice to plant it with early potatoes. These, if cultivated with ordinary care, will soon cover the surface with their leaves, and prevent the growth of weeds; and the operation of digging up the crop and removing it tends to pulverize and loosen the soil. The potatoes can be removed and grass seed sown by the middle of August to the middle of September, and the grasses will vegetate and cover the surface before frosts. A top dressing of thinly sprinkled manure will protect the young plants during the winter, and a good thick-set lawn will be secured early in the following summer.

In hard, clayey loams, where a sufficiently comminuted surface is not so easily obtained, the ground should be prepared in the latter portion of the year and plowed over, so as to leave a rough surface to be acted upon by frost during the winter. This will insure a friability not easily attainable by mechanical means on tenacious soils. The seeds should be sown as early as can be done in the spring, but not until the ground is dry. Working a clayey soil when it is wet is ruinous to the future crop.

In the immediate preparation of the ground before seeding the surface should be pulverized by the harrow and roller if necessary. The seed will be sufficiently covered by passing a light harrow or roller over the ground. The former is best in clayey or baking soils, and the roller on light and sandy soils.

The best grasses for permanent lawns are red top (*Agrostis vulgaris*) and June grass (*Poa pratensis*.) The following proportions have been used in the lawns of this Department with great satisfaction: One bushel red top, 2 bushels June grass, 1 quart timothy to each acre of

land. These should be thoroughly mixed before sowing. This is heavy seeding, but experiments demonstrate that a good lawn can only be secured by heavy seeding when sown in the spring; autumn sowing may be thinner, but the thick seeding will be most satisfactory. There is no grass equal to the June grass for fine lawns; this is also known as green grass and Kentucky blue grass. The red top also forms a good sward where the soil is good and the summers comparatively cool and moist; but during dry warm weather it becomes hard and wiry. The timothy grass vegetates quickly and greatly assists the growth of the others.

The practice of sowing oats, barley, or other grains with the grasses, under the impression that they will protect the young plants from the sun and drought, is altogether wrong, as it practically does much more harm than good. The larger growing plants rob the soil of its moisture, to the destruction of the tender and more feebly rooting grass plants. No such protection is necessary even were it possible to supply it without injury. With fair preparation of ground, the seed put in as soon as practicable in the spring, the lawn will be fit to mow in June at latest.

A very successful improver, especially in the making of lawns, sows down in August and adds about 2 pounds of turnip seed to the acre. The gradual growth of the turnip foliage forms a congenial dampshade for the vegetation and spread of the young grass plants. The larger leaves of the vegetable also protect the grass against injury from the early frosts. Their gradual decay and ultimate removal are effected before the grasses are so far advanced as to be hurt by continuous shade, and a thick sward is secured before winter. A slight covering of strawy manure will be of advantage to autumn-sown lawns, particularly so if the soil inclines to be wet, and therefore liable to have the young plants thrown to the surface by the alternate action of freezing and thawing: A heavy roller should be passed over it as early in the spring as the firmness of the soil will admit, in order to tighten the earth around the roots, and press down such plants as have been loosened during the winter.

While it is true that a fine lawn can not be produced without good preparation, it is equally true that a fine lawn can not be maintained without frequent mowing. The recent improvements in lawn-mowers leave but little to be desired so far as mowing facilities are concerned. They also roll the lawn at the same time that it is cut, which is essential to the most perfect keeping. That which was formerly regarded as a formidable operation is now one of the easiest, and the lawn is kept in good order at less cost than any other portion of the pleasure grounds. One of the best points in the lawn-mower is its incapacity for cutting long grass, thus compelling frequent mowing, which is the great secret in keeping a superior lawn. Mow early and often is the rule. Even on newly seeded lawns the mower should be at work as soon as the grass is high enough to cut; indeed, much injury results from procrastination.

mination at this time; weeds will gain the ascendancy, and unequal growths follow. A lawn sown down in April was cut six times before the first of August, and had the appearance of a thick-set sod.

Neither in the preparation and formation of a lawn, nor in its keeping in this climate, are there any half-way compromises. The work must be done thoroughly to begin with, and then timely attention to cutting all through the growing season will insure a satisfactory result. Neither soil nor climate can justly be blamed for poor lawns, although it is a very convenient mode of shifting responsibility, and one frequently adopted.

As already remarked, lawn mowing machines will not operate to any good purpose where the grass is long; hence it has been recommended to leave the cut grass as a mulch. During the first year this course may be followed with advantage; but experience shows that a long continuance of the practice injures the lawn materially, particularly during early spring or late in the season. In the hottest portion of summer the cut grass dries up so thoroughly as to be but of slight influence either way.

The lawn will be benefitted by a top dressing once in three or four years; not, however, by throwing over it an unsightly covering of rough, strawy litter, which, however beneficial, is not commendable in neatly kept grounds. A compost made up of fresh stable manure and any ordinary good surface soil, thrown together in layers, and intermixed and pulverized by frequent turnings during the summer, will be in condition for application any time in early winter. This should be evenly distributed, broken up, and raked in among the roots, taking advantage of frost to assist in the work of disintegration, and removing the rougher portions altogether before rolling the lawn in the spring.

BELTS OR MARGINAL PLANTATIONS.

In suburban districts, where surrounding properties are likely to be improved and the scenery is liable to be changed at any time, too much value should not be given to neighboring views. It frequently occurs that the site for a dwelling house is selected mainly on account of its commanding certain distant views, even to sacrificing other important considerations in order to secure the prospect, and before the house is completed the fine views are obstructed by operations on an adjoining property. In localities of this kind the interest of the position should not so much depend upon external beauties that are beyond control as upon the internal improvements and local objects. Preliminary to this acquirement the grounds should be isolated by an umbrageous boundary of trees and shrubs, which will form a pleasant margin to the ground improvements, and provide that seclusion, retirement, and privacy which are always congenial to home comfort.

Whether the place is large or small, a carefully planted boundary of selected trees and shrubs should encircle that portion of the grounds

appropriated to gardening purposes. With regard to small places in thickly populated neighborhoods this should be the first consideration. The place will thus be made to look larger and the house can be partly surrounded by a somewhat open lawn, which will be distinctly defined and fringed by the border of shrubs. In grounds of greater extent shelter and protection, both to plants and animals, will be largely secured by thickly set evergreen trees on the most exposed quarters. Distinctiveness of arrangement will also necessitate the formation of a well-marked division between the garden, the lawn, and the open fields beyond, and here a continuous belting of foliage will serve to render the boundary line more pleasing if not less conspicuous.

Much of the efficiency as well as the beauty of this boundary belt will depend upon the form of its ground plan, as well as upon its sky outline, which is a curving line, widening and narrowing at certain points, as heavy masses of planting may be made to hide deformities or openings left through which to view the distant scenery. In arranging openings it is not necessary to arrest the continuous line of shrubbery. This can be maintained by using very low growing plants opposite to the selected openings. This will further have the effect of varying the sky outline both by elevation and perspective. The projecting points giving space for larger growing plants, will enhance variety in sky outline. These occasional masses of heavier plantings produce a pleasing variety of effect when contrasted with open spaces of lawn and groups of low-growing shrubbery.

The selection of the species and varieties, as well as the disposition of plants in a marginal border, requires skill and forethought. The proper gradation of heights, the contrasting and harmonizing of forms and colorings of foliage and flowers, and the general adaptation of the whole to the extent of grounds and to the requirements of the architectural and other improvements, will influence, to a certain degree, both the selection and disposition of the plants.

Where the grounds are so extensive as to admit of a plantation belt, varying in width from 50 to 200 feet, thus affording space for the growth of the largest trees, the selection of sorts will be less difficult than where the space limits the border to a maximum breadth of 50 feet. The following list includes some of the best trees of the smallest size, suitable to small grounds:

Acer campestre.
Acer Pennsylvanicum.
Amelanchier Canadensis, var. *botryapium.*
Aralia spinosa.
Carpinus betulus.
Cercis Canadensis.
Chionanthus Virginica.
Cornus florida.
Elæagnus angustifolia.
Fraxinus viridis.
Halesia tetraptera.
Hamamelis Virginica.
Kæltreuteria paniculata.

Laburnum vulgare.
Maclura aurantiaca.
Magnolia conspicua.
Magnolia glauca.
Paliurus aculeatus.
Prunus mahaleb.
Prunus padus.
Ptelea trifoliata.
Pyrus aucuparia.
Pyrus coronaria.
Shepherdia argentea.
Sophora Japonica.

FENCES AND HEDGES.

Some sort of fence is usually necessary to guard against intruders, or to designate ownership, and the kind of fence used will generally be governed by necessity.

Whichever material may be used for outside fences, they should be strong and substantial. Inside fences for such purposes as that of separating the lawn from the vegetable garden may be of lighter construction, especially if a fence crosses a lawn, as seen from the house with an open view beyond, it should be as light and elegant as is consistent with strength and durability. In such cases it is often desired to conceal the fence as an intrusive object in the landscape by adopting the sunken fence. This may be described as a ditch-like excavation 4 or 5 feet in depth, finished by a perpendicular wall on the lawn side and the ground flatly sloped on the opposite.

The propriety of persistently concealing the fence in such positions may be questioned. Utility is a strong element of the beautiful, and if no visible barrier intervenes between the pleasure ground and a grazing field we at once condemn the incongruity. We can not distinguish where the flower garden ends or the grazing meadow begins, and must suppose that the cattle can perambulate the flower garden if they choose; we can imagine the result, and we feel that a fence becomes a necessity to separate objects that can not be united without injury to one or both. Wire fences are well adapted to this purpose, as they are so light as not materially to interrupt the view, and if properly constructed are sufficiently strong and permanent.

Even in those happy communities where cattle are not permitted to run at large some kind of fence will be necessary to designate boundary lines of property. It has been claimed that the highest degree of rural beauty is a village without fences or any other distinctive marks to properties. As well might it be claimed that the best arrangement in a picture gallery will be produced by taking the paintings out of the frames and nailing the canvas to the walls. The love of exclusive possession is the mainstay of society. Well-defined boundary lines to property greatly enhance its enjoyment, especially when applied to lawns and gardens.

For this purpose the live fence is by far the most appropriate, and that formed of evergreen plants the most permanently beautiful. The Siberian arbor vitæ, Nootka cypress, and hemlock spruce are among the best for northern climates. In the South the Chinese arbor vitæ, Japan euonymus, and other evergreen shrubs may be added to the list. If deciduous plants are preferred, a selection may be made from the following list: Japan quince, buckthorn, elæagnus, Japan privet; and, if a somewhat formidable fence is desired, the Osage orange and honey locust will answer that purpose.

Hedges are also useful as shelter to gardens, rendering them earlier,

more productive, and greatly exempt from casualties of climate and locality. In the growth of all kind of small fruits as well as those of larger orchard growth, shelter is always of the greatest benefit. Many of the diseases of our fruit trees and imperfections in the products can be effaced by sheltering hedges and plantations, facts that are now being fully appreciated by fruit-growers.

In grounds of very limited dimensions, where the boundary lines are at no great distance from the house, an evergreen hedge set inside the fence will afford great relief to the eye and form a background, as it were, to the shrubbery and flower borders. The stiff line of the hedge can be modified in appearance by planting small diversified groups of shrubs or low-growing evergreens along its front. A continuous border varying in width and curving outline, running a direction parallel with the hedge, and thickly planted with flowering shrubs of variety, interspersed with such flowering herbaceous perennials as hollyhocks, phloxes, chrysanthemums, delphiniums, etc., is one of the best modes of treating a small pleasure garden and lawn.

ROCKERIES.

A rockery properly located and tastefully arranged is capable of affording much of interest and pleasure to those who can appreciate the beauties of nature. It is not advised to attempt the imitation of rocky scenery, which can rarely be successfully accomplished, even with the command of unlimited means. Abortions of this kind, where the means have been made more conspicuous than the end, have tended to discard rockeries from situations where they would be highly prized, were their real purpose fully understood.

The simplest form of rockwork may be described as a mound of soil covered with stones; and its purpose that of securing conditions for culture of the native plants of our woods and dells, as mosses, ferns, and others of similar habits, which will not flourish in the ordinary borders or beds of the flower garden, where they are too much exposed to sultry suns and drying winds.

A secluded spot or corner of the pleasure grounds shaded by trees, but not directly under them, is the position for a rockwork of the kind in question. Here, concealed from all points by an inclosure of shrubbery, or by an evergreen hedge, and approached by a rustic pathway through a leafy thicket, the rockery may be located, without any violation of good taste or interference with other and more ambitious decorations.

A basin to contain water may be cheaply constructed of brick and cement, and will add very much to the variety of the plants that may be grown. Shade and humidity, which are essential to the growth of many woodland plants, such as the *sarracenias* or pitcher plants, and also a constant evaporation during dry periods will enable these and

plants of similar habits to flourish as luxuriantly in an artificial state as they do in their native wilds.

A circular basin, 8 or 10 feet in diameter and 12 to 16 inches in depth, surrounded by a rock-covered mound of varied breadth and elevation, will afford space for a large number of plants. It will also allow scope for tasteful arrangement, both in the construction of the work and in the distribution of the plants. If some of the largest pieces of rock are allowed to project over the water, in varied shapes and masses, some of them forming foundation for miniature perpendicular cliffs, and others for rapidly receding cavities, a pleasing play of light and shadow will be thrown over the surface of the water.

An additional feature may be given by running through and around the rockwork a concealed pipe, with numerous small perforations over its surface through which water will be conducted to the plants, trickling over the rocks and dropping into the pool below, producing at once a charming rural effect and a congenial atmosphere for the vegetation.

This, or some similar simple method of arrangement, will usually be more satisfactory than an iron or even a marble fountain, with numerous fanciful jets and basins, supported by questionable statuary, displayed in a conspicuous position on the lawn.

By the use of small stones and cement a center ornament may be erected in the basin, and a jet inserted, through which the water is delivered in a finely divided spray. This will provide hygrometric temperature peculiarly adapted to such situations and objects.

There are but few country places where the means for securing these specialties can not readily be obtained. The water supply may not always be convenient, still by exercising a little ingenuity plans may be devised for its introduction, either by utilizing the waste from cisterns or forcing it into elevated receptacles. It may be mentioned that small jets are sometimes supplied by rainwater collected in cisterns, although this is not recommended as a plan likely to prove satisfactory.

A species of rock garden of more elaborate character may be formed by laying out a small geometric plan of raised beds of earth, supported by irregular-shaped stones. Old tree-roots may also be used to elevate and diversify the sky outline. These will in time become covered with foliage of creeping plants, ferns, mosses, and other low growths. The beds should be planted with low-growing hardy evergreens, such as various species of *Juniperus*, *Cupressus*, *Biota*, *Thuja*, *Taxus*, and *Retinospora*. The Mahonias are well suited to plant in such positions. Yuccas are admirable, giving a somewhat oriental character when massed in groups. Larger trees may be used where space will admit. The hemlock spruce is beautiful everywhere; the silvery deodar cedar will give variety of color; and the Pyracanth, Rhododendrons, and Kalmias, with many others, may be formed into picturesque groups of great beauty, depending very much, however, upon their location and skillful arrangement.

The more robust plants may be pruned when necessary to keep them within prescribed limits, and shaded spots will be found where the *Epigæas*, *Mitchellas*, ferns, and kindred plants can be introduced, desirable and interesting either for their floral beauty or their historical and botanical associations.

WATER—LAKES.

When appropriately introduced the effect of water in pleasure grounds is always pleasing; frequently it is strikingly beautiful, and, of all the materials that enter into the composition of natural scenery there are none that produce a greater amount of varied interest and beauty. It is therefore eagerly desired as an adjunct to the mere artificial improvements of private residences, public institutions, and city parks, and is always a valuable acquisition where it can be secured.

To form an artificial lake the first requisite is an ample supply of water at all seasons. There can not well be a more unsatisfactory object in artificial grounds than a lake where the supply of water is insufficient to keep it properly filled, and where natural facilities for a constant supply does not exist, its construction should not be attempted. The surface water or casual supply derived from rains and snows may be sufficient during winter and spring, but entirely inadequate to meet the evaporation during the summer; and lakes that are dependent upon this source, and become partially empty and stagnant during the warm season, are as injurious to health as they are opposed to all correct ideas of beauty.

Water for ponds is sometimes procured from the discharges of underground drains, and where the drained area is extensive enough to furnish all the water necessary, which can be ascertained by observations during summer, a pond may be excavated at the lowest point, allowing the surface of the water to be on a level with the discharge pipes of the drains. The excavated soil can be used in forming banks of varied heights and configurations. The outline of the pond, like that of a belt of trees or shrubbery border skirting a lawn, should be varied and irregular, with bold points and deep indentations, and these should be few and bold rather than frequent and tame. The resemblance between a level lawn, surrounded by curved outlines of shrubbery, and that of a smooth sheet of water in a pond or small lake, with jutting banks and retiring bays, is very close so far as relates to their artistic treatment in ornamental planting.

The most natural position for a sheet of water is in a hollow or low ground occupied by a constantly running stream. It frequently occurs that small streams are so situated that by skillfully throwing a dam across the valley hollow through which the water runs a large surface may be flooded and the water permanently retained. The water level on the surrounding ground will probably show a beautifully varied outline, which may be increased or rendered more definite by deepening

bay-like recesses and adding to prominent or jutting points. This, together with the effects that may be produced by planting, will give variety to otherwise monotonous outlines.

In geometrically arranged flower gardens simple basins of water may be introduced with good effect either with fountains or without them. In these situations the marginal finish or connection between the grass and water should be of an architectural description. Any attempt made toward a rugged or what is usually termed a natural-looking finish will certainly prove unsatisfactory.

ENTRANCE GATES AND CARRIAGE TURNS.

First impressions are strongly influencing and oftentimes prove to be the foundation of lasting prejudices. A neatly designed and tastefully arranged gateway at the entrance of a property creates the favorable expectation of finding these characteristics pervading other improvements. An imposing entrance way therefore becomes an important feature; but it should always bear a close relation to the general style and scale of the situation, and if it is architectural in design, should harmonize with the style of the mansion to which it is an adjunct; at the same time it may be more highly ornamented, keeping strictly in mind that no amount of mere decoration will compensate for any appearance of insufficient strength or utility.

Iron gates appear to greatest advantage when they are hung to stone posts or attached to pillars of masonry. A single block of granite, fashioned into a post forms a very satisfactory support for an ordinary iron gate. Large, heavy, and elaborately constructed iron gates demand heavier and more massive supporting pillars, ornamented to correspond with the style and finish of the gate. The main or principal entrance gate to any place, even of the most humble description, should be placed on a line receding more or less from the line of the outside or public road, being connected with the latter by a curved line of fence. The extent of this recess will vary with the extent of the place, facilities of position, and size and style of the gate, but 10 to 30 feet may be given as a range. Even in places of quite limited extent the former distance will be sufficient to give a decided effect without encroaching too severely on the grounds, and will establish a largeness of expression to the whole surroundings. In placing posts for gates the mistake is frequently made of setting them parallel to the public road instead of having them at a right angle to the road to which they properly belong. When the private road leaves the public one at right angles and continues in a straight line for some distance the gate will, of course, be properly placed in a line parallel to the public road; but where the front lawn is small in extent and it becomes a necessity to branch the road suddenly to right or left the importance of adhering strictly to the rule of placing the gate at a right angle to the carriage road will appear very conspicuous, for if the posts are set parallel with

the public road it will be found to be a matter of much nicety to drive a carriage through the gateway without either coming in contact with the post or allowing the horses to walk on the grass or road edging. Examples of this may be seen in most suburban districts.

The greater the inequality of the respective distances between the posts and the line of the outside or public road the more difference will there be in the length of the curved lines connecting them with the fence. One will be much shorter and have a different radius from the other; but this will not destroy the symmetry of composition which a gateway should possess, since the apparent utility of the arrangement will convey a strong reason for its adoption, which can be further increased by the judicious planting of trees; besides, it should be remembered that an expression of symmetry can be obtained without having a strict adherence to uniformity in detail.

A space sufficiently large to allow a carriage to turn is a necessary convenience to a house, and should be as near the main entrance as practicable. In the front of very large buildings a gravel space wide enough for this purpose is sometimes provided; but when the house is one of ordinary dimensions, and the grounds of only moderate extent, a large gravel space will very materially abridge the breadth of the front. The reflection of heat from gravel is not pleasant, neither is it so agreeable to the eye as the grassy lawn. Some of the objections to an open gravel space are removed by forming a circular carriage-way directly in front of the house, inclosing a bed for shrubbery or a grass plot. The amount of roadway is, by this mode, somewhat reduced, but the evil of breaking up the front still exists; nor does it provide all the requirements of a carriage turn, as there is no alternative but to perambulate the circle when retiring; and the annoyance of having vehicles and animals obstructing the view from the principal windows of the house is also a great objection to this arrangement. The best position for a carriage-turn is beyond the house, so that a vehicle, after approaching the main entrance can proceed onward, turn, and approach the house again in the opposite direction. The turn in this case can be partially screened from the house by planting shrubbery; and arrangements for tying horses can be made in unobjectionable positions where they will not present annoying features as seen from the house. This allows the grass or lawn to be carried closer to the building, the roadway only intervening, and the side grouping of plants can be executed much more effectively. The curve of the road, entering into the grounds on one side, will be balanced by a similar curve on the other side towards the turn. In this proximity to a building, the walks, as well as artificial plantings, should be symmetrical in their tendencies and in keeping with the formal style of treatment which such a position demands. The central view from the building will be open, and impart an expression of freedom and apparent extent of lawn, which is always pleasing, particularly in limited areas.

PLANTING ROADS AND AVENUES.

In the planting of straight roads and avenues it is essential to preserve regularity of line, as also uniformity in the color and shape of the trees. The nearest approach to the sublime in landscape gardening is in effects produced by extended uniform lines of trees. Continuity of line and uniformity of object, when combined with great extension, produce sublimity. Objects are sublime which possess quantity and simplicity in conjunction. It is not on a small rivulet, however transparent or beautifully winding it may be; it is not on a narrow valley, though variegated with flowers of a thousand hues; it is not on small elevations, though they are clothed with the most delightful verdure, that we bestow the epithet sublime; but it is upon Niagara, the Mississippi, the Andes, the ocean, the wide expanse of the firmament, or the immensity of space uniformly extended, without limit and without apparent termination. To produce this effect it is therefore imperative that only one variety of tree should be used. Anything that tends to break up the uniform continuity will at once destroy it. A straight avenue planted with a variety of trees of varied forms, some broad and spreading, others tall, pointed, and spiry, is as much at variance with good taste as would be a Grecian façade furnished with columns embracing all the different orders of architecture. Among the best trees for planting wide avenues are the tulip tree, the sugar and the silver maple, lindens, sycamores, walnuts, oaks, and chestnuts. For narrower roads, those from 16 to 20 feet in width, the Norway maple, the black and white ash, the horse chestnut, and those of kindred habit will be more suitable.

On long and wide avenues, in positions where a side view of the lines is prominent, the wall-like effect may be very much softened and toned down by setting a double or even triple row of trees, and this will be still further increased by planting each opposite row, respectively, with a distinct kind. An avenue of tulip trees will in this arrangement be well supported by an outside line of red maples, their forms will blend-pleasingly, and the contrast of their spring verdure and autumn colorings will be agreeable. In a similar disposition the sugar maple, sweet gum, and ash-leaved maple may be used. Such combinations may be indefinitely varied and adapted to the embellishment of avenues as their extent and importance may demand or require.

In planting curving roads, the disposition of the trees will obviously be determined by the general character of the grounds through which the road passes.

In places of 6 to 10 acres in extent, and in form nearly of a square or parallelogram, with the mansion placed 100 yards back of the front line, the entrance gate may be judiciously set near one of the corners, and the road gradually curve to the building. A single continuous row of trees on one side of this road would have a monotonous effect,

and a row on each side would destroy and completely break up any attempt at breadth of view. The road should rather appear to curve round and pass through masses of trees and shrubbery plantations. While attention may be given to partially shading the road by placing suitable trees mainly on the south and west sides, yet these shade trees should form only a portion of groups, with an occasional isolated single specimen tree; or, what is still better, two trees of the same kind set 6 to 10 feet apart, so that when they grow up they will give a distant appearance as of a single tree, with the additional variety of aspect when closely viewed. The planting of groups should be more extensive and massive on the inner circle, around which the road will curve, with frequent open vistas looking in upon the lawn. The width and length of the road and extent of lawn will designate the size of the groups, and also suggest the particular kind of trees and shrubs of which they are to be composed. Shade trees may be thus introduced in sufficient quantities, even on winding roads, to answer the combined purposes of shade and garniture, without producing an appearance of strained effort to secure it.

Where the road is wholly on the southern side of the dwelling, deciduous trees should be used in front or near the building. If the entrance and the road are north of the house, a straight avenue of evergreen trees will form an admirable feature, if ample space is allowed for both road and trees. The Norway spruce is, perhaps, the first choice of tree for such planting. The hemlock spruce is the more graceful and the best adapted to short roads or narrow grounds. The Austrian, the Scotch, and the white pine may be used where the grounds are extensive. Even when the Norway spruce is used the parallel lines should be 60 feet apart, not only to admit of sun and winds to act directly on the roadway, but also to give ample room for the spread of the lower branches of the trees; and in no case should they be planted nearer than 16 feet from the edge of the road, and when the larger and more widely-spreading pines are used, a space of at least 20 feet should be given. A very meager effect will result from planting close to roadways, narrowing them into mere strips, which for at least one-half of the year are seldom dry.

PLANTING NEAR BUILDINGS.

A mischievous error, and one too frequently perpetrated, is that of placing trees close to buildings. Although trees and shrubs are the chief decorative ornaments of a place, they become not only disagreeable but positively injurious to animal life, when closely massed around a habitation, by shutting out light and preventing the rays of the sun and drying action of the winds from exerting their salutary influence on the walls, which in consequence are constantly damp and unhealthy. Where large trees are allowed to spread and overhang the roofs, choking gutters and water leaders, and causing a deposit of mold and other

fungoid growths as far as their influence extends, it is impossible for the house to be dry, comfortable, or healthy for human beings. Many of the older houses throughout the country are rendered almost uninhabitable by the dense surroundings of trees and shrubbery, and the evil is greatly aggravated when the trees are of evergreen species. Ventilation is produced by heat, and a building shaded from the rays of the sun by lofty trees and sheltered from currents of air by thickets of shrubbery is deprived of the influences most conducive to health, and is a fitting subject for the attention of a sanitary commission.

Plantings of the finer species of dwarf flowering shrubs may be placed in moderately large masses on the lawn near the house without any great injury if not too frequently repeated; but even the smaller growing shrubbery, if planted in continuous thickets near the building, in any way except a northerly direction, will sensibly exclude the genial cool breezes so grateful during the summer. A house nestling on the sunny side of an evergreen plantation is suggestive of comfort, and presents a cheerful, sheltered appearance during winter. It is as economical as it is attractive, as many persons can testify who have had the foresight to plant sheltering borders of evergreens in bleak and treeless situations, and in consequence are realizing a higher thermometric temperature; but even these, to be of greatest benefit, should not approach within 100 feet of the house, at least not in a mass. Isolated specimens of rare or otherwise specially interesting trees may be planted nearer, but only on the northern sides of the house.

A certain amount of shade is very desirable in connection with a house, especially in climates where, during a great portion of the time, it is more agreeable out of doors than it is in rooms; yet it had better be secured by covered verandas than by trees. It is also more conducive to health to sit under a covered roof. Exposure to evening dews is a well-known fruitful source of sickness, and the partial protection afforded by the overhanging branches of trees is not sufficient when dew is forming.

Trees of the large-growing species should not be planted nearer than 60 feet to the walls of a dwelling house. Such trees are the sugar and the silver maple, the sycamore, elm, linden, ash, chestnut, and poplar. Trees of medium growth, such as the Norway and the English maple, and others of this class that do not attain a height of more than 30 feet, may be planted 30 to 40 feet from the building.

Another disadvantage resulting from surrounding the building with a thicket of foliage is, that it shuts out the views of immediate and distant scenery; as seen from the house at the same time the house, as an object of the local landscape, is completely hidden from view. If the architecture of the structure has received any study as a work of artistic design, it should in itself form a picture which to be properly appreciated must be seen and viewed as a whole, so that its proportions, outlines, elevations, and ornamental details may be taken in at one view. Even beds

of low shrubbery, if abundantly introduced near the base of a building, will foreshorten the elevation, obstruct the view of the horizontal base line, and seemingly destroy architectural proportions. Many of the finest structures, both public and private, are ruinously shorn of their beauty by careless or ignorant planters, who, in their endeavors to beautify a building, succeed only in concealing those salient lines and projections that give it character and distinctiveness.

A proper connection of the house with its surroundings is the first point to which attention should be given in laying out grounds, as it is the most prominent and leading detail of improvements. A house should not appear to have risen out of the green lawn like a tree. It is necessary that some evidence should be apparent of suitable preparation having been made for the building; at least a level platform of more or less width should project from the base line. The ground line should be level, and all walks should correspond with the lines of the ground plan. Zigzag and curving walks close to the straight lines of a large or even the most humble building are directly opposed to beauty or propriety; they are sure evidence of unskilled labor.

The principal front of a building should show a terrace, either architecturally treated or at least with the architectural appendages. The level line of the terrace will furnish a uniform base to the building, and masses of low-growing plants may be introduced below the terrace where they will not interfere with the view of the structure. A few trees may be planted at the ends or in the rear, which will serve to connect the house with the grounds and their scenery, and this can be done without either hiding or overshadowing the building.

It has long been laid down as a general principle that round-headed trees contrast best with the prevailing perpendicular lines of Gothic architecture, and those of the pointed or conic shape with the horizontal of the Grecian. It may be questioned whether either of these rules is sufficiently accurate to be worthy of consideration; certain it is that there may be found compositions of expressive beauty where the arrangements are the reverse of those proposed in this general principle. It is perhaps nearer the facts to state that in the arrangement of forms harmony will prove more pleasing than contrast; but when applied to colors contrast will develop the most distinct and expressive compositions.

GROUPING TREES AND SHRUBS AND PLANTING IN MASSES.

Among the various operative details in landscape gardening the arrangement of vegetation is the most important, and there is no other that shows so distinctly the artistic skill and arboricultural knowledge of the operator. While this is the most decisive as to the ultimate beauty and value of the improvements, it is acknowledged to be the least understood; for artists of considerable repute, who may establish grades, run lines of roads, and stake out places for groups and single

trees, fail to designate the kind of plants to be used, thus leaving to mere chance the only features where artistic merit can be developed.

Some of the principal and most conspicuous effects that may be realized from grouping and placing trees are as follows :

1. *The formation of distinct groups of the various species and varieties of trees.*—In planting public parks, college and school-house grounds, or private grounds, if of sufficient extent, a great amount of arboricultural interest will be induced by forming groups of certain families, genera, or natural orders or plants. It might be presumed that this mode of arrangement would sacrifice beauty, in order to carry out a mere mechanical system of disposition, such as may be seen in orchards, and would prove monotonous, and destitute of that variety which results from a combination of different species. This is to a certain extent true where the grounds are not extensive and the planting is confined to one principal group. In that case the use of diversified materials will invest the group with a greater variety of interest to the lover of trees, and that also without impairing the landscape effect, if the arrangement is properly carried out ; but where the plantation is extended over several acres, the groups will be more definite and distinctive in character if each is chiefly planted with the plants of one genus. This may be partly illustrated by supposing that there are twelve principal masses to be planted, and twelve species of trees are employed. If each mass is composed of a mixture of the twelve species, the result will be twelve groups of precisely the same character ; whereas if each group is strictly confined to one species, the groups will be entirely dissimilar, each forming a distinct feature. Thus groups of maples, oaks, birches, elms, etc., will follow in succession ; and where whole families are thus connected, there will be sufficient difference in form and habit of growth among the species to give variety to the group when inspected in detail, and at the same time the mass will present distinctive features peculiar to the genus represented. In ornamenting the grounds of colleges and other seats of education this mode of planting is particularly appropriate, affording admirable facilities for studying the individual trees and comparing them with other species of the same family. The beauty of this arrangement will depend upon the harmonious connection of forms and adaptation of the respective growths to certain positions in the groups.

2. *Planting evergreens with a view to forming a distinct winter scenery.*—No effective or perfectly satisfactory results will be produced from a general intermixture of deciduous and evergreen plants. In forming shrubbery borders this distinction is not so strictly important as it is in the case of trees ; but even in the arrangement of shrubs a far more polished and artistic finish will be given by placing the larger growth of deciduous plants in the background, and bordering towards the front with some of the low-growing evergreen species. One of the most desirable plants for an edging to a border of shrubbery is the *Mahonia*

acquistifolia. It grows in a compact, rounding form, and is beautiful at all seasons, whether in the glossy brightness of its varnished foliage during winter, the profuse cluster of its yellow blossoms in spring, the fern-like delicacy of its young foliage in early summer, or when laden with clusters of its dark-colored berries. Where the mercury frequently sinks below zero this plant will not prove ornamental. The recent additions to our hardy evergreen shrubs have been notable and valuable. The *retinosporas* alone comprise great variety. The *Euonymus japonicus* and its silver and gold striped varieties, furnish valuable material where they will withstand the winters. The *taxus*, *cupressus*, *juniperus*, and *thujas* furnish numerous plants of dwarf growth for the shrubbery.

In respect to the heavier tree growths, it is clearly manifest that the finest examples of arrangement are those where evergreen and deciduous trees are treated as forming distinct scenery; and of these the evergreens are, perhaps, the most valuable because they furnish a winter clothing to the landscape, with but little aid from deciduous plants, while the summer assistance of the latter only supplement and adorn the forms and colors of the evergreens.

To produce the best winter effect from evergreens, they should be planted mainly in the foreground, particularly on such projecting points as are conspicuous, so that while these points or groups may be rather widely separated, they will have a continuous appearance by the tops of those in one group apparently connecting with the lower branches of the group beyond, as seen from the principal points of view. An indiscriminate mixture of all kinds of trees is destructive of beauty. The deciduous varieties diminish the beauty of evergreens during winter by breaking up the continuity of color and repose so essential to the best effects, either in gardening or painting; and during the summer season, the more numerous the branches and broader expanse of foliage of the deciduous trees, if close to evergreens, will overpower the latter, and, in time, completely destroy them, by an excessive amount of shade, and also by the extraction of moisture from the soil. For defining outlines or rounding off groups, no plant is so appropriate or can so well be adapted to any position as the hemlock spruce. Its wavy branches convey a more finished impression than any other hardy evergreen, and no other can excel it either in beauty of growth or general usefulness in producing the best effects of landscape gardening.

3. *To gradually blend evergreen and deciduous plantations by pleasing connections.*—The majority of evergreen trees are conical and pointed in form, while among deciduous species the prevailing habit is flat or round-headed; but trees of those opposite forms may be found in both classes. Spiry topped and conical forms are seen in the larches, Carolina cypress, Lombardy, and other poplars, and round-headed evergreens are seen in the Scotch and Austrian pine. Many species of the pine tribe, although of a pyramidal or pointed form when the plants are young, assume an open, spreading habit as they become older.

To connect evergreen and deciduous groups those trees that partake of intermediate characteristics should be employed in blending the two classes, where the plantation is continuous; and where a more distinct but not abrupt line of separation is required between the two, it may be judiciously accomplished and the margin of each group be toned down by introducing a few of the most graceful trees of both classes, such as the Norway and English maple, negundo, and yellow wood among deciduous, and the hemlock spruce, Lawson's cypress, arbor vitæ, and *retinosporas* among evergreen species. The rather novel difference between the arboreal aspect and the botanical classification of the *Salix-burialia adiantifolia* renders it peculiarly appropriate for an intermediate position between evergreen and deciduous trees.

4. *To place certain trees in conspicuous positions.*—Trees that are pre-eminently notable, on account of their rarity, beauty, or botanical historical associations, may be placed as isolated specimens in prominent positions on the lawn. This interpolation, however, should be carefully studied; a single tree, if wrongly placed, may destroy a fine picture. Indeed, it is everywhere evident that the greatest prevailing error in arranging ornamental plantations is the oft-repeated single tree, dotting every spare surface with a plant, producing a spottiness quite opposed either to beauty or design.

Single trees may be made still more conspicuous by planting them on slightly elevated mounds; this will add to their general effect, and allow perfect freedom for assuming their normal habit of growth. Trees worthy of so distinguished sites, for their beauty of growth, are very numerous; but for extensive grounds, where the largest class may be introduced, the *Magnolia acuminata*, the sugar and Norway maple, *Cladastris tinctoria*, Osage orange, negundo, willow-leaved oak, and English maple may be noted as a few of the deciduous; while among evergreens, the hemlock and Norway spruce, Himalaya pine, Nordman fir, Nootka cypress, and Siberian arbor vitæ, may be specially mentioned.

Of rare and interesting trees the list is extensive, and will vary according to individual tastes and studies; the extent of ground and general disposition of other plants will also influence the selection and number of single specimens.

5. *Plant with reference to individual beauty, as also with regard to that resulting from a combination of forms.*—Isolating the trees, as alluded to in the preceding paragraph, will produce the highest degree of individual beauty and development. But to realize all the variety that may be obtained from contrast of forms, foliage, and flowers requires more careful study and preparation. Irregularity of distance between plants will in itself affect variety in composition. Very little either of beauty or interest can attach to lawns where every tree is equidistant, or apparently so, from its neighbor, like so many cabbages or currant bushes. If we observe the disposition of trees in any natural group that attracts our attention, we shall learn that the influence of

unequal distance in massing foliage and causing minor groupings of branches and stems is very great. To produce a similarly pleasing variety of stems and outlines it will be essential to imitate to some extent the mode in which natural groves are formed, even to placing several trees together so as to present the appearance of several stems issuing from the same root. A degree of naturalness will thus be imposed upon groups, even should there not be any attempt at contrasting or harmonizing forms; but this latter will show more decidedly the foresight and skill of the designer.

6. *To produce a pleasing sky outline to all heavy masses or distinct groups.*—The sky outline composition of groups is a pleasing and noticeable feature. The monotonous sameness in the aspect of a peach or an apple orchard is a familiar result and example of what may be intensified by closely planted masses of formal growing trees. But it is a rare occurrence to find such monotony in natural forest scenery. A great diversity of sky outline will prevail, especially on the margins of groves, where the foliage is continued by suitable undergrowths down to the surface of the ground. Such distinct and unique forms as the Lombardy poplar, deciduous cypress, larches, and similarly pointed trees will give a spirited effect to the most commonplace groups.

The edges of plantations composed of larger growing trees will be softened by the introduction of drooping forms; and one of the most beautiful compositions, with reference to direction and curvature of branches, as well as to sky outline, is that produced by surrounding two or three Lombardy poplars with a circle of weeping willows. The poplars should not be more than 12 feet apart, and should form one central figure; if spread out singly the distinctive feature of a spiry column will not be secured.

Similar effects may be secured with groups of evergreen trees. The balsam fir is admirably effective as a center to a mass of lighter colored evergreens, owing to its heavy, dark hue. The Scotch pine and the Austrian are well adapted, both in color and form, to accompany the balsam fir, and the beauty of finish can be added by introducing the wavy branchlets of the hemlock spruce.

7. *Plant with regard to autumn coloring and the introduction of flowering trees.*—The cheerful appearance of flowering trees should be made a point of attraction in any arrangement of groups or masses. These can be introduced under any system, as they are mainly trees of the third class, such as dogwood, Judas tree, Virginia fringe, silver bell, etc. Their appropriate position is on the margin of groups, and an occasional dogwood planted where its white flowers will be displayed against a darker color of evergreen will brighten the early summer scenery. The dwarfer growths of *spiræas*, *forsythias*, *deutzias*, *cydonias*, and other species of flowering shrubbery may be so introduced, with the finest effect.

In arranging trees for the purpose of producing strong contrasts

from the changing colors of autumn foliage there is a wide field for the artist.

The most conspicuous colors are the scarlet of the sour gum, red maple, wild cherry, and some of the oaks, and the yellow of the hickories, tulip tree, sugar maple, and others. The dogwood and sassafras are also decided in their fall colorings.

The beauty of groups will greatly depend upon their definiteness, distinction, and separation by expansive open, green lawns. These grassy openings are the lights of the natural picture, while the trees and vegetation furnish the shade. The error of too much planting is frequent and disastrous in its effects. The open, clear, well-kept lawn should largely predominate, for, as Bacon remarked 300 years ago, "there is nothing more pleasant to the eye than green grass kept finely shorn."

ON DRAINING LANDS.

The statement is sometimes made that draining is of but little use in a climate where hot dry suns and dry weather are so common; that instead of trying to get rid of the water we should rather try to retain it; but those who reason in this way do not seem to be aware that the purpose served by draining land is the removal of superfluous water only, and not that of extracting all the available moisture which it contains. Every variety of soil has its relative degree of porosity or power of retaining moisture. Peaty or mossy soils, which are mainly composed of organic matter in different stages of decomposition, are very porous, and in consequence absorb water readily and in great quantities. Clay soils, on the other hand, being close and compact, absorb water slowly and to a limited degree as compared with the first mentioned. Draining a peaty soil will not deprive it of porosity. It may be likened to a sponge, which will retain all the water which may be poured on it until its pores become filled; afterwards the water will drop from it as fast as it is poured on. So it is with draining soil; no water will escape by the drains until the soil is saturated and is unable to contain any more; then the superfluous water passes off by the drains, leaving the land always in a condition for healthy plant growth, which is completely reversed when the superfluous water is only removed by the slow and chilling process of surface evaporation.

Clay soils can not be cropped to their best advantage until they are drained. The ordinary operation of plowing has a tendency to form a hard surface at the bottom of the furrow, which in time becomes compacted and acts as a basin holding water. Soils of this kind are well designated as cold. The heat of the sun can not warm the soil until the water is first removed by evaporation, a process which produces cold; so that, in addition to the impracticability of putting in crops early in spring, every heavy summer rain cools the earth, and the plants

growing in it receive a series of checks in their progress towards maturity. Draining removes all these evil consequences.

Briefly, it may be stated that some of the advantages of draining are the removal of superfluous water from the soil, thus keeping the temperature of the earth near the surface at its normal state. This makes early planting possible, and hastens the growth of the crops; it equalizes the temperature of the land; it equalizes the moisture of the soil, and growing plants are thus, to a great degree, exempted from the evils which follow either deficiency or excess of rainfall; the roots of plants are more generously supplied with soluble food carried down by rains; the formation of plant food is increased by admission of air to the soil; the land is more economically worked, and cultivation suffers less interruption at all seasons, and, as a consequence, crops are increased to their maximum production, at least so far as they are dependent upon the physical condition of the soil, a factor of equal importance with that of its chemical constitution, and one which is greatly underestimated.

SOWING SEEDS AND RAISING YOUNG PLANTS OF FOREST TREES.

Seeds should be sown as soon as practicable after they are ripe. They will vegetate sooner if sown immediately after being gathered from the plant than they will at any other time. Exposure to the air hardens their outside coverings, which tends to prevent germination, so that the time required for a seed to germinate after being sown depends greatly upon the amount of drying and exposure to the air to which it has been subjected since gathered from the plant. But it is not always practicable or convenient to sow seeds immediately after they are gathered. Some ripen so late in the season that they can not be sown immediately on account of frost; therefore the alternative is to preserve them in the best manner to retain their vitality and facilitate speedy germination when sown. Among those which do best when sown in the fall are the seeds of the peach, cherry, chestnut, hazelnut, walnut, hickory, oak, horse-chestnut, Judas tree, hackberry, yellow locust, Osage orange, and the magnolia. These mostly form very hard shells when exposed to the air for a length of time, and are afterwards very slow to vegetate. If they have to be kept over winter for spring sowing they should be kept from the air by mixing them with dry sand, and kept in a cool, ventilated shed or cellar. If kept damp and warm they will either vegetate prematurely or decay. Acorns are specially liable to lose their vegetative power by exposure to dry air. They can be best preserved by spreading them on the surface of the ground in the open air and covering them with 1 or 2 inches of light soil or sand, but no water should be allowed to lodge around them, otherwise decay is certain.

There are some seeds that ripen early in summer and will not keep well, consequently have to be sown immediately when gathered so that the young plants may attain some size and strength before winter. Of these the silver maple, elm, and poplar may be mentioned. Silver-maple seed is usually ripe in May, and if then sown young plants from 2 to 4 feet in height will be produced before winter.

Small seeds, and those which are light and chaffy, such as seeds of the alder, birch, sycamore, paulownia, mulberry, and tulip tree, as also some of the later-ripening winged seeds, as the sugar maple, negundo, and the species of ash, should be gathered when ripe, and spread thinly in an airy, shady situation to partially dry, then stored in coarse bags in a cool place until wanted for sowing in spring. Larch, pine, and seeds of coniferous plants generally should be kept in a similar manner during winter. Seeds of the tulip tree should be sown very thickly, as they are mostly very imperfect.

To succeed in raising healthy plants it is essentially necessary that the seed should be sown in deeply worked loamy soil. It should not only be deeply pulverized, but also as rich and fertile as it can be made. No half-way measures should be tolerated in a thoroughly good preparation of the soil; as a general rule there is altogether too little account made of this greatest source of success, and numerous failures at raising plants from seeds are clearly traced to the use of poor, thin soil, while the want of success is attributed to the poor quality of the seeds, or reflections are cast upon the reliability and good faith of those who furnished them. The most convenient method for after culture is to sow in drills. The distance between the drills will be guided by circumstances. If hand culture only is to be employed, 18 inches apart will be a good distance for most tree seeds, although some of the finer or smaller kinds and such as require several years' growth before the plants become large enough for removal may be placed closer. All the pine family belong to this class. The depth of covering will also be regulated by the size of the seed and to some extent to the kind of soil and the situation. On sandy soils the covering may be deeper than when the soil is liable to form a crust on the surface after rains. This character of the soil is not well fitted for raising young plants in dry climates, unless rains can be prevented from beating on the surface immediately above the seeds. Acorns and the larger kinds of nuts should be covered with about 2 inches of soil, and if this covering is composed of light mold and sand, somewhat firmly pressed over the seeds, moisture will be secured more uniformly, and the young shoots will meet with no impediment in their growth; a slight covering of short straw or chaff may be used to great advantage if carefully removed after vegetation has started. Chaff is an admirable covering for seeds, and only the most slender growths will require its removal.

Light and small seeds, such as those of the birch, catalpa, paulownia, and mulberry, should be sown on the surface of the soil, which is

afterwards raked evenly and smoothly without disturbing the regularity of the seeds, and this will afford sufficient covering. By passing a light wooden roller over the surface a finer pulverization will be given, and the pressure will tend to preserve the moisture of the soil from rapid evaporation. A finely pulverized, firm surface acts as a substitute for mulching.

The ordinary care given to crops, such as weeding, hoeing, or merely loosening the surface, will be necessary when the young plants appear above the soil, so as to encourage their growth. There are various kinds of hand cultivators now in use which answer an admirable purpose in removing weeds from young plants that are in drills, especially on light soils, and even on tenacious soils they can be used to advantage when the soil is softened from previous rains; but judgment is required in selecting the best time to work on these soils; if tramped upon when wet they become caked and lumpy; on the other hand, when stirred at the proper time they can be finely pulverized.

Very small seeds can be sown in boxes and covered with glass, or otherwise protected against rapid evaporation. Such coverings may be removed when the young plants have sufficient roots to supply moisture to the leaves.

MAKING AND KEEPING LAWNS.

To have a perfect lawn it is absolutely necessary to have it properly laid down to begin with. The primary requisite is the proper preparation of the ground. There is nothing that can be done to the soil with the view of making it productive and in the best condition for plant growth that is not necessary to be done to soil intended to support a permanent green lawn. Draining, deep working, manuring, and thorough pulverization are all requisites to the best degree of success. In preparing a lawn of any great size, where it is practicable to use a plow, the work should be done with exact thoroughness. It will in all cases be best to work the ground in autumn if it is of a clayey character. It should be turned over as deeply as practicable, and a subsoil plow should follow in each furrow, breaking up but not turning over the subsoil, nor bringing any of it to the surface. Subsoiling is often so slovenly performed that it is of but little benefit, but it is of so much importance that special care should be given to its proper execution, so that it be something more than a mere scratching of the ground. In the immediate preparation of the surface previous to seeding in spring, the ground should again be plowed over so as to turn under any of the poorer portions of subsoil which may have been brought to the surface by the previous deep plowing. This is very important where the subsoil is at all of a clayey, adhesive nature, as a surface soil of this character prevents the uniform growth of the young grass plants, and becomes hard and compact on the surface, destroying the grass even after it has vegetated.

Previous to this shallow plowing a dressing of barnyard manure should be spread on the surface and covered. This may be substituted by an application of bone fertilizer of not less than 500 pounds to the acre, harrowed in just before sowing. After sowing, a light harrow should be run over it, followed by a roller to press the seed into the soil, but no rolling should be given to clayey land unless it is thoroughly surface dry at the time.

The one best grass for a permanent lawn is the blue grass (*Poa pratensis*), and under favorable conditions of soil and weather no addition is needed. But the seed of this grass is rather slow to vegetate and, if the surface becomes hard and compact before the young plants make their appearance there will be much loss. The best general mixture, after various trials with other kinds and mixtures of grasses, is to mix 2 bushels of blue grass, 1 bushel of red top (*Agrostis vulgaris*), and 1 quart timothy (*Phleum pratense*) for 1 acre. This is a heavy seeding, but experiments show that there is a gain in rapidly securing a thick sod by seeding thus heavily. Some prefer to add about 1 pound of white clover to the above, which may assist in forming a dense lawn, but the best lawns are those in which white clover is not to be found. The practice of sowing oats, barley, or other grains with the grass seeds, under the impression that these latter plants will protect and foster the young grass plants from sun and drought, is altogether wrong and ruinous to a young lawn. It may be asserted that no good lawn was ever produced in one year where grain crops are sown with the grasses. Yet the practice is continued, and continued disappointments follow. When the mixture of grasses just given is sown in a proper manner about the early part of spring, the grass will be ready for the lawn-mower by the middle of June; after two or three weekly cuttings the lawn will have the thickness and appearance of old sod. But when the oats are sown, they will be cut over once or twice until their stubble dies, and the few weak grass plants which have struggled into existence will succumb to a week of dry, sunny weather; then weeds take the place of grass, and the lawn will have to be renewed by additional sowings. While it is true that a good lawn can not be produced unless everything has been properly prepared, it is equally true that a good lawn can not be maintained without proper attention to mowing and fertilizing. Lawn-mowing machines are now so cheap and efficient that the cutting of the lawn is merely a mechanical operation, and one requiring but little skill in its performance, and the numerous fine lawns now everywhere to be seen are, in a great degree, due to the introduction of these machines.

When a lawn becomes thin and the growth of the grass declining in vigor, the best treatment is to apply a heavy dressing of well-rotted stable manure during the latter part of December. It is important that manure for this purpose should be well rotted before being used, and as occasion offers during winter it should be broken up and harrowed or raked, so as to distribute it equally over the surface and settle down

and nourish the grass. When spring opens, all the rough and strawy portions should be removed; otherwise it will interfere with the action of the mower.

Bone-meal is one of the best applications that can be given to a lawn. The practice of allowing the cuttings from the mowing machine to remain on the lawn is, upon the whole, very injurious. With newly-formed lawns it is of some value for one or two cuttings; after that it tends to injury.

SPRING AND FALL PLANTING OF TREES.

The relative advantages of spring and fall planting have given rise to many opinions, and it is not strange that a wide difference in opinion should be held on the question, since so much of success or failure depends upon the season, locality, and other attendant circumstances. The influencing agents of vegetation are subject to such vast variety of modifications, which can neither be foreseen nor prevented, that no isolated observation, however truthfully noted, will suffice as a guide in establishing definite rules; and it may be remarked that the many seemingly conflicting opinions upon certain points of practice could, in most instances, be reconciled if all attending facts and circumstances were clearly produced, but these items are difficult to obtain.

Perhaps the strongest argument in favor of fall planting is the particularly favorable peculiarities in the relative conditions of the soil and the atmosphere at that season. Independent of this, it is theoretically true that autumn is the best time for removing trees. A plant that has occupied its position for several years can not be removed without curtailing and injuring its roots more or less, but there are certain portions of the year when the roots are of a minimum importance to the plant. It is very evident that they are most essential when the tree is in full foliage and vigorous growth, and during this period any reduction of roots would be speedily perceptible; on the other hand, when the seasonable growth is completed and the plant defoliated, the offices of the roots are less important. From the above we learn that the best time to transplant is between the fall of the leaves in autumn and the bursting of the buds into growth in the spring or during what is termed the dormant season.

The "particularly favorable conditions of the soil and air" may now be noted. During the month of October the soil averages 10° warmer than the atmosphere. This forms a species of natural hot bed into which we place a newly removed tree, the formation of young roots is encouraged, and before many weeks elapse the plant is well established to withstand the vicissitudes of winter and make an early and vigorous start in the following spring. The low atmospheric temperature prevents any growth in the branches, which is so far favorable under the circumstances.

In spring we find these physical conditions reversed; the soil is then

cold, and accumulates heat slowly while the air rapidly increases in warmth; the buds are excited to growth, new-leaves are formed in advance of the roots, each leaf acts as a pump extracting sap from the branches and trunk of the tree, which as yet has no active roots to supply the demand; and if evaporation is severe and continued, the plant must either succumb or receive such a check as will require the whole season to recover. Hence it may frequently be observed that spring-planted trees will show a profusion of leaves, apparently vigorous and healthy, but suddenly wither and decay under the influence of clear, dry, and warm weather.

These, so far, show great advantages in favor of fall planting, but there are other considerations to be canvassed before deciding the question. It is very clear that unless planting is performed within a certain period the advantage of immediate root-growth will not be secured; if delayed beyond the first week in November, success will be less certain. The best period is undoubtedly as soon as the leaves change color, stripping off the foliage before removal.

The character of the soil and location will also materially influence success. In undrained clayey soils the trees may not get sufficient root hold to enable them to resist the throwing-out tendency of alternate freezing and thawing, or the young spongioles may be destroyed by constant saturation. Again, in very bleak and exposed localities the drying winds of spring may exhaust the juices faster than the young roots can supply the demands of evaporation. Of course the very evident precaution of securing the plant from swaying should be attended to; otherwise many of the young rootlets will be twisted off. Staking may have to be done where the trees are tall, but it is much preferable to stay them with a slight mound of soil over the roots, which can be removed when of no further use. It will also be of great benefit if the frost can be kept from penetrating to the roots. A covering of loose material will be a protection, a wise precaution, even on well-established trees.

In northern latitudes, where the winters commence early and continue long and severe, fall planting will not so generally be successful as in more temperate regions, except in particularly favorable localities. Early spring planting, taking the precaution to prune the branches, so as to restore the balance destroyed by the root mutilation inseparable from removals, and mulching over the roots, so as to retain moisture during summer, will be the most likely auxiliaries towards success.

Evergreens can, in all cases, be most successfully transplanted just as growth commences. When the young shoots exhibit symptoms of pushing, they can be removed without risk of failure with ordinary care. They may also be removed in August and September, so that they can have a good season to furnish new roots before winter. Early spring removal of such trees is not advisable, as they have a large evaporating surface, which, when subjected to drying spring winds, requires a constant action of root to maintain life.

KEEPING HEDGES.

One of the principal objections urged against the employment of live fences or hedges is the cost of keeping them in efficient repair, for it admits of no qualification that unless they receive proper attention they will prove to be of but little value as a fence against live stock.

Unfortunately, our best hedge plants so far are of strong growth, especially when young, and consequently require to be trimmed two or three times during the summer, at least for several years after planting, and this at a time when farm crops demand attention, so that in a vast number of cases the hedge is neglected and soon ceases to be serviceable. The best hedge plant is one that could be kept by winter trimming only, because in that season of comparative leisure it would probably receive attention, but with such strong growing plants as the osage orange and honey locust, our two popular hedge plants, it is impracticable to produce a close fence without frequent summer trimmings. There is one thing, however, which should be put to their credit, that after a few years the growth will be less profuse; the weakening effect of continued summer pruning ultimately weakens the plants, so that they become easier managed. This also prevents them from sending out their roots to a great distance, so that they do not interfere with cultivated crops, an evil which soon becomes visible when a hedge is neglected and allowed to take care of itself. When a hedge gets into a condition that one summer trimming and one winter trimming will keep it in fairly good condition, the labor and cost is reduced to a minimum. It will also have a tendency to retard the exuberance of early summer growth, if the winter trimming is delayed until after the buds begin to push in spring. This will make a difference of several weeks in regard to summer trimming, and will prove of some importance when summer pruning is confined to one operation.

The weakest part of a hedge is always nearest the ground. The criterion of a well-kept hedge is that of thickness at the bottom; this should also be its widest part, and it should taper upwards to a point. Unless this form is strictly maintained, the lower branches will gradually weaken and ultimately die out, leaving gaps which are not easily closed. Hedges which become weak and full of gaps through neglect may be renewed by cutting them down in early winter to within 18 inches or so from the ground; the plants will then branch out vigorously, and, by proper pruning, soon be all that need be desired as a fence.

CULTIVATION.

The great aim of all thorough cultivators is to maintain a continued healthy and vigorous growth from the period the seed vegetates until the plant reaches its maturity. The word "cultivation" may be defined as a term whereby we recognize those operations necessary to maintain

a constant and proper equilibrium of the elements of plant growth. Therefore, in order that we should be able to do so understandingly, it is absolutely necessary that we be thoroughly conversant with the principles governing vegetable growth. In the absence of such knowledge practice is merely empirical.

One of the prominent operations in culture is that of stirring the surface of the soil around growing crops. The soil may be looked upon as the laboratory of nature, where her decomposing agencies, air and water, prepare the food of plants, and the object of culture is to facilitate these chemical operations as far as our knowledge will admit; and experience fully proves that frequent forking, loosening, or stirring the surface stratum of the soil, thus allowing an unimpeded access of air and moisture to penetrate and follow the various ramifications of plant roots, is undoubtedly the most essential item in what is termed cultivation.

The efficacy of this treatment depends, however, upon the nature and condition of the soil, as also upon the time and mode of performing the operation. Unless the subsoil is also porous and permeable, its benefits will be comparatively slight. Hence soils that are not naturally pervious must be rendered so by draining and subsoiling.

Soils so treated will continue to support vegetation in a healthy and luxuriant growth even in long-continued dry seasons. This is owing to the facility with which the rain water can penetrate deeply, its downward passage being encouraged by the admission of air, and when, in addition to drainage, the surface is kept loose and open, the rains of a heavy shower penetrate at once instead of passing off on the surface, as will be the case when the top soil is compact and the subsoil undisturbed. Clayey and tenacious soils require more careful treatment than those of a gravelly or sandy character; these are liable to become hardened on the surface after even slight showers. This is occasioned by their easy solubility, and good management of such soils demand that they should be surface-stirred after every heavy rain. Much now depends upon the time such stirring is performed. Between the softening of the surface by rains and its hardening again by sun and dry air there is a period when it is in the most favorable condition for culture. Here it is difficult to lay down a definite rule, as the practice that would be suitable for one soil and climate would be unsuited to another differently circumstanced. The principle being understood, the practice may readily be deduced. In order to facilitate cultivation all crops should be grown as far as practicable on the drill system.

There is room for improvement in this respect, especially in garden culture. Garden crops should invariably be grown in drills sufficiently wide apart to admit of deep hoeing and forking. And it may be further remarked that there is a wide distinction between what is frequently termed a well-kept garden and one that is well cultivated. The former may be kept perfectly clear of weeds by the use of the hoe and rake,

every spot smooth and polished, and although vegetation may wilt and present a starved and stunted aspect, yet many people would pronounce such gardening as perfect. This, however, is not cultivation. Hoeing, as understood by a thorough culturist, means more than merely killing weeds. He aims at having the soil deeply and thoroughly broken up, and left loose, rough, and untramped. His criterion of beauty here is not influenced by the element of smoothness.

MECHANICAL PREPARATION OF SOIL.

The physical or mechanical condition of the soil, its relation to air and water, has not received the attention from agricultural chemists which its importance demands. They have devoted their investigations almost solely to its chemical constituents, seeming to lose sight of the fact that the permeability of the soil to atmospheric influences is of more importance than the most approved manures. If half the money that has been expended upon artificial manures during the last twenty years had been devoted to drainage, subsoiling, and trenching, the products of the country would have been vastly increased.

The soil performs various offices towards growth of plants. It serves as a basis in which they may fix their roots and sustain themselves in position; it also supplies inorganic food during all periods of their growth, and may be looked upon as a laboratory in which many chemical changes are taking place, preparing the various kinds of food which it is destined to yield to the growing plant. Analyses have shown that in most soils the presence of all the constituents of the ashes of plants may be detected, though in variable proportions. But the mere presence of certain substances in soils does not insure productiveness, for it has been shown that crops have failed even in soils possessing all the mineral ingredients required, because, although present, they were not in a sufficiently soluble state to be available. Thus in wet, clayey soils, although containing enough of plant food, the water prevents free access to the decomposing influence of the atmosphere, and crops perish, not because of a deficiency of raw material, but on account of the processes for its preparation being arrested.

This leads to the foundation of all improvements of such soils, viz, draining. It is a remark frequently made by those having no experience that draining must be worse than useless in a climate where summer droughts are among the greatest calamities against which the cultivator has to contend. All who have witnessed the effects of draining need not be told that even in soils not particularly retentive, draining, in connection with deep culture, will secure a more ample and lasting supply of moisture in dry weather and maintain a growing vegetation during the most severe droughts. Draining increases the capability of the soil for absorbing moisture; all soils have their certain absorbing properties; like a sponge, they absorb until their pores

are filled, and only the superfluous water that can not be taken up passes through the drains.

Draining is only the first step towards improvement. The soil must be deeply loosened and pulverized, either by subsoiling or trenching. Either process will be beneficial, and circumstances will decide as to which is to be adopted. Trenching involves a thorough reversion of the soil of more or less depth, according to its nature and the purposes for which it is to be used. Subsoiling is merely a loosening or stirring up of the immediate subsoil without reversing its position. When the ground is intended for a permanent crop, such as fruit trees, grapevines, etc., trenching may be adopted. The top surface of good soil will then be placed where the roots will be immediately benefited by it and the crude subsoil brought to the surface, where it can be enriched by the aid of manures and the ameliorating processes of cultivation.

On the other hand, if the ground is to be immediately cropped with small seeds, as in some portions of a vegetable garden, a finely pulverized surface is necessary, and few subsoils can be made available or be reduced to that condition while in their crude state. Subsoiling will, in such cases, be most advisable, and trenching can be executed as crops will admit of the operation.

The first process, then, towards securing a profitable depth of soil is draining; next, breaking into the subsoil, taking into consideration whether, in view of the crops to be cultivated, it will be most immediately profitable (of ultimate profit there is no uncertainty) to trench it at once or merely break up and loosen the subsoil, admitting water and other fertilizing agencies to penetrate, and by a gradual trenching improve to the required depth. When all this has been satisfactorily accomplished manures can be applied to the greatest advantage and failures from droughts almost entirely obviated.

MULCHING.

This is an auxiliary operation in cultivation that would be more generally practiced if its beneficial effects were better understood.

The objects to be obtained by mulching are twofold, viz, to preserve a uniform degree of moisture in the soil during summer, and to protect the roots of plants from severe frosts during winter. These conditions are obviously important to vegetation, and they can be very efficiently secured by covering the surface with a stratum of porous materials, such as tan bark, charcoal dust, leaves, or strawy manure, which will prevent the surface soil from becoming compact or hard, and at the same time assist in maintaining a uniformity in its mechanical texture favorable to the retention of moisture. Air is the best nonconductor, and bodies are represented as good or bad conductors just as they are solid or porous. Iron is a better conductor than wood, granite stone a better conductor than brick, hard-pressed soil is a better conductor than soil

that is loose and porous. A hard trodden path is warmer in summer and colder in winter than the cultivated ground alongside of it. When the soil particles are in pressed contact, the condition is favorable to rapid conduction; summer winds passing over such a surface carry off the moisture which the heat evaporates, the surface is speedily parched dry, and vegetation languishes.

When the surface is covered with a mulch of such porous materials as those enumerated it in effect secures a stratum of air in repose between the soil and the causes of radiation and evaporation. In the case of recently planted trees, the preservation of a uniform degree of moisture in the soil surrounding their roots is a great point towards their successful growth, and, other things being equal, they will languish or flourish in proportion as this condition of uniform moisture is secured.

Although mulching is a very simple operation, yet serious losses have occurred from its misapplication. We have seen trees destroyed from too heavy mulchings of grass, manure, and tan bark. Before applying the mulch to a recently planted tree, if in spring, shape the soil around it in basin form, extending the rim beyond the extremities of the roots; by this configuration of surface rains will be retained and, if required, artificial waterings can be applied to best advantage. With regard to fall planting, the process should be reversed and a slight mound formed towards the stem of the plant, so as to throw off the heavy rains of winter. Of course such mound should be removed before the following summer.

As already remarked, the principal use of winter mulching is to prevent frosts from reaching the roots. The best material for this purpose is charcoal dust. Where manure is used it should not be thrown close up to the stem of the plant, otherwise it might prove a harbor for ground mice, which in rough ground or under a coarse covering are sometimes very destructive, by eating the bark of young trees. When they are troublesome the precaution should be taken to trample firmly over the roots and around the stem after heavy snows and keep the surface dry and compact.

In order to be effectual it is not necessary that summer mulching should be heavy. When tan or charcoal dust is used a layer of 2 inches in depth will be quite sufficient. Grass cut from lawns is very suitable, but a mere sprinkling only should be applied at a time. Thick coatings promote fungoid growths, which frequently destroy the trees. Fruit or ornamental trees that have been transplanted will rarely be much benefited by mulching after the first year's growth. The advantage of mulching to growing vegetables are equally important. Cabbages, potatoes, peas, onions, and other crops will thus be enabled to maintain growth during the driest weather. This covering is not intended to supersede stirring the soil, but when plants become so far advanced in growth as to be beyond the hoe and plow, mulching may be applied, and those who give it a fair trial on their crops in a dry season will not require further promptings to repeat the practice.

SITUATIONS FOR ORCHARDS.

From the circumstance that fruit orchards which are situated in valleys and in low, sheltered places are not so healthy and prolific, and are more liable to injury from changes of temperature than those situated in more elevated and exposed places, it has been argued that all kinds of protection and shelter to fruit trees should be condemned as injurious, and that the coldest and bleakest positions on northern slopes are greatly to be preferred for fruits. This is probably going from one extreme to another. It is conceded that one of the very worst situations for a fruit orchard is in the rich land of a contracted, sheltered valley, for in such a position the trees are subjected to great extremes of temperature; a difference of 20 degrees is not uncommon between the temperature of the valley and that of a point on the hillside 60 feet above it during periods of severe frosts. It is very evident that such a site would be of the worst selection, and, so far as topography is concerned, the elevated northern exposure would be greatly preferable; but, a sufficiently elevated site once selected, it does not follow that it should not be judiciously sheltered, locally, from the exhausting effects of arid or cold winds. The benefits of local shelter are well known, and should not be confounded with the evils which follow a bad selection, as above stated.

ORCHARD PLANTING.

It is a common observation that the outer rows of trees in established orchards are finer and more productive than the trees in the interior plantation. This superiority is all the more conspicuous if the orchard is bordered by cultivated fields, and it is fair to presume that the extra luxuriance is owing to the trees having a greater extent of unoccupied soil for the ramification of their roots. Something is also undoubtedly due to the greater space available for the expansion and spread of the branches; but it is in accordance with all experience in the cultivation of plants that a rotation of crops is absolutely essential towards securing the best results of the fertility of the soil. Keeping these facts in view, it is suggested that an improvement upon the present method of planting orchards would be gained by planting two rows of trees from 18 to 25 or more feet apart, depending upon the nature of the trees, and alternating the plants in the rows. Then allow a space, varying in extent from 300 feet to any greater distance, before planting another series of rows, and so increase the plantation as far as may be desired. The intervening spaces between these double rows of trees would be available for the cultivation of the ordinary crops of the farm. The roots of the trees would not only participate in the benefits of cultivation, but would also have practically unlimited room for extension before meeting with other roots of their kind. Immediately under the

trees and for a distance on each side of the rows as far as the branches spread the surface could be kept in grass. If not sown down immediately after planting, which might not be desirable in all cases, it should be done after the trees attain a fruit-bearing size, or from five to seven years after setting out. The shelter which will be afforded to other crops by these orchards will be found valuable as a protection from winds as well as in forwarding early crops. This method is particularly applicable to apple and pear trees.

MANAGEMENT OF ORCHARDS.

Whether the land occupied by orchard or fruit trees should be plowed and cultivated, or sown in grass or clover and remain undisturbed, is still a frequent subject of inquiry in the correspondence of the Department. The object in planting fruit trees, it is hardly necessary to state, is to produce fruit, and that course of general treatment which best maintains the trees in a healthy state of growth and at the same time keeps them in a condition of productiveness may be considered as being good, whether the treatment involves the plowing and cultivation of the soil or whether these good results are attained by sowing the orchard in grass and keeping the surface covered with sod. It is well known that eminently productive and profitable orchards can be shown under both of the above systems of management, for the time being. Cultivation or noncultivation are simply expedients to be adopted in gaining certain wished-for results; the primary mistake is to attempt to turn either expedient into a fixed and unchangeable system.

It is understood that the processes generally included in the term "cultivation," such as plowing, harrowing, etc., are all favorable to the encouragement of growth in plants, and when applied to fruit trees the usual result of increased vigor will be produced. But it is also well understood that the greatest vigor of growth is not always combined with the greatest productiveness of fruit; on the contrary, it is a recognized fact that a tree can not display unusually great vigor of growth and at the same time be correspondingly fruitful. On the other hand, it is common knowledge that trees growing in poor soil, and without receiving cultivation of any kind, will not long continue to maintain sufficient vitality to enable them to produce perfect fruit, nor, indeed, fruit of any quality. These extremes of poverty and luxuriance are similar, inasmuch as neither condition is the best for the production of fruit, and therefore the efforts of the fruit-grower should constantly be directed towards a medium between these extremes. When young trees are planted in ordinary good soil, and afterwards receive good care, so far as cultivating, stirring, and manuring the soil is concerned, they usually make strong growths. It is well to encourage this luxuriance at this stage of their existence, the

only precaution being to guard against an immature condition of wood when frosts occur.

Mistakes are sometimes made, in climates where the season of active growth is comparatively short, in stimulating the plants to such a degree that the wood fails to ripen thoroughly and the young shoots are destroyed by frosts while in an immature state, giving rise to various diseases, such as yellows in the peach, etc. When the trees reach the fruit-bearing size, but give no evidence of fruit-bearing disposition, it may be assumed that their barrenness is owing to excessive growth, and it will therefore be in order to adopt some means of checking the growth, and, as a consequence, induce the tree to bear fruit. Various measures may be pursued to effect this object, but perhaps there is none so simple and so easily applied as that of laying the orchard in grass. The absence of all culture will speedily cause the formation of fruit buds and satisfactory crops of fruit, and so long as this continues no change need be made; but if the trees become weak, from overbearing or from want of nourishment, top dressing of manure will again renew their vigor; and, further, if the trees appear stunted and do not respond to surface stimulants, the grass may be plowed under and a system of thorough culture inaugurated and kept up so long as observation determines that it is the best practice to follow.

The condition of the trees will therefore be the best evidence as to whether the orchard should be cultivated or kept in grass. Each orchard will answer the question for itself. It is not a question as to the advisability of establishing a system based upon either expedient, although it is usually and erroneously submitted in that shape.

PRUNING.

Pruning is an operation of vast importance in the management of trees, and the principles upon which it is founded must be clearly understood before complete success in fruit culture can be attained.

Plants left to nature maintain a well-balanced reciprocal action between their branches and roots; and every branch, bud, or leaf that is removed must exercise an influence either injurious or beneficial, and no one should attempt to remove branches unless they foresee the effects and influence of such removals.

The time of pruning, whether during the summer or during winter, will depend upon the object to be attained; a brief consideration of plant growth will assist us in determining this question.

When a seed is deposited in a suitable germinating medium, its first effort is to send a root downwards in the earth, and then push a shoot upwards in the air. The seed contains within itself all the nutriment necessary for this process; but as soon as the young plant is so far formed, its mode of existence is changed, and it becomes dependent upon the soil and atmosphere for future support.

The elementary substances absorbed by the roots undergo decomposition through the influence of the leaves, and the material is thus prepared for further root-growth and extension. The roots have no inherent power of extension, but are dependent upon the health and action of the foliage; and although in germination the roots are first formed, their growth is due to the action of the foliage of the plant that produced the seed from which they emitted.

It is, therefore, apparent that the increase in size of the plant, the quality and quantity of its secretions, and the extension of its roots are all dependent upon the healthy action of the leaves.

When it is considered how essential the foliage is to the healthy development of the plant, we may well pause before infringing upon the reciprocal action nature has established between the roots and branches, for it is evident that every branch or leaf removed has an effect either for good or for evil upon the plant. The correlative action between the leaves and roots being so intimately connected, it follows that any diminution of leaf growth during the period of active vegetation must retard root development. Hence it is an axiom, now becoming recognized, that summer pruning weakens growth, while winter pruning produces a contrary effect.

Summer pruning can be useful where wood-growth is to be checked, and it will be repressed in proportion to the severity of the removal of the foliage. Fruit trees, when planted in a generous soil, frequently attain a luxuriance incompatible with a fruitful habit, and their flowering may be somewhat hastened by judicious pruning or pinching, so as to retard wood-growth; but care must be exercised, and much observation and experience are requisite before the object can be safely attained.

Winter pruning invigorates wood-growth. When a portion of the branches of a tree is removed after the fall of the leaves, the balance of growth is destroyed and the roots have the preponderance; the remaining buds will now shoot forth with increased vigor—an important consideration with trees or vines that have become weakened from overbearing or any other cause, imparting new vigor to weak and sickly plants.

The time for winter pruning may be regulated by the condition of the plant; if pruned immediately after the leaves fall or ripen, the shoots will be stronger the succeeding season than they would be if the operation had been delayed until spring. This arises from the fact that during winter the plant still continues to absorb food by its roots, which is distributed over the branches; and as the principal flow of sap is always directed to the extreme points of shoots, the highest buds are most fully developed. If, therefore, pruning is delayed till spring, this accumulation is cut and thrown away, and to that extent the plant is weakened. Early winter pruning is eminently advantageous to native grapes. As the retained buds become charged with sap during winter, they start and advance rapidly—a matter of much moment where the

summers are rather short for ripening the fruit and wood of these plants.

There is a tendency in many varieties of trees to form strong central growths at the expense of the side branches, more especially while the plants are young. Pruning these strong shoots in winter only increases the evil, unless summer pruning is attended to by pinching out the ends of every shoot before it gains sufficient headway to injure the growth of the lower branches. Strong growths should be pruned in summer and weak ones in winter. In the management of hedges, where uniformity of growth is all important, this rule should constantly be kept in view.

When the size of a tree is the only object sought, summer pruning should not be practiced. But it may be said that pruning of any kind is a negative operation, and probably it is within the limits of possibility that trees may be trained to any form and maintained in a fruitful condition without any instrumental pruning whatever, unless to remedy disease and casualties. It is much easier, for instance, to rub off a bud in May than it is to cut out a branch in December; and if a judicious system of disbudding and pinching was strictly followed there would be no occasion for winter pruning; or, were it possible to place a tree in such a soil, and under such conditions that it would only make a moderate growth of well-matured wood, little, if any, pruning would be required. But as all of these conditions are difficult to realize in in happy combination, we have to resort to pruning, and a knowledge of the principles involved will materially assist the operator.

REMARKS ON PEAR CULTURE.

The value of the pear as a domestic fruit is second only to that of the apple. For culinary purposes the latter is probably more highly esteemed, but for the dessert the pear is almost universally held as much superior. The pear tree is hardy and attains to a great age, greater, it is conceded, than the apple, notwithstanding the popular impression that it is subject to more casualties and is not so enduring. History proves that the pear is of very ancient cultivation, although it has not been so largely or so generally planted as the apple; various reasons may have influenced this discrimination, the most prominent of which are the greater care required in harvesting the crop, and the difficulty of keeping and ripening the fruit to its highest degree of perfection. Even at the present time the management of the finest varieties is far from being generally understood. The prevailing opinion that the tree is constitutionally tender, and more subjected to diseases and casualties than other fruit trees, has undoubtedly exerted a strong influence against its extended culture; but, however much these reasons may have gained credence in the past, they have now lost their efficacy, and many extensive pear orchards have been planted during the past fifteen years, and their number is constantly increasing.

SITES AND SHELTER OF PEAR ORCHARDS.

Low situations should be avoided on account of the greater extremes of temperature prevalent in valleys than places of moderate elevation, and the consequent probability of injury from late spring and early winter frosts. A sloping hillside, contiguous to a well-defined valley, forms the choicest orchard site, not only for pears, but for other fruits as well. To insure the greatest advantage from position the trees should not be planted lower than within 100 feet of upright elevation from the lowest point in the valley. The cold air will then settle during the night in a stratum below the trees, and the warm air accumulated in the lower ground during the day will be pressed up to the higher altitude occupied by the orchard, and thus afford considerable protection in cold nights.

The obvious necessity of shelter to pear orchards has led, in some instances, to the mistake of selecting low grounds for their apparently well-protected position, which, for the reasons given above, are the worst possible localities. Contrasted with valley planting, even what might be termed bleak exposures have the preference, and the unsatisfactory results attending orchards in low protected grounds has led to a supposition that shelter is injurious rather than beneficial.

The addition of shelter to an otherwise judiciously selected site is altogether different from endeavoring to secure it by choosing a low situation. The efficacy of protection is now generally well understood, especially by those who attempt pear culture in regions that are comparatively treeless. Even the White Doyenne, the famed Virgalieu, or butter pear, worthless in exposed situations, is produced in all its pristine excellence where the tree is protected, as may be seen in many old gardens in cities, where this variety is very common.

The shelter required is not so much to repel or alleviate mere thermometric cold as it is to arrest evaporation and its accompanying exhaustion of vitality, by checking the rapid and penetrating action of dry winds.

Evergreen trees afford the most perfect shelter in the least space. A single row of Norway firs, Austrian pines, or other equally hardy evergreen trees will give shelter for a considerable distance; thickly planted belts of deciduous trees will also render effective service. How far apart these belts and hedges should be placed, and in what direction they will be most useful, will depend upon the surroundings and local specialties. As the best mode of draining the field will depend upon its surface undulations, so the best mode of sheltering will be guided by the general aspect and position of the orchard.

SOIL.

The pear will exist in a variety of soils, but attains greatest perfection in clayey loam. Even on stiff clays the tree will grow and pro-

duce very satisfactorily under the ameliorating influences of the preparation and culture which such soils require. Draining first and subsoiling afterwards are the chief requisites for gradual amelioration; in short, while a water-soaked clay is the most utterly worthless of all lands for the growth of any crop, a properly drained and aerated clay soil is by far the most valuable, and only requires careful management to render it available for the best productions of the orchard, farm, or garden. The prominent precaution in managing a clayey soil is never to work on it while wet, but only when it is dry to friability. No expedient or process of culture will compensate for the injury sustained by working clay soils during summer, when saturated with water; the injury can not be remedied except by a winter's freezing, which will again produce friability, under proper treatment.

Soils of a sandy or gravelly character are not well adapted to the pear. In these soils, so variable in their degree of moisture, the trees ripen prematurely and drop their foliage if the weather proves dry towards the end of summer; then, in the event of moist weather following a period of drought, a late secondary growth will be produced, which, failing to mature, induces a tendency to blight, and predisposes to other diseases. Surface dressing of compost, repeated cultivation, or constant mulching will counteract, to some extent, the effects of uncongenial soil for the pear roots, but where it is impracticable to select any but a thin gravel or sand for the growth of this fruit, the dwarf tree is preferable, as the roots of the quince can be confined to a small area, which may be prepared and maintained to meet all the requirements of growth.

PLANTING.

Where the soil has been prepared by deep tillage it will not be necessary to dig holes deeper than required to merely cover the roots of the plants. In heavy soils that have not been prepared in the most thorough manner the holes should be made wide rather than deep. In gravelly subsoils pits may be dug 18 inches in depth, the surface soil and the subsoil being thrown out at opposite sides, and filled in equally until the proper height is reached for setting the plant. In either case about a bushel of compost, made up of leaf mould, rotted manure, and light soil, if carefully spread around the roots, will form an admirable rooting medium; this should be finely pulverized and rather dry than wet when used.

Deep planting and shallow planting are the injurious extremes in setting trees. The plain and incontrovertible rule is to set the plant so that the point from whence the stem and roots proceed in opposite directions will be about 1 inch below the surface of the ground. It is infinitely better to plant so that future surface dressing may be required to cover the swelling, exposed roots, than to have them buried below the ready influence of atmospheric heat and air.

MULCHING.

The preservation of a proper degree of moisture in the soil surrounding the roots of the tree is the principal object of culture during the first summer after planting. Both the kind and amount of care will depend upon the nature of the soil and the condition of the weather; something will also depend upon the first preparation of the ground. Where the soil has been drained, deepened, and pulverized, and the surface is loose and mellow, nothing further will be required than merely to prevent a growth of weeds. If the surface is tenacious, frequent stirring, especially after rains, will probably suffice, but where the soil is shallow and largely composed of sand or gravel mulching will most effectually accomplish the purpose.

Any loose material will answer for a mulch, such as coarse manure, strawy litter of any kind, or short grass cut from lawns. Where a few trees only are to be cared for, tan bark and refuse charcoal dust are frequently employed. Mulch should not be applied before the middle of June, unless the weather proves very dry and warm previous to that time, and on clean ground it may remain during the following winter, or be renewed if exhausted; but in rough, soddy ground, where field mice may lurk, the soil around the trees should be thoroughly comminuted and kept clean and compressed.

CULTURE.

The best mode of treating the soil in pear orchards is an important question both in regard to the health of the tree and the production of fruit. Laying aside all special circumstances, it appears evident that the condition of the plants will indicate the treatment required. The object being to maintain health and encourage fruitfulness, the measure of successful accomplishment of these conditions will greatly depend upon the knowledge of the principles governing vegetable growth possessed by the cultivator. When the trees are young the chief object is to encourage judicious growth by employing expedients known to favor vegetable extension, such as the application of manures, breaking up and pulverizing the soil, surface stirring, and other similar operations. By judicious growth is meant a luxuriance not incompatible with maturity, and as this will depend upon climate and locality it is evident that a discriminating knowledge of cause and effect will largely influence success. In northern latitudes, where the season of growth is confined to 5 months' duration, it will be impossible to mature the same amount of wood that can be produced on trees in a locality having 7 months of growing season. In the latter case stimulating applications may be used with the best effects that would only tend to dissolution in the climate of short summers. The great desideratum in fruit culture is ripened wood; all useful cultivation begins and ends with this single object in view, and is the criterion of good or bad management.

To cultivate or not to cultivate is a question to be determined by climate and condition of soil. Where it is deemed advisable to encourage growth it will be proper to employ such appliances of culture as are known to produce that result; and again, when ample luxuriance is secured, and the tendency is still in that direction, all surface culture should be abandoned and the orchard laid down in grass, cultivation to be again practiced when the trees indicate its necessity.

PRUNING.

The pear tree is usually a victim of excessive pruning. It is pruned in winter to make it grow, and pruned and pinched in summer to make it fruit. Why it is that the pear more than other spur-bearing fruit trees should be supposed to require so close and continued pruning does not appear of easy explanation. It is evident that this immoderate pruning is not followed by satisfactory results, for while apple, plum, and cherry trees fruit with abundant regularity, with but little attention to pruning, unfruitfulness in the pear is a frequent cause of complaint, especially with those who pay the strictest attention to pruning rules, showing clearly that successful pear culture is not dependent upon pruning alone. While it is perhaps equally erroneous to assert that pear trees should not be pruned at all—an extreme which no experienced cultivator will indorse—it is worthy of inquiry whether unpruned trees do not exhibit a better fruit-bearing record than those which have been subject to the highest pruning codes. How far the proverbial liability of the pear to suffer from blight may be due to the interference and disarrangement of growths caused by summer pruning it may not be possible to decide, but the tendency to late fall growths, and the consequent immaturity of wood which is thereby encouraged, is well known to be of much injury and greatly conducive to disease. Perhaps no advice that has been given is so fruitful a cause of failure and disappointment in fruit culture as that embodied in the brief sentence, “Prune in summer for fruit.”

The physiological principle upon which this advice is based is that which recognizes barrenness in fruit trees as the result of an undue amount of wood growth, and that, in accordance with acknowledged laws, any process that will secure a reduction of growth will induce fruitfulness. The removal of foliage from a tree in active growth will weaken its vitality by causing a corresponding check to the extension of roots, but the removal of the mere points of strong shoots has no palpable effect in checking root growth, the roots proceed to grow and the sap seeks outlets in other channels, forming new shoots, which in no way increase the fruitfulness of the plant.

While it may be confidently stated that, as a practical rule, easily followed, and of general application, summer pruning for fruit can not be recommended except as an expedient rarely successful, it is also true that there are certain periods in the growth of a plant when the

removal of a portion of the shoots would tend to increase the development of the remaining buds without causing them to form shoots. For example, if the growing shoots of a pear tree are shortened or pruned by removing one-third of their length, say, towards the end of June, the check will immediately cause the remaining buds on these shoots to push into growth and produce a mass of twigs as far removed as may be from fruit-bearing branches. Again, if this pruning is delayed until August, and the season subsequently proves to be warm and dry, the probabilities are that the remaining buds will develop into short spur-like shoots, from which blossom buds may in course of time be formed; but if the season continues wet, and mild and growing weather extends late into the fall, these same shoots will be lengthened into weakly, slender growths, which never mature, and are of no use whatever. There is no certainty as to the proper time to summer prune, because no two seasons are precisely alike, and trees vary in their vigor from year to year; and yet this uncertain, indefinite, and constantly experimental procedure is the base upon which the advice to "prune in summer for fruit" is founded.

The pear tree, in fact, requires very little pruning, and that only so far as may be necessary to regulate branches in either of two exigencies. In the first place, when the young tree is placed in its permanent position in the orchard its roots will be greatly disturbed and many of them destroyed; it will therefore be expedient in this exigency to abridge the branches, so as to restore the balance of growth that existed between the roots and branches previous to removal.

This pruning at transplanting has its opponents on the theoretical grounds that, as the formation of roots is dependent upon the action of leaves, it must follow that the more branches and leaves left upon a plant the more rapidly will new roots be produced; but there is one important element overlooked in this reasoning, namely, the loss of sap by evaporation, which speedily exhausts the plant, while it has no active roots to meet the demand. The proper practice is to reduce the branches so as to give the roots the preponderance, and many kinds of trees can only be successfully removed by cutting the stem off close to the ground.

If the tree has been pruned close back at planting, the first summer will develop the foundation for a well-balanced, symmetrical plant, but as this result depends upon a good start, it is well to keep an eye on the young growths during the first season, and if any of the shoots appear to be developing to the detriment of others equally necessary for future branches, the points of such shoots should be pinched off, but in doing so, let there be as small a removal of foliage as possible, the object being not to weaken, but merely to equalize growth. As a general rule no advantage will be gained by pruning any portion of the shoots after the first season, unless in the case of weakly trees, which will be strengthened by pruning down in winter. The removal of

branches during the summer weakens growth, but when a portion of the branches are removed after growth is completed, the roots, not having been disturbed, will have the preponderance, and the number of buds being diminished, those that are left will receive increased vigor.

It should never be forgotten that there is nothing more certain than that by shortening in or pruning back the ends of shoots, either in summer or winter, the fruit-producing period is retarded and the fruit-producing capabilities of the trees abridged. Fruiting spurs will not form where the growths are constantly interrupted and excited by pruning; but after the third or fourth year, young shoots will, in the majority of cases, become covered with fruiting spurs the second year after their formation, if left to their natural mode and condition of growth. Of course this refers to trees in soils of moderate fertility, grown in a climate favorable to the plant.

The only pruning then that is really essential after the plant has become established will be confined to thinning out crowded branches; and this forms the second exigency for pruning. If low-headed trees are preferred, those branches that have become destitute of fruiting spurs near the body of the tree may be cut out and a young shoot be allowed to take the place of the one removed. There will be no lack of young shoots for this purpose, as they will be reproduced from the base of the cut branch, selecting the strongest and best placed to occupy the vacancy, if such occupancy is desired. This mode of cutting back branches will be more particularly essential in the case of dwarf pears, as the quince roots are unable to support a tall, heavy-headed tree, but in all other respects dwarf pears should be treated the same as standards.

INFLUENCE OF STOCKS ON GROWTH AND QUALITY OF FRUIT.

In comparing remarks and observations made by different cultivators with reference to the merits of varieties, their growth, productiveness, size, and quality of fruit, and other characteristics, there is found so great a disparity as to lead to a supposition that different varieties are being discussed under the same name. No doubt this is occasionally the case, but the difference caused by the influence of the stock upon which they are worked is frequently to blame for these discrepancies. Every nurseryman is aware of the great irregularity of growth in plants of the same variety; they may have been grafted at the same time on stocks of equal size, planted on the same day and in the same soil, yet their comparative growths will vary considerably; so much difference exists that the plants will be classed into two or more sizes and held at different valuations. Although the vigor of growth is thus varied, the habit of the variety is not changed, the upright form of growth will still characterize the Buffum, and the spreading habit of the Rostiezer will remain with each individual of that variety; but in a plantation of fifty of any sort there will be some weak growers and an occasional speci-

men that after lingering on in a sickly condition for several years will finally be removed.

It is reasonable to expect these diversities in the growth of stocks produced from seed, and the influence they impart to the graft, but it is seldom that allowance is made for the many peculiarities that may undoubtedly be traced to this cause. This is still further confirmed by the more uniform growth of dwarf pears, the stocks of which are produced from cuttings or layers, and are consequently of more uniform vigor, being an extension of one individuality instead of the separate individualities of seedling plants.

BLIGHT.

The greatest drawback to extended pear culture is the disease familiarly known as blight. The predisposing cause of this malady has not been specifically determined ; the active cause of dissolution is known to parasitical fungi. This much, however, experience seems to confirm: that trees placed in positions and under circumstances of soil and climate that insure a growth of moderate vigor, which growth shall become perfectly matured and solidified before the advent of winter, are so seldom attacked by this disease as to be, for all practical purposes, exempt.

A safe practice, and one that will probably become general when further and extended experiments prove its value, is to cover the body of the tree and all the principal branches with a wash, formed by placing 1 peck of lime and 4 pounds of sulphur in a vessel and adding sufficient boiling water to slack the lime. If the white color is objectionable it can be changed to any other more suitable. The spread of the fungi on the bark of trees has been arrested by timely applications of this mixture.

DISTANCES APART FOR PEAR TREES.

The opinion is now becoming prevalent that close planting, so that the trees shelter each other, is advantageous. For standard trees, 18 feet apart is considered a good maximum, and 10 feet for dwarfs. These distances preclude the practicability of using horse-power in the culture of the soil, at all events after a few year's growth, which, all things being considered, may be regarded as a step in the right direction.

NATIVE GRAPES.

It is very generally conceded that the culture of native grapes is not so promising a remunerative industry as could be desired. New varieties, some of them possessing merit, are still being announced, but there is no improvement in their adaptability to general culture in ordinary localities. It was formerly the custom to compare the grape zone, as it was called, to that of Indian corn, which was intended to convey the idea that where this crop would mature the native grape would also

reach maturity. So far as heat and cold are involved in temperatures, this criterion is probably nearly correct, the amount of heat necessary to insure a crop of corn being also sufficient to mature most of the varieties of cultivated grapes which have been derived from our native northern species; but the numerous failures in profitable grape culture prove that other factors besides those of heat and cold have an important influence upon the health of a vineyard.

To those who are conversant with the history of the progress of grape culture in the United States for the past 30 years and have acquainted themselves with the cause of varying failures and successes, it must seem difficult to account for the fact that grape-growers in general have been slow, and apparently unwilling, to recognize the true reason for most of the failures which occur. In some of the earliest reports of the Department of Agriculture the statement was dwelt upon that the greatest obstacle to complete success in grape culture could be referred to the deterioration of the plants consequent upon the injury they sustained from mildew on the leaves. This explanation of failure was not generally considered as conclusive. Both grape-growers and authors of treatises on grape culture, especially the latter, usually referred failures to some other cause or causes, which were expressed by the phrase "improper treatment," and this was considered a sufficient answer to all inquiries regarding failures.

This profound explanation was generally accompanied by the further advice that by giving vineyards "proper treatment" they would be exempt from failure or loss. When called upon to define "improper" and "proper" treatment, the answers would be often contradictory, and more frequently unsatisfactory. This want of recognition of the true source of trouble has been greatly against progressive grape culture. Varieties of grapes much lauded for their superior qualities have been procured at great expense and extensively planted, the result only adding another disappointment to the planter. The main cause of failure has been frequently pointed out, and from time to time the Department has published lists of those varieties best adapted to general culture, as also those which require special localities, and further experience has borne conclusive evidence of the value and accuracy of these reports. It was distinctly shown, and it is now clearly admitted, that the distinguishing feature of a good grape climate is that where there is entire absence of mildew on the foliage or on the fruit of the vines. While making this statement prominent it is not forgotten that heavy losses are occasioned by rot in the berry. This disease is not, however, confined to varieties subject to leaf mildew, but it is equally prevalent in those which are rarely attacked by it. We need no stronger proof of the influence that the presence or absence of mildew on the leaves of our native grapes has upon the determination of their value than to turn to the list of the varieties which are most extensively cultivated,

when it will be found that they are valued more because of their freedom from disease than from the qualities of their fruit.

Again, it is clearly ascertained that the most fatal species of mildew is caused by dampness, so that the further statement may be made that where we find a locality in which grapes are specially remunerative we will find that its climate is characterized by the absence of heavy dews. It is only in these latter localities and under their special conditions that the best varieties afford a profitable return. Where heavy dews prevail during the summer months it has been found unsatisfactory to cultivate such varieties as the Iona, Walter, Eumelan, Diana, Croton, Delaware, Catawba, and others of first excellence. Partial success may sometimes be attained, owing to local conditions of protection and shelter; and, as has long been thoroughly demonstrated and reported, all these varieties can be grown to perfection when they are protected from heavy dews, either by artificial or natural expedients, such as those of covering the trellis upon which they are tied by a canopy of boards, canvas, or glass, or by allowing the vines to grow up in trees whose foliage will protect that of the vine.

But little further progress can be attained in the culture of the grape, either for table use or for the manufacture of wine, until a distinction is practically recognized between the species and their varieties which are severally best suited for these respective purposes. In Europe, where all the cultivated grapes are said to have been produced from one species, the varieties are numerous, but they are divided into distinct classes based upon their values as regards suitableness for wine, for table use, or for drying into raisins.

In the United States we have several distinct native species, from one or other of which have been originated all the varieties now in cultivation. The only classification of these which has been presented looking to the arrangement of varieties under the species from which they have been produced will be found at page 81 of the Report of the Department of Agriculture for the year 1869. An attempt was there made to draw attention to the most valuable peculiarities of the different species, peculiarities which are more or less inherited by the varieties which have originated from them, as also the climates to which they seemed best adapted. Since then some attention has been given to the significance and importance of the points embraced in that classification, but the subject is still unrecognized by the majority of those engaged in grape culture.

The idea that our native grapes would be more rapidly improved by securing hybrid kinds between them and the foreign species has long been entertained; and, although it has constantly been argued by some that no good result could be obtained, yet of late years much attention has been directed to this mode of improvement, and, as was to be expected, varieties of very superior merits have been produced, many of them equal to the best of the foreign varieties, in flavor as well as in

appearance, but no variety so produced has yet proved able to maintain itself as worthy of general cultivation; in fact, they are altogether unreliable except under conditions where even foreign grapes can be raised with a good degree of success. This is much to be regretted, but it is nevertheless the truth that nothing of value and reliability has by this means been added to our list of hardy grapes, and all experience, so far, in this direction only tends to prove the wisdom of the advice given many years ago that the line of improvement should be confined to hybridizing our native species with each other, and by selection ultimately procure varieties of reputed merit both for table use and for the manufacture of wines. But this improvement can not be systematically pursued unless accompanied by a very distinct and clear understanding of the respective merits of American species.

Until quite recently varieties of the fox grape (*Vitis labrusca*) have mostly been produced, and these have been recommended and cultivated both for wine and table use, and but little attention has been given to the improvement of other species, notwithstanding that the summer grape (*Vitis aestivalis*) and its varieties have vastly superior merits as wine grapes. No better evidence of this fact need be desired than the estimate given to these wines in foreign countries. Most of the American wines which have been specially recognized at foreign expositions have been the products of this class of grapes. But the ultimate value of these grapes will not be realized until vineyards of them are established in localities where they can be ripened. They require a longer warm season than suffices for varieties of the *labrusca* family; consequently they are not successfully grown in localities where the improved fox grapes are most largely cultivated, and for that reason the summer grapes are but little known, and in the localities where they may be produced in perfection the culture of wine grapes has not yet become an established industry.

Among the best known varieties of this eminently wine-producing species may be mentioned the Lenoir, Herbermont, Devereaux, Alvey, Cynthiana, and Norton's Virginia Seedling. These varieties yield wines of very high excellence and of varied qualities. But they can only be grown to perfection in certain locations in the States of North Carolina, Virginia, and other States having similar climates.

It therefore appears probable that in the further improvement of hardy grapes these peculiarities of species and the purposes for which they are best adapted must receive more attention than has hitherto been given them.

GRAPES—MILDEW.

In some of the earlier reports of this Department much attention was given to grape mildew, its causes and preventions, with practical deductions based upon extended observations on the subject.

In the report for 1865 mildew is characterized as "the great obstacle

in the way of extended grape culture," and a summary of some points is made as follows:

The *Peronospora*, or mildew, which attacks the leaves on their under surface, is encouraged by the atmospherical conditions accompanying dull, cloudy weather, with occasional showers; or when heavy dews are deposited in positions where the rays of the sun can not penetrate, or at least where the moisture can not readily be evaporated. That, so far as is known, no peculiar constitution of soil or mode of soil culture has any influence on its prevention. That, so far as is known, no mode of pruning or training, except so far as they agree with the next paragraph, has any effect in warding off the disease. That shelter and protection by covered trellises, or masses of foliage, will greatly modify if not entirely prevent injury from mildew.

The distinguishing peculiarity of a good grape climate is, primarily, that of an entire absence of mildew on the foliage. The presence of water or moisture on the leaves is necessary for the extension of mildew, therefore the best grape climates in this country are those of greatest immunity from dews.

A covered grape trellis was described in the Patent Office report for 1861. A trellis similar to that described was erected in the garden of this Department in the spring of 1863. The grapevines grown on this trellis were entirely free from mildew on the leaves and from rot in the fruit, and many varieties ripened under this protection that failed to mature on common trellises a few yards distant on account of the failure of the leaves during summer from mildew. The philosophy of the action of protection in this particular case seems to be its tendency to arrest radiation of heat, thus protecting the foliage from the cooling effects of night temperatures, which in turn prevents condensation of atmospheric moisture on the leaves, thereby checking, to a certain extent, the predisposing cause of mildew.

In experimenting with registering thermometers it was found that during clear, still nights of July, an exposed thermometer, projecting four feet from the covered trellis, would mark from 6° to 10° lower than would a thermometer fastened to the trellis; the foliage being thus kept warmer and drier on the protected plants, mildew was in reality prevented. It was also found that the fruit ripened on protected vines some time before that on vines not protected.

It would therefore appear that the best grape climates or localities would be those where dews were light or altogether absent. Such localities can be found. Indeed, it may be observed that wherever native grape culture has become popular and extensive it is in localities where exemption from heavy or frequent dews prevail. The localities may be found either surrounded by large bodies of water or on hillsides at certain elevations.

The influence of large bodies of water in ameliorating climates is well authenticated, and is often turned to practical advantage in fruit culture. Briefly stated, the water accumulates heat as warm weather prevails, which is radiated at night, and its influence is felt on vegeta-

tion in islands, which may occur as well for a considerable distance inland from the margin of the water. The presence of this stratum of air is evidenced by the absence of light frosts during late fall, and the freshness of vegetation as far as the heated atmosphere extends, while immediately beyond its influence a wintry aspect prevails.

In this case the cause of exemption from cold also prevents the formation of dew, and is so far favorable to the healthy growth and freedom from mildew of the grape.

Again, in districts where hills and valleys are closely and distinctly defined, there are, at certain elevations on the hillsides, a zone or belt where dews are not known and where frosts are modified. The width of this belt varies according to the degree of cold and, to some extent, configuration of surface, but it exists in all countries that are traversed by high mountains and deep valleys. Several years ago, when collecting data on this subject, a correspondent in Macon County, North Carolina, wrote as follows:

The frost line is not permanently fixed at any particular height on a mountain, but takes a higher or lower range according to the degree of frost that produces it; within the space of 11 years its maximum height has been 300, and its minimum height 125 feet, vertical. Another fact ascertained is that there is no fixed dew line on our mountain sides, but that it gradually abates as you ascend, and at the height of 300 feet the dew is too light to produce either rot in the berry of the grape-vine or mildew on its leaves. Hence we understand why the thermal zone is both warm and dry. I will not venture to say that the grape will never rot within the limits of that zone, but I can say that the Catawba grape is altogether unreliable when planted in our low valleys, but where the vines are growing on the slopes of the mountains they have not failed to ripen their fruit for more than 30 years, whether the season was wet or dry. It is a fact that all attempts to cultivate the grape in our low damp valleys have utterly failed, the plants invariably being destroyed by mildew on the leaves, while the few vines that grow upon the small farms lying high up on the mountain sides have ever matured their fruit in the greatest perfection.

In view of these facts, I say confidently that any well-conducted effort at grape culture will succeed, whether it be upon the slopes of our Alleghanies or upon the mountain sides that skirt the valleys of more northern States, and all that is required to insure success is to ascertain where this warm belt is, and to plant the vine within its limits.

In the report of the Department for 1867 mention is made of the great success in grape culture in the region near Hammondsport, Steuben County, New York. Here the Catawba and other late grapes mature and reach remarkable perfection, taking the latitude into consideration. These vineyards are mostly on hillsides extending for several hundred feet above the valley and surface of Keuka Lake. The soil is a drift formation, and the surface is thickly covered with loose shale. The marked adaptability of this locality for grape culture may be attributed to its elevation and nature of the soil. The general elevation of the land prevents the deposition of heavy dews, and as it is supplemented by the heat absorbed during the day by the abounding stony surfaces, mildew is unknown, and the growth proceeds unchecked until

it is arrested by frost. There is a happy combination of favorable conditions; the soil is of a character that insures a healthy but not over-luxuriant growth; the young shoots commence to mature at an early period during the summer, and when they cease to lengthen they are brown and hard up to their extreme points. Then the fruit is fully ripened, and the quality is of the best, for thoroughly ripened grapes can not be gathered from immature growths.

I consider this matter of selecting good grape-growing localities as of the greatest importance at the present time. In all localities where mildew prevails successful grape culture can not be realized without constant vigilance in the application of correctives and preventives, and even these can not always be depended upon. Failures will occur under the best management where the environments are inimical to best success, and in no event can an imperfect climate compare with a perfect one. In view of the fact that perfect localities for grape culture can be selected under climatic conditions of the most favorable character for the protection of the best vines, the subject can not be too strongly urged for the consideration of cultivators of the grape.

PROPAGATING NATIVE GRAPES.

For the past few years most of the grapes raised in the garden have been propagated in beds in the open air. Hard, well-ripened wood is selected and made into cuttings, which are each about 4 inches in length. Whether the cutting contains one bud or eye, or more, is not important, and if a single eye can be obtained with 3 inches of wood attached, it is considered a good cutting, although lengths which are under 3 inches are looked upon as uncertain should the weather during the early portion of summer prove to be hot and dry.

The ground is prepared by turning it over to a depth of 12 inches in the fall, leaving it as rough as possible, so that it may be effectually permeated by frosts. As early in spring as the ground can be worked the surface is carefully forked over and broken up as minutely as practicable; it is important that the soil should be deeply pulverized.

Previous to inserting the cuttings the surface, is further broken by using a rake having iron teeth 4 inches in length. This operation does not merely consist in raking over the surface, but in pushing the rake to and fro to the full length of the teeth, so as to thoroughly comminute the soil as deep as they will reach.

The beds are marked off in breadths of 10 feet, with 3 feet wide alleys between. The cuttings are inserted in rows across the beds; they are placed about 2 inches apart, and the rows are formed about 6 inches from each other, so as to admit of a narrow hoe to be run between them.

To avoid tramping on the soil a wide board is used to stand upon

while planting the cuttings. The whole of the cutting is pushed into the soil, so that the upper bud or end (the cutting being closely cut above a bud) is level with the surface.

The bed is afterwards covered over with a layer an inch in depth, consisting of a light friable soil; pure sand may be used if nothing better can be procured; a mixture made of one part of sand and one-half rotten tan bark is preferable to the pure sand; swamp muck, dried and pulverized, so that the finer portions of it can be secured by sifting, forms the very best material for this purpose. In the garden of the Department the sweepings of the streets are sifted and used with good results.

When the buds of the cuttings commence to swell an additional half inch or more of the covering is evenly distributed over the surface. The young shoots push vigorously through the surface dressing, and it serves as a mulch to retain moisture during summer. Although the cuttings are rather closely set, owing to the limited area of the grounds, yet the largest portion of the plants are sufficiently strong for permanent planting when 1 year old.

FOREIGN GRAPES IN GLASS STRUCTURES.

The simplicity and certainty with which the foreign grape can be produced in glazed houses is not generally known. Many amateurs, whose success with other fruits is quite satisfactory, feel doubtful of their ability to manage the exotic graper.

To those whose only acquaintance with the subject is derived from perusing publications on the growth of the fruit the supposition of inability is pardonable, for there is certainly much to appal the beginner in perusing the various ideas of soil and border making, the conflicting opinions relative to watering, and the multitudinous, fussy details of management which he will find in print.

So much has been written of late years on this subject that it would not now be referred to were it not with a hope that information might be imparted that would tend to dispel the idea of difficulty or mystery in connection with the culture of this, without exception, most economical of fruit productions. It is well known that in favorable locations the Chasselas, Black Hamburg, and many other of the varieties of the foreign grape will occasionally produce perfectly ripened fruit with no further care than that usually given to the Isabellas, or any other native variety. But although the result may occasionally be reached, it is well known that all attempts to cultivate the foreign grape in the open air east of the Rocky Mountains have sooner or later proved abortive.

That these failures are attributable either to a deficiency of sunlight or to a deficiency of summer heat are questions easily answered; for

we find that in the climate of Britain, where the dull, sunless days are more abundant, and the summer heat of less intensity and of shorter duration than with us, the Hamburg and other exotic grapes ripen yearly trained on outside walls and trellises, and this in a climate where the heat is not sufficient to mature Indian corn, tomatoes, or even peaches in common field culture, as with us. Neither can it be supposed that our own summers are too hot or our winters too cold, as it is well known that there is scarcely any plant that will not withstand extremes of summer heat and winter cold so well as the grape provided it maintains good health. But, unfortunately, there are climatic conditions here during which the grape is rendered subject to the attack of fungoids, by which its growth is checked, the wood prevented from maturing, and a general debility engendered which enfeebles the plant to a degree that sooner or later ends in its total destruction.

This tendency to mildew is, then, the only obstacle in the way of successful open-air culture in this section of the best wine and table grapes of Europe, and is the only reason why glass structures have to be employed in their culture, where an artificial temperature, more in accordance with their requirements, may be maintained. The tendency to mildew in the foreign grape having been found so great a barrier to its extended culture in the open air, recourse was had to glass houses, where protection could be afforded and means adopted for the exclusion of this malady; but in many cases even here success has not been equal to expectations. The mistaken eagerness of many to keep the plants in an artificial instead of a natural condition has led to frequent failures. It appears very obvious that a plant which occasionally succeeds in the absence of any particular protection would be enabled to do so uniformly by a very slight additional care, provided that this additional care was bestowed in the proper direction; and that such is the case has been proved beyond a doubt.

Having on another page of this report treated more particularly on mildew and its origin, it may suffice to remark here, that it is altogether dependent upon the amount of atmospheric moisture and proper ventilation; and without proper attention to these points, mildew is just as likely to destroy the plants under glass as it would be those in the open air. Keeping in view that these remarks are intended to refer to the general routine management of what is now more definitely known by the term cold grapery, we will briefly allude to what is considered the main points of treatment.

The principal points, then, are a low night temperature, exclusive top ventilation, and the constant presence of moisture available for evaporation. The baneful effects of a high temperature in plant houses has been shown in previous reports. It has been proved repeatedly that low or bottom ventilation in a grapery is conducive to mildew, and aridity must be prevented by the presence of moisture.

It would require considerable space to enter fully into the elucidation of all the principles involved ; it will, therefore, be considered sufficient for the present to briefly trace the course of practice deduced from many years' extended observation and experience in the growth of the foreign grape.

As soon as spring growth commences attention is at once directed to the night temperature, so that it will fall at least 20° below the average heat in the house during the day. In dull, cloudy weather, of course, this difference between day and night may not be so great, and if the nights are frosty it will be necessary to close the house ; but in the absence of actual external freezing the ventilators should not be wholly closed, even during the night. When all danger from night frosts is passed—which will vary, according to locality, from the middle of May to the middle of June—the ventilators may be left open day and night. During dull, cold weather it may be necessary to partially close the ventilation both day and night ; but, as a general rule, the same amount is used day and night. We have seen graperies where the ventilators were never disturbed from the period of blossoming until the ripening of the fruit. No constant anxiety is, therefore, felt about shutting or opening sashes, and the liability to create sudden changes of temperature, that frequent alterations of the ventilators are sure to produce, are prevented. The temperature of the house will, therefore, participate in the general changes of external atmosphere, and though warm during sunlight, will be cool during darkness. During the warmest part of the summer the day temperature may vary from 90° to 100° by day to 65° to 80° during the night. This lowering of temperature during darkness insures a hardihood of growth that enables the plants to endure any unfavorable change that may occur, without sustaining the least injury.

As air is heated its capacity for abstracting and containing moisture increases, and unless the moisture is supplied from other sources it will be drawn from the plants. To supply this evaporation, the soil in the house should be kept damp on the surface. Once a day at least in bright weather the soil will require to be sprinkled. It is a good rule never to allow the surface soil to be entirely dry until the fruit is coloring to ripen ; but it is important to know that, unless in connection with constantly night ventilation, this treatment may prove injurious.

So far as the management of the atmosphere is concerned, this is all the care required, and a crop of grapes is thus as easily grown as a crop of potatoes, only with more certainty, because more under our control.

With regard to soil, pruning, etc., we will at present only remark, that soil capable of growing good cabbages will grow good grapes, and the strongest yearly growths give the best fruit.

INSIDE BORDERS FOR GRAPERIES.

It has been strenuously advocated that the soil in which foreign grapes are grown should be wholly under the glass, and many of these structures have been so arranged, but not with successful or satisfactory results. There were two very distinct and seemingly weighty reasons urged by those who advocated this mode, first, that in the case of forcing houses it was essential to have the soil for the roots in the same temperature as the branches; and, second, that in the case of cold graperies, when the borders are exposed, the roots are influenced by rains during the ripening of the fruit, retarding maturity and inducing rot in the bunches. These results may be guarded against by the use of inside borders; nevertheless, as ordinarily managed, they have proved failures. They are useful to a certain extent where early-forced fruit is an especial object of culture. The plants will succeed for a few years very satisfactorily, and by a renewal of both plants and soil from time to time the practice may be sustained; but, in the management of what are termed cold graperies, the ordinary warmth of the soil is all-sufficient; and as far as regards the second consideration, viz, the protection of the roots from heavy rains when the crop is attaining maturity, that may be secured by less costly expedients; light wooden shutters have been used for covering the borders, and when the surface is sloping a covering of leaves or straw will answer every purpose. The main reason for alluding to these borders here is for the purpose of noting that where it is practicable to remove the sashes or roof, so as fully to expose the border to the action of the weather for a period extending from the ripening of the wood until forcing again commences, it will tend to maintain the healthy action of the soil for a long series of years. Winter rains, snows, and slight frosts are all of great benefit, as has been fully realized with an inside grape border in this garden.

THRIPS OF GRAPES.

For several years the foreign grapes under glass have been severely injured by thrips. All efforts and expedients to eradicate them have been but partially effective. During the early part of the growing season the insects could be kept in check, either by fumigations with tobacco, syringing with water in which tobacco had been steeped, or spraying the foliage with a weak solution of quassia chips; but when the fruit approached maturity, or rather when it commenced to color, these applications had to be discontinued, so that the fruit would not be rendered unfit for use; then the insects would increase rapidly and injure the foliage so that the fruit became comparatively worthless. Further than this, the annual destruction of the foliage before the growth was matured was gradually weakening the plants, so that their

utter destruction was only a question of time unless some means could be adopted to annihilate the insects.

This means has been adopted. It consists simply in covering the floor of the house with tobacco-stems, the refuse of cigar manufactories; this mulching proves quite effectual, as, since the application was made, no thrips have been seen, and, although the insect has spread considerably before the tobacco-stems were used, they rapidly disappeared after the application.

It is perhaps worthy of remark that since using the tobacco mulching no sign of mildew has been observed on the grapes. Of course it is known that mildew may be avoided by strict attention to ventilation, but in the early part of the season, when the ventilators have to be closed at night and opened during the morning, it is not always practicable to prevent cold currents of air from striking some portions of the foliage, a circumstance which will induce fungus growths on the leaves; not the slightest indication of mildew has been observed since the tobacco-stems were sprinkled over the floor.

PROPAGATING BY CUTTINGS.

To be successful in any pursuit it is very necessary that we should be conversant with the rationale upon which our operations are founded, and in no horticultural process does this apply with so much force as in plant propagation by cuttings.

There is, however, much in connection with this subject that remains unexplained. We know not why it is that some plants will propagate readily, while others, seemingly of similar structure, with the greatest tardiness and difficulty.

A cutting may be described as a portion of the branch of a plant that is removed and placed in a position to form roots, so as to become an independent individual, possessing all the properties and being a living representation of the original from which it was taken. Cuttings are of various kinds. Young, tender shoots, perfectly matured growths, and wood in all stages of maturity intermediate between these extremes are used for cuttings.

The best condition of wood growth also varies with the kind of plant. This is a question that can only be ascertained by experiment. We know of no external appearance that will indicate the special proportionate arrangement of the constituents of plants most favorable for the formation of roots from cuttings.

As an extension of roots is dependent upon the previous or simultaneous action of foliage, it is found that in general the best shoots for propagation are those possessing a considerable portion of the organized matter consequent upon a ripening of wood growth, but in which the process of vegetation is still in full operation; in other words, those shoots that have commenced to mature, but are still

possessed of healthy and active foliage, familiarly termed "half-ripened wood."

The art of "striking" cuttings mainly consists in guarding against the exhaustion of the sap of the shoot by evaporation until the roots are formed to support it.

The various expedients resorted to, such as keeping the cutting in close frames, covering them with bell glasses, shading from sun, etc., have for their object the preservation of the juices of the shoot.

The reason for the adoption of these expedients being known, their necessity in individual cases will be readily understood. The greatest care is required in the case of young, tender cuttings, and the least with those of matured wood. Cuttings of the latter frequently succeed when planted in the open air without further care or attention. On the other hand, a young succulent cutting, furnished with one or more leaves, must be carefully guarded against excess of light and aridity. Shading from bright sun will be required to prevent the foliage from wilting, and its surrounding atmosphere must be sufficiently moist to prevent evaporation from its surfaces.

The great stimulants of vegetable life are heat, air, light, and moisture, and in the management of cuttings these must be regulated with care and precision.

Under certain conditions, cuttings will grow and will produce a few leaves without any attempt at the formation of roots, while under different circumstances the same kind of cuttings will produce roots without indicating the slightest symptoms of bud growth. Heat is the active stimulant of the vital forces of plants, and when the atmosphere by which they are surrounded is of a comparatively higher temperature than the soil in which they are placed, the branches are excited before the roots receive any impulse. On the contrary, when the soil is warmer than the air, the root-forming process will be active, although the branches show no indication of growth. Of course neither of these conditions can continue exclusively for any lengthened period, for without a reciprocal action all growth will in time cease. These effects are frequently illustrated in tree planting in spring. Towards the latter portion of spring and the early part of summer the air is many degrees warmer than the soil; the heated atmosphere excites the buds, and leaves are developed; but the recently disturbed roots in the colder soil have not yet been excited, and are not in a state to supply the demands of the foliage, the juices of the tree are soon exhausted, and the promised healthy growth suddenly and hopelessly checked.

The main point of consideration, therefore, in the management of cuttings, so far as mere application of heat is concerned, is to stimulate into action the processes carried on in the vessels of the cutting inserted in the soil, while the upward bud growth is retarded. This is secured by heating the soil and not heating the air. The rule is that cuttings should be kept in an atmospherical temperature as low as the

nature of the plant will allow, and the soil in which they are inserted should be as high as the roots will endure. The more completely these conditions are maintained the greater the certainty of success, and with ordinary care few failures need occur.

"Bottom heat," as it is termed, or a warming of the soil, may be attained by various means. Those whose requirements are extensive usually have a structure specially fitted for the purposes of propagation, where the soil is heated by hot water either in pipes or wooden or cement tanks. The latter mode is perhaps the best; but where the quantity desired is limited to the wants of an ordinary flower garden or greenhouse no special structure need be necessary. A small hot bed, with frame, will afford considerable convenience; and those who have a greenhouse may form one of the best propagating shelves by inclosing a portion of the heating channel, whether flue or pipes, at the warmest end, so as to form a tight chamber, with the heater passing through it. Usually there is a front shelf in greenhouses over the heating apparatus, so that by simply inclosing a space below it an air-chamber will be formed, where the heat will collect and warm a bed of sand or soil laid on the shelf. For all ordinary purposes this will be found sufficient, and the space can be enlarged to suit the wants of the propagator.

SOWING SEEDS.

The Department is frequently in receipt of letters wherein the writers complain of their inability to raise plants from seeds distributed by it, as well as from those procured from other sources. The cause of failure is at once attributed to the quality of the seeds, and the source from whence they were obtained is denounced for sending out a bad article. It is safe to state that good seeds are the rule, and bad seeds the rare exception. So far as the Department is concerned, there is proof of their good qualities, as most of them are germinated and the plants grown here; and every respectable seedsman in the country uses all the precautions that experience and business competition suggests in order to secure seeds of the best quality. The truth is that they fail to germinate because they are improperly managed; and of all the causes of failure the most frequent is that of covering them too deeply with soil, where they either rot, owing to the excess of water and want of air, or the feeble germ is unable to overcome the weight of soil it has to move before reaching the light. The proper depth for each seed must be judged by its appearance. The rule has been given to cover with a depth of soil equal to the diameter of the seed, which is probably as nearly correct and as definite as can be reached. The greatest difficulty is in case of small seeds, which succeed best when merely scattered on the surface and pressed into the soil. In the moist atmosphere of a greenhouse or similar structure they will do very well; but when sown in the open

air expedients must be used in order to keep the earth suitably moist, such as sprinkling the surface with chaff, moss, leaves, or straw, taking care to remove immediately after the seeds germinate. This will also prevent the soil from becoming hard and compact, and thereby obviate another cause of failure. It is also a fatal error to sow too early; the soil should be dry, friable, and warm in order to excite germination and maintain an uninterrupted healthy growth. Unhealthy plants are sure to result when heat and moisture are presented in varying quantities to the tender germ.

Seeds that are inclosed in a hard shell vegetate most freely when sown as soon as ripe. For instance, seeds of the grape, if planted immediately when the fruit is ripe, will vegetate in a few weeks, but if kept dry until the following spring and then sown but few will vegetate until they have lain in the soil for twelve months.

SEED-SAVING.

Whether it is best for farmers and gardeners to save their own seed or make yearly purchases depends very much upon circumstances, or rather upon the particular kinds of seeds in question and the manner of saving them. Seed-raising is a business which requires skill in culture and great discriminating knowledge, which can only be acquired by observant practice. As a general rule it is cheaper in the long run to buy seeds than attempt to save them; this remark applies with greater force to the seeds of improved varieties than species which are reproduced with more certainty from seeds. It is one of the great arts in seed-raising to keep varieties true to their descriptive peculiarities, and with some kinds of seeds this requires an amount of attention and labor of which the majority of those who purchase seeds have but a faint conception. As an example we will specify the cabbage, and in the first place we would remark that it is now held that cabbage seed raised near the seacoast is always better than that raised inland; so confident of this are the market gardeners around New York that they endeavor to procure their early cabbage seed from growers on the eastern Atlantic side of Long Island. The seed raiser is, as a matter of course, very careful as to the seeds he sows for his cabbage crop; but in order that any variety should be maintained as near to its perfection as possible, the crop is carefully inspected after the plants have headed, and all those that do not come up to the perfect standard in regard to compactness, size, shape, and time of heading are destroyed, and only those which pass inspection are retained. The seed dealer who acquires a reputation for care and accuracy in this matter can sell his seed at highly remunerative prices, which may be double the amount asked by others for the same variety, but which has been carelessly and indiscriminately saved. Varieties must always be grown very widely apart for seed, for so far as bees can fly there is danger of crossing with other

and inferior kinds. Of course any farmer or gardener who uses the same precautions can have similar results, but where the attempt is made to grow several varieties in one field the distinctive characteristics of each variety can not be maintained.

Climates have also much to do in the matter of seed-saving. When seeds are grown in a climate unsuited to their best maturity they will perpetuate a weak progeny. For example, the oat plant requires a cool, moist climate for its perfect development; hence seed oats grown in a warm, dry climate are very inferior. In countries suited to the plant it is not difficult to find seed that will weigh 45 pounds and more per bushel. Yet these heavy seeds if sown in the middle States will rapidly deteriorate; no matter how carefully crops may be managed an annual shortage will be found both in the quantity and quality. In cases of this kind it is the best economy to procure seeds from the best localities, for no efforts towards acclimation will prove of any value.

But in climates entirely suited to the growth and full development of a plant it is possible to gradually improve its qualities by carefully selecting seeds from the most perfect plants only, and this is within the reach of every person who desires to save his own seeds.

Then the question of cost may be considered. Those who make a business of growing seeds can do so much more advantageously in most cases than the amateur in this line. We know that there is often much complaint about bad seeds, but in most instances these complaints have originated through bad management in sowing. The most common mistakes are those of covering the seeds too deeply with soil and negligence in firming the surface after the seeds are sown; rolling the surface after seeding is one of the most important points in seeding.

ROTATION IN CROPPING.

It may be surmised that the necessity for rotation of crops soon became apparent to the earlier cultivators. They would discover that their best efforts in appliances were unavailable in maintaining a continuous profitable growth of the same kind of plant on the same soil. When soils became unproductive it was supposed that the land required rest, hence the practice of fallowing was introduced. Fallowing was a common practice among the Romans. It was their usual course to allow the land to rest after each crop—a crop and a year's fallow succeeding each other. Where manure was applied two crops were taken, and on some lands several crops were taken between the fallowing periods. It was a very natural deduction that the land required rest when observation showed that after successive crops of the same plant it refused to grow, although the land had not apparently diminished in fertility.

The agriculture of the ancient Egyptians being confined to the banks and lowlands adjacent to rivers, where from annual overflows a rich

deposit of mud and sand was left on the surface, which formed an annual layer of fresh material, did not include the process of fallowing or resting lands, because constant fertility was maintained by the annual top dressing which was left by receding waters.

The practice of resting and fallowing soils, or that of changing the crops more or less systematically, has always been found to be advantageous, although the reasons for its necessity have not been satisfactorily explained.

Various theories have been offered by physiologists explanatory of the principles upon which the benefits of rotative cropping depends. Modern chemistry has shown that plants require certain mineral substances for their support, and that although the same primary elements may be found in all, yet they are found to be in very different proportions in different kinds, some showing a mere trace of a substance which may abound in others. These mineral matters being obtained from the soil, it follows that if they are not present in sufficient quantities, or do not exist in a sufficiently soluble state so as to be taken up by the roots, the plant which demands them for its normal growth must suffer in consequence of such deficiency; and in regard to specific inorganic substances, it is evident that the plant which requires a large percentage of such would fail to succeed where another plant requiring only a trace of the substance would maintain a healthy growth. Some plants require much potash or soda, some much lime, others a large proportion of silica. A rotation which would allow these plants to follow each other in succession, or cause one crop which requires only a small quantity of any particular inorganic substance to succeed another which requires that substance in large amount, would consequently be beneficial.

Taking these facts as a basis, the theory is propounded that the necessity for a rotation of crops is caused by the exhaustion of certain inorganic substances which, if supplied in due quantities, would insure the successful growth of the same plant on the same soil for an indefinite period. But in the absence of the knowledge indispensably necessary for an accurate estimate of the exact quantities required, a system of rotation is not only advisable but it is the only resource of the cultivator until science determines the exact specific relations which exist between the plant and the soil from whence it receives its food.

The deductions naturally following the above explanation regarding plant food led to the supposition that chemical analysis would indicate with a degree of certainty the exact line of practice to be followed in regard to rotation of crops, or perhaps obviate the necessity for any change except that of convenience. This was to be effected by analyzing the soil and the plant to be grown in it, so that the ingredients removed by the latter could be replaced, and thus the fertility of the soil indefinitely maintained. But at present there are no indications that such accurate knowledge is forthcoming, neither the analyses of

soils nor the analyses of plants furnishing the data seemingly necessary for practical purposes.

The phenomena attending the growth of certain crops for a series of years on the same soil apparently includes certain factors that are not readily explained. For instance, it is observed that even in the case of such humble plants as the petunia and verbenæ, if they are continued for a few years in the same ground they will cease to give satisfaction, even although the soil is annually manured with ground bones, rotted stable manure, or other kinds of ordinary manurial applications. In flower gardens, when it is desired to grow these plants year after year in the same spot, it is found necessary to renew the soil yearly by removing 6 or 8 inches from the surface and replacing it by fresh earth from other sources.

The same results have been found in the culture of the grape. For a number of years past it has been customary for the Department to propagate several thousands of plants, embracing many varieties of native grapes. These are mostly grown from single-eye cuttings in sand beds under glass, and placed singly in pots when rooted. About the end of May they are turned out of the pots and planted out in the open field rather closely in rows which are about 3 feet apart. When they have finished growth for the season they are lifted and removed from the field, the ground receives a coating of rotted manure, which is either plowed in or worked with a spade, leaving the surface rough, to be acted upon by the frost. In the following spring the surface is again worked over and the soil placed in good order for planting. At the proper period young grapes are again planted as before. These are removed at the end of the season, and the ground receives similar treatment to that of the previous year. Notwithstanding this treatment the third crop is very indifferent, and if a fourth crop is planted it will prove to be an entire failure.

Experience shows that by selecting a field which has never been occupied with grapes the young plants will make an average growth of about 4 feet in length the first year; the average growth of the second year will reach about 2 feet; the growth of the third year will be exceedingly weak, the best plants reaching to about 18 inches in length, many weak kinds not reaching the length of 1 foot.

This result of diminishing yearly growths has not been sensibly affected by the application of different manures, and the question naturally arises that if a deterioration of growth becomes so marked in so short a time, and with such attention to the soil, what may be expected when acres are closely planted with grapes, as in the case with vineyards, where the entire soil speedily becomes filled with roots? It need not be a matter for surprise if vineyards become unproductive after producing several unsatisfactory crops.

It is well known that nurserymen who pride themselves in maintaining a high standard of quality in their stock of pear or other kinds of

fruit trees are careful not to attempt to grow two successive crops on the same land. Even after employing all kinds and qualities of manures that their skill and experience may suggest, the quality of their young stock will depreciate if grown on the same soil unless long periods elapse between the rotations. These and facts of a similar kind might be assumed as an indication that there may be some as yet unrecognized cause that exerts an influence in plant nutrition.

Many years ago the hypothesis was advanced that plants secrete or form certain matters during their growth which they exude by their roots, and the accumulation of these ingredients in the soil exercises an injurious influence upon future crops of the same plants, but does not prevent the growth of plants of a different kind. It was even surmised that the exudations of one species furnished nutritious matters for a different species, and for this reason a rotation of crops becomes advantageous and furnishes an explanation for the benefits consequent upon the practice.

The experiments and explanations brought forward in behalf of this hypothesis have not been considered sufficiently conclusive to establish a theory upon which to base any definite action, and has not of late years been entertained as a factor worthy of consideration in the study of plant life or as pertaining to plant culture. And yet every practical cultivator must have observed phenomena in the course of his practice which appears to be more readily explained upon the supposition of the formation of some injurious matters than from the exclusive action of exhaustion; and this may occur without conceding that there is necessarily any function of an excretory character in the roots of plants.

If we attempt to remove a silver maple tree of 3 or 4 years' growth from the seed we will find that the soil closely surrounding the stem and circling for several feet beyond it is filled with small fibrous roots, mostly dead; active spongioles will be found mainly at the extremities of the larger or main roots. But if we take a tree of the same species which has attained the age of 10 years and dig similarly around its stem, we will not find so many roots as in the case of the younger tree, but instead we will find a few large roots which are destitute of fibers except at their extremities. It seems evident that there is an annual decay of these fibrous roots, and it is a question whether the decomposition of this mass of fiber may not be obnoxious to the plants which produced it, and at the same time not be injurious to plants of a different species.

Instructions relative to the removal and replanting of trees are usually very explicit in regard to the special necessity of protecting the small fibrous roots because of their great importance to the future growth of the plant. In reality these roots are of no value after they are separated from the soil, as they immediately decay on removal. The larger roots, if healthy and their outer bark uninjured, are only to be depended upon for the emission of an abundance of fresh and vigorous spongioles.

It will be admitted that examples can be found where the same crop has succeeded measurably well on the same soil for a series of years, but close observation and accurate comparisons will show that such instances are rare indeed; but even the successes have not enabled us to remedy the failures, and it seems probable that the causes have not been fully explained.

EXPEDIENTS FOR PROMOTING FRUITFULNESS IN PLANTS.

All expedients for inducing early fruiting are founded upon the well-known law that excessive growth and great prolificness can not simultaneously exist in the same plant. Some of the most familiar modes of inducing fruit are as under:

BY DWARFING.

In horticultural parlance, trees are said to be dwarfed when grafted or budded on stocks of weaker growth than themselves. Thus we have the pear on the quince, the cherry on the mahaleb, the apple on the Paradise stock, the peach on the plum, etc. This is a popular and efficient mode of rendering trees fruitful. Properly speaking, any low tree is dwarf; the term when applied to a system is merely technical.

BY BENDING THE BRANCHES.

This process practically consists in allowing the branches of a young tree to grow undisturbed by the pruning knife for several years until the plant attains considerable size; the young shoots are then bent down and secured to pegs fastened in the ground. This mode is eminently adapted for standard pear trees, especially such varieties as Dix, Bartlett, Sheldon, and others that make long yearly shoots. These when bent down soon become studded thickly with blossom spurs, and very ornamental and symmetrical trees can be formed by a little attention to the bending and regulating the shoots; the pendent form soon becomes fixed, and trees so treated are certain to be productive. The proper season to commence tying down is the month of August; the young wood will then be sufficiently matured to bend, and many of the most forward buds will form short fruit spurs, and bloom the following spring. Trees and plants of all kinds can be incited to flower and fruit, no matter how luxuriant their growth, by careful observance of the bending process. Horizontal training is a modification of this system, and is a well-known method of encouraging fruitfulness.

BY PRUNING THE ROOTS.

When a tree has reached a fruit-bearing size, and shows no symptoms of a fruit-bearing disposition, but instead throws out vigorous branches, root-pruning is a very efficacious mode of checking growth. In highly cultivated gardens, where trees are planted and the roots have access to the rich soil, an immense crop of branches will be produced, but

little if any fruit. Root-pruning will check such growths most effectually and render the trees fruitful. The operation is performed by digging out a circular trench at a distance of from 3 to 6 feet from the stem, according to the size of the tree, and cutting all the roots that are encountered or can be reached. The soil is again thrown back and the process is completed. If done in August, the supply of sap will immediately be lessened, the wood-maturing principle accelerated, the fruit buds formed. The operation has been performed in spring with but little benefit, but if done in the fall can not fail in producing the desired results.

Root-pruning has been successfully applied to young evergreens that, in consequence of growing late in fall, are liable to have the points of shoots injured by early frost. When growth is stopped by root-pruning the shoots mature sufficiently to withstand the winter without being injured. A few years of such treatment when the plant is young is found sufficient, as the specimen will attain hardihood with age.

BY RINGING THE BRANCHES.

This operation is performed by removing a ring of the bark from a branch, so as to arrest circulation. This, however, is done with a view to hastening the ripening process of fruit, and has long been practiced, particularly on the grape vine. It is, however, of doubtful utility, as the branch beyond the point of operation is destroyed. It has the effect of not only hastening the ripening, but the fruit will be somewhat increased in size. Grapes produced in this manner are easily recognized by their thick skins and the coarse texture of the fruit.

BY LIMITING ROOT GROWTH.

The most satisfactory application of the principle is that of restricting the growth by confining the roots in pots, boxes, or other similar conveniences, as is well exemplified by the great crops produced on fruit trees in pots. Florists are also alive to the fact that their flowering plants will blossom most profusely when the pots become well filled with roots.

IMPORTANCE OF A UNIFORM SUPPLY OF WATER IN PLANT CULTURE.

If there is any one element in plant growth of more importance than another it is water. Crops usually fail or succeed in proportion as they receive an equal distribution or uniform supply of this element. Failures are more frequently referred either to a deficiency or a surplus of rainfalls than to any other cause. Hence one of the chief essentials to culture is to maintain the presence of a proper amount of available water to crops, and, as far as practicable, guard against excess on either side. And this is entirely within the control of the cultivator. The three operations of draining, subsoiling, and mulching, when properly under-

stood, comprise all the requisites of success, and enable him in a very great measure to regard with comparative indifference whether the season prove unusually wet or unusually dry ; if the former, the drains remove all superfluous water, and the loosening of the subsoil allows the egress of water through all its pores, which are speedily filled ; and mulching the surface, so as to prevent evaporation, retains the water where plants can reach it, instead of its being rapidly consumed by drying winds sweeping over the soil.

Of all operations relating to soil culture, there are none whose values are so well established as these, and yet they are operations to which the great majority of cultivators are strangers. Crops may be deluged, starved, for want of proper depths of soil, or burned up by drought and heat, yet the well-known remedies against such extremes are practically ignored.

Objectors to draining frequently argue that in a climate subject to long-continued droughts it is worse than useless, as it would still further increase the evils resulting from a deficient supply of moisture. It seems not to be generally understood that draining in connection with proper culture increases the capability of the soil for absorbing and retaining moisture. Place a sponge in a vessel and sprinkle it with water ; for a time it will all be absorbed, but as soon as the pores are filled it ceases to be taken up. Soils act in a similar manner. They also have their respective absorbing capacities, varying of course according to their nature, whether a compact clay or a peaty morass. The last is of such an absorbent character as to be called spongy. The object in draining is simply to allow the superfluous water to pass off. No water can reach the drains until the pores of the soil are satisfied or filled. It is therefore evident that the deeper the soil is drained the greater becomes the reservoir of contained moisture, so that on soils of gravely or sandy nature a more luxuriant vegetation will be produced after they are artificially drained. With clay soils this improvement is still more obvious ; no good clay soil can be considered in best cropping condition until drained. Tillage, manures, and seed are to a certain extent wasted on the best clays without this fundamental improvement.

The utility of deepening the soil can not be questioned. In common parlance, a good soil is seldom mentioned without the addition of the word *deep*, thus testifying to the value of this property, yet how few make any attempt to deepen a shallow soil. The probability of bringing to the surface a poor strata has been given in argument against subsoiling. Even if this were the result it would be an additional reason in favor of the process, as it would place the soil where it can be enriched ; but subsoiling proper only loosens the under strata. Trenching, which implies a reversal of the soil, may occasionally afford grounds for this objection, at least for a time, until it becomes properly ameliorated.

Draining and subsoiling therefore increase the amount of available moisture in the soil. To keep it there for the benefit of vegetation, and prevent its escape by mere surface evaporation, we have recourse to mulching. As it is generally known, this operation consists in covering the soil with any loose material, such as straw, wood chips, tan bark, etc., and although it may not be practicable to carry out this process to any great extent in agriculture, yet in orcharding, and indeed all tree culture, as well as in the case of small fruits, it is a commendable practice, the advantages of which are well authenticated. Especially in newly formed plantations is its great value conspicuous; not only is evaporation arrested, but the soil is secured against the compacting effects of heavy rainfalls, weeds are kept down, and root growth encouraged. But where it is not expedient to apply foreign matter to the surface an efficient substitute can be had in the soil itself by simply keeping the surface loose by cultivation. A few inches of loose, powdery soil on the surface forms a capital nonconducting stratum, and likewise has the great advantage of being easily secured.

It can not be too often repeated that the three cardinal operations in soil culture are drainage, subsoiling, and mulching.

LIQUID MANURE FOR PLANTS IN POT CULTURE.

The importance of liquid manure in general cultivation is acknowledged, but the expense of its application on an extensive scale, such as to farm crops, furnishes a strong reason against its use.

It is also acknowledged that the liquid state is the best in which stimulating and fertilizing ingredients can be presented to the roots, as they can absorb nourishment only through the medium of water, and all matters that enter into the interior of plants must be in a soluble condition, or so minutely divided as to be carried along with the water before they can enter into the vessels of the plant.

In the pot culture of plants, where the amount of soil is limited, the use of liquid manure is of vast service when judiciously applied, but much harm may be occasioned by its indiscriminate use. Many persons consider it necessary to resort to the use of guano and other solutions on sickly plants, and are surprised to find that the application only hastens the dissolution of the patient.

It is only healthy and well-rooted plants that are to be benefited by manures, and such as are supplied with hungry roots but growing slowly for want of nutriment. Such plants as have been for years in the same pot or tub, as we frequently find orange and lemon trees, camelias, oleanders, etc., will be greatly stimulated by the application of manurial liquids during their period of growth. For plants of all kinds that have their pots filled with roots it will be serviceable, and to such as fuchsias, pelargoniums, cineraries, etc., while in flower, they will bloom longer and in greater perfection. But it should be kept in

mind that stimulants should not be applied while flower buds are forming, as it might induce an increased wood growth at the expense of the flowering principle.

Manurial liquids may be applied most freely when growth is active, discontinued during the formation of flower buds, and applied more sparingly during the expansion of the blossom. It is a safe rule to dilute severely and use the solution in a perfectly clear state. Thick, muddy water will not be of much benefit and stops up the pores in the soil, preventing free action of atmospheric gases to the roots.

Almost any substance that has manurial properties and will dissolve readily may be rendered available. Every greenhouse or conservatory should have a barrel fitted for the purpose. If furnished with a false bottom or close wire and a tap between it and the bottom of the barrel for drawing out the liquid, manure water can be easily prepared.

FLOWER POTS.

The relative value of hard-burned and soft or porous flower pots, so far as culture of plants is concerned, is a subject of occasional inquiry. Hard-burned pots are not generally esteemed and many persons consider them unfit for the best results of plant culture, while others find no objection to them, and use indiscriminately glazed pots or even slate tubs when they can be procured. The only difference seems to be that the porous pots require more water than will be found necessary in the case of hard-burned pots or slate tubs. The porous pot will part with much water by evaporation from its sides, especially when exposed to the sun or a dry atmosphere. In a dry atmosphere the hard, close-grained pot will retain more moisture in the soil. Plants, therefore, require water less frequently in the hard pots; and in the ordinary greenhouse, where a considerable amount of humidity generally prevails, special care will be required in order that water is not given in excess. The same amount of water applied to plants of similar size and vigor, some of which are in hard and others in soft pots, will speedily show unhealthiness in those in the hard pots. It is perfectly practicable to grow plants equally well either in soft or in hard pots, but the details of management are different, and to those who are not experts in plant culture the porous pots will be most suitable.

NIGHT TEMPERATURE IN GLASS STRUCTURES.

One of the most prevalent and injurious errors in the management of greenhouses and other plant houses is that of keeping the temperature too high during the night. With many the aim seems to be to maintain as high a degree of heat during the darkness as during light, a practice opposed both to science and the results of experience, and one that can not be too severely condemned.

It has been observed that plants will lengthen very fast during darkness in a high, moist atmosphere, and it has therefore been supposed that a gain in growth is thus secured; but strictly this is not the fact. Any extension of growth made under such conditions is at the expense of that made during the presence of light, as it is only then that those chemical changes are in operation that change the matters absorbed by the roots into the woody fiber and other constituents of plants. Consequently the same quantity of material is simply elongated, as in drawing out a wire, which may be lengthened without adding anything to its structure.

Plants grown in a nearly uniform temperature under glass seldom ripen or mature their wood in a thorough manner; the buds are immature and make feeble growth, and the whole plant contracts a delicate habit of constitution, which renders it incapable of withstanding the slightest neglect without injury, thus entailing great care to keep it, even in its sickly condition, and never by any means developing its natural capacities. On the contrary, plants constantly subjected to a suitable lowering of night temperature are more robust, have short-jointed and matured growths, flowers not only expand more fully, but remain longer in perfection, fruits better colored and flavored and more perfect in every respect than those developed in an atmosphere of uniform heat and moisture.

With regard to greenhouse plants, it should be remembered that they require no heat during the night further than to exclude frosts. It has been stated and urged as a reason for keeping a higher temperature that it is necessary to do so in order to secure a succession of bloom, but it had been amply proved that by allowing a more liberal heat, say from 70° to 80° during the day, that a more profuse crop of flowers will be gained than in the more equable conditions insisted upon.

Another injury consequent upon a high night temperature during winter arises from the extraction of moisture from the atmosphere. To maintain an inside temperature of even 50° when the external is near zero involves a rapid generation of heat, and as the capacity of air for taking moisture increases in proportion to its rise, a great demand is made upon the plants and everything in the house capable of giving up moisture. The quantity of water thus carried off may be seen by the deposition of ice on the inner surface of the glass after a night of severe frost. Ice one-fourth of an inch in thickness is often found under these circumstances, the result of condensation and freezing of the water carried from the contained moisture in the atmosphere and from the surfaces of the plants. The parched and unhealthy aspect of the plants subjected to such treatment is sufficient evidence against the propriety of the practice. The expense of fuel and labor required to maintain this injurious temperature is also an important consideration.

WATERING PLANTS IN POTS.

“How often should I water my plants?” This question is very frequently asked, and it is a rather perplexing one to answer definitely; a general answer would be: Never apply water to a plant until it requires it, that is until it is dry, and then apply a sufficient quantity to saturate the soil, which will be indicated by the surplus passing through the drainage.

Novices in plant culture usually make the mistake of merely sprinkling the surface of the soil, perhaps daily, without any time applying enough water to saturate the mass. Plants can not flourish under such conditions; the surface will appear wet, while the main body of the soil is hard and dry. One drawback to properly watering plants in parlor and window gardening (to which these remarks are more particularly directed) arises from the inconvenience attending the use of water in sufficient quantities; another evil is the dryness of the air. Both of these obstacles to success can be greatly modified by the use of a table properly fitted for the reception of the flower pots or small vases in which the plants are kept. This table may be of any required size; a surface of 2 by 3 feet would be suitable for most windows; it should be made tight and neatly fitted. A ledge is made by fastening a strip 3 inches wide around the edge; then fill with 2 inches of clean, white sand, upon which the plants are placed; lining the table with zinc would completely guard against drip. The table should be fitted with rollers to facilitate the operation of watering and cleaning the plants. With a table of this kind the plants can be watered freely, and occasionally sprinkled, without any injury to surrounding objects. The sand should be kept constantly wet, so that moisture will be evaporated from it, and thus overcome, in some degree, one of the chief obstacles to the successful culture of plants in dwelling rooms—a dry atmosphere.

There are a few general rules with regard to watering plants which may be noted. Watering should be preferably applied during the early part of the day, especially so in the winter season. Plants in pots well supplied with roots will require much more water than those which are newly potted or have a quantity of soil with few roots. Plants with narrow or small foliage will not use so much water as those with large spreading leaves. Plants in the shade will not need as much water as will those in the sun; a damp atmosphere will also reduce the necessity of water at the roots. Plants that are growing freely will require a regular supply, as they are sensible of a check at this period; on the other hand, plants which are comparatively resting will need but little, and the supply gradually diminished as growth is being completed.

But in cases when water is applied it should be done copiously, and when gradually withheld the watering should be less frequent, not less in quantity, when it is necessary to make the application.

WATER PLANTS.

In improving that part of the grounds formerly occupied by the canal advantage was taken of the position to construct a small lake, mainly for the purpose of introducing a collection of native water plants.

The ornamental as well as the picturesque effects of this class of plants are mostly quite neglected in modern landscape gardening. It is not uncommon to find artificial lakes in parks and pleasure grounds wholly destitute of this class of vegetation, and although water surface is seldom uninteresting in scenery there is no reason why it should not possess all the attractions and sanitary effects which can be imparted by the introduction of suitable flowering plants.

No flower in the garden border can excel, either in beauty of form or in delicacy of fragrance, the white water-lily, *Nymphaea odorata*; the large cup-shaped yellowish flowers, boldly projected out of the water on long foot stalks, of the *Nelumbium luteum*; and the less showy blossoms of the yellow pond-lily, *Nuphar advena*, in connection with the massive spread of the large leaves, especially those of the *Nelumbium*, which are frequently 18 inches in diameter, produce an effect equal to the best efforts of the most distinguished artist in that popular formation of "foliage" plants known as "carpet bedding."

In addition to the water-lilies, various other interesting species of water plants have been introduced and are spreading rapidly in the lake. Several of the curiously horned seeds of the *Trapa natans* were thrown in, and in due time the small triangular-shaped leaves made their appearance on the surface, neatly arranged in rosette form. Several plants of a tropical *Limncharis* spread rapidly during the summer, and produced abundantly of its yellow flowers. The duck-weed, *Lemna*, thrown in a sheltered cove, speedily covered the surface with its diminutive greenery. In deeper water, plants of the eel-grass (*Vallisneria spiralis*) were planted, and in shallow recesses various species were introduced, as *Potamogeton*, *Calla*, *Pontederia*, *Caltha*, *Acorus*, *Polygonum*, etc. On prominent points, tall, reedy plants will be disposed, such as *Typhas* and *Sparaganiums*, with *Cyperus*, *Juncus*, and smaller growths as marginal plants to the taller central groups.

A small island was formed, having its surface raised about 6 inches above the water level with sphagnum, in which various low-growing bog plants were inserted, such as the pitcher plant (*Sarracenia purpurea*), the horse-tail grasses (*Equisetums*), with *Habenarias*, and similar low-growing forms that are to be found in woody swamps and wet meadows.

The effective arrangement of water and bog plants in and on the margins of lakes should be as much a subject of artistic study as is the arrangement of trees and shrubs in park scenery. This branch of landscape decoration is wholly neglected, but it is destined to become popu-

lar, and it will awaken an interest in an extensive class of plants that are but little known and that possess a characteristic individuality of form and beauty which, when received in connection with their natural surroundings, can not fail to recall pleasant associations to the mind compared to which the landscape effect produced by a group of flowering shrubs will appear exceedingly tame and uninteresting.

GLAZING GREENHOUSE ROOFS.

The ordinary method of fastening glass in window sashes is to lay in the glass without a putty bedding, secure it with small triangular bits of tin, then complete the operation by filling the outside of the sash-bar with putty, lapping it slightly over the glass. When this method is applied to greenhouse roofs it causes a great amount of trouble to prevent leakage. The presence of moisture, which is almost always to be found on the inside of the roof during cold weather, and the action of frosts and rains on the outside, have a tendency to loosen and destroy the putty, so that an annual overhauling is necessary to keep it in repair. But there are now very few greenhouses glazed in the above manner. The old plan has given place to a more permanent and more effectual system so far as regards a tight roof. This plan consists in placing a layer of the best putty on the sash-bar, then pressing the pane of glass until it reaches a firm uniform bed, and so working up a portion of the putty that it will fill all spaces between the edge of the glass and the sash-bar. After the surplus putty is trimmed off it is allowed to dry for a day or two, which will cause it to shrink slightly from the wood; then a coat of thickish paint is applied, which effectually fills up all crevices and makes a perfectly water-tight finish. No putty is used on the outside, and consequently there is no leakage from its decay; and instead of tin fastenings the glass is secured by brad-nails three-fourths of an inch in length, four to each pane, fastened at the corners.

The popular method of roofing glass structures is what is known as a fixed-bar plan. In this plan no framed sashes are used; the rafters are placed about 8 feet apart, their exact distance depending upon the size of the glass, so that, for a neat job, the glass bar will come in the center of the rafter. Between the rafters horizontal purlines are inserted to support the sash-bars. The sash-bars are usually made an inch and a half in depth and $1\frac{1}{2}$ in width; these are fastened in parallel lines, their distance apart depending upon the size of glass employed; after testing various-sized panes, the size 10 inches by 12 inches is generally preferred. For this size the sash-bars are placed $12\frac{1}{2}$ inches apart, measuring from their centers, allowing one-fourth inch rebate for the glass to rest upon on each side. In setting the panes of this size it is of some importance to place the concave surface uppermost, which makes

the center of the pane the lowest point, so that the water which falls on the roof will be diverted from the sides to the center of the line of glass. The glass should not lap more than one-sixteenth of an inch; wide laps hold dust, which in turn hold water, which may freeze in very cold weather and split the glass. This method of glazing admits of laying roofs nearly flat without trouble from leakage. Ventilation is provided for by hinged sashes on the roof, which may be arranged in various ways to prevent them from leaking; the amount of ventilating space allowed will have some dependence upon the purposes to which the structure will be devoted.

RASPBERRY CULTURE.

Within a few years back a notable change has been introduced in the general management of the raspberry. The only pruning formerly given to this plant was confined to cutting out the old stems which had fruited, thinning out the young stems which were to produce the next crop, and shortening them by cutting off a portion of their tops. These would then be fastened to a stake or some similar support, and this completed the pruning for the season. But the more modern system obviates the necessity of any kind of support and the plants are managed so that they are able to support themselves when full of fruit. This is accomplished by allowing the first year's growth of newly set-out plants to grow undisturbed; the second year two or more shoots will be produced, and when these have reached to a height of about 2 feet their tops are pinched off, so as to stop their further upright growth; they will then proceed to push out side shoots or laterals on all sides, balancing and supporting themselves very effectually and appearing like small evenly headed trees. When growth has been completed for the season and the leaves have fallen these side shoots are pruned back so as to leave them from 12 to 16 inches in length, according to their strength. This pruning can be done quite rapidly with pruning shears. At the same time, if not before, all the old stems or canes which have fruited are also removed; but many cultivators prefer to remove these old stems immediately after the fruit has been gathered, claiming that by so doing the young canes have greater freedom of growth; also, that by promptly removing the old canes many kinds of insects which lodge in the old wood and have cocoons and nests upon it are thus destroyed by burning all the prunings as they are collected. This system is continued annually; no greater number of young shoots than is required are allowed to grow, all others being destroyed as they reach a few inches in height. The summer topping is attended to as previously stated, and the result of this routine treatment is a self-supporting plant and improved fruit.

FIGS.

The culture of figs has never attracted much attention in the Middle and Northern States owing to the susceptibility of the plants to cold. They are perfectly adapted to the climates of the Southern States, where they have long been cultivated for domestic purposes, but not produced in sufficient quantities to be included among commercial products.

The fig may be fruited in sheltered localities in the Northern States by taking the precaution of covering the branches during winter, so as to protect them from severe freezing. This is not difficult to accomplish, the most simple and effectual method being that of bending down the branches, and fastening them as close to the ground as practicable, in which condition they can readily be covered with 8 to 10 inches of soil, or an equally thorough coating of forest leaves protected by a covering of boards to exclude rain.

The fig bears most satisfactorily when it is planted in gravelly or sandy soils; in strong, rich soils luxuriant growths are produced, and the young fruit will drop prematurely; the wood will also ripen imperfectly, and thus diminish the number of perfect fruit buds. After the fruit makes its appearance, and all during its progress toward ripening, the plants require an abundance of water; if the roots are kept dry at any time during this period the fruit will probably drop; but when the fruit becomes soft, indicating ripeness, a less supply of water will improve its flavor, and further tend to harden and ripen the annual growths of the tree.

VANILLA.

The opinion prevails that the vanilla plant can be successfully cultivated in Florida, and applications for plants and inquiries as to their growth and culture are frequently received.

The vanilla belongs to the family of orchids and grows wild in Mexico, Peru, Brazil, and other parts of South America. It is also found in Trinidad, Jamaica, and other West India islands, and it is exceedingly doubtful if the climate of any portion of Florida would prove suitable for its profitable cultivation.

The vanilla is a climbing plant and is propagated by cuttings inserted near the stems of trees, upon which it climbs, adhering to the bark by its fleshy roots.

The best marketable pods are supposed to be produced by the species *Vanilla planifolia*, and the principal supply comes from Vera Cruz.

Assertions have been made that the vanilla plant grows wild in Florida. In answer to requests for specimens, leaves of *Liatris odoratissima* have been received. This plant has aromatic foliage and is sometimes used for flavoring cigars and tobacco, and is locally known as wild vanilla, but it has no relation whatever to the vanilla plant that produces the fragrant pods of that name.

INDIA-RUBBER PLANTS.

In the praiseworthy endeavors to introduce new industries into the Southern States, requests are made for economic plants of many kinds that are strictly tropical productions, and among these may be placed the India-rubber-bearing trees.

Various plants afford caoutchouc, the elastic gummy substance better known as India rubber, but as far as it is known it is solely produced by plants of tropical climates. In the East Indies it is collected from *Urceola elastica*; from several species of *Ficus*, mainly from *Ficus elastica*, and from a few other species, natives of the East Indies and western tropical Africa.

South American rubber is also extracted from plants of different genera. The best is said to be obtained from *Hevea brasiliensis*, a native of the Para forests, considered to be distinct from the *Sophonia elastica*, which furnishes the largest portion of the rubber entering into the commerce of that country. The sand-box tree, *Hura crepitans*, yields a milky juice which is similarly converted into caoutchouc by evaporation. These plants belong to the natural order *Euphorbiaceæ*, a large family of plants, mostly yielding a milky juice, containing acrid and poisonous properties.

Mexican rubber is extracted from a native tree, the *Castilloa elastica*, which grows abundantly near the Gulf coast. This plant is botanically allied to the rubber producing *Ficus* of the East Indies.

A new elastic gum has recently been produced in Mexico, which is said to be derived from a native herbaceous plant allied to the family of asters. This plant would probably succeed in the Southern States.

These are strictly tropical trees, for which we have no suitable climate; but attention might profitably be directed to the gum-producing Mesquite tree of Texas, *Algarobia glandulosa*, which yields a nonelastic gum of the nature and possessing all the essential qualities of gum-arabic.

CITRON.

CITRUS MEDICA.

The thick rind of the citron is valued for the purpose of candying or preserving in sugar for use in confectionery, etc. Growers of citrous fruits in California and Florida have repeatedly requested information as to the method of preparation and manufacture of this condiment. As contributing to this information, the following extract from an authentic source is offered:

In all the countries I have mentioned above as contributing the raw fruit for this industry, it is treated in the same manner for the over-sea passage. The fruit is simply halved and placed in hogsheads or large casks filled with a fairly strong solution of brine, the fruit being halved merely to insure thorough preservation of the rind by an equal saturation of the interior as well as the exterior surface. In these casks it arrives at the doors of the manufactory.

The first process to which it is then subjected is the separation of the fruit from the rind. This is done by women, who, seated around a large vessel, take out the fruit, skillfully gouge out the inside with a few rapid motions of the forefinger and thumb, and throwing this aside place the rind unbroken in a vessel alongside them.

The rind is next carried to large casks filled with fresh cold water, in which it is immersed for between 2 and 3 days to rid it of the salt it has absorbed. When taken out of these casks the rinds are boiled with the double object of making them tender and of completely driving out any trace of salt that may be still left in them. For this purpose they are boiled in a large copper cauldron for a time varying from 1 to 2 hours, according to the quality of the fruit and the number of days it has been immersed in the brine. When removed from this cauldron the peel should be quite free from any flavor of salt, and at the same time be sufficiently soft to absorb the sugar readily from the sirup, in which it is now ready to be immersed.

The next process to which the rind is subjected is that of a slow low absorption of sugar, and this occupies no less than 8 days. Needless to say that the absorption of sugar by fresh fruit in order to be thorough must be slow, and not only slow, but it must be gradual—that is to say, the fruit should at first be treated with a weak solution of sugar, which may then be gradually strengthened, for the power of absorption is one that grows by feeding. The fruit (and this holds good more especially with the rind) would absorb with difficulty and more slowly if plunged at once into thick sirup than if gradually treated with weak solution easier of absorption, and by which it has been thoroughly permeated first. It is a knowledge of this fact that governs the process I now describe.

The fruit has now passed into what I may call the saturating room, where on every side are to be seen long rows of immense earthenware vessels about 4 feet high and $2\frac{1}{2}$ feet in diameter, in outline roughly resembling the famed Etruscan jar, but with a girth altogether out of proportion to their height, and with very short necks and large, open mouths. All the vessels are filled to their brims with citron and orange peel in every stage of absorption, *i. e.*, steeped in sugar of (roughly speaking) eight different degrees of strength. I said before that this is a process that occupies almost always 8 days, and as the sirup in each jar is changed every day, we may divide the mass of vessels before us into groups of eight. Take one group of this number, and we are able to follow the fruit completely through this stage of its treatment. With vessels of such great size and weight, holding at least half a ton of fruit and sirup, it is clearly easier to deal with the sirup than with the fruit. To take the fruit out of one solution and to place it into the next stronger, and so on, throughout the series, would be a toilsome process, and one, moreover, injurious to the fruit. In each of these jars, therefore, is fixed a wooden well, into which a simple suction-pump being introduced the sirup is pumped from each jar daily into the adjoining one.

“How is the relative strength of the sirup in each jar regulated?” is the next question. “The fruit itself does that,” is the foreman’s reply; and this becomes clear from the following explanations: Number your group of jars from 1 to 8 respectively, and assume No. 1 to be that which has just been filled with peel brought straight from the boiler, in which it has been deprived of the last trace of salt, and No. 8 to contain that which, having passed through every stage of absorption but the last, is now steeped in the freshly prepared and therefore strongest solution of sirup used in this stage. “We prepare daily a sirup of the strength of 30 degrees, measured by the ‘provino,’ a graduated test for measuring the density of the sirup,” continued the foreman, “and that is poured upon the fruit in jar No. 8. To-morrow the sirup from this jar, weakened by the absorption from it by the fruit of a certain proportion of sugar, will be pumped into jar No. 7, and so on daily through the series. Thus, No. 1, containing the fruit itself, regulates the strength of the sirup, as I said.” “But if the sirup has lost all its strength before the seventh day, or arrival at jar No. 1?” we ask. “Care must be taken to prevent that, by constant testing with the ‘provino,’” is the reply; “and if that is found to be the case, a little stronger sirup must be added to the jar.”

A slight fermentation takes place in most of the jars, but this, so far from being harmful, is regarded as necessary, but of course it must not be allowed to go too far.

There is yet another stage, and that perhaps the most important, through which the peel has to pass before it can be pronounced sufficiently saturated with sugar. It is now boiled in a still stronger sirup, of a density of 40 degrees by the testing tube, and this is done in large copper vessels over a slow coke fire, care being taken to prevent the peel adhering to the side of the vessel by gentle stirring with a long paddle-shaped ladle. The second boiling will occupy about an hour.

Taken off the fire, the vessels are carried to a large wooden trough, over which is spread a coarse, open wire netting. The contents are poured over this, and the peel distributed over the surface of the netting, so that the sirup—now thickened to the consistency of treacle—may drain off the surface of the peel into the trough below. The peel has now taken up as much sugar as is necessary.

Now comes the final process, the true candying of the covering of the surface of the peel with the layer of sugar-crystals which is seen upon all candied fruits. To effect this a quantity of crystallized sugar—at Leghorn the same quality of sugar is used as is employed in the preparation of the sirup—is just dissolved in a little water, and in this the now dried peel, taken off the wire netting, is immersed. The same copper vessels are used, and the mixture is again boiled over a slow fire. A short boiling will suffice for this, the last process, for the little water will be quickly driven off, and the sugar upon cooling will form its natural crystals over the surface of the fruit. Poured off from these vessels, it is again dried upon the surface of the wire netting, as before described. The candying is now complete, and the candied peel is ready for the packing room, to which it is carried off in shallow baskets.

In the packing room may be seen hundreds of boxes of oval shapes, or, if I may so speak, of rectangular shape, with rounded corners and of different sizes, for each country prefers its boxes to be of a particular weight, Hamburg taking the largest of 15 and 30 kilogrammes; the United States of America preferring smaller, of 10 and 12 kilogrammes; whilst England takes the smallest, of 5 kilogrammes, and one containing about 7 English pounds. The wood of which the tops and bottoms of these boxes are made comes to us in thin planks from Trieste, and a skillful packing is generally done by women, and the boxes are lined with white paper. They are then packed in cases of 100 kilogrammes, ten of the smaller American boxes filling a case. The candied peel is now ready for export.

SPECIAL INQUIRIES AND ANSWERS.

That portion of the official correspondence of the Department which relates to subject-matter connected with the operations and specialties of the horticultural division, and is referred to the horticulturist for consideration and reply, embraces a variety of subjects upon which advice is repeatedly asked by different individuals; and as the replies made, so far as the Department is concerned, reach only to the individual addressed, and as this correspondence is largely of general application and directly practical in its nature, I have selected the following from the many similar communications with a view to lessen repetitions of these particular inquiries:

VANILLA.

S. M. R., Polk County, Florida. I understand that the Vanilla Bean grows well in all parts of Mexico and in cool places. I am sure it would do well in this county,

and would be obliged to you for some plants for trial. Also would be glad to know something about its cultivation and preparing the crop for market.

Answer.—The vanilla bean (*Vanilla planifolia*) is a native of tropical countries. It is produced in the warmer parts of Mexico, and not by any means in cool places; in fact its area of profitable culture is said to be limited to certain favorable localities near the Gulf coast. It is very doubtful, indeed, whether the plant can be grown profitably in any part of Florida.

The vanilla is a climbing orchid, or air plant, having a fleshy stem and succulent leaves. It is propagated by cuttings of the stem planted close to the tree upon which the plants climb. They usually receive but little cultivation further than to keep down growths which might interfere with the gathering of the fruit, the plants receiving their nourishment mostly from the atmosphere.

The peculiar odor of the bean is developed during the process of curing, and much of the commercial value of the article depends upon its preparation for the market.

The fruit is gathered before it is quite ripe. If allowed to remain on the plant the pod splits and becomes black; when drying it exudes a dark-colored unctuous liquid, and when quite dry becomes brittle and devoid of perfume.

In Guiana the pods are cured by placing them in ashes until they begin to shrivel, when they are wiped, rubbed over with olive oil, then hung in the open air to dry.

In Peru the pods are dipped in boiling water, then hung out in the open air for a month, afterwards smeared with castor oil and tied in bundles for sale.

In Mexico the curing process is more elaborate and varied. The pods are placed in a heap under protection from the weather until they begin to shrivel, when they are submitted to a sweating process. This is accomplished by wrapping the pods in blankets inclosed in tight boxes; afterwards they are exposed to the sun. They are now tied into small bales or bundles, which are first wrapped in woolen blankets, then in a coating of banana leaves, first sprinkled with water, then placed in an oven heated up to above 140° F. Here they remain for from 24 to 48 hours, according to the size of the pods, the largest requiring the longer time. After this heating they are exposed to the sun daily for 50 or 60 days until they are thoroughly dried and ready for the market.

In the valley of Mazatlan the vanilla abounds in a wild state and the article is of the finest grade. The curing is thus described: "To cure properly requires about 90 days, and the manipulation is almost infinite, each bean being handled critically from three hundred to five hundred times in the process by the Indians. The beans, as gathered, are disposed of in layers, first a layer of beans and then a blanket, and so on till a pile is formed. This is called the sweating process, and during its continuance the piles are turned two or three times a day until most of the water is sweated out. This process is followed by drying in the sun, and here the natives exercise the utmost care and attention. When finished the beans are to be the color of a very dark cigar. The attendant picks up each bean occasionally for examination, and if he observes any part of the pod is coloring more rapidly than another he twists a bit of the leaf around the spot until the action of the sun shall have affected all alike."

MAHOGANY TREE.

J. S., Eastern Shore, Maryland. I inclose a few seeds of the mahogany tree which grows in this part of the State. Since I learned that this tree was the mahogany I am saving the seeds and mean to plant all I can get, and would ask you where I can get a supply, as I suppose that the tree is in other parts of this country.

Answer.—The seeds sent are those of the Kentucky coffee tree (*Gymnocladus canadensis*), and has no botanical relation to the tree which yields the mahogany wood of commerce.

It is called coffee tree for the given reason that the early settlers in Kentucky, where the tree grows in the forests, used the bean as a substitute for coffee.

The timber of this tree is of a fine compact grain and is sometimes used in cabinet work, hence it is in some places called the mahogany tree.

J. H., Guadalupe County, Texas. I take the liberty of writing to you, as I wish to know if you could give me any information about cochineal. We have plenty of prickly pear (cactus), and believe it is the same kind used in Madeira for the growth of the insect. I should be very thankful if you would let me know something about the matter.

Answer.—The cochineal insect (*Coccus cacti*) feeds upon different kinds of *Opuntia*, or prickly pears. *Opuntia tuna* and *Opuntia* or *Nopalea coccinellifera* are the species principally used in Mexico, and these, with *Opuntia ficus indica*, are employed for a like purpose in the Canary Islands, New Grenada, and Madeira.

In arranging plantations, or, as they are sometimes termed *nopaleries*, for raising the cochineal insect, the plants are set out in formal lines several feet apart, so that they can be cultivated similarly to a carefully checkered cornfield, and when the plants are large enough the insects are distributed upon the plants. These soon give origin to countless numbers of minute insects, of which the females soon increase rapidly in size until they almost lose the appearance of insects and look like small warts. At this stage of their growth they are gathered by detaching them from the plant by a flat, wedge-like stick, and placed in a bag, which is then dipped in boiling water to kill the insects, afterwards drying them in the sun.

It has been estimated that 70,000 of these insects are required to make a pound of cochineal.

It may be surmised that the profits of this industry will greatly depend upon the cost of the labor required for these manipulations.

TREATMENT OF LAND.

J. G. T., Delaware. Two years ago I took in hand a piece of ground completely exhausted through continued cropping without manure, and so full of wire-worms that not even weeds can be got to grow. The ground is a very heavy loam, lying upon a stiff clay; every shower of rain makes it a puddle, and forty-eight hours of sunshine makes it so hard that it is next to impossible to break it up; manure plowed in can be turned up months afterwards in the condition in which it was put on. I have used lime at the rate of 25 bushels to the acre, but not with the result expected, and intend to apply the same quantity of common salt, in the hope that it will destroy the worms.

Will you kindly say if I have adopted the proper method? Any advice you may tender will be very kindly received and carefully followed.

Answer.—There can be no permanent or satisfactory improvement made upon such land as described until it is thoroughly tile-trained. Thorough draining would involve parallel lines of tiles not more than 25 feet apart, and placed to a depth averaging 30 inches. Then it should be deeply plowed in the fall; fall plowing is an important factor in the management of heavy land, and no mechanical appliances can pulverize it so effectually as the influence of frost.

After plowing in the fall, sow salt at the rate of 15 to 20 bushels to the acre, and when it is dry enough to work in spring, spread lime over the surface at the rate of from 50 to 75 bushels per acre and harrow it in before putting in a crop.

It should be well understood that land of this character should never be worked when wet. After heavy summer rains there is always a period between wetting and drying when it can be pulverized on the surface and thus effectually prevent its becoming hard and compact.

Draining will greatly modify the tendency to cake or become hard on the surface. It will also allow of a gradual deepening of the plowed stratum, and is, in fact, the foundation of all improvement towards increasing the productiveness of lands resting upon a clay subsoil.

APPLE TREES.

J. K. E., Fairfield County, South Carolina. Also, I want what information you can give me about apple trees for this climate. I am told that the Northern-grown trees, or trees from Northern nurseries, are not desirable, as the fruit will not keep for any length of time during the winter, or after it is taken from the tree. I am comparatively a new-comer here, but would like to set out some apple as well as other fruit trees, and would act advisedly in the matter.

Answer.—So far as it concerns the trees, provided they have been well grown, healthy, and wood properly matured, it probably makes but little difference whether they are from Northern or from Southern nurseries; but when it comes to the selection of varieties, especially winter-keeping kinds, it is essential to recognize that most of the Northern winter varieties become summer and fall ripening kinds when grown in South Carolina.

It therefore becomes necessary to procure the best kinds from Southern nurseries, where attention has been given to the propagation of fruit specially adapted to their sections, of which there are numerous varieties which for size, beauty, and quality are equal to any produced in more northern regions.

COFFEE.

W. W., Erie County, New York. I am desirous of gaining information in regard to the cultivation and raising of coffee.

I should like to get cuttings or slips of the coffee tree for grafting purposes. I have a ranch in California upon which there is wild coffee growing which produces a berry similar to Mocha, only smaller. If I could get cuttings or buds to graft I should like to make an effort to see what could be done in the matter.

Answer.—The so-called wild coffee of California is the seed of a plant belonging to the buckthorn family, called *Rhamnus californicus*, and has no more relation to Arabian coffee than it has to a hazel bush or a maple tree.

Of course it would be wholly impracticable to graft or bud the coffee into a *Rhamnus* and expect the scion to grow.

The coffee plant, so far as experiments have been noted, has not been a success in California.

The tropical summer period is too short and the winter temperature too low over by far the greater portion of the State. The coffee plant suffers or is checked in growth when its surrounding temperature is so low as 40° F.

LOTUS PLANT.

H. S., New York City. Can I get from you a description and sketch of the lotus plant of Egypt?

Answer.—The Egyptian lotus is given by some authorities as being the fruit of a water plant, *Nymphaealotus*. The fruit of *Nelumbium speciosum*, also a water plant, is also known as lotus.

The fruit of *Zizyphus lotus*, a prickly branching tree allied to the jujube tree, is supposed to be the true lotus of the Lotophagi. This fruit is described as small farinaceous berries, of a yellow color and delicious taste. This farinaceous substance, when dried, is pounded into a kind of flour, which, being formed into cakes with water and dried in the sun, makes a kind of sweetish bread.

LE CONTE PEAR.

B. B., Lake County, Florida. I have about a dozen Le Conte pear trees which have made fine growth, and are bushy trees some 12 to 15 feet in height, but they do not bear any fruit. For several years past a few sickly looking flowers would appear, but no fruit.

I write to ask you if you think that they need to be fertilized. The soil grows orange trees well; of course they receive some fertilizer, but the pear trees were treated the same.

If you could advise me what to do I would be much obliged.

Answer.—The main reason why the Le Conte pear fails to fruit with you is that the climate is too continuously warm and the trees have no decided or definite period of rest. This continued activity of growth prevents the formation of flower buds and encourages growth of shoots. If the growth of the plant is arrested or checked in the early fall it would tend towards the formation of flower buds, and possibly secure a crop of fruit. This may be effected by pruning the roots. Practically this operation would consist in digging out a circular trench about 4 feet from the stem of the tree, cutting out all the roots encountered to a depth of 30 inches, then undermine the ball so as to sever all deep-running tap roots. Then throw the earth back into the ditch, firming it properly as the filling proceeds.

If this operation is performed about the end of August it would check longitudinal growth of shoots and tend towards the formation of fruit spurs on the older branches.

This is not a new or untried process, but has long been practiced successfully in rendering barren trees fruitful under conditions similar to those here mentioned.

LAWN-MAKING.

J. S., Baltimore County, Maryland. Now I want to tell you about my lawn, or rather I should say my failure in trying to get one. Two years ago I had the ground plowed deep; at least my instructions were to plow it deep and good, but I now think that it was not very deeply plowed. It was then made smooth and level; was fertilized with 300 pounds of superphosphate (it is about half an acre), and lawn-grass seed sown and harrowed over. With the bushel of grass seed was mixed about 2 pecks of oats. It was sown about the end of March, and came up beautiful and green in a few weeks, at least the oats did. When the oats were about to head I was advised to mow them so as to let the grass grow. This was done; weeds came up, but very little grass was seen, and, in short, although the weeds were mown down several times during the summer, the grass made no show, and when the most of the weeds were killed by the frost my poor lawn looked very sickly indeed, with here and there a tuft of grass and clover; but the greater portion looked as bare as the day the seeds were sown.

I was advised to cover it all over with a coating of manure just before setting in of winter, which was done. When the spring came round the coarse portions of manure were removed and the finer portions harrowed into the soil. It was again seeded as before, and the oats did well, but not the grass, and I have yet no lawn.

Please tell me why I have failed and how I can get a good lawn.

Answer.—The letter indicates very clearly the cause of failure. First, the soil was probably imperfectly prepared; second, the allowance of grass seed was too small; and, third, the oat seed allowance was so large that, even if the other two factors had been of the best, the oat crop would have rendered it a failure.

To secure a good lawn the primary requisite is proper preparation of the soil. Where this can be done by the plow a deep furrow should be thrown out with the turning plow, and a subsoil plow run into the bottom of each furrow. This will turn and loosen to a depth of from 15 to 18 inches, according to the thoroughness of the work. If done by hand labor it should be spaded as deep as the spade can penetrate and the subsoil loosened with a pick, but in no case should the subsoil be brought to the surface if the sowing is to be immediate.

The next operation is to level the surface so that it may be made smooth and regular. No pains or expense should be grudged to make the surface perfect at this stage of the work, as it will be difficult to make corrections after sowing.

If good barnyard manure can be provided a heavy dressing of it should be spread

over the surface and plowed in. This soil preparation is best when done in the fall and the surface left rough during the winter.

Even with the above manuring the second plowing should not be omitted. As a substitute for the fall manuring apply bone dust at the rate of at least one-half ton per acre in the spring on the surface and harrow it in. Before sowing the surface should be harrowed and cross-harrowed until a smooth, even surface is produced; then sow the seed and cover it by rolling.

The best lawn grass is *Poa pratensis*, variously known as blue grass, green grass, and June grass, and the many mixtures sold as lawn grasses are largely composed of this species. A good mixture is 2 bushels of the above, 1 bushel of red top (*Agrostis vulgaris*), and 1 quart of timothy (*Phlem pratense*). The timothy seed is included because it vegetates quickly and strongly, loosens the surface soil, and thus facilitates the growth of the other grasses, and soon disappears. If sown under good conditions from the first of March to the middle of April, it will be fit for the lawn mower by first of June, and by the end of that month will present the appearance of a good lawn.

A fine lawn can not be maintained without frequent mowing, and now that numerous and cheap and efficient lawn mowers are to be found everywhere, there is really no excuse for imperfectly kept lawns.

During the first summer the cuttings of the mower may be allowed to remain on the surface as a mulch, but experience shows that the practice is not to be commended after the first year.

It is pernicious to sow oats, rye, barley, or other grains with the grass seed. These strong-growing plants rob the soil and injure the growth of the lower grasses. They do not require any protection of this kind, and many failures in lawn-making can be traced to the practice of mixing these with the grass seeds.

BRAZIL NUT.

W. W. W., Iowa. I wish to know whether the tree that bears Brazil nuts will thrive in the United States, and whether they will bear much, if any, frost without injury, and whether they will thrive where oranges and almonds do. Also, best mode of starting young trees from the nut.

Answer.—The tree that yields these nuts is the *Bertholletia excelsa*, a native of Guiana, Venezuela, and Brazil. It is found in large forests on the banks of the Amazon, and is therefore strictly a tropical tree, and would not be at all likely to grow to any degree of perfection in Florida.

Climates suited to almonds and oranges are no criterion for tropical vegetation. The former will grow wherever peaches do well, and a bearing orange tree will withstand 10° of frost without injury.

CHICLE GUM.

R. P., New York City. Among the importations at this port is an article called Chicle Gum. After considerable inquiry I have not been able to find the name of the plant which produced it, but have learned that it comes from Mexico.

If you can tell me the name of the tree or plant, and where it can be obtained, I should like to try it in Clay County, Florida, where I have interests.

Answer.—Chicle Gum is furnished by *Sapota achras*, a tree of the West Indies and of some parts of Mexico.

The fruit is called Naseberry, or Sapodilla plum. It is stated that the succulent gummy pulp surrounding the seeds is named chicle, and that it is employed in the preparation of gum-drops.

The tree will not flourish in Clay County, Florida, although it is to be found growing in the southern extremes of the State, where it has been introduced.

OPIUM POPPY.

C. E., Liberty County, Georgia. I have reason to believe that the opium poppy will do well here, and would try it if I had enough seed of the right variety to make a plantation of several acres. Can you furnish seed or procure it for me at my expense?

I should be obliged for any information in regard to its culture, and how best to get the opium from it.

Answer.—So far as climate is to be considered the poppy plant will grow in Georgia, and, indeed, in most of the United States, and seed can easily be secured, and the plants are easily raised. The soil should be very finely pulverized on the surface, and the seed sown in shallow drills, or rather mere marks. The seeds are very minute and should be mixed in fifty parts of dry sand, then sand and seed sprinkled thinly on the surface and covered simply by passing a light roller over them. These drills may be 2 feet apart, and when the plants appear they are thinned out so that they will be from 6 to 8 inches apart.

It is highly improbable that it can be profitably produced in this country, as may be gleaned from the details of collecting the juice.

When the seed pods are properly matured the milky juice is obtained by making incisions in the pods with small lancets. This requires great care, so that the incision is not made through the entire substance of the pod; the surface is only scarified. The cutting being performed in the afternoon, the opium is allowed to exude and remain on the pod till next morning, when it is scraped off, drop by drop, and thus collected in a small cup. Successive incisions are required to secure complete exudation.

It is thus seen that the process is slow and tedious, and it is stated that the average pay of the operators does not reach 10 cents per day.

The factory operations in preparing the article for commerce are also tedious and complicated, involving much manual labor, which is cheaply procured in Asiatic countries.

CAMPHOR TREE.

J. S. R., Hernando County, Florida. A camphor tree received from your Department 6 years ago has grown up into a fine tree some 15 feet in height. It is a beautiful ornamental tree, and is valuable on that account alone, but if this is the tree from which the camphor of trade is obtained I would be obliged if you can inform me how to get it. I have tried cutting the bark, but could not see any exudation of gum.

Answer.—The camphor tree (*Camphora officinarum*) is a native of China and Japan, and yields the camphor of commerce.

Camphor is obtained by chopping the wood into small pieces and boiling them with water in an iron vessel till the camphor begins to adhere to the stirring utensil; the liquor is then strained, and the camphor concretes on standing. It is afterwards mixed with finely powdered earth and sublimed from one metallic vessel into another.

In Japan the chips are boiled in a vessel to which an earthen head containing straw has been fitted, and the camphor sublimes and condenses on the straw. Crude camphor very much resembles moist sugar before it is cleaned; it is refined by sublimation, an operation which requires care and experience.

~~BAHIA ORANGE.~~

E. S., Putnam County, Florida. I have seen a statement that the Bahia orange, as seen in the greenhouse in Washington, has no pollen on its blossoms, and that is

given as a reason for its poor bearing in Florida. I would like you to answer me the following questions:

If the want of the pollen is the cause of its not fruiting in Florida, why does it fruit so well in California?

If it has no pollen, how does it happen that it affects trees all around it and causes them to produce navel oranges?

Answer.—The statement has not been made that because the Bahia orange flowers are lacking in pollen here this variety does not fruit well in Florida, but rather that it does not fruit well there for the same reason, that is, want of pollen to properly pollinize the pistil; this we know to be a fact from personal inspection of trees of this variety when in flower in Florida. Since the first flowering of the Bahia here, quite a dozen years ago, this defect has been recognized. After the fruit became popular in California it was ascertained by inquiry that while the trees did not bear so abundantly as many other varieties, yet it produced a fairly profitable crop in that State.

It therefore seems probable that the climatic and cultural conditions permit of a better development of pollen in California than in Florida and in some other places. This would not be an exceptional case. It is well known that climatic conditions affect the pollen of plants. Those who are in the habit of saving seeds know that plants will often fail to set seeds in the extreme heat of summer, but will produce fruit and seed abundantly later in the season when the temperature is lower. The reverse of this is also known; some plants will only seed well during the warmest part of the season, and fail to do so in cooler weather. Whether the flowering season of the Bahia in California is more favorable to the ripening of its pollen than is its flowering season in Florida is a point to be determined.

With regard to the question: If this navel orange has no pollen, how does it happen that it affects trees all around it and causes them to produce navel oranges? it may be stated that this question has been frequently similarly presented for explanation. Presented in this manner it suggests doubt as to the accuracy of the observation of those who have been unable to find pollen in the flowers of this variety of orange; at the same time it furnishes no proof of the existence of pollen on the trees which are stated to exert so powerful an influence upon their neighbors. The question can therefore only be looked upon as an imaginary hypothesis.

The absence or presence of pollen in a blossom is a matter easily determined; a few minutes of inspection would enable the observer to state definitely whether it has no pollen or the reverse.

If the statement is varied, that the tree has an abundance of perfect pollen, the cause of nonproductiveness would then become a question of further inquiry. This direct evidence of an abundance of pollen would be entitled to a degree of respect which is certainly not afforded by the supposition that because other fruit show a navel mark therefore the suspected tree must have had an abundance of perfect pollen.

The navel mark on oranges is a very indefinite article. Sometimes fruits may be taken from a tree some of which will have a scarcely perceptible indentation as a mark, while others will show a protuberance half an inch in diameter. The cause of this mark has not been explained. This much may, however, be looked upon as certain, that if a vegetable physiologist picked a fruit having something of a navel mark from a tree of the St. Michael's, or from a tree of Maltese oval, or from one of any variety not known as a navel, he would not be apt to attribute the appearance of the mark to pollen influence of any kind. X

CANARY SEED.

G. M. E., Cecil County, Maryland. I write for information upon the subject of canary seed. I have in view the subject of planting it for a crop if it will grow here and pay. I shall be obliged for what information you can give me as to the character of

Wm Saunders

the plant, the probability of its successful growth here, yield per acre, time of sowing, etc.

Answer.—Canary seed is produced by a species of grass, *Phalaris canariensis*, said to be a native of Asia, but found growing wild in various parts of the eastern world.

But little is known here about its yield or the profits pertaining to its culture. It is stated that the amount entering into consumption annually is about 200,000 bushels, and it is chiefly from Turkey and Barbary.

As cultivated in these countries the seeds are sown early in spring, in drills 6 inches apart, and the plants thinned to 2 inches apart in the rows. It is a slow-growing, slender-stemmed plant, requiring frequent hoeing to keep weeds from destroying it. Much care is required in harvesting, as the seeds fall off easily. Birds are fond of it when it is opening. In some countries the seeds are fed to race horses, as they are said to strengthen muscle without being fattening. No doubt the plant will grow well in Maryland. Probably there would be but little profit in its production. This can only be ascertained from a practical experiment.

TREE-PLANTING.

J. R. E., Fairfax County, Virginia, The question as to the best time to plant shade trees, of apple and pear trees, has been discussed at our club meeting. Some prefer fall planting because the soil becomes well settled about the roots before spring and the trees do much better than those planted in the spring; others maintain that fall planting has no advantages, but, on the contrary, they have lost trees which were set out just before winter set in, and consider spring planting to be more reliable. Can the Department of Agriculture advise us of the results and conclusions reached on these points?

Answer.—Fall planting is preferable to spring planting because the conditions of the soil and climate are then more favorable. In propagating plants by cuttings it is found that rooting is most successful when the bed in which the cuttings are inserted is 15 or 20 degrees warmer than the atmosphere surrounding them. The heated soil encourages the formation of roots, while the cool atmosphere prevents bud growths. When these conditions are reversed the cutting will grow for a time without forming roots.

It is found that during the month of October in this locality the soil averages several degrees warmer than the atmosphere. This gives a kind of natural hot-bed into which we place a newly removed tree; the formation of young roots commences at once, and in a few weeks a good system of roots is established, enabling the tree to stand the vicissitudes of winter and make an early and vigorous start the following spring.

If planting is delayed until spring these physical conditions of soil and atmosphere are to a certain degree reversed; the soil is then cold and accumulates heat slowly, while the air rapidly increases in warmth. Trees planted at this time will have the buds excited to growth, and leaves will be formed in advance of the roots; these extract sap from the branches and the stem of the tree, which as yet has no active roots to supply this demand. If the weather proves to be dry and warm the evaporation will either destroy the tree or greatly check its growth and well-doing. This is the reason why spring-planted trees occasionally come out into leaf, apparently vigorous and healthy, but will suddenly wither and die under the influence of dry weather.

From the above it will appear evident that fall planting should be performed as soon as the leaves drop. In fact it is most successful when the leaves are stripped from the trees, not later than the middle of October, and planting done at once. If delayed beyond the middle of November in this locality success will be less certain and none of the advantages of fall planting secured. Many failures occur by thus delaying the work, and fall planting is denounced as wrong in practice.

PEAR BLIGHT.

J. D., Kansas. What effect has the stock on pear blight? The original Kieffer tree is said to be free from blight, and for years it was claimed that all Kieffers were blight-proof, yet of late years we have undoubtable evidence that they do blight. Now, why this change? Is it from foreign sap introduced into the tree through budding and grafting? First it was budded on the common pear stock, then scions from that were grafted on another, and so the process was continued until the original sap, we might say, has all been worked out, and as a consequence we have blight.

The Le Conte pear was claimed to be exempt from blight, yet we find in late years it has blighted. Those who profess to know say that there has never been a case of blight on any tree that can be traced back to the original cuttings, but the blight is only on trees which have been grafted.

Now the question arises, are any pear trees blight-proof; and if so, can they be kept in that condition by propagating only from cuttings?

Answer.—It may be said that those who claimed that the Kieffer pear would be blight-proof simply made a mistake. As its culture extended and plantations were set out in different localities cases of blight were reported. When the Kieffer comes under the influences which cause blight, it seems to be just as sensitive as many other varieties of its species.

The causes of blight on the pear are not yet understood. The opinion that it is caused by bacteria is quite prevalent, but there are many others who maintain that bacteria is not the cause of the disease, but exists because of the disease; in other words, that bacteria has nothing to do with the origin of disease in plants or animals, but let the animal tissue die and it is in the condition to decompose, and can only do so by bacterial growth. The same with plants. The germs of bacteria swarm in the air and are always ready to light upon disorganized tissue and perform the great and important task of reducing the vegetable world to its ultimate elements.

Budding upon other than the Kieffer stock can have nothing to do with blight. The entire foliage being Kieffer will naturally determine and control the cell growth of the whole plant.

The claims made for the Le Conte pears as being blight-proof rest on no better foundation. Trees of this variety procured from Thomasville, Georgia, which were propagated from cuttings, have blighted badly, so badly as to entirely destroy the tree. They have suffered more than the Kieffer under similar conditions; that is, they were growing within 40 feet of each other.

If any variety of pear is blight-proof it has not yet been made known, and it is beyond controversy that pear trees raised from cuttings are just as liable to be attacked by blight as are varieties propagated by any other method.

COFFEE.

W. H. M., Sanford, Florida. I shall be pleased to receive, at your earliest convenience, as many coffee plants as you can spare me; also as much coffee seed as you can send.

I have had several years' experience in coffee growing in southern India, and want to try it here, as I think the climate and soil well adapted to successful cultivation of coffee.

Answer.—The Department of Agriculture has for nearly a quarter of a century made yearly distributions of coffee plants, sending them to the warmest localities in the United States, but the returns have not been of a nature to warrant further continuance of the distribution of these plants so far as relates to the object in view of establishing a profitable industry.

It is true that several years ago a small quantity of ripened berries were produced on coffee plants growing near the Manatee River, but it was understood that these plants were in a very well sheltered position, and received additional protection

during the severest weather in winter. Subsequently these trees were frozen to the ground by a cold of unusual severity for that locality.

It is quite certain that coffee can not become a profitable crop at Sanford, Florida, where a lowering of temperature down to or below the point of freezing occurs almost every winter. Although the freezing point may not be reached, yet occasional low temperatures in the fall or early winter months retards the ripening of the fruit, even when the plant is apparently uninjured. A tropical climate means something more than mere exemption from frost.

Experienced coffee-growers state that the culture is not commercially profitable in a climate where the thermometer falls below 50° F. at any time during the year. The plant will survive a much lower temperature than the above, but this estimate refers to the value of the crop.

MUSTARD SEED.

J. W. H., West Virginia. I am using in my business a large quantity of mustard seed, and being desirous of raising the seed in this section I write for information as to its culture.

Answer.—Black-seeded mustard (*Sinapsis nigra*) and white-seeded mustard (*Sinapsis alba*) are the kinds usually cultivated. The former is said to have the preference for manufacture into flour.

As far as can be learned there have been but few attempts to cultivate the mustard plant in this country, and the results obtained have not been very satisfactory.

Mustard requires a rich, loamy soil for its growth. It is sown in spring, usually broadcast, although sometimes in drills about 1 foot apart. The soil requires to have a finely pulverized surface before sowing, so that the seed may be equally covered by harrow and roller; if they are covered more than one-half inch with soil they may remain dormant for many years. It is found that buried mustard seeds will remain dormant for decades and vegetate when brought near the surface; so it is difficult to get rid of it in fields where it has once been grown, the seeds shaken out in harvesting being sufficient to furnish a crop, as weeds, for many years.

About one-half peck of seed will sow an acre, and a good crop will return 30 bushels per acre. This quantity is procured only where soil and climate conduce to best results. In dry seasons this amount would be much reduced.

GRAPE ROT.

J. K., Fairfax County, Virginia. My grapes were, I may say, a complete failure this year from rot. Ever since my vines commenced bearing they have suffered more or less, some seasons less than others. Four years ago I may say that the crop was as total a failure as this. Last year I saved a good half crop. I need not say that I am discouraged, and will abandon the culture if this disease continues, but I am loath to dig them up if anything can be done to save them. They have been carefully pruned and fertilized with bone, the land is not poor, and the vines make plenty of growth.

What is the general result of putting paper bags over the bunches? If any particular point in culture or management can modify or extirpate this ruinous infliction I would be glad to know it.

Answer.—As to the general result of putting paper bags over the bunches, it may be stated that it is successful. Some few report unfavorably, but it has been found necessary to place the bunches in bags as soon as the berries are formed, and that, when the covering is delayed much beyond this period, rotted berries have been found in the bags.

It has long been observed and noted that grapevines protected by a canopy or covering, such as the projecting eaves of a building, or even the casual protection afforded them when growing up through the branches of a tree, are measurably exempt from fungous diseases. Recent reports show that grapes under a board or even must lin cover are almost entirely exempt from rot. A protected grape trellis is described

and figured in the Agricultural Report for 1861, and was in use in the garden of the Department for many years, with the best results. This board-covered trellis was substituted by a T-shaped trellis, the flat top being wired, and the vines allowed to cover it with a dense mass of foliage. This arrangement was found to be quite as effectual in protecting from mildew and rot as the more solid but more expensive cover of boards. In this case the more robust growing varieties of grapes were planted at intervals of 30 feet, and trained exclusively on top of the trellis. So far as economy is concerned this plan has an advantage over all others, inasmuch as the vines used for protection also yield their crop of fruit.

Even on the ordinary wired trellis exemption from rot has been observed when the summer growth has been allowed to accumulate on the top wire, and the ends of long shoots and laterals allowed to hang down like a screen over the plants. To secure this heavy top growth summer pruning will be abandoned, which is perhaps an advantage to the crop. Summer pruning, when done at all, is usually overdone, and is but little practiced by the most successful grape-growers.

LICORICE.

P. W. J., Accomack County, Virginia. I would be greatly indebted if you will let me know what you think about the culture of licorice in this county. Our winters are not quite so severe as at Washington, District of Columbia, and my soil is somewhat sandy. I am anxious to learn something about its cultivation, and whether the crop would be a profitable one to raise.

Answer.—So far as regards the cold of winter the licorice will not be injured, but its profitable culture may be considered as doubtful.

To produce good licorice roots the soil must be rich, and it must be deeply worked, at least to a depth of 2 feet. It is very essential to have a deep soil to allow the downward growth of the roots, which increases their commercial value and enables the plant to withstand hot, dry summers, for if the plants are weakened or checked in luxuriance they are liable to the attacks of the red spider, which destroys the foliage.

The plants are propagated by the slender side roots, which are removed in trimming the saleable portions. They are set in the prepared soil by making a perpendicular hole with a sharp pointed stick or dibble and inserting the root slip so that it will be covered entirely, exactly as horseradish sets are planted.

Frequent hoeing will be necessary during the summer, not only to destroy weeds, but to maintain growth, and the deeper the culture, without hurting the roots, the better the plants.

As winter approaches the tops will become yellow, and after growth is completed they can be cleaned off and the plants covered with manure.

At the end of the third summer's growth, if the plants have done well, the roots will be large enough for market. The process of digging out and harvesting the roots is perhaps the most tedious operation with the crop. They run from 2 to more feet in depth and can only be secured safely by the use of the spade, so that the whole root may be secured without breakage.

The marketable portions are trimmed of all side roots, washed, dried, and tied in bundles for sale.

The labor and cost of manure for thorough preparation of the ground from 2 to 3 feet in depth, the planting and cultivation for 3 or 4 years in producing one crop, and the cost of harvesting the roots leads to the opinion that its profitable culture is doubtful, at least while the price of the article remains as at present.

PRUNING GRAPES.

F. M. D., Steuben County, New York. There seems to be a diversity of opinion as to the best time to prune the grapevine. Some prune in the fall and others any time during the winter or spring. Many growers think there is no particular time better

than another so far as fruit is concerned. If the Department of Agriculture has any rule for this operation I would be obliged for information as to the time, and why any particular time is preferred.

Answer.—The best time for the winter pruning of grapes is soon after the fall of the leaves, and the sooner the better, for the reason that the buds will push with more vigor in spring, will bear better fruit, will ripen somewhat earlier. This arises from the circumstance that the plant during winter continues to absorb more or less nutriment by its roots, which is distributed in the branches or wood. If, therefore, pruning is delayed until the approach of spring this winter accumulation is largely destroyed and lost. When, however, the vine is pruned in the fall the winter accumulation of increase will be deposited in the buds and parts left after pruning, and such buds will start vigorously and, in consequence of their better development, the fruit they show will be increased, and the shoots will advance rapidly in growth and attain maturity sooner than those from weaker buds, as may be tested by comparative trials and close observation of results.

This becomes a matter of considerable importance in localities where the growing season is barely of sufficient length to ripen the fruit.

TONKA BEAN.

N. B. G., Orange County, Florida. Among other tropical plants which I am trying to grow I would like to raise the Tonka bean plant, and would be greatly obliged for some plants or seeds of it for trial, also some information as to the particular value and use of the bean.

I hear of a wild vanilla said to be growing in some parts of this State; would like to know something about it and where seeds or plants can be secured.

Answer.—The Tonka bean is the seed of a tropical tree of Guiana, called *Dipterix odorata*, which reaches to a height of 60 or 80 feet. The bean has a strong odor, somewhat resembling that of cloves, and is due to the principle called coumarine, a fragrant principle found in the dried leaves of the vernal grass, *Anthoxanthum odoratum*, and in the leaves of the yellow melilot, *Melilotus officinalis*. The Tonka bean has been used to scent snuff, hence it is called the snuff bean. It is sometimes employed to adulterate vanilla. It imparts to true vanilla a sharp, rank odor and taste, which some persons think indicate "strength," but it detracts from the genuine vanilla flavor.

The *Dipterix* would not succeed with you, as it requires a strictly tropical climate.

The term wild vanilla is given to a composite plant of the Southern States, called *Liatris odoratissima*. The dried leaves emit a peculiar odor, also due to the principle coumarine. The leaves are used in scenting tobacco and snuff. The *Liatris* is found in swampy woods throughout Florida, which, with the assistance of a local botanist, you can procure without much trouble or expense.

ZANTE CURRANT.

H. H. M., San Bernardino County, California. I am anxious to test the soil here in producing the "Zante Currant," and desire to know the kind of vine that produces this fruit and where plants can be obtained.

Answer.—The Zante Currant is the product of a variety of the foreign grape and will undoubtedly grow where other varieties of *Vitis vinifera* flourish.

It is merely a seedless form of a black grape; the origin or cause of its being seedless has not clearly been explained, except that it results from a deficiency of pollen at the blooming period of the flowers. Similar results are not uncommon with Black Hamburg and other varieties when grown in glass structures; bunches will sometimes fail to be properly pollenized, so that a few berries may reach full size with a more or less percentage of small seedless fruits.

Statements have been made that Zante currants can be produced only in Greece,

and that in other countries where it has been tried the plant will produce so many full-formed berries as to depreciate its value as a currant crop.

The plant has long been introduced into California and is advertised for sale by various nurserymen throughout the State.

LIME WASH FOR TREES.

E. D. S., Steuben County, New York. I am told that the Department recommends the whitewashing of fruit trees as a cure for blights, yellows, and other diseases. If this is true, may I ask what this wash consists of, and how applied so as not to injure the tree. Will not the clogging of the pores in the bark of the tree by a coating of lime or other wash do more harm than good?

Some of my apple and pear trees have blighted to some extent, but I have seen it stated that washing the bark of trees has no effect, either as a preventive or as a cure for blight. Can you inform me on this point?

Answer.—The reports of this Department have nowhere recommended whitewashing as a cure for "yellows and other plant diseases," but frequent mention has been made of the application on pear and other trees as a preventive of blight, at least on the parts covered with the mixture. No harm need be feared in regard to clogging the pores in the bark, as there are no pores in the bark that can be harmed by the application.

The wash is prepared by placing one-half bushel of lime and 8 pounds of powdered sulphur in a vessel of any suitable kind, covering with boiling water to properly slacken the lime.

The mixture is applied with a brush, covering all parts of the tree that can readily be reached. The most potent ingredient of the wash is the sulphur. The heat of the sun acting upon the wash evolves sulphurous gases which are fatal to bacteria and microscopic fungi, which, as has been demonstrated, are active agents in blight. It is well known that these microscopic spores are destroyed by sulphurous gases and heat is required to evolve them. Sulphur applications are often made for the destruction of mildew on roses and on other plants, but the efficacy of the sulphur depends upon its connection with a certain degree of heat; but it must not ignite. The gases of burning sulphur are fatal to the higher order of vegetation and are speedily destructive to all plants.

Those who have used this lime and sulphur wash on their orchard trees are pleased with the results and have faith in its efficacy in preventing blight.

But it is well to keep in view that, while blight will not maintain on the portion covered with the wash, the fumes of the sulphur may not be sufficient to prevent blight on the extreme points of branches which can not be reached with the brush. If blight is discovered on a twig or on a branch it should be removed without delay. With this attention and covering the main branches with the wash losses from blight need not greatly be feared.

RHUBARB.

N. E. C., Walton County, Georgia. I am anxious to purchase a small quantity of seed of the true medicinal rhubarb. If you will kindly inform me of its botanical name and where it can be obtained, and anything you may know about its culture or preparation for market, you will place me under great obligations. I want the best Turkey rhubarb, or the best commercial kind.

Answer.—Efforts hitherto made by the Department to procure seeds of the best medicinal rhubarb have not been successful. It appears that medico-botanists differ in opinions as to the species of rhubarb which yields the best medicinal root; on the other hand, it has been stated that the roots of the common kinds, grown for culinary purposes under the name of pie-plant, yield good medicinal roots, and that much of the article in commerce comes from this source.

It is an article of very ancient use. It is said to be mentioned by Chinese writers 4,500 years ago. It is mentioned by early writers as having been brought from beyond the Bosphorus. The Rha, which came into Europe by the ancient caravan routes from northern China, by Bokhara and Asia Minor, was *Rha-ponticum*, and that which came by Russia and Danube was called *Rha-barbarum*. The designations Turkey, Russia, East India, and Canton rhubarb merely indicate the commercial channel through which the article has been derived in modern times.

To the species *Rheum palmatum* has been attributed the origin of Persian, Turkey, Russian, and Muscovite rhubarbs, and Chinese rhubarbs are said to be produced chiefly, if not wholly, by *Rheum australe*.

It is now claimed that the source of the best medicinal rhubarb is *Rheum officinale*, a native of Thibet.

The ordinary species of rhubarb are herbaceous perennials, with a thick root stock and deciduous leaves. In *Rheum officinale*, after the third or fourth year of its growth from seed, the root stock gradually decays and a stem is formed above ground from which roots are emitted to support the plant. These stems have thick branches, often from 6 to 8 inches in diameter, and are the parts used in medicine, and not the rhizome or root.

It is considered that very much of the difference of appearance and quality of commercial rhubarb is largely owing to the time of lifting the root and the care given in its preparation for market. The roots are in many places taken up early in autumn. The Chinese dig up the roots early in spring, just before the leaves appear.

When the roots are lifted they are first divested of all small fibers, then thoroughly cleaned by washing. After drying in the sun for several days they are cut in thin slices, and after a further due exposure to the sun a hole is bored in each slice and strung on a thread until properly dried.

The pieces are then put through a finishing process by being placed in a close cylinder where they are subjected to abrasion by the rapid revolution of the vessel. This smooths their surfaces, liberating at the same time a fine dust or powder which envelopes each piece with a fine bloom, like that upon the surface of a ripe plum.

There is no reason to doubt that the root if grown in the warmer climates here would be equal to the best, provided species which yield a good article could be procured. Its culture is simple and its preparation easily accomplished.

GINSENG.

P. W., Albemarle County, Virginia. Has the Chinese ginseng plant been cultivated in this country? I would try it if I knew where to purchase seed. If you can give me any information as to how seeds or plants can be had and how it is cultivated I will be obliged; also would like to know the probable profit of the crop.

Answer.—So far as can be learned ginseng has not been successfully cultivated in this country. It is a product of the woods, and efforts made in its culture have not proved satisfactory. Chinese ginseng is closely allied to our native species; seeds have occasionally been received from China and Japan, but so far as ascertained they have not vegetated. It is possible that they soon lose their germinating power, as, it is stated, the Japanese deposit the seeds in the ground as soon as they are collected in order to keep them fresh until wanted to sow.

The Japanese cultivate the plant to some extent, and their method is to select a sheltered position and make a bed of leaf mold in which the seeds are sown, and where the plants remain until they are ready for use. These beds are protected from the sun by a roof of straw laid on poles, which are supported on posts. After growing 4 years the roots are lifted, carefully washed in boiling water, then dried in a high temperature until they become brittle. The best article sells for about \$5 a pound in Japan. It is a plant which does not submit readily to culture, and its production as a profitable crop would be very doubtful.

HORSE-CHESTNUT TREE.

B. D., Oswego, New York. I understand that horse-chestnuts are raised in considerable quantities in France, and are used as food for horses, cattle, and hogs to fatten them. The nut has a bitter taste, and it is said that the French people use some kind of alkali to kill this bitter taste and thus make it palatable to their cattle. I wish to find this out, and my reason is that in this city and county horse-chestnuts are grown for shade trees, and thus large quantities of the nuts are grown and go to waste, and we want to know how to use them. Also, the wood is white and could be used for fancy work and finishing furniture. Have you data on the utilization of the horse-chestnut tree?

Answer.—The nuts of the horse-chestnut tree, *Aesculus hippocastanum*, contain about 20 per cent of starch, but contain a bitter principle, which makes them unpalatable to most animals, although it is stated that goats, sheep, and deer eat them. They are some times boiled, which reduces their bitterness, and are then fed to poultry. When the nuts are dried and reduced to a coarse flour the bitterness is removed by simply washing the flour with water. A paste made with this flour before washing is used by bookbinders and pasteboard manufacturers, its bitterness saving it from the attacks of insects. The bitter principle is called esculin.

The following products are obtained from the nuts in France :

- (1) An alkali lye from the burnt seed vessels.
- (2) A charcoal from the skin of the nut, which forms the base of different printing inks.
- (3) From the amylaceous pulp the fecula is extracted, which can be transformed into dextrine, glucose, alcohol, or vinegar.
- (4) A fatty matter, which serves to make a kind of soap, and which is also employed to render certain mineral colors more fixed and solid.
- (5) A yellow coloring matter, which serves for various purposes of dyeing.
- (6) The ashes of the burnt nut contains 75 per cent of potash.
- (7) The bark has been used as a substitute for cinchona.
- (8) Tannin is found in all parts of the tree, leaves, bark, and fruit.
- (9) Water in which the nuts are boiled is used for bleaching hemp, flax, and other fibers.

INDIA GRAINS.

M. H. N., Texas. During a residence in India I became acquainted with several kinds of grain which are superior to anything grown in this country as feed for stock. These grains are grown in the dry regions, and for that reason I think they would be specially adapted to southwestern Texas. There is a kind called Gram grown in central India, and in southern India another kind also called Gram. These are ground before fed to stock. Then there is a grain called Bajery, which is used for making bread, of which the yield per acre is very large.

The Department might procure these seeds through the consular service or from merchants in Bombay. If they can be secured I will have them tried in southwestern Texas and make known the result.

Answer.—The word Gram is used in India to designate various kinds of peas and beans grown for food, just as we use the word grain to designate various useful seeds. Among the species known as Gram the following are noted: *Cicer arietinum*, *Phaseolus* of many kinds, *Dolichos uniflorus*, *Soja hispida*, and various species of *Vigna*, which are largely grown in the Southern States under the name of cowpeas. These, however, are not peas; they are small beans.

Bajery or Bajree is a name applied to the seeds of *Penicillaria spicata*, which is well known here as pearl millet, and may be procured from most dealers in agricultural seeds in the United States.

SEEDLING ORANGES.

M. E. R., Frederick County, Maryland. I have three orange and one lemon tree in tubs; the plants are about 4 feet high; the lemon tree is the tallest. They have not had any blossom, and I am told that before they will flower they must be cut down and grafted; but the plants are so fine, and I value them so highly, having raised them from seeds planted by myself, that I will be very sorry to have them cut if it can be helped. Please inform me if it is true that they will not flower unless they are grafted.

Answer.—Undoubtedly they will flower without being grafted. Probably one-half of all the fruit-bearing orange trees on this continent have never been grafted, but they seldom blossom until they are 8 or 10 years old, unless under special treatment. This special treatment consists in what is technically known as “stunting” the plant, or allowing it to become “pot-bound,” thus retarding its growth for want of nourishment, which in all cases tends to the formation of blossom buds, and checks the growth of wood. But this must not be carried so far as to interfere with the general health of the plant, because it would then have a tendency to produce disease.

Orange trees are grafted or budded only when it is desired to extend by propagation any particular variety.

The orange reproduces itself from seed more closely than most varieties of tree fruits, but no dependence can be placed upon this mode of reproduction for absolute similarity in all of the essential qualities. But budding or grafting has a tendency to hasten the flowering period, and the operation is often performed for this purpose on the orange where it is grown only as an ornamental plant.

PEEN-TO PEACH.

B. F. G., Wilmington, Delaware. I have applied to several nurseries for plants of the Peen-to peach, but have not been successful. In reply to my last application I was informed that the variety would not live in Delaware, and also that the fruit was small and not worth having.

This does not conform with what I have heard about the fruit as grown in the South, where it is claimed to be the earliest and best peach that they can grow. What is the experience or knowledge of the Department on this tree and fruit?

Answer.—The Peen-to peach will not do well in your climate; the winters are too severe for it.

As to the fruit, it is, when well grown, not above the medium size, and when fully ripened on the tree is of fairly good quality for so early a fruit, but if gathered before full maturity it has somewhat of a bitter taste.

In portions of Florida, where the common peach rarely bears fruit, the Peen-to is the earliest and best peach they grow, and it will undoubtedly be the parent of a class of trees particularly suited to that climate. It is stated that already seedlings of the Peen-to have been procured which prove to excel the parent both in size and quality.

INDIGO.

H. S. B., Sanford, Florida. I should be much obliged if you could give me any information as to the planting, fertilizing, and preparation of indigo, and also if it would flourish in this soil and climate.

Answer.—The indigo (*Indigofera tinctoria*) is a native of Asia, but has been cultivated in many parts of the world. Indigo was at one time an article of export from South Carolina and other Southern States, but its production in the States has long ceased to be of commercial importance.

The plant requires a moderately rich soil, the seeds being sown early in spring, sometimes broadcast, but preferably in shallow drills about 16 inches apart, so that weeds can be removed or kept down by hoeing. The plant will be ready to cut in

about 3 months after sowing the seeds. They are cut just before coming into flower, and if conditions of growth are favorable a second crop may be cut in about 2 months afterwards.

The coloring matter does not exist as indigo in the plant, but when the plant is steeped in water and subjected to certain processes the blue color is educed.

As soon as the plants are cut they are thrown into vats of water, where they are allowed to remain until sufficiently macerated. The liquid is then drawn into another vat, where it is subjected to agitation by beating with rods for several hours, or until the water changes from a greenish to a deep purple color. It is then allowed to settle. The water gradually clears and the indigo sediment is found on the bottom of the vat.

It is then boiled, strained through bags, and otherwise treated until prepared for commerce.

All the processes require careful, skilled treatment to secure the best results.

Indigo was produced near St. Augustine prior to the year 1700, and records show that it was cultivated in Virginia about 1680.

There seems no reason to doubt its adaptability to the climate of southern Florida, provided the seed is sown in deep rich soil, but it is somewhat doubtful that it would prove to be a profitable crop.

NAVEL ORANGES.

From Putnam County, Florida. As there seems to be an uncertainty about the proper distinction regarding navel oranges, I would be pleased to have you inform me whether or not the Bahia, Washington navel, Riverside navel, and Parsons navel are all one kind. Also, would like to know if any of these were ever sent to Florida by your Department.

Answer.—Of the above the only variety of the navel orange sent out from this Department was the Bahia. This variety was imported from Bahia some years ago, and to designate it from other navel oranges the name of Bahia was attached to it. Young plants of this variety were distributed in California and Florida about the same time, but mostly in Florida, where there are now large trees of first distributions. However, the conditions of climate, probably, in California seemed to suit the variety better than Florida. At all events, its value there soon brought it into notice, and as it first fruited at a place named Riverside it received that name, also that of Washington, thus ignoring the name on the label attached to the plant when received.

As to the variety known as Parsons navel, this Department has no knowledge of its origin.

With regard to the distribution of the Bahia from here, as between California and Florida, many more have been sent to the latter-named State.

NETTLE FIBER.

From South Carolina. I wish you would advise me of any improvements or developments that have been made recently in the preparation of nettle fiber. Our country is overrun with nettles, and it would be a blessing if they could be put to some use.

Answer.—The Department is not aware that nettle fiber enters into commerce to any extent. Ramie, one of the best fiber plants of the nettle family, has considerable commercial value, but the expense of its preparation for market has, hitherto at least, prevented its profitable culture, although machinery for its profitable preparation has lately been announced.

EUCALYPTUS TREE.

From York, Pennsylvania. I have seen it stated at various times that *Eucalyptus globulus* trees were being planted in the public grounds in Washington on account of their supposed power to prevent malarial emanations from the soil.

Desiring to plant a shade tree in front of my house, I desire to ascertain whether the Eucalyptus is likely to thrive well in this climate.

Answer.—The *Eucalyptus globulus* has not been planted in the public grounds at Washington.

The tree is altogether too tender for this climate. It will not withstand more than 5° or 6° of frost, and has been killed by cold at Galveston, Tex., and in Florida as far south as latitude 29°.

PERUVIAN TEA.

E. H., North Carolina. Can you furnish me with any plants of the Peruvian tea or maté for experiment here?

Answer.—The plant which yields the leaves used as tea in Brazil and Peru is *Ilex paraguayensis*, a large-sized tree, which would not grow in North Carolina.

It seems unnecessary to ignore the Chinese tea-plant, *Camellia thea*, which will grow well in most parts of North Carolina, and contains more theine than the Peruvian plant.

BLACK PEPPER.

A. C. P., Portland, Oregon. If possible I should like to be supplied with seeds of the Black pepper tree or vine from the most northern latitude where it flourishes. I would try the experiment of raising it in the warm valleys of southern Oregon.

Answer.—The Black pepper vine, *Piper nigrum*, is a tropical plant, therefore it would be futile to expect it to grow in any part of Oregon; it requires even a warmer climate than either the Pineapple or the Banana, neither of which can be cultivated profitably in Oregon.

RAMIE.

B., New York. Can Ramie be successfully grown in this State?

Answer.—Ramie can be grown in New York State by lifting the roots during the fall and preserving them all winter, like potatoes. But for commercial purposes this process would not be profitable, unless the profits on the crop were greater than they are at present. South of Maryland the plant occupies the ground like clover, and once planted no renewal is needed for many years.

MAHWAH TREE.

A. P., South Carolina. I send you a slip from a newspaper strongly advocating the introduction of the Mahwah tree from Africa as a sugar-producing plant of more value than any other sugar-plant now in cultivation. Please send me some seeds or plants for trial here, or inform me where they can be procured.

Answer.—The Mahwah tree, *Bassia latifolia*, is a native of Bengal and other highly tropical districts in the East Indies, and it is far from probable that it would flourish anywhere in the United States, but certainly it could not stand the climate of South Carolina. The flowers of this tree are sweet to the taste, and are eaten raw by the natives of Guzerat and other places where the trees abound. A fiery kind of spirits is distilled from the flowers.

The sugar of these flowers is mainly uncrystallizable. Analysis of sun-dried flowers yield 56 per cent of sugar and 15 per cent of water; further analysis showed that sucrose (cane sugar) was only present in the proportion of 2 per cent while glucose (lævulose and dextrine) yielded 52 per cent. Hence it can not possibly be substituted for cane or beet sugars. Of nitrogenous matters the flowers contained 2 per cent. The usual proportion of useful nitrogenous food should have one part of flesh formers to five saccharine; but in Mahwah flowers it was only two to fifty-five, hence these have but little of nutritious value.

OSAGE ORANGE.

L. B. C., Missouri. I write to ask if you can tell me of a way to destroy the osage orange hedge fence. This is becoming unpopular among the best farmers on account of the cost of trimming, making it hog-proof, and its taking the substance of the ground for such a wide space each side of it. Cutting it, letting it dry, and then burning will not do, as it will sprout again from the old roots.

Answer.—The best method of destroying the hedge is to cut the tops of the plants so that the remaining stock and roots can be grubbed out, and the more effectually these are removed the less trouble will result with suckers; but when these do appear they should be hoed out as other weeds are destroyed. Plowing the ground deeply for several feet on each side of the original hedge line will break and bring to the surface some of the roots, every fragment of which should be removed. It will not be practicable to get rid of every piece of root at once, but if timely attention is given to the removal of such growths as may appear, the whole will eventually be eradicated.

WELL-RIPENED WOOD.

This is a technical phrase much used by fruit-growers to indicate a favorable condition of fruit-bearing plants, and as indicating the basis of success for fruit production and healthy vitality of the plant. No plant can long remain in a state of health if placed under conditions where its yearly growths do not mature, and it can not be too vividly impressed upon the mind of the cultivator of fruits that full and complete maturity of the seasonal growths of his trees and plants is the foundation of success. Without it, so far as fruit production is concerned, failure is inevitable.

The amount of cold which plants can endure without injury depends greatly upon the degree of maturity of their growths. Too much importance can not be placed upon the recognition of the fact that whatever tends to render plant tissue moist increases the susceptibility of the plant to injury from cold, and whatever tends to reduce humidity and hasten the conversion of fluid matter into woody fiber increases its power of resisting cold, and it is clearly within the province of the cultivator to largely control this power of resistance in plants so far that failures or successes will in many cases depend upon his perception of the application of principles influencing vegetable growth.

It would be no easy task to determine how much of the disappointments and failures in fruit culture are due to luxuriant late growths which have been struck by cold, and growth arrested before reaching maturity.

The amount of cold that plants can resist without being injured can not be definitely answered, because a plant will sometimes be destroyed by a degree of cold that it previously encountered without harm. This simply shows that the resisting powers of plants are not constant, but that they are dependent upon the condition of growth with reference to its maturity.

Future investigation will undoubtedly determine that most of the so-called diseases of plants originate from injuries received from sudden checks of growth, and it will likely be found that the results, although

ultimately fatal, may linger for long periods before final termination, and observation has led to the conviction that such instances are by no means rare.

It may often be observed that in an orchard or plantation of trees of any kind individual plants will suffer and show disease while closely neighboring plants remain in perfect health. In such cases it will be found that the injured plants are those which, for some reason, are the most succulent of growths, and succumb to influences from which those of mature growths are exempt, and thus "the one is taken and the other left."

The result of cold acting upon succulent shoots is well exemplified in the case of peach trees. The disease known as "yellows" has long been attributed by reliable authorities, and this on grounds which have never been successfully controverted, to the freezing of immature shoots in the fall.

Downing, 40 years ago, in his "Fruits of America," referring to peaches, says :

And it is well worth remarking that certain fine old sorts, the ends of the branches of which have a peculiar mildewed appearance, which seems to check the growth without impairing the health, are rarely if ever attacked by the yellows. Slow-growing and moderately productive sorts are almost entirely exempt.

Again, on the same subject, he states—

The most luxuriant and healthy growing varieties appear most liable to it. Slow-growing sorts are rarely affected.

In Britain peaches are always grafted on plum stocks, which has a somewhat similar effect upon the peach as that produced by grafting the pear on the quince; that is, the growth is checked, and succulent late summer shoots prevented.

The following extract from a late number of an English periodical shows how the yellows in peaches is produced in that climate:

I never had to deal with peach trees on peach stocks, but the history of the peach stock is not favorable in some climates. The late Mr. Thompson, of the Chiswick Gardens, relates how the trees on the peach stock at Chiswick "invariably became affected" and were done away with as useless. In America the peaches are on the peach stock, and the trees perish wholesale from the same disease that attacked them at Chiswick, viz, the yellows.

If I could be sure of a blazing sun and long hot summers I would use the freest growing stock I could get, but I am told that peach stock makes gross roots which produce equally gross shoots that can not always be ripened here, even under glass, and not at all out doors, and a foundation of ill-ripened wood is the beginning of all evils.

The following remarks are taken from a Maryland paper of date November, 1870:

I am clearly of the opinion that the great drawback to the peach is that in many places it has no chance to fully ripen its wood; I mean that the trees grow so continuously, and sometimes very luxuriantly, until their foliage is suddenly destroyed by frost. There is no gradual change of color in the foliage during autumn, followed

by natural fall of leaves before cold weather, as we see in most other trees, but on the contrary, the trees maintain their green foliage and keep pushing out young leaves until a severe frost occurs and completely checks growth. This sudden check and its effects upon the vitality of the plant produce, in my opinion, the disease called yellows.

It is in the power of the cultivator, in some cases, to modify the conditions which encourage late growths, as well as to lessen the evil effects which result from frosted growths. It is readily apparent that trees set in constantly damp or very rich soil will have their growing season prolonged beyond those planted in dry or poor soils. It is also evident that in districts where the season for active growth is comparatively short, the soil should be well drained and manures sparingly applied, and only in spring. In such cases stimulating culture should not be prolonged through late summer, and even should weeds appear they should be mowed over with a scythe rather than to disturb the soil by cultivator or plow.

But something can be done even with plants that have been injured by the freezing of unripened growths, and that is the immediate removal of the injured shoots, pruning them back to sound wood. If this is performed in time the plant may escape further injury.

In some parts of Florida the orange trees occasionally suffer from slight frosts. During an unusually severe frost a few years ago many of the young orange groves suffered quite severely from freezing of succulent shoots. Hundreds of plants were destroyed and were removed during the following summer, and hundreds of others lingered on for a time, making sickly, yellow-leaved shoots, indicative of the cause of their unhealthiness. A prompt removal of the injured shoots would have saved most of these trees from utter destruction.

One of the most effectual methods of hastening the maturity of yearly shoots is that of pruning the roots, or by restricting their growths. The restriction of root growth is applicable to plants in pots or tubs. Florists recognize the fact that, with many kinds of plants, the best flowering results are obtained when the pots in which they are growing become well filled with roots. When this condition is reached vigorous growth is checked and flower buds are produced in profusion. With some perennial plants this cramped condition of roots is allowed to exist for years, the plants being stimulated during the period of wood extension by applications of liquid manures.

Pruning the roots to hasten maturity of wood growth is of long and successful practice. In no instance have we seen it so marked as when applied to the roots of Asiatic conifers, and also those of our own Pacific coast. These plants have a tendency to make late growths during the moist autumn weather of the Eastern States, and this growth is mostly destroyed by early winter frosts. A marked instance is recorded where an avenue of the Japan cedar, *Cryptomeria Japonica*, had each alternate tree root-pruned in August, which completely stopped their growth for the season. The trees not operated upon

added from 18 inches to 2 feet to their growth, after the root-pruned specimens had ceased to lengthen. The result was that the trees operated upon stood through the winter unharmed, while those not root-pruned were frozen back so severely that they never recovered, but gradually died of the yellows.

NOTES ON ORANGE CULTURE AND THE PINEAPPLE.

Recent visits to Florida in the interest of the Department have enabled me to acquire some knowledge of the climate, soil, and productions of that State as far south as latitude 28°. The following desultory remarks, the result of observations made, are offered for what they may afford in the way of answering some of the many inquiries constantly being directed to this division by prospective cultivators and residents of Florida.

For at least 9 months of the year the climate over the larger portion of the State may be considered as being tropical, so the most of the vegetation of warm countries will find a congenial atmosphere during that period. Occasionally this tropical season is longer than that stated above, especially in the most southern parts; but there is a liability to a brief season of low temperature about the end of November sufficient to injure tender vegetation, although the weather may afterwards assume its tropical conditions for weeks. During the winter months an occasional depression of temperature, running down to or below the freezing point, may occur at any time up to the end of February or later. These fitful periods of low temperatures are very injurious to early crops of culinary vegetables, as well as to all plants which have started into growth.

The early winter frosts are also hurtful to plants which have succulent shoots not sufficiently matured to withstand the low temperature. This is especially noticeable on young orange and lemon trees which have been subjected to constant culture or to recent applications of fertilizers, causing a stimulation to late growths. Trees of any age, if so treated, will be liable to injury from slight frost, but when the shoots of the previous season on old trees are well matured they are not sensibly hurt by frost severe enough to injure their matured fruits; but young trees are more sensible in this respect, so that the management of young orange groves requires a greater degree of discriminate care and consideration than is necessary with trees of deciduous habits.

Orange groves located in the neighborhood of Indian River have long been noted for their superior productions, and packages of oranges marked "Indian River" command a higher price than those from other sections of the State. Inquiries have frequently been made with a view of ascertaining the cause of the reputed superior qualities of these fruits, but answers to these inquiries have not been explicit or satisfactory. A recent visit in that section of the State, and a studied in-

spection of the soil, culture, and general condition of orange trees in places where the products were typical of the best results of that region, resulted in the conviction that the superiority of the fruit was, primarily, owing to the sheltered and shaded position of the trees. The soil in which they are growing does not differ from that in many parts of the State, although it contains a larger portion of organic matter than can be found in numerous localities where orange trees are planted, but even when this deficiency is supplied on lands openly exposed to sun and winds, the products will not generally compare favorably with those from sheltered groves; so that the conclusion seems clear that the superior quality of the fruit is owing to the fact that the trees producing it are afforded an ample degree of shade and protection. It may further be presumed that in any part of the orange belt or climate where the trees are similarly sheltered fruits may be produced equally good in every particular.

In passing through the country the effects of shelter, especially on young trees, is everywhere apparent. It might truthfully be stated that the best looking young groves are those which are best protected.

As the trees increase in height and expanse they will, in a certain degree, shelter each other, and so far as they shade the ground and break the force of drying winds so far will evaporation of moisture be reduced; but a recognition of all the facts pertaining to the growth of the orange would tend to the conclusion that the trees would be benefited by being well sheltered, if not also partially shaded, no matter what their age may be.

What might be termed conclusive evidence on this point is afforded by the localities in which the sour or bitter orange has become naturalized. This plant asserts itself as an example of the "survival of the fittest" of the Citrus family in this State, under strictly natural conditions of propagation and growth.

There are throughout parts of Florida extensive tracts of rather low lands, where the palmetto abounds and flourishes, interspersed with a variety of oaks and undergrowths. Here also is found the so-called wild or sour orange, luxuriating in and forming a part of the dense thickets, nourished by a soil rich in organic matter, and sometimes growing in places where their roots are covered with water for weeks at a time.

Some of the most valuable orange groves in the State have been formed by a partial clearing out of these thickets, removing the tops of the wild orange trees and budding the plants with the best varieties of sweet oranges. Looking into these seminaturalized groves we observe an indiscriminate assemblage of orange trees and tall palmettos, the latter towering above the former, which give evidence by the vivid color of their leaves and the brightness of their fruits that they enjoy the shade and protection thus afforded them. The fruit from these groves is noted for fine appearance and quality, and if intermixed with "In-

dian River" oranges the task of separating them would be difficult if not impracticable.

The comparative freedom from rust on the fruit produced in groves where the trees are afforded protection is worthy of special notice. It is attributed to the ravages of a minute insect, but I find that many persons are undecided as to whether the insect is the cause or only a consequence of a diseased condition which has been produced by other influences.

If we now direct our attention to thousands of acres of young orange groves which may be found throughout the State planted in sandy soils on high pine lands, and contrast their condition and appearance with those which have been described, the difference will be found as striking as it is apparent, even to the casual observer.

In the preparation for planting an orange grove on pine lands the first process is that of removing all the forest trees, taking them up by the roots, and clearing up the land so that it can be broken up with the plow. After thorough preparation by plow and harrow the soil is ready for the orange trees, which are carefully set out. Without shade, shelter, or any kind of protection from the scorching sun and arid breezes, the young trees are subjected to great vicissitudes. When rains are frequent vegetation proceeds rapidly; a week or two of dry weather intervenes, and active growth receives a check for a time; the foliage of the young tree loses its vivid color, and this is considered as indicating the need of a manurial dressing. Fertilizers of some kind are applied, rains follow, and growth again proceeds satisfactorily so long as sufficient moisture is present in the light sandy soil.

This somewhat erratic condition prevails in a more or less decided manner during the active growing period of the year, and may extend into the early winter with but a slight lowering on the general summer temperature, until a sudden depression is experienced, and the thermometer indicates that the freezing point is reached. The temperature again rapidly rises, and the scorching rays of the sun, pouring through a cloudless sky, produce disastrous effects upon the frost-bitten tender shoots and leaves.

When young trees have been subjected to such casualties it is a difficult matter to prognosticate the extent of the injuries they have received; much depends upon the individual plant; but in a general way those which have shown the greatest luxuriance will suffer most. Of course injuries from frost depend upon its severity. Six to eight degrees of frost may prove fatal, even although the plants may linger between life and death for a year or two. If the sap of the plant be contaminated from that of the frozen shoots or branches, an early death is quite certain.

A simple precaution, and one that may be looked on as an effectual preventive from further injury to the frost-bitten plant is to remove the injured twigs as promptly as practicable. The longer this is delayed

the deeper seated the injury becomes. The diseased portions will exhibit a discoloration in the wood, and all such parts should be removed.

The following extract from a recent publication was communicated by a well-known horticulturist and successful orange-grower, and is worthy of the serious consideration of every person contemplating the establishment of an orange grove on forest lands :

I wish to say a word about the plan of deadening the timber instead of making a naked clearing, which is often referred to as a "shiftless cracker way." I came to Florida many years ago with these same prejudices very strong against the "shiftless cracker" deadening. I cleared off every tree and stump and planted to oranges and lemons 25 acres of heavy pine timber. I think I have learned something by experience, and I can now see the "crackers" were right and I was wrong.

A deadening is vastly superior to a naked clearing in economy and favorable conditions for the growth and health of the newly set grove.

As soon as the timber is deadened it ceases to make damaging drafts on the soil, and it makes a semi shade on the ground very grateful to the young tree in its new quarters. It also breaks the sweep of the winds and thus decreases the evaporation from the tree and the soil in which it is placed. After awhile the leaves begin to come down and cover the ground with a thin mulch, retaining moisture and protecting the soil from the blazing rays of the sun. A year or more later the smaller twigs and fragments of bark are added to the leaves, and when the ground is plowed a most valuable dressing of vegetable matter is incorporated in a soil whose greatest want is humus. At the end of three years your grove is well established and the decaying timber begins to be dangerous. Then chop it down. All the branches and much of the bark will break into fragments so small the plow will dispose of them. Cut up the bodies in some 10-foot lengths and pile them in the checks midway between the rows. In 3 years more the sap wood and a large part of the heart will be thoroughly rotted and can be spread and plowed in like a manure pile. Those hearts that remain sound are valuable for posts, rails, and fuel. The cost of clearing a lot after it has been dead 3 years is about two-fifths of the cost of clearing green timber. In fact, the interest for 3 years on the cost of clearing green timber will nearly clear the deadening.

But, after all, the great gain is in the superior vigor of the young grove the first few years and the great improvement to the soil by the shade and added humus.

There are many hundreds of acres of young orange groves which would be greatly assisted by the introduction among them of some kind of tree for shelter. Additional trees would involve additional expenses for manure; the trees should therefore be of such kinds as would afford some remunerative crop. Peach trees and Japan persimmon might be tried, although an evergreen tree would be more valuable. The Loquat, known in many localities as Japan plum, having heavy foliage, would afford effective protection; it is also much hardier than the orange. Perhaps the olive tree might be profitably employed. Of course any tree used for this purpose would be removed when their presence was no longer required.

PLANTING A GROVE.

There are numerous methods in vogue for establishing an orange grove. That most widely adopted, according to my observation, is to set out trees three or four years from the seed.

Those are produced from seeds which have been saved from good kinds, so that, in the event of the trees not being budded, they will produce fruit of at least average merit. It is well ascertained that the orange reproduces its kind more closely than does any other class of long cultivated fruits; but there is still much difference in the qualities of oranges from groves where the trees have not been budded, a fact which purchasers of these fruits soon discover. It is questionable if this method is the best that can be followed for either of the two purposes in view; that is, whether these trees are the best for budding, and, again, whether it is advisable to trust to seedling trees for the best marketable products.

Trees of the ages mentioned are too old to be set out for budding. After being set out they are usually allowed to establish themselves for some time before being budded. By that time they have made a well-developed top of small branches, all in a healthy and vigorous condition.

The trees are budded in their main stems at points varying in their distances from the ground, and seemingly as found most convenient to the operator, and after the buds are well started the entire top of the stock is removed. This is a severe check to root extension. The plant will make efforts to restore the former balance which existed between the roots and the leaves by throwing out young shoots or suckers, which, right or wrong, are promptly removed, thus throwing the whole force of the plant into the growth of one shoot, which progresses rapidly, producing large leaves and a bulky succulent shoot; a condition which maintains until its growth is suddenly arrested by cold nights, and if frosts occur the results are disastrous.

There are thousands of orange trees in Florida, to my personal knowledge, which are in stunted, scrubby condition from causes such as those outlined above, and which should, as a matter of pure economy, be removed at once, and their places supplied by a better class of plants.

The best class of trees are those which are produced by budding healthy stocks not more than two years from seed, and when the buds have made a growth in the nursery the trees will be in good condition for permanent planting. In some countries the orange is mainly propagated by grafting; in Florida it may be said that budding is the only method practiced.

With regard to the relative merits of the sweet and the sour orange as stocks opinions are varied. The sour stock is regarded as being more hardy under low temperature, and as withstanding greater extremes in respect to wetness or dryness of soil. The opinion which is sometimes mooted, that the sour stock impairs the sweet flavor of the fruit, does not seem to be of much importance, since it is well known that some of the best fruits are produced on these stocks.

Some growers expressed an indifference as to the kinds of stock they used for budding upon, but the preponderance of answers in reply to interrogatories on this point was in favor of the sour stock.

Northern orchardists find it to their advantage to purchase their young fruit trees from reliable nurserymen whose business it is to propagate and supply such trees, healthy as to vitality and authentic as to name and character. Promoters of orange groves will ultimately learn that it will prove most economical and in every way to their advantage to procure their young trees from similar sources.

As to trusting to seedling trees for the best marketable products, it is found that opinions do not vary so much on this point as they did some years ago. Consumers are learning that there are differences in oranges as there are in apples; pears, and other fruits, and shipments of choice named kinds will take precedence over those which contain fruits of various merits as gathered indiscriminately from groves of seedling trees and whose uniformity can not be guaranteed.

THE PINEAPPLE.

The pineapple can not be considered as a perfectly safe crop in Florida north of the twenty-eighth degree of latitude. Its cultivation is sometimes attempted a full degree north of this limit with winter protection, and unless the thermometer sinks below 30° they will pass through the winter unhurt. Being allowed ample space and freely manured, the plants attain large size and produce fruits from 4 to 9 pounds in weight varying according to the variety.

Pineapples are commonly protected by erecting a horizontal platform of small poles or laths, supported by posts, and elevated high enough so as not to interfere with the upward growth of the plants. This platform is closely covered with palm leaves during the winter, and forms a good protection against light frosts. A slight shade is always allowed during summer. This, it is claimed, enhances the value of the fruit, causing it to be more tender and juicy than it would be if exposed to the full force of the sun throughout the summer. The plants are usually grown in beds 8 or 10 feet in width; the covering is thus easily applied.

North of the latitude mentioned pineapple production in the open field does not appear promising, unless in exceptionally favored places and under the best conditions of culture. In the plantations visited, on an island near the southern junction of the Indian and Banana Rivers, the plants appear to be set about 18 inches apart, in masses, thus preventing effective cultivation. The brown and bleached aspect of the leaves indicate injury from cold weather. The fruits are mostly small, and having to enter markets in competition with fruits of the same kind imported from the West Indies, which sometimes sell at prices not much above those given for the best oranges, the profits are not encouraging.

When plants are allowed space for full development, and due attention given to the slight protection necessary during the winter, fruits weighing from 6 to 10 pounds are produced, and these command remunerative prices.

INDEX.

	Page.
Apple trees for South Carolina	95
Avenues, trees for	29
Bahia orange, pollen of	98
Bean, Tonka or snuff, culture of	104
Belts or marginal plantations	21
Bending of branches to promote fruiting	79
Boundaries, trees and shrubs for	21
Brazil nut, habitat of	97
Buildings, arranging details of	13
selecting sites for	11, 12
Camphor, method of obtaining	98
Canary seed, culture of	99
Carriage turns	27
Chicle gum, sources of	97
Citron, preparation of	90
Cochineal industry	94
Coffee, cultivation of	95
plants, distribution of	101
tree, Kentucky	93
Cropping, rotation in	75
Cultivation of crops	44
Currant, Zante variety of	104
Cuttings for grape propagation	71, 77
Drainage of lands	37, 46, 94
Driveways, construction of	16
laying out of	15
Dwarfing to promote fruitfulness	79
Dwellings, selecting sites for	11, 12
Entrances to grounds	27
Eucalyptus trees, tenderness of	109
Evergreens for winter scenery	33
transplanting of	43
Fences	23
Fig-culture	89
Flower pots	83
Forest trees from seeds and plants	38
Fruit trees, necessity of ripened wood	111
Fruiting, expedients to promote	79
Gardening, antiquity of	7
Gateways	27
Ginseng culture	106
Grain, varieties from India	107
Grape rot, remedies for	102
Grapes, foreign, in glass structures	67
mildew of	63, 68

	Page.
Grapes, native, propagation of	66
varieties of	60
propagation by cuttings	71, 77
thrips of	70
Graperies, inside borders for	70
Grapevines, pruning of	103
Greenhouses, glazing roofs of	87
night temperature in	83
Grounds, arranging details of	13
location of	11, 12
Hardiness of fruit trees, sources of	111
Hedges, desirability of	23
management of	44
Horse chestnuts, utilization of	107
India, varieties of grain from	107
India-rubber plants	90
Indigo, production of	108
Lakes, artificial	26
plants for	86
Landscape gardening	7
styles of	9
Lawns, formation and care of	18, 40, 96
grasses for	19, 41
Le Conte pear in Florida	95
Lemon trees, flowering of	108
Licorice, culture of	103
Lime wash for trees	105
Lotus plant, fruit of	95
Mahogany tree, so-called	93
Mahwah tree, as a source of sugar	110
Manure, liquid, used in pot culture	82
Mildew of grapes	63
Mulching	47
Mustard, culture of	102
Navel oranges, varieties of	109
Nettles, utilization of	109
Opium, method of production	98
Orange, Bahia, pollen of	98
culture, notes on	114
groves, planting of	117
trees, flowering of	108
Oranges, navel varieties of	109
Orchards, management of	50
planting of	49
situations for	49
Osage orange, method of destroying	111
Outbuildings, arrangement of details of	14
Peach, Peen-to variety of	108
Pear blight	60, 101
culture	53
orchards, culture of	56
mulching of	56
planting of	55
pruning of	57
sites and shelter of	54

	Page.
Pear orchards, soils suited for.....	54
stocks, influence on fruit	59
trees, distance apart for setting	60
Peen-to peach, hardness of	108
Pepper, black, habitat of.....	110
Peruvian tea, habitat of	110
Pineapple culture, notes on	114, 119
Plants, expedients to promote fruiting of.....	79
for lakes and ponds.....	86
in pots, watering of.....	85
Ponds, artificial	26
plants for	86
Poppy culture for opium	98
Pot culture, liquid manure for.....	82
use of water in	85
Pruning, notes on.....	51
of grape vines.....	103
pear trees	57
roots to promote fruiting.....	79
Ramie, culture of.....	110
Raspberries, culture of.....	88
Renovation of land	94
Rhubarb, medicinal.....	105
Ringling of branches to promote fruitfulness.....	80
Roadbed, construction of.....	17
Roads, trees for.....	29
Roadways, construction of	16
laying out of	15
Rockerries	24
Root-pruning, for maturity of wood growth	113
to promote fruitfulness	79
Roots, limiting growth to promote fruiting	80
Rotation in cropping	75
Seeds of forest trees, planting of	38
saving of	74
sowing of.....	73
Shrubs for vicinity of buildings.....	30
grouping and massing of.....	32
Sites for buildings and grounds.....	11, 12
Soil, mechanical preparation of	46
Stables, arrangement of details of.....	14
Stocks, pear, influence on fruit	59
Subsoiling.....	47
Thrips of grapes	70
Tonka bean, culture of.....	104
Tree seeds, planting of	38
Trees, arrangement for various effects	33
for roads and avenues	29
vicinity of buildings.....	30
grouping and massing of	32
spring and fall planting of.....	42
time for planting in Virginia	100
varieties for boundaries	22
Trenching	47
Vanilla plants, culture of	89

	Page.
Walks, construction of	16
laying out of	15
Water, importance of supply in plant-culture	80
plants	86
use in the ornamentation of grounds	26
Watering of plants in pots	85
Whitewashing of fruit trees	105
Wood growth, hastening maturity of	113
Zante currant	104

U. S. DEPARTMENT OF AGRICULTURE.
DIVISION OF VEGETABLE PATHOLOGY.

BULLETIN No. 1.

ADDITIONAL EVIDENCE

ON THE

COMMUNICABILITY OF PEACH YELLOWS

AND

PEACH ROSETTE.

BY

ERWIN F. SMITH, Sc. D.,
SPECIAL AGENT.

PUBLISHED BY AUTHORITY OF THE SECRETARY OF AGRICULTURE.

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NOTE.

Owing to the fact that the Section of Vegetable Pathology of the Botanical Division has recently been made a separate Division by act of Congress, it has been thought best to begin a new series of publications of which this is Bulletin No. 1.

Below is given a full list of publications of the Section and Division to date. Frequent requests are received for bulletins which are out of print. Those still on hand for distribution are indicated by an asterisk (*). It will be seen that in this series Nos. 1, 3, 4, and 6 are missing. These represent bulletins of the Botanical Division.

1. Bulletin No. 2. Fungous Diseases of the Grape. 1886, pp. 136, pl. 7.
2. Bulletin No. 5. Report on the Experiments made in 1887 in the Treatment of Downy Mildew and Black Rot of the Grape. 1888, pp. 113.
3. Bulletin No. 7. Black Rot. 1888, pp. 29, pl. 1.
4. Bulletin No. 8. A Record of Some of the Work of the Division. 1889, pp. 69.
5. Bulletin No. 9. Peach Yellows. 1888, pp. 254, pl. 36.
6. Bulletin No. 10. Report on the Experiments made in 1888 in the Treatment of Downy Mildew and Black Rot of the Grape, pp. 61.
7. Bulletin No. 11.* Report on the Experiments made in 1889 in the Treatment of Fungous Diseases of Plants. 1890, pp. 119.
8. Journal of Mycology, vol. 5, Nos. 1, 2, 3, and 4. 1889, pp. 249, pl. 14.
9. Journal of Mycology, vol. 6, Nos. 1, 2,* 3,* and 4*. 1890-91, pp. 207, pl. 18.
10. Circular No. 1. Treatment of Downy Mildew and Black Rot of the Grape. 1885, pp. 3.
11. Circular No. 2. Grape Vine Mildew and Black Rot. 1885, pp. 3.
12. Circular No. 3. Treatment of Grape Rot and Mildew. 1886, pp. 2.
13. Circular No. 4. Treatment of the Potato for Blight and Rot. 1886, pp. 3.
14. Circular No. 5. Fungicides or Remedies for Plant Diseases. 1888, pp. 10.
15. Circular No. 6.* Treatment of Black Rot of the Grape. 1888, pp. 3.
16. Circular No. 7.* Grape Vine Diseases. 1889, pp. 4.
17. Circular No. 8.* Experiments in the Treatment of Pear Leaf Blight and Apple Powdery Mildew, pp. 11.
18. Circular No. 9. Root Rot of Cotton. 1889, pp. 4.
19. Farmers' Bulletin No. 4.* Fungous Diseases of the Grape and their Treatment. 1891, pp. 12.
20. Circular No. 10.* Treatment of Nursery Stock for Leaf Blight and Powdery Mildew. 1891, pp. 8.

TABLE OF CONTENTS.

	Page.
Letter of transmittal.....	7
Letter of submittal.....	9
PART I.—PEACH YELLOWS.	
I.—Introductory :	
(1) Destructive nature of yellows.....	11
(2) Characteristics of the disease.....	12
II.—Inoculations :	
Experiment 1. The Barnard trees.....	16
Experiment 2. The Shallcross trees	18
Experiment 3. The Nicholson trees	21
Experiment 4. The Barnard trees.....	21
Experiment 5. The Department trees.....	22
III.—Excisions :	
A.—Orchard of William Brothers, Dover, Delaware	24
B.—Orchard of James W. Green, Magnolia, Delaware.....	25
C.—Orchard of George Gildersleve, Rising Sun, Delaware.....	27
D.—Orchard of John A. Nicholson, Leipsic, Delaware	27
E.—Old orchard of George Davis, Still Pond, Maryland	28
F.—Young orchard of George Davis, Still Pond, Maryland.....	29
G.—Orchard of F. H. Harper, Still Pond, Maryland.....	29
IV.—Observations and experiments bearing on immunity :	
(1) Are trees from healthy localities exempt ?	38
(2) The Kerr trees (peach on plum).....	38
(a) Plantation in Mr. Greene's orchard.....	40
(b) Plantation in Mr. Harper's orchard	40
(c) Plantation in Dr. Maxwell's orchard	41
(3) Stones from Persia	42
(4) Yellows in old trees	42
V.—Conclusions :	
Facts established	43
Hypotheses rendered probable	44
Inquiries suggested	45
PART II.—PEACH ROSETTE.	
I.—Introductory :	
(1) Plants attacked	45
(2) Characteristics of the disease.....	45
(3) First appearance and present distribution.....	48
II.—Inoculations :	
Experiment 1. The Husted trees.....	49
Experiment 2. The Husted trees (peach on plum).....	52
III.—Conclusions	
Explanation of plates.....	55
Index.....	59

LETTER OF TRANSMITTAL.

SIR: I have the honor to transmit herewith a report on the investigations and experiments made the past three years by Dr. Erwin F. Smith, under the direction of this Division, with a view of obtaining evidence as to the communicability of peach yellows. There is no longer any doubt as to the contagious nature of this disease, and it now remains as a part of this line of work to determine definitely its period of incubation, methods of spreading other than by budding, and the nature of the contagium. Investigations bearing on these points, as well as exceedingly extended and laborious ones with fertilizers, are now, and have been for some time, under way.

Respectfully,

B. T. GALLOWAY,
Chief of Division.

Hon. J. M. RUSK,
Secretary of Agriculture.

LETTER OF SUBMITTAL.

SIR: In accordance with your request I submit herewith a report on the evidence now at hand respecting the communicability of peach yellows.

Although some of the experiments described in the following pages have not been completed, it has been thought best to report upon them all at this time, so that peach-growers, and more especially scientific workers, may know not only just what has been done, but also what is now under way. To make the report complete the beginnings of certain experiments from the first bulletin on yellows have been repeated. A brief account of the disease, for the sake of those into whose hands the former report did not fall and also for a clearer understanding of what follows, has also been prefixed.

The histological and bacteriological part of this inquiry is as yet incomplete, and for this reason it is omitted entirely. In accordance with your instructions no report on the effect of fertilizers will be made until the results of a third year's work can be included.

A peach disease prevalent in Georgia and Kansas has also received considerable attention. This was formerly confused with yellows, but is now believed to be distinct and is so described. It is a disease of the same peculiar type as yellows and may be considered very properly in connection with the latter. The inoculations herein described demonstrate for the first time its dangerous, contagious nature, and point to prompt destruction as the best method of dealing with affected trees.

In conclusion, thanks are due to many peach-growers who have furthered my inquiries, and very especially to the men whose names are mentioned in the body of this report and whose warm interest in the advancement of horticulture has made them willing, even at a personal sacrifice, to place their orchards and nurseries at the disposal of the Department for experimental purposes. Without this cordial coöperation much of my labor would necessarily have been fruitless.

Respectfully,

ERWIN F. SMITH,
Special Agent.

B. T. GALLOWAY,
Chief of Division.

ADDITIONAL EVIDENCE ON THE COMMUNICABILITY OF PEACH YELLOWS AND PEACH ROSETTE.

By ERWIN F. SMITH.

PART I.—PEACH YELLOWs.

I.—INTRODUCTORY.

(1) *Destructive nature of yellows.*—Peach yellows is a perplexing and destructive disease. On all hands it is conceded to be one of the most serious with which American fruit-growers have to contend. Formerly this disease was confined to a small district on the Atlantic coast, but during the last twenty years it has invaded distant regions hitherto free, and has entirely ruined the peach industry over very considerable areas. Within ten years the disease has taken a fresh and very strong hold upon orchards in the Delaware and Chesapeake region, the north portion of the peninsula, and has destroyed thousands and thousands of trees, rendering a great industry unprofitable or precarious. It seems to be native to the eastern United States, having, so far as we know, not been reported from California. Diligent inquiry also has thus far failed to bring to light any notice of its occurrence in Europe or other parts of the globe.

The last negative evidence is from Mr. Newton B. Pierce, of the Division of Vegetable Pathology. From May to October, 1890, he was in Mediterranean countries investigating vine diseases. Mr. Pierce traveled extensively in France, Italy, Sicily, and Algeria, and looked carefully for this disease. He examined peach trees in a great many localities, and observed the fruit in the principal markets, but failed to find any traces of yellows. Inquiries of many persons devoted to the scientific study of agriculture and horticulture also proved fruitless. They had not seen or heard of anything resembling this disease.

The distribution of the disease and the losses occasioned thereby were set forth somewhat fully in my first bulletin and do not concern us at this time. It is proper to state, however, that the losses continue in the infected districts; that the disease has appeared in new localities; and that regions now healthy are also threatened. The yellows is certainly as far south as southern Virginia and probably as far west as

Arkansas and northeastern Texas. Peach-growers are earnestly advised to stamp out the disease upon its first appearance, and are warned against the importation of trees from infected districts. These remarks apply with especial force to the Pacific coast, and in this connection it is well to remember that the apricot and almond are also subject to yellows. It would be much safer for the Californians to grow their own peach trees than to introduce any from the eastern United States. If trees are imported it should be known beyond question that they are from regions where this disease does not occur. The mere fact that the nursery stock is healthy at the date of shipment is not a sufficient guaranty that it will continue so.

(2) *Characteristics of the disease.*—The primary and peculiar symptoms of peach yellows are only two: (1) The red spotting and abnormally early maturity of the fruit; and (2) the premature germination of ordinary winter buds, or of obscure buds buried in the bark of the trunk and limbs or formed in the cambium. All other symptoms result from these, or are only the common indications of disease and decay in plants.

Plate I represents two peaches, natural size, one healthy and the other diseased. They are of one variety and were gathered the same day. They were picked from neighboring trees, but might have come from the same tree, since in the first stages of yellows both sorts are usually found upon the same tree. The unspotted peach (Fig. 1) was hard, green, and normal in all respects. It would not have ripened under two weeks. When ripe its skin would have been creamy white with a blush on one cheek, composed of very minute and nearly uniform crimson punctations. Its flesh would have been melting and juicy, slightly acid, aromatic, and delicious. The color of the flesh would have been uniformly white, except for a narrow zone of crimson immediately surrounding the stone. The diseased peach (Fig. 2) was fully ripe. Its size was normal; its color, abnormal. The skin was beautifully mottled and blotched with crimson, giving an appearance quite unlike that of healthy fruit. Many of these spots were large enough and sufficiently unlike the rest of the skin to admit of being easily photographed. The flesh was also copiously streaked and spotted with crimson. On tangential section these brightly colored portions were usually oval or roundish; on radial section they appeared more often in the form of streaks or elongated spots. There was also more than the usual amount of color around the stone. The flavor of the peach was inferior. This diseased peach was only one out of thousands occurring that year in the infected districts. High-colored, premature fruits are one of the conspicuous symptoms of the disease, and are easily distinguishable even from a car window. In July, 1891, I saw hundreds of bushels of this worthless fruit in upper Maryland and Delaware, and the entire loss thereby in 1891 certainly exceeded half a million dollars.

The amount of color appears to depend somewhat upon variety. Sometimes there is comparatively little crimson spotting, and again,

it is a very marked feature, the skin being almost purple and the flesh of the deepest crimson, even in pure white varieties. In an experience covering four years and including a great many thousand trees diseased by yellows, I have never known but one in which there was entire absence of red spotting in the fruit. This tree bore premature, insipid peaches and the characteristic shoots. The time of ripening also varies within wide limits. I have known such peaches to ripen forty days in advance of the proper time, and also to ripen with the healthy fruit or only a few days in advance. Generally they ripen two or three weeks in advance and are gone when the healthy fruit matures. In size the prematured fruit is usually normal the first season, and sometimes even noticeably large and showy. If any is produced the second year it is commonly small and inferior. The taste varies as much as the color, running from tolerably good to mawkish or bitter. Such fruits are generally insipid, even when of good size and color, and their sale not only defrauds the consumer but also reacts upon the grower, seriously impairing the subsequent demand for healthy fruit.

In many cases the red-spotted, prematurely-ripened fruits are the first indications of disease, or at least the first symptoms striking enough to attract general attention. They are very often borne exclusively upon one or two limbs of otherwise healthy-looking trees. These limbs are not different in appearance from the rest of the tree. They bear vigorous shoots and full-grown, smooth, dark-green foliage; often, also, green half-grown fruits, which afterwards ripen in a normal manner. There is no indication of disease except in the fruit, which, in color and size, contrasts strikingly with the fine green foliage and the normal immature fruit. Occasionally, in places, the foliage already begins to look yellowish green, while weak, pale sprouts begin to push through the bark. Sometimes branches bearing good foliage are covered from base to tip with these feeble shoots. They grow vertically through the bark on the upper surface. Later, in summer or autumn, or the following spring, such branches begin to show marked indications of disease. The spring foliage is yellowish or reddish green, dwarfed, rolled, and curled; and the shoot-axes are stunted. Commonly, especially in moist seasons, many feeble branched sprouts are developed on the trunk and the base of the main limbs. Again, stem and limb shoots will grow normally and very vigorously for several feet and then all at once branch repeatedly near the extremity in a very feeble and peculiar way. Many of these growths are due to the excessive and abnormal development of obscure buds hidden in the deeper layers of the bark or developed from the cambium. Why they should germinate in such numbers, and often in midsummer or autumn when the tree has passed its period of active growth, remains to be explained. The appearance suggests a profound disturbance of the distributive metabolism of the plant followed by an equally profound disturbance of the function of assimilation. The branched character of many of the growths results

from the premature and abnormal development of ordinary winter buds. These begin to grow as soon as they are formed in the leaf axils, and the feeble shoots to which they give rise develop buds which also germinate the same season, and so on (plates V and VI). The winter buds upon healthy-looking terminal branches and stem and limb shoots may also unfold prematurely into diseased growths. This may take place at any time from early spring to late autumn. It is very common in September, October, and November, and is one of the striking characteristics of this disease (plate II, from a photograph made at Amherst, Massachusetts, December 4; see also plates III and IV, made from photographs taken in Maryland in the autumn of 1890). Plate II represents a shoot taken from the trunk near the earth. Plate III represents one healthy shoot and three diseased shoots taken from the base of main limbs. The spring foliage remains on the healthy shoot (Fig. 2) and its winter buds are dormant. On the contrary, nearly all of the spring foliage has fallen from the diseased shoots (Fig. 1), and many of the winter buds, terminal and axillary, have germinated. Plates IV and VI represent the same appearances in terminal branches. The prematurity extends also to the blossoms, which generally come out earlier than on healthy trees, and appear sometimes even in autumn (plate IV, made from a photograph taken October 15, 1890). My attention was first drawn to this symptom in the spring of 1890, but extensive observations were then impossible. In the autumn of 1890, and again in the spring of 1891, about 6,000 trees were examined with special reference to the effect of yellows upon the blossoms. All of these trees are in Maryland and Delaware, and all were healthy in the autumn of 1890. About 500 of them were found diseased in whole or in part in the spring of 1891, having developed yellows between fall and spring. The most characteristic symptom was the general pushing of leaf buds one to two weeks in advance of the proper time. This was peculiarly striking by contrast whenever the trees developed symptoms on one or two limbs only. On many of these trees some of the blossoms also came out very early, and were destroyed by frosts, but in general, the disease could be detected in these trees before the blossoms opened.

In this climate under normal conditions winter buds of the peach do not germinate until after a considerable period of rest. They never unfold in the autumn, and it is difficult to induce them to do so even in winter. This period of rest may be shortened somewhat by mild winters and early springs, or by artificial means, *e. g.*, June budding, but it is not abrogated in nature, so far as I know, except under the influence of this peculiar disease, and the one described in Part II.

When the winter buds become affected in spring, the growths to which they give rise are occasionally more extensive but are somewhat variable, their appearance depending, of course, to a great extent, upon the length of the internodes and the amount of branching. Different forms of these terminal spring and summer growths are shown in plates

v and VI. Plate v is from a Michigan tree, and is very unusually tufted. Plate VI, No. 1, is the ordinary Delaware form; while No. 2 of the same plate is an appearance common in late autumn. In Delaware and Maryland these last were more than usually abundant in the tops of vigorous trees in the summer and autumn of 1890.

So much concerning the characteristics of the disease. Now, in conclusion, some words upon its progress.

Gradually or simultaneously, as the case may be, all of the limbs develop the same symptoms. Consequently, the tree falls into a decline and finally dies. Trees once attacked rarely, if ever, recover. This statement is still in dispute, but I feel quite sure. Hundreds of yellowed and decaying orchards on the upper part of the Chesapeake and Delaware peninsula bear witness every day to the truth of this assertion. In a very few instances I have had trees pointed out to me as once diseased and now recovered, but no such cases have ever come under my own observation. Always such trees have shown symptoms of disease later on, or else there was some uncertainty connected with the original diagnosis of the case (p. 30).

The duration of the disease varies greatly. If the symptoms progress slowly from limb to limb, the tree may live a long time. If the whole tree is speedily involved, decay and death are correspondingly rapid. I have known trees to die at the end of the first season, but such is not usually the case. In Maryland and Delaware, as well as in regions farther north, the affected trees generally live from two to five years, and possibly longer in some cases. Incidentally I am keeping watch of several hundred trees to determine this point more accurately. The trees are worthless from the start and should be removed as soon as the disease appears. If allowed to remain, complete death occurs, very frequently, the third or fourth year, the last feeble sign of vitality being a few yellowish tufts on the trunk or some of the limbs (plate VIIa). The tree shown in plate VIIb was attacked in the spring of 1887, when it was 5 years old, *i. e.*, set 5 years. At that time the tree was remarkably vigorous and handsome. It died in the summer of 1890, *i. e.*, about $3\frac{1}{2}$ years from the time it first developed symptoms, but its foliage was yellowish the second year, and vegetation during the last year of its life was very scanty and feeble, being confined principally to branching sprouts on the bases of the larger limbs.

Generally speaking, the longer the disease has prevailed unmolested in any locality the greater is the number of cases annually, and the less is the probability of getting trees up to bearing age before they are attacked. This peculiar and interesting fact has been observed repeatedly in Connecticut, New York, New Jersey, Maryland, Delaware, and Michigan.

II.—INOCULATIONS.

Experiment 1.—The trees selected for this series of inoculations were grown from Smock seed, procured in Kent County, Maryland. They formed part of a large nursery owned by Norris Barnard, Still Pond, Maryland. When first seen the seedlings were about 5 months old, and were being worked for commercial purposes. They numbered more than 100,000, and all presented a very healthy, thrifty appearance. The trees devoted to the experiment were in one corner, and not different in appearance from the rest.

The buds for inoculation were cut in an orchard on the Bay farm of James S. Harris, Still Pond, Maryland. They came from *diseased shoots* on 15 or 20 vigorous, 4-year old trees. These trees had shown no symptoms of disease until that summer, when they bore the red-spotted, prematurely ripened fruit as well as the characteristic shoots.

The buds were cut August 12, 1887, and inserted the same day. The manner of insertion was like that ordinarily practiced in reproduction by budding, *i. e.*, the bud, with a portion of the surrounding bark and often some of the underlying wood, was inserted under the bark of the seedling about 6 inches from the ground, by means of a T-shaped slit. The insert was then bound into place securely by strings, which were cut or loosened at the expiration of ten days. According to their size the trees received one or two buds, none more than two.

In most instances the wood and bark which were inserted healed on quickly and retained their vitality over winter, but there was no growth from the buds that autumn, nor any symptoms of disease in the stocks. The seedling tops were removed in the spring.

One year from budding these trees were reëxamined. Three-quarters of the inserted buds had failed to push. Of the rest some had grown into diseased shoots; others (a few) had grown into shoots which did not yet show the characteristic symptoms of yellows. The effect on the stocks was marked. About 34 per cent of the whole number (202) had become diseased beyond question, while only 23 per cent were entirely healthy. Some of the trees had died during the summer, evidently from the effects of the disease. A few yet living were badly affected, but most of them showed only slight symptoms. Nevertheless, here were the feeble shoots and the winter buds germinating 6 months in advance of the proper time.

The evidence seemed to be overwhelming and complete, for while the experiment was performed in a region where the disease occurs it was on a large scale, and moreover the remainder of this nursery and other nurseries in the same region, subject so far as known to the same influences, were examined in vain for anything which would correspond. The 542 trees in adjoining rows, which were examined critically for comparison, showed no traces of the disease, although all other conditions appeared to be identical. The fact that peach yellows in that

locality was comparatively rare in trees under 3 years of age, is also opposed to the view that the proximity of diseased orchards had anything to do with this special case. With a full knowledge of the facts the conclusion was irresistible that the infection came only from the inserted buds.

An examination made in November, *i. e.*, 3 months later, showed plainly that the disease was progressing—more trees were dead and fewer were healthy. At that date the number of stocks clearly affected amounted to 40 per cent. The control trees were still free from the disease, although they stood close upon both sides in parallel rows. Plate VIII, made from photographs, shows the condition of 3 of these inoculated trees November 3, 1888.

Ten of the inoculated and diseased trees were removed that autumn and set in Washington on the grounds of the Department of Agriculture. The remainder were left over winter in the nursery rows. In the spring of 1889 the latter were carefully removed and set out on the farm of Dr. W. S. Maxwell, some miles distant. None made any growth worth mentioning and all died within a year—some from the shock of transplanting and the rest with plain symptoms of yellows.

The ten trees set on the Department grounds made considerable growth in 1889, and developed into very characteristic specimens of yellows. The germination of the winter buds 6 or 8 months in advance of the proper time occurred freely on many shoots arising from the stock and fully set at rest all lingering doubts respecting the nature of the disease. The foliage was yellowish or reddish, and the total growth as compared with neighboring healthy trees was also very meager and stunted (plate IX, from a photograph made October 21, 1889, wherein the trees are contrasted with two healthy seedlings—each 1 year younger). Plate X, from a part of the same row, brings out certain details more distinctly. These trees were again photographed, November 21, 1890, at which time the unbudded seedlings were much larger and still healthy, while the inoculated trees were dead or nearly dead (plates XI and XII). Between this date and the time when the trees were set they were examined repeatedly and shown to various persons. During all this period they had unmistakable symptoms of yellows and became gradually more and more feeble. The moving of the trees into different and fertile soil did no good. The five unbudded seedling trees standing in the same row are more than 100 times as large, although one year younger. There was no shock from transplanting, and the difference in size must be ascribed to the stunting effect of the disease. In passing, it is interesting to note that the 5 healthy seedlings are those noted in my first Report,* p. 145, as having grown from the pits of premature peaches. These trees have continued healthy and now bear a heavy crop of green fruit (July, 1891).

* Peach Yellows: A preliminary report. U. S. Department of Agriculture, 1888.

Of the entire 202 trees inoculated August 12, 1887, only 3 are now living, and each of these is badly diseased and likely to die within 6 months. Of this experiment it may be said that all doubts concerning the nature of the disease were long since set at rest. It has corresponded exactly in manner of development and in results to the disease in the trees from which the buds came. Exception must, of course, be noted that none of these trees have ever borne fruit.*

The virulent nature of the disease is shown by the fact that only one or two buds, *i. e.*, 1-2 square centimetres of diseased surface, were inserted into each tree. Its slow progress through the tissues is inferred from the fact that no symptoms were visible until after 3 months and probably none until the following May or June—8 to 9 months after the date of inoculation. It should also be noted that the inserted buds produced the same effect, although cut from many different trees.

Experiment 2.—The trees selected for this series of inoculations were much like those used in No. 1. They were grown from Tennessee seed and formed part of a large nursery owned by Thomas J. Shallcross, Locust Grove, Maryland. The seedlings numbered about 100,000, and were very thrifty. I first saw them at budding time, when they were about 5 months old. The trees devoted to this experiment were two outer rows, not different in appearance from the rest.

The buds for inoculation were cut from an orchard on the same farm. They came from *healthy-looking shoots* on a vigorous 6-year-old tree. This tree had shown no symptoms of disease until that summer, when some of its limbs bore premature fruit and the characteristic shoots.

* So far as I know, the only *well-authenticated* case in which buds taken from a diseased tree and inserted into a healthy stock have lived long enough and developed vigorously enough to bear peaches, is one communicated by Prof. E. S. Goff, horticulturist of the State Experiment Station, Madison, Wisconsin. This experiment was begun on the grounds of the Experiment Station at Geneva, New York, in 1886. Professor Goff's statement from memory is as follows:

"The tree budded was a very vigorous seedling of bearing size. In the latter part of the summer in 1886, I budded several of the branches with buds of two (or three?) varieties of the peach, sent me by a young man of western New York whose orchard was badly infested with yellows and who was deeply interested in the subject. He assured me at the time that the buds came from diseased trees.

"More than one-half the buds failed, but several survived and made a good growth the following season, without exhibiting any abnormal appearance. The next season (1888) the branches from the buds bore a good crop of fruit, and the peaches early began to manifest a peculiar appearance, which I recognized from description as the yellows. The ground of the fruit became a golden-yellow color, sprinkled and blotched on the sunny side with very bright or sometimes with deep red. I am not personally familiar with the yellows, having seen but a few trees affected with it, but I came to the conclusion that the branches from the buds inserted into this tree were attacked with the disease. I came away from Geneva in the spring of 1889, and in the fall of that year, anxious to know what further symptoms this tree had manifested, if any, I wrote to Mr. Churchill, who then had charge of the fruit trees, and was informed by him that the tree had died."

Dr. Collier, the present director of the Geneva Station, says that the tree was in an exposed situation and died from an accidental injury.

One limb of the tree was badly diseased only a short distance from where the shoots were cut.

The buds were cut August 3, 1887, and inserted the same day. One bud only was put into each tree. The manner of inoculation was substantially like that already described. Subsequent examination showed that a union between bud and stock had taken place in every instance, or nearly every one, the budder having been very expert. No buds pushed and no symptoms of disease developed that autumn.

In the spring of 1888, while the buds were yet dormant, these trees were removed to Hubbardston, Michigan, and set 10 by 10 feet apart, principally upon a moderately fertile, sandy loam, which had been used for a garden. This location was selected as, on the whole, the best that could be had at that time. The soil has been cleared of forest and brought under cultivation since 1850. There were and are no known cases of yellows within 40 miles, and the nearest commercial orchards are 20 miles away, and not extensive. By long residence I am familiar with the whole country, and believe that the only peach trees in that township or the adjoining ones are such as have been planted very sparingly in gardens or around houses. To most farms and gardens this tree is an entire stranger. The principal objection to the location, and a serious one, was the danger from low winter temperatures and sudden fluctuations, which in the past had frequently killed peach trees to the ground, and consequently had long since very effectually discouraged planting. However, the risk was taken, and, as good fortune would have it, the winters of 1889 and 1890 were so mild that the trees did not suffer in the least.

Altogether 336 trees were set, and upon my father's place, that I might have the land more fully under control. Two hundred and ten were the inoculated trees already mentioned and 126 were unbudded seedlings from the same nursery to be used in making comparisons.

These trees were set out April 24, under personal direction, and were examined carefully, one by one, as late as June 26 of that year. At that date there was no difference in the appearance of the two lots. Six of each were dead, apparently from the shock of transplanting. The remainder of the unbudded trees were perfectly healthy; and the remainder of the inoculated ones appeared to be so, with the exception of one tree which began to look suspicious. In 60 per cent of the inoculated trees the bud had failed to push, although the bark inserted with it was yet alive in most instances.

In 96 per cent of the seedlings the top was purposely allowed to remain at the time of transplanting, only enough being removed to balance the slight loss of roots. The others were cut back to the inserted bud. The trees suffered no injury in transit, were provided with excellent roots, and, with the exception of 87 set in new ground on upturned and tough sod, grew vigorously from the start and promised well.

In autumn, on several occasions, my father reported that some of the inoculated trees had begun to look yellow and sickly. However, I did not see them until July 1, 1889, *i. e.*, one year from the previous examination and twenty-three months from the insertion of the buds. The change was then so great that I could scarcely credit my eyes. With one exception, the unbudded trees continued healthy and had made a good growth. On the other hand a very considerable number of the inoculated trees were already dead, and most of the remainder were in all stages of decline, dwarfed, yellow, and sickly. Evidently some sort of virus was communicated by the inoculated diseased bud to the previously healthy seedling, and this was probably transmitted to all parts of the tree. At least, symptoms were visible to the very extremities of the branches, 3 to 4 feet from the point of inoculation. A few trees only had made a tolerable growth and seemed to be resisting the evil influence.

As in Experiment 1, here were the feeble, branched growths and the winter buds germinating months in advance of the proper time. Again there could be no question as to the nature of the disease. Some representative photographs (plates XIII-XVII) made July 1, 1889, show, as well as can be done in black and white, the strikingly different appearance of these two lots of trees. The exact conditions in August were as follows:

TABLE I.—*Result of inoculations two years from the time the buds were inserted as shown by comparison of budded and unbudded trees.*

126 unbudded trees.				210 budded trees.			
Healthy.	Doubtful.	Diseased.	Dead.	Healthy.	Doubtful.	Diseased.	Dead.
117	1	0	8	3	16	103	83

From that day to this the contrast has become greater and greater as the condition of the inoculated trees has gone on from bad to worse.

The orchard was reëxamined July 29-31, 1890, and another series of photographs procured (plates XVIII-XXIV). The condition of the inoculated trees was found to be much worse than last year. All which were doubtful or seemed to be healthy in 1889 had become diseased, and many more had died with the characteristic symptoms of the yellows. Only two of the inoculated trees made any noteworthy growth in 1890, and the best one of these two is shown in plate XVIII, fig. 1. Of the entire 219* trees which received diseased buds August 3, 1887, only 15 were living at the expiration of the third year. Nearly all of those which died were more or less stunted and showed symptoms of yellows either in the form of branching summer growths or of winter buds which germinated in autumn.

* Nine were rejected at time of planting on account of injuries received in digging. The number 198 given in my *Preliminary Report* is a typographical error.

Up to date only one case of yellows has developed in the unbudded trees, the tree noted as suspicious in 1889.

A number of the unbudded trees at one end of the orchard died in the spring of 1890 from some unknown cause, not yellows. They dried up suddenly, much as if they had been injured by plowing or by moles. The roots, however, seemed intact and the origin of the trouble was not to be learned in July. It is sufficient that it was not yellows or anything suggestive of that disease. Four of the trees set on sod ground also dried up during the summer. All the rest of these trees (86) made an excellent growth in 1890 and were thrifty and beautiful to look upon (plates XXIII and XXIV).* The photographs from the unbudded trees represent average specimens, while those from the inoculated trees include the best, and, in fact, almost everything.

For several reasons this experiment is more interesting than No. 1, although the results are identical. First, the inserted buds were taken from shoots that appeared to be healthy; second, the disease developed more slowly than in Experiment 1, owing probably to the different character of the buds; third, a smaller amount of infective material was used; fourth, the inception and progress of the disease occurred in a locality entirely free from yellows. This experiment confirms No. 1. In addition, it proves that yellows may be communicated by parts of a tree which seem to be healthy and renders it probable that the disease is incubating in all parts of a tree when it appears in any part. In passing, it may be said that the results of the excision experiments described in Part III point to the same conclusion. It is also noteworthy that each of these trees was infected by a single bud, and that all of these buds were cut from a single tree. The inference is very strong that this one tree contained infective material sufficient to destroy entire orchards if properly introduced into the trees. Both experiments go to show that the germ or virus of the disease must be quite uniformly distributed through the affected parts.

Experiments 3 and 4 (the R. G. Nicholson trees and the D. P. Barnard trees) are incomplete, owing to the temporary discontinuance of this investigation in the spring of 1888.

* These trees were re-examined August 12, 1891, with the following results:

Average height of the north two rows (37 trees), 9.9 feet; average circumference of trunk, 8 inches. Average height of the south three rows (49 trees), 8.1 feet; average circumference of trunk, 5.7 inches. Twelve of the trees have mildewed badly this year, one has yellows, and several others are small. Otherwise all are healthy and growing vigorously. The difference in amount of growth is referable to the unlike methods of treatment. They have been cultivated with crops as follows:

Plot.	1888.	1889.	1890.	1891.
North two rows...	Corn and cucumbers...	Corn.....	Strawberries	Strawberries.
South three rows ..	Corn.....	Wheat.....	Clover	Corn.

The growth of a crop of wheat in 1889 and the absence of cultivation the following year, when the trees were in clover sod, checked the growth of the south three rows nearly one-third. Of the inoculated trees only six remain, and they are like the three left from Experiment 1.

At the time of removal Mr. Barnard reserved ten trees from experiment 4, and set them with others of the same age in an orchard on his farm. According to his statement, January 10, 1889, they made a good growth in 1888 and were as healthy as any trees. September 20, 1890, Mr. Barnard reported that the trees were still healthy, but they were not personally inspected until January 26, 1891.

At that date the following conditions prevailed: One tree was gone; one tree had made no growth worth mentioning and was dead with symptoms of yellows; three were much smaller than should be and were suffering from yellows or at least presented what seemed to me satisfactory symptoms; one was doubtful; and four were nice trees. The latter had made a reasonable growth and appeared to be free from disease. Plate xxv shows the best one of the healthy trees. These trees were budded in a locality where yellows is very prevalent and have remained there ever since, *i. e.*, over $3\frac{1}{2}$ years. Therefore, it can not be asserted unqualifiedly that the diseased trees resulted from the insertion of diseased buds, since the possibility of subsequent infection is not excluded. The possibility, however, is not great, because the trees were badly dwarfed, as if they had been diseased from the start. The trees which still appear to be healthy are, therefore, the only really interesting ones. Their behavior during the next year or two will be a matter of considerable interest, as throwing additional light on the question whether the whole tree is diseased when symptoms appear in any part of it.

For this experiment the buds were selected with great care from *terminal branches* upon the healthy-looking side of a diseased seedling tree which was about 4 years old. If any portion of the tree was free from the disease these branches should have been. The buds were cut and inserted September 7, 1887. The tree from which they were taken manifested symptoms of yellows in all parts in the spring of 1888, and died that summer.

One failure of another kind remains to be recorded. A large and vigorous seedling tree in the yard of Prof. Cleveland Abbe, in Washington, was inoculated in a dozen terminal branches with buds taken from one of the 10 trees set on the Department grounds and described under Experiment 1. The buds were cut August 15, 1889, and inserted the same day. The growth of the tree from which the buds came had been stronger and healthier looking than that of the others, but fully one-half of the winter buds were then germinating and the inserted buds were of this character.

This tree has remained healthy, but no stress should be laid upon the fact because owing to the use of a dull knife or to the fact that the shoot-axes had already pushed, all of the buds dried up in a few days and entirely failed to unite with the branches. So far as relates to the propagation of yellows it must be classed with pruning and other experiments of simple contact and I have not yet obtained any indis-

putable evidence that the disease can be spread in this way, although it seems very probable. Several extensive experiments of this kind are now in progress. In experiments 1 and 2, in all or almost all of the inoculations there was a distinct union between the bud and the stock, *i. e.*, between the diseased and healthy tissues, some months prior to the first appearance of symptoms in the stocks.

Experiment 5.—In order to be absolutely certain as to the healthy character and sound constitution of the seedlings, stones were procured in quantity from three localities free from yellows. These were planted November 8, 1889, upon well drained and fertile soil in the grounds at the Department of Agriculture. Row No. 1 were Tennessee pits. "These pits were bought of Johnson & Stokes, Philadelphia, and came from London, Tennessee." I procured them from Charles Wright, Seaford, Delaware. Row No. 2 came from Sussex County, Delaware, and were also procured from Mr. Wright, who had purchased them for his own use. Concerning them he wrote: "The Delaware pits were collected by myself of William P. Brown, of Seaford, and were saved from old seedling trees in his orchard near town." Row No. 3 came from Caroline County, Maryland. They were collected by J. W. Kerr, of Denton, for his own use.

The seedlings came up satisfactorily and made a good growth in the season of 1890. About 100 of each row were inoculated and the rest were reserved for future experiments.

The buds for inoculation were selected with the greatest care from 17 diseased trees in the older orchard of James W. Green, Magnolia, Delaware (No. 14 of first report). I did not have an orchard map when the buds were cut, but, judging from the appearance of the trees, all were cases of 1889. Each one was plainly diseased by yellows, but none were wholly diseased, *i. e.*, none appeared to be so. One-third to one-half of each tree was more or less yellow and bore the diseased shoots, but the other side was green and thrifty and although examined very minutely gave no indication of disease. Two shoots were taken from each tree (different limbs). These were 2 to 3 feet long, robust, well matured for the time of year, and to all appearances perfectly healthy. Each shoot came from the healthy-looking side of the tree, and all bore smooth, green, and vigorous leaves, 6 to 9 inches long. Better *looking* buds were never used. These shoots grew out at much greater distances from diseased parts than those used for Experiment 2. They were cut July 18, 1890, immediately stripped of foliage, and wrapped in damp cloths. Row 1, was budded July 19; row 2, July 21; and row 3, July 22. All of the buds were used except some on the base of the shoots which proved too large for the stocks. Two buds were put into each seedling, but owing to dry weather and unskillful manipulation, many of them failed to unite with the stock. Others healed on satisfactorily but made no growth. Still others made a growth of 1 to 10 inches, although the upper portion of the stocks was purposely left uncut in order to prevent this.

The stocks were healthy (December 13, 1890), and it was only the few buds which had already developed into shoots that I desired to notice here. None of these appeared to be perfectly healthy, and some of them had developed very characteristic symptoms of yellows. Plate XXVI, from photographs, represents two good examples. One is from row 1, the other is from row 3. In both a majority of the winter buds germinated in autumn. Since then there have been new developments. At this date (July 16, 1891), 28 stocks show symptoms of yellows, and the foliage on five or six vigorous shoots, which have grown from inserted buds, begins to take on a peculiar yellow tint very suggestive of this disease. There are cases in each of the rows, but most at present in the S. row.

This experiment is, in part, a repetition of No. 2. Whether these trees (the stocks) will all perish in the same way remains to be seen. Another point important to be settled is whether *any* of the inserted buds will develop into healthy trees. The seedlings will be transplanted at an early date to a locality entirely free from yellows and kept under observation until this can be determined.

III.—EXCISIONS.

Symptoms of peach yellows, as already noted, frequently appear at first on one branch only, or on one side of a tree, while the rest remains for several or many months, to all appearances, perfectly normal. The symptoms of the disease are progressive from part to part until the whole tree is involved, and this has favored the idea that the disease is local at first and only constitutional or universal after the lapse of considerable time. Generally, in bearing years the earliest plain symptoms are found in the fruit, and this fact has led to a strong popular belief that the disease is communicated from tree to tree by pollen, through the instrumentality of bees or otherwise. There is, however, absolutely no foundation in observation for any such belief. The following experiments were undertaken in the hope of determining whether the disease is local or constitutional when the first symptoms appear. Assuming that the cause of the disease is a contagium which has gained an entrance into the tree through such blossoms as develop into prematurely ripened fruit, then it follows that the disease is first of a local nature, as the appearances indicate; and it would seem that it might be removed, in some cases at least, if the excisions were very prompt and rigorous. Anyway, this was the theory on which I proceeded.

The experiments are as follows:

A.—*Orchard of William Brothers, Dover, Delaware.*—Trees set $3\frac{1}{2}$ years; both of them cases of 1887; selected out of 27 as being most suitable for this experiment. The limbs which bore affected branches were cut away close to the body of the tree, and the stumps were painted.

(1) September 16, 1887. Variety, Beers' Smock. This tree seemed to be healthy, except parts of one large limb. This limb showed slight beginnings of diseased sprouts, and bore one peach, which was ripe, red-spotted on the skin and red spotted and streaked in the flesh. The limb was removed.

RESULT.—August 16, 1888. The tree is full of peaches, and three-fourths of them are now ripe and red-spotted. The proper time of ripening of this variety in this locality is about the middle of September. Only two small limbs bear green, healthy fruit. The foliage of the affected limbs is yellowish, and they bear a few small diseased shoots.

(2) September 16, 1887. Variety not recorded. This tree bore no fruit, but diseased sprouts had developed on one limb, and to a greater extent than on No. 1. This limb was cut away. The rest of the tree seemed to be healthy.

RESULT.—August 16, 1888. The tree is badly diseased. It now bears premature fruit on all parts. Also on all of the main limbs there are many diseased shoots, and some of them are large.

All of the diseased trees, except these two, were removed in 1887.

B.—*Orchard of James W. Green, Magnolia, Delaware.*—Trees set $5\frac{1}{2}$ years; all cases of 1887; selected out of several hundred as being freest from symptoms of yellows. In all of these trees the disease appeared to be localized on one or more of the several main limbs. In fact, I was at great pains to select trees which showed the premature peaches and feeble shoots only upon a few limbs. Many otherwise promising trees were rejected because of slight symptoms upon the base of the main limbs. In several cases there were yet no diseased sprouts. In none were there very many. In some of the trees healthy shoots of that summer had grown out between the diseased parts and the point of amputation. The limbs were sawed off smoothly and the stumps were painted. Whenever a small diseased branch joined a larger healthy limb I severed both, cutting below next to the body of the tree in order to be more certain of success. In most cases, from one-third to one-half of the tree was removed. All that was left, and much of what was cut away, appeared to be perfectly healthy. In some trees the symptoms of disease were more pronounced than in others, but the final results were the same.

(1) September 15, 1887. Variety, Beers' Smock. Two main limbs were removed; five of the same size were left.

RESULT.—August 17, 1888. The tree now bears premature fruit on every main limb. It also bears diseased shoots. Some of the smaller branches bear a few sound peaches.

(2) September 15, 1887. Variety, Beers' Smock. Three limbs were removed; three were left.

RESULT.—August 17, 1888. The tree bears many peaches, most of which are premature. Upon two of the three main limbs, some branches only still bear green, healthy peaches. The trunk and limbs also bear diseased shoots.

(3) September 15, 1887. Variety, Beers' Smock. One small limb, $1\frac{1}{2}$ inches in diameter at the base, was removed; four large limbs with many branches were left.

RESULT.—August 17, 1888. The tree is now badly diseased in every limb, and bears almost nothing but premature fruit, *i. e.*, there are not over 40 green peaches on the entire tree. Diseased shoots have also grown from every limb and from the trunk near the earth.

(4) September 15, 1887. Variety, Beers' Smock. A smaller tree than No. 3. One limb was removed, two were left.

RESULT.—August 17, 1888. One of the two main limbs bears green, healthy peaches; the other bears mixed fruit. That on two branches is premature; that on three others is healthy. There are no diseased shoots.

(5) September 15, 1887. Variety, Beers' Smock. A large, fine tree. One limb was removed, four limbs were left.

RESULT.—August 17, 1888. The tree is now full of fruit and at least one-half of it is premature. The diseased peaches are not confined to any special part but are borne on all of the main limbs. There are also characteristic, feeble shoots on the trunk.

(6) September 15, 1887. Variety, Beers' Smock. A large tree. One limb was removed, four were left.

RESULT.—August 17, 1888. Two of the four limbs bear green, healthy peaches; and two bear premature ones, far out toward the ends of the branches. Diseased shoots have also grown from the base of these two limbs and from the trunk below the excised limb. There are a few green peaches on the prematured limbs.

(7) September 15, 1887. Variety, Wilkins' Cling. Two limbs were removed, three were left.

RESULT.—August 17, 1888. One limb is sound, *i. e.*, no symptoms have developed. The other two bear mixed fruit; on some branches it is premature and now fully ripe, on others it is healthy and still green. Both limbs bear branched and very characteristic yellows shoots.

(8) September 15, 1887. Variety, Wilkins' Cling. One branch was removed from a large limb. The remainder of this limb and three other limbs were left.

RESULT.—August 17, 1888. One limb bears green, healthy peaches; the others bear prematurely ripe fruit and branched and unbranched yellows shoots. But some branches bear sound peaches. The limb from which the branch was removed is not worse affected than another on the opposite side of the tree.

(9) September 15, 1887. Variety, Wilkins' Cling. One small limb was removed; three larger ones were left.

RESULT.—August 17, 1888. Most of the peaches on this tree are green and healthy, but branches upon two of the three limbs bear ripe red-spotted peaches and the diseased shoots.

(10) September 15, 1887. Variety, Beers' Smock. One limb was removed; three limbs were left.

RESULT.—August 17, 1888. There are many premature peaches on all parts of the tree, but some of the branches still bear green ones. There are no sickly shoots.

(11) September 17, 1887. Variety, Crawford's Late. One limb was removed; three were left.

RESULT.—August 17, 1888. Most of this tree is healthy, *i. e.*, appears to be. Two branches of one limb only bear premature, ripe fruit, and small feeble shoots. A large branched shoot, very typical of yellows, has also grown from the body below the excised limb.

(12) September 17, 1887. Variety, Crawford's Late. Two limbs were removed; three were left.

RESULT.—August 17, 1888. There are premature peaches and characteristic yellows shoots on every main limb. Some of the branches on these limbs also bear green, healthy fruit.

(13) September 17, 1887. Variety, Old Mixon. One limb was removed; three were left.

RESULT.—August 17, 1888. Most of the tree bears green, healthy peaches. One limb, however, bears nothing but ripe prematures. A small branch on another limb also bears this kind of fruit. The sickly shoots have developed on both and on the trunk below the excised limb.

(14) September 17, 1887. Variety, Old Mixon. Two limbs were removed; three were left.

RESULT.—August 17, 1888. All of the main limbs bear premature peaches and diseased shoots. There are also two much-branched, yellows shoots on the trunk—one below the excised limbs and one on the opposite side. The tree still bears some green, healthy peaches.

(15) September 17, 1887. Variety, Stump the World. One limb was removed; three were left.

RESULT.—August 17, 1888. One limb bears green, healthy peaches. The other two bear mixed fruit, *i. e.*, premature, fully ripe peaches on some branches and immature normal ones on other branches. There are no diseased shoots. One small branch on this tree bears premature peaches upon three twigs, and green peaches upon two others. One of the latter is 3 inches and the other is 14 inches below the lowest twig

bearing the prematures. The foliage and bark on this branch appear to be perfectly normal, and I can see no difference between the twigs bearing sound peaches and those bearing diseased ones.

(16) September 17, 1887. Variety, Stump the World. One limb was removed; three were left.

RESULT.—August 17, 1888. This tree bears a great quantity of fruit and only a very a little of it is premature. One diseased shoot has grown from under the excised limb, and there are several noticeable ones at the junction of the stem and roots. Otherwise the foliage is normal and the tree appears to be healthy.

(17) September 17, 1887. Variety, Stump the World. One limb was removed; four were left.

RESULT.—August 17, 1888. There are premature peaches and numerous diseased shoots upon every limb. Some of the shoots are much branched.

(18) September 17, 1887. Variety, Stump the World. One limb was removed; three were left.

RESULT.—August 17, 1888. This tree bears only a few peaches. On two limbs there are a few prematures, and one shoot which has grown from the trunk beneath the excised limb does not look perfectly healthy. The foliage of the tree is normal, and as in No. 16 the symptoms are slight.

(19) September 17, 1887. Variety, Stump the World. One limb was removed; three were left.

RESULT.—August 17, 1888. There are premature peaches on every limb, and also many diseased shoots. There are sound peaches on one branch of one limb only.

These 19 trees were reexamined in the autumn of 1889. All of them were then yellowish and quite badly affected. Few bore any fruit. They were again examined in the autumn of 1890. At that date all of the shoot-axes were dwarfed, many winter buds were germinating, and the trees bore no healthy foliage. The leaves were stunted and pale green, yellowish, or red. Many branches were dead, but no entire trees. They bore no fruit in 1890.

So far as I can see, the progress of the disease in these trees was not retarded by the excisions. They are now neither better off nor worse than many other cases of 1887, left for comparison. In 9, 16, and 18 the symptoms on the remaining limbs were not very numerous in 1888, but I can not be sure that such might not have been the case in any event, because sometimes the entire tree does not succumb until the third year.

C.—*Orchard of George Gildersleve, near Rising Sun, Delaware* (G. D. Jackson, tenant).—Trees set 6 years; all cases of 1887; selected out of several hundred as being freest from symptoms of yellows and, therefore, most suitable for the experiment. The trees were free-growing, thrifty specimens, and in each the disease appeared to be localized on the upper part of one limb. This was cut away next to the stem and the stump was painted.

(1) September 19, 1887. Variety, Smock. One main limb was removed; two were left.

RESULT.—August 18, 1888. One of the limbs bears premature peaches on all parts, and also many diseased shoots. The other bears green, healthy peaches, and shows no indication of disease.

(2) September 19, 1887. Variety, Smock. One limb was removed; four were left.

RESULT.—August 18, 1888. This tree bears healthy fruit and foliage on all parts, except one branch of one limb. This bears premature peaches and about 30 diseased shoots. The effects of the disease are also apparent in the spring foliage and in the terminal growths. The union of this branch with the main limb, which otherwise seems healthy, is 4 feet above the stump of the excised limb.

(3) September 19, 1887. Variety, Reeves's Favorite. One limb was removed; two were left.

RESULT.—August 18, 1888. This tree now bears only a few peaches. There were

no prematures, unless a few may have ripened very early and disappeared. The foliage is healthy, and the only indications of disease are copious yellows shoots on the trunk at the earth's surface, just below the excised limb.

D.—*Orchard of John A. Nicholson, Leipsic, Delaware.*—September 21, 1887. An effort was made to cut the disease from 3 trees forming part of a 3-year-old, 39-acre orchard on the farm of John A. Nicholson, near Leipsic, Delaware. There were 19 diseased trees and I selected the ones which seemed most favorable, removing large limbs.

This orchard was not revisited, but I was told that the remainder of each tree showed yellows the following season and that there were 500 new cases.

All these experiments were begun in mid-September. The next year I repeated the experiments in other orchards, cutting away the limbs in August, *i. e.*, 5 weeks earlier.

E.—*Orchard of George Davis, Still Pond, Maryland.*—Trees set 19 years; cases of 1888; selected from about fifty as most suitable for the experiment. The trees were very large and vigorous for their age, trunks, about 1 foot in diameter; height, 25 to 30 feet. I was particular in the selection of trees and cut back very severely, wasting much good fruit. The limbs were severed next to the body of the tree and the stumps were painted.

(1) August 9, 1888. Variety, not recorded. The tree was full of peaches, nearly all of which were green and healthy. Two small branches had been cut away recently because they bore premature fruit. The large limb which had borne these branches still bore a few ripe, red-spotted peaches, but most of its fruit was healthy. This limb was cut away next the trunk, the stump being 6 inches in diameter and sound. Part of the other main limb, with much sound fruit, was also cut away because a few twigs on one branch bore premature fruit. One comparatively small limb was left. This bore green peaches and appeared to be perfectly healthy. There were yet no diseased shoots on any part of the tree.

RESULT.—September 20, 1889. Tree gone. Supposed to have been removed accidentally in spring or summer on account of disease, the order being to remove all diseased trees.

(2) August 9, 1888. Variety, Mountain Rose. A small branch which bore premature peaches had been removed recently, and another small branch on the same limb bore the ripe and red-spotted fruit. There were no other indications of disease. Even on this limb nine-tenths of the fruit and all of the foliage appeared to be perfectly normal. The limb was cut away close to the trunk. The sound stump was 7 inches in diameter. The limb which remained bore thrifty foliage and was full of green, healthy peaches. A very careful examination of all parts showed no trace of disease.

RESULT.—September 20, 1889. There is no fruit. One branch bears three diseased shoots, but the spring foliage of the tree is still normal in size and color.

(3) August 9, 1888. Variety, Reeves's Favorite. Parts of one limb showed symptoms of disease; a small branch had been cut away recently on account of yellows and two other small branches bore large, red-spotted, ripe fruits, which were in very marked contrast to the unripe peaches upon the remainder of this limb and upon other parts of the tree. Eighteen inches above the cut a feeble shoot, one-fourth inch long, was pushing through the rough bark. Eighteen inches farther up the limb was a shoot, 2 to 3 years old, which bore diseased sprouts on its base and also 6 feet above in its top. These sprouts were small, *i. e.*, recent growths. There were no other diseased sprouts on the tree, and, even on this shoot, most of the buds were dormant and most of the foliage was green and full grown. The limb which bore these premature peaches and diseased sprouts was cut away close to the body of the tree, although almost the whole of it bore only healthy fruit and all of it bore only dark-green and vigorous spring foliage. The stump was six inches in diameter and decaying at the center. One limb remained. This bore green, healthy peaches upon

all of its branches. Its foliage was also full grown, dark green, and very healthy in appearance. There was not the least indication of disease.

RESULT.—September 20, 1889. There is no fruit. This tree now bears an abundance of healthy foliage and there are no diseased sprouts or other indications of yellows—none whatever.

This tree was reexamined October 20, 1890, and found to be diseased in all parts.* The wind had blown away the top 9 feet above the ground, but three small branches remained. These bore many diseased sprouts. The trunk also bore similar sprouts.

F.—*Orchard of George Davis, Still Pond, Maryland.*—Trees set 5 years; cases of 1888; selected out of about thirty as most suitable for the experiment. The whole orchard was thrifty and fair to look upon.

(1) August 9, 1888. Variety, Smock. Two limbs were removed; one was left. Those which were cut away bore premature peaches. The one which was left bore green fruit, and seemed to be healthy.

RESULT.—September 20, 1889. Still diseased.

(2) August 9, 1888. Variety, not recorded. This tree ramified near the ground into three main limbs. Two small branches on one of these limbs bore premature peaches. The remainder of that limb, *i. e.* most of it, and the rest of the tree, bore green, healthy fruit. There were no diseased sprouts, and no other indications of yellows, the foliage of the whole tree being green, full-grown, and healthy.

RESULT.—September 20, 1889. The tree is now diseased in all parts.

G.—*Orchard of F. H. Harper, Still Pond, Maryland.*—Trees set $7\frac{1}{2}$ years; all cases of 1888; selected out of several hundred as being freest from symptoms of yellows, and therefore most suitable for the experiment. As in Mr. Greene's orchard, and elsewhere many otherwise promising trees were rejected because of slight symptoms on the base of some of the main limbs. All of these trees were free-growing and thrifty. None of the spring foliage was rolled, curled, or yellowish, except upon one tree. The fine green color and robust growth of this foliage, even on affected limbs, was very noticeable. The trees were freer from symptoms of disease than at Mr. Greene's, but a larger portion of each was cut away. In fact, the excisions were very severe and wasted a great many baskets of good fruit. Roughly stated, I removed from one-third to two-thirds of the whole top of each tree, only a small portion of which in most cases showed any indications of disease. The limbs were cut close to the body of the tree, and their stumps were carefully coated with paint. These were 3 to 4 inches in diameter.

This orchard was believed to be well adapted to the experiment because of the healthful appearance of the trees, and because of the very gradual manner in which many of them had succumbed to the disease in 1887 and 1888. The cases of 1887 were dug out and removed that fall or the following spring; the cases of 1888, exclusive of the trees under consideration, were cut back to the stem that autumn, but were not removed until the end of the next growing season.

(1) August 10, 1888. Variety, Christiana. One limb was removed; two limbs were left. The excised limb bore premature fruit on a small portion only, *i. e.* two small branches. The remainder of its fruit was green and healthy. The limb was sound and there were no diseased sprouts. The fruit upon the remaining limbs was green and healthy and the foliage was excellent.

RESULT.—May 13, 1889. Apparently healthy.

September 17, 1889. Still diseased; slight symptoms upon two limbs. No fruit this year.

October 11, 1890. Tree decidedly inferior looking. Foliage, red, yellow, dwarfed, and rolled. In marked contrast to neighboring healthy trees. Tree, very twiggy; many of the small, unbranched, sickly shoots which grew early in the season have dried up. A few winter buds are now pushing, and the terminal buds on a number of shoots germinated about 6 weeks ago. No fruit this year.

* See note to G 3.

(2) August 10, 1888. Variety, Old Mixon. One limb was removed; two limbs were left. The excised limb bore sound green peaches on nearly all parts; but there were premature peaches on one small branch. Foliage, excellent; no diseased sprouts; stump, sound. The limbs which were left bore green peaches and beautiful foliage.

RESULT.—May 13, 1889. Apparently healthy.

September 18, 1889. Still diseased, but the symptoms are slight. No fruit this year.

October 10, 1890. Plainly diseased in all parts. The spring foliage is reddish. Some weeks ago many terminal buds pushed on branches in the top of the tree, and each now bears a whorl of pale green, spindling leaves, 2 to 3 inches long. On many of these branches the lower buds have also germinated, but more recently. The same symptoms occur on a dozen shoots which have grown from the base of the main limbs. No fruit this year.

(3) August 11, 1888. Variety, Old Mixon. One limb was removed; one was left. The excised limb branched into two equal forks 16 inches above the cut. The stump was sound and the foliage on both forks was full-grown, green, and healthy. All of the fruit on one fork was green and healthy. Most of that on the other was also green and healthy, but two small branches bore ripe, red-spotted fruit, and also two diseased shoots each only about one-fourth inch long. The remaining limb bore green peaches and perfectly healthy foliage. There was not the least sign of yellows.

May 13, 1889. Doubtful. Vegetation is not far enough advanced to tell positively.

September 18, 1889. Excision apparently entirely successful. No symptoms of yellows. There are no diseased sprouts or germinating buds. The foliage also is thrifty and of the proper form and color. Half a dozen vigorous shoots have grown from the base of the remaining limb. These are 2 to 3 feet long, and bear excellent foliage. No fruit this year.

October 10, 1890. The tree is now diseased, but the symptoms are confined to one shoot. This grew in the summer of 1890 upon the base of the main limb. It is robust, unbranched, and 2 feet long. The terminal bud developed some time ago, has grown $2\frac{1}{4}$ inches, and now bears a whorl of immature leaves. Below, on the same shoot, a dozen buds have germinated recently and sent out leaves which are one-fourth to three-fourths inch long.

Otherwise the tree looks as well as its healthy fellows, and, but for this one shoot I should certainly think it sound.

Apparently the disease was not removed by the excision, but has hung about the tree, or been dormant in it, ever since 1888.*

(4) August 10, 1888. Variety, Old Mixon. Two limbs were removed, both from one side. On one of these limbs was a small branch bearing 8 or 10 premature peaches, on the other were two small branches each bearing 10 to 12 premature peaches. The remainder of the peaches on both limbs, 200 or more, were green and healthy. The spring foliage was abundant, full-grown, and healthy. A few small diseased shoots, one-half inch long, were pushing from the base of a small limb 3 feet above the cut. There were no other signs of disease and the stump was sound. The foliage upon

* On September 20, 1889, Mr. J. Frank Wilson, of Still Pond, Maryland, took me to a tree in one of his older orchards, No. 4 of my first report, which then appeared to be perfectly healthy, but which he said had shown unmistakable symptoms of yellows in the fall of 1888, at which time he had cut away all but one small limb. At the date of my visit this limb seemed likely to grow into a new and healthy top. This tree was reexamined October 15, 1890, and found to be so badly diseased in all parts that I was compelled to believe that it had not been free from disease at any time since 1888, although it developed no symptoms in the season of 1889.

Several cases similar to this one have come under my observation, but usually the period of immunity has been shorter.

the rest of the tree was entirely healthy. The peaches were numerous, green, and normal.

May 13, 1889. Apparently still diseased. Some puny-looking sprouts are growing from the base of the excised limbs and from the trunk under them.

September 17, 1889. To casual observation this tree is as healthy as No. 3, but I find scars on the stub of the excised limb from which some one has broken shoots. A search in the weeds under the tree brings to light several dried up but much-branched and quite characteristic yellows shoots, which correspond to the scars on the stub. There are no present indications of yellows, but unquestionably the tree is diseased. No fruit this year.

October 11, 1890. Most of the foliage has fallen, probably nineteen-twentieths. Some of it is redder than should be. It is not yet a bad-looking tree, although plainly diseased. Winter buds are now germinating on half a dozen shoots. I counted fourteen on one not over a foot long.

(5) August 10, 1888. Variety, Reeves's Favorite. One limb was removed; one was left. The excised limb bore 25 to 30 premature peaches distributed on two branches. The rest of the limb bore many sound, green peaches. There were no diseased sprouts, and the foliage of the entire limb was full-grown, and of a healthy green. The limb which was left bore green, healthy peaches and healthy foliage.

May 13, 1889. Apparently healthy.

September 17, 1889. There are now slight but unquestionable symptoms of disease, *i. e.* a half dozen feeble shoots on the trunk and limbs. The spring foliage is dark green and thrifty. No fruit.

October 11, 1890. The tree is well provided with good foliage, and there are only a few diseased shoots. One is a terminal bud which has grown about one-half inch, developing a whorl of immature leaves now 2 to 3 inches long. Another is a small, feeble shoot on the trunk.

(6) August 10, 1888. Variety, Reeves's Favorite. One limb was removed; one was left. The excised limb tri-parted a short distance above the cut; two of the three parts bore premature peaches upon some branches and green ones upon others. The third fork bore only green, healthy fruit. The foliage of this tri-partite limb was full-grown, green, and healthy. There were no diseased shoots and the stump was sound. The remainder of the tree bore green, healthy peaches, and excellent foliage. There was no least sign of yellows.

May 13, 1889. Appears to be diseased.

September 17, 1889. At first sight this tree appears to be as healthy as No. 3. The entire foliage is vigorous and of a healthy green. Seven lusty shoots have grown out of the trunk just below the excised limb. These are 3 to 4 feet long, and most are one-half inch in diameter at the base. All look healthy and bear excellent foliage. However, on the base of the remaining limb, 4 inches from the cut, there is a scar easily overlooked. Some one wrenched a shoot from this spot in the summer. Search in the weeds under the tree brings it to light. This shoot is $2\frac{1}{2}$ feet long and branched in the characteristic manner. There is, therefore, no doubt that the tree is still affected, although at present it shows no symptoms of disease. No fruit this year.

October 11, 1890. Tree much like No. 5. There is an abundance of good foliage, but upon two shoots about a dozen winter buds are now pushing.

(7) August 10, 1888. Variety, Beers's Smock. One limb was removed. This limb biparted just above the cut. On one fork two small branches bore about a hundred red-spotted peaches which were ripe or nearly ripe, while 5 or 6 others of about equal size bore only green, healthy fruit. The other fork bore nothing but healthy peaches. There were no diseased shoots, and the foliage of the entire limb had every appearance of health. The stump was sound. The rest of the tree seemed healthy. It bore sound, green peaches, and full-grown, green foliage.

May 13, 1889. There are diseased shoots at the base of the excised limb. A few have also grown from the base of the adjoining limb.

September 17, 1889. Still diseased. The symptoms are confined principally to the stump of the excised limb and to one other limb, the top of which was cut out in the spring or summer during my absence. No fruit this year.

October 11, 1890. Not recovered and not better looking than other diseased trees in the same orchard. All of the foliage which remains is unnaturally rolled, curled, red and yellow. The tree bears diseased sprouts and some of its winter buds are now pushing.

(8) August 10, 1888. Variety, Christiana. One limb was removed; three were left. The excised limb biparted 8 inches above the cut. One fork bore 230 premature peaches and only a few healthy green ones. On the lower part, pushing from the bark, were several diseased growths each only about one-half inch long. One of these was within 18 inches of the cut. The spring foliage was full-grown, dark-green, and healthy. The winter buds were dormant and there were no other indications of disease. The other fork, which was of the same size or a little larger, bore healthy foliage and between two and three hundred healthy, green peaches. The limbs which remained appeared to be perfectly healthy. They bore only green peaches and healthy-looking foliage.

May 13, 1889. Apparently still diseased. There are some feeble shoots with reddish foliage on the main limbs near the trunk.

September 17, 1889. The symptoms of yellows are more apparent on this tree than on any of the preceding seven, yet the tree would not be called badly diseased. There is no fruit to judge by, but the spring foliage on the entire tree is somewhat curled and yellowish. There are also a number of feeble shoots, and winter buds are now germinating in a number of places upon both the main branches of a limb opposite to the one which was excised.

October 11, 1890. Most of the foliage has fallen; what remains is unnaturally rolled, curled, and red. The tree is rather twiggy from last year's diseased shoots now dead. On one branch and on one stem-shoot, the winter buds are now germinating. Not many diseased sprouts appeared this year and the tree has made a fair growth.

(9) August 10, 1888. Variety, Old Mixon. One limb was removed; two limbs were left. The excised limb biparted 14 inches above the cut. The larger fork bore 100 to 200 healthy, green peaches; the smaller fork bore about one-half as many premature peaches, but also some green ones on the top branches. A few sprouts near the base of the smaller fork are not quite healthy, and the smallest, which is only about one-half inch long, is not over 2 feet above the cut. The stump was sound, and the spring foliage on the entire limb was full-grown and healthy. The peaches and foliage on the remaining limbs were perfectly healthy in appearance.

May 13, 1889. Signs of disease are now visible on the trunk just below the stump of the excised limb.

September 17, 1889. Still diseased. A tuft of yellowish, much-branched, feeble sprouts has grown from the stub of the excised limb. One of the main limbs bears diseased growths at its base, 6 feet above, and on the extremities of several branches, at a distance of over 10 feet from the trunk. The other main limb looks healthy, except that the terminal buds on two thrifty "watershoots" began to grow in August, something very unusual in healthy peach trees in this climate, although not uncommon in Georgia in midsummer. The spring foliage on both limbs continues to look healthy.

October 11, 1890. Most of the foliage has fallen. The remainder is unnaturally reddish. Terminal buds pushed some time ago in the top of the tree, and several lusty stem-shoots are now full of germinating buds.

(10) August 10, 1888. Variety, Reeves's Favorite. One limb was removed. It

bore 20 to 30 green peaches and about the same number of fully-ripe ones,* but none of the latter were within 10 feet of the cut. There were no diseased sprouts or germinating winter buds. The foliage was full grown and entirely healthy. The remaining limbs bore healthy peaches and excellent foliage. One small shoot, however, on the base of the east branch, did not appear quite right, yet I could not say it was affected by yellows. It was 14 inches long and unbranched. The leaves were somewhat paler than normal and were attacked by a shot-hole fungus, which is quite common on the leaves of diseased trees.

May 13, 1889. The entire top was blown away by a tornado which occurred soon after the excision, but the stubs of the limbs appear to be diseased.

September 17, 1889. Numerous yellowish, much-branched, feeble, spindling shoots have grown from the stub.

October 11, 1890. The trunk is now dead.

(11) August 10, 1888. Variety, Reeves' Favorite. One limb was removed. This subdivided $2\frac{1}{2}$ feet above the cut into four branches, three of which bore a few large, ripe peaches, while the fourth bore about twenty green ones. The proper time for the ripening of this variety in that orchard is August 20. The foliage was full grown and healthy looking, and there were no diseased shoots either from winter buds or obscure buds.† The stump was sound. The remaining limbs bore healthy, green peaches and excellent foliage. There was no sign of yellows.

May 13, 1889. The entire top was blown away by the tornado. There are no vigorous shoots on the trunk or stubs of the limbs, but only three or four buds pushing feebly and two small, dried-up shoots. The stump looks nearly dead, but this is probably due in part to the effect of the wind.

September 17, 1889. Dead. No growth of any sort since spring.

(12) August 10, 1888. Variety, Reeves' Favorite. One limb was removed. This bore about twenty large, showy, ripe peaches, and about the same number of much smaller green ones—all of the latter upon one branch. There were no diseased shoots; the foliage was healthy; and the stump was sound. The remaining limbs appeared to be healthy. They bore green peaches and vigorous foliage.

May 13, 1889. Doubtful; a feeble shoot is pushing just beneath the stub of the excised limb.

September 17, 1889. The tree is diseased, but the symptoms are slight and confined to the trunk. There is a diseased shoot 6 inches below the excision, and another stouter one on the margin of the cut. The winter buds upon the latter are now germinating. The foliage of the entire top looks healthy and is vigorous for the time of year. Had these two shoots been removed prior to examination, or had they never grown, any one would have pronounced the tree entirely healthy.

October 11, 1890. Still diseased. Most of the foliage has fallen; what remains is abnormally reddish. Numerous winter buds are now germinating upon two shoots.

*The premature peaches on this tree, like those on all the others, were large and showy; the skin was red-spotted and high colored; the flesh was also much streaked and spotted with bright red. Many of these spots were to be seen on radial as well as tangential sections. They were about one-sixteenth inch in diameter, and were not confined to the fibro-vascular system, but formed part of the ordinary parenchyma of the fruit. The streaks of color were limited principally to radial sections, but did not extend from from pit to skin. Some of these peaches tasted very well; others were insipid or sickish. Sometimes, even, one-half of a peach tasted well and the remainder was not palatable.

† Upon the diseased trees in this orchard there were fewer yellows shoots in 1888 than in 1887. This was also true for all the other orchards in that region. It was correlated with dry weather, which also had its effect upon the total growth. At least, in this orchard, where I examined most particularly, the healthy terminal growths of 1888 were considerably shorter than those of 1887. There have been rather more cases, however, in the dry seasons than in the wet ones.

(13) August 10, 1888. Variety, Reeves' Favorite. One limb was removed; two limbs were left. The excised limb bore about a dozen large, ripe peaches and more than one hundred green ones. There were no diseased shoots; the foliage was full grown and vigorous and the stump was sound. The remaining limbs bore healthy, green peaches and excellent foliage.

May 13, 1889. Apparently diseased, *i. e.*, there are a few feeble shoots on the trunk, but it is too early in the growing season to decide positively. One large limb was blown away by the tornado.

September 17, 1889. Still diseased. There are a few sickly shoots on the base of the trunk below the excision, but some robust, healthy-looking shoots also grow from the vicinity. Diseased shoots also grow from beneath the base of the limb which was blown away by the tornado. The crown of the tree still bears full-grown, dark-green foliage, but on one branch some of it curls and droops a little. There are no other signs of disease. No fruit this year.

October 11, 1890. The tree is well provided with good-looking foliage, but diseased sprouts have grown from the base of the trunk, and many winter buds are now germinating. No fruit.

(14) August 10, 1888. Variety, Old Mixon. Two limbs were removed, *i. e.*, about two-thirds of the whole top; and two were left. One of the excised limbs was loaded with peaches which were ripe, and red-spotted on the skin and in the flesh. The other limb biparted one foot above the cut. The larger fork was loaded with ripe peaches; the smaller one bore many green peaches and only a few premature ones. This smaller fork had lost a branch and was dozy at the heart from that point downward for a distance of 3 feet, rain having entered. One stump was sound; the other showed two small dozy spots in the center, the result of the downward movement of the decay which began at the base of the broken branch. There were no diseased shoots and the foliage was healthy. The remaining limbs were healthy, *i. e.*, seemed to be. The peaches were green, and the foliage was excellent. I mention condition of stumps because yellows has been attributed to injuries. In this connection it may be noted that these trees were covered with smooth, sound bark and were very free from injuries of any sort on any part, limbs, trunk, or roots. The entire orchard has escaped the attacks of the borer (*Egeria*) to a remarkable degree. Most of the trees used in this experiment were entirely free from them and had always been so while none of them had been seriously injured. Possibly the character of the soil has had something to do with this immunity. I find this insect most troublesome upon sandy or friable soils. On the light sands of Sussex and Caroline Counties the borers have to be removed once a year and sometimes twice. Otherwise the orchards would soon be destroyed.

May 13, 1889. Apparently still diseased. The suspicious appearances are upon the trunk near where the limbs were removed.

September 17, 1889. Still diseased. Six inches below the lowest excision there is a feeble, much-branched yellows shoot. The smaller limb was blown away by the tornado. The remaining limb is now plainly diseased. Its spring foliage is full grown, but lighter green than should be, and is somewhat inclined to droop and curl. There are also well-marked, feeble yellows shoots on several branches at distances of 8 to 10 feet from the excision. No fruit.

October 11, 1890. Most of the foliage has fallen; what remains is abnormally reddish. The tree is twiggy, and there are signs of disease in the top. One stem shoot also bears fifteen buds, which have germinated recently. No fruit this year.

(15) August 10, 1888. Variety, Christiana. Two limbs were removed, both from one side; one limb was left. Nearly all of the fruit on both of the excised limbs was premature; on both limbs 3 feet above the cut diseased shoots had pushed through the rough bark, but were only from one-half inch to 2 inches long. On one of the limbs at the same height there were also stout, healthy-looking shoots of this season's growth. The other limb bore an additional 15 or 20 feeble shoots 5 to 8 feet above the

cut. These were 1 or 2 inches long and had also developed from obscure buds buried in the bark or formed in the cambium. The stumps were sound and the spring foliage was healthy. The remaining limb bore green peaches and healthy foliage, but I had little hope of saving it, owing to the number of branches which manifested symptoms.

May 13, 1889. Apparently still diseased. A number of feeble shoots are pushing on the base of the limbs.

September 17, 1889. Still diseased. Half a dozen lusty shoots have grown from the base of the remaining limb, and three of these are much branched, feeble at the extremities, and badly diseased. The leaves upon the crown of the tree are of normal size and color, but are somewhat curled.

October 11, 1890. The spring foliage is of good size, but it is unnaturally rolled and curled, reddish and yellowish-green and unhealthy looking. The winter buds are germinating upon four different shoots, in the same manner as shown in Fig. 1, Plate III.

(16) August 10, 1888. Variety, Old Mixon. Two limbs were removed, both on one side. Each of the excised limbs bore a few high-colored, red-spotted peaches, and a much larger number of green ones. About $4\frac{1}{2}$ feet above the cut one branch bore a few small unbranched, but diseased sprouts. There were no others on the tree. The stumps were sound. The remaining limbs bore many green peaches and excellent foliage. There was no trace of yellows.

May 13, 1889. Apparently still diseased. The suspicious shoots are on the base of the main limbs.

September 17, 1889. The tree is still diseased, and in all parts. Numerous, branched, feeble shoots have grown from the trunk and from the stubs of both excised limbs. These feeble shoots also occur on all of the larger branches and even in the top of the tree. The spring foliage is curled and yellow. This tree is much worse than any yet examined. No fruit this year.

October 11, 1890. Nineteen-twentieths of the foliage has fallen; what remains is rolled, curled, and very red. The winter buds are now germinating on a dozen different shoots. No fruit in 1890.

(17) August 10, 1888. Variety, Reeves' Favorite. One limb was removed. This biparted 10 inches above the cut. The larger fork bore healthy, green peaches and the smaller one bore 20 to 30 ripe peaches, which, however, were confined to two small branches. There were no diseased shoots. The stump was sound and the foliage was luxuriant. The remaining limbs were loaded with green peaches and the foliage was like that of the excised limb.

May 13, 1889. The entire top was blown away by the tornado of Aug. 21, 1888. Apparently, the stubs of the limbs are still diseased.

September 17, 1889. Branched, diseased growths now cover the whole upper part of the trunk. They have grown from the stubs of each limb, and also very abundantly from several places on the body below the excision. On the trunk they are very wiry and feeble.

October 11, 1890. This stub is trying hard to live. It now bears thrifty shoots, provided with an abundance of foliage of normal size and nearly natural color, which is now yellowing and nearly ready to fall. But it also bears a half-dozen spindling, sickly, branched shoots, and winter buds are now pushing on a number of others.

(18) August 10, 1888. Variety, Reeves's Favorite. One small limb was removed; two larger ones were left. The excised limb bore ripe and nearly ripe peaches on many branches, and bore no green fruit. There were some small, diseased shoots well out upon one branch, and a feeble shoot one-fourth inch long had developed from an obscure bud and pushed through the bark only 1 inch above the cut. This was not discovered in time or the tree would have been rejected. The spring foliage was full grown, but in places it began to look yellowish. The stump was sound. The remainder of the tree was full of green peaches and healthy foliage.

May 13, 1889. Doubtful. A few feeble shoots are growing on the trunk below the stub of the excised limb, and on the base of another limb.

September 17, 1889. Symptoms of yellows are now present. From the stub of the excised limb have grown two much-branched, feeble shoots upon which winter buds are now germinating. Such a shoot has grown also from the trunk, 14 inches below the cut. There is also a small, diseased shoot on the base of a main limb, 12 inches above the excision. Otherwise the tree appears to be healthy. There was no fruit this year.

October 11, 1890. The foliage is abnormally reddish, and the winter buds are now germinating upon two large shoots, which have grown from the base of the main limbs. No fruit in 1890.

(19) August 10, 1888. Variety, Reeves's Favorite. One limb was removed. Two small branches bore ripe, red-spotted fruit. These branches joined the main limb about 8 feet above the cut. Six other branches of about the same size bore green peaches. The entire limb bore full-grown, dark-green foliage; and there were no diseased shoots. The stump was sound. The remaining limbs bore healthy, green peaches and excellent foliage.

May 13, 1889. There are a few sprouts of uncertain character on the stub of the excised limb. Otherwise the tree appears to be healthy.

September 17, 1889. The top bears good foliage and looks healthy, but several branched and feeble diseased shoots have grown from the stub of the excised limb. There is no fruit, and I can find no certain indications of disease on any other part of the tree.

October 11, 1890. For the time of year there is more than the usual amount of foliage on this tree, and it is of better size and color, and less curled than on many of the trees. However, several terminal buds have pushed in the top of the tree, and winter buds are now germinating on six different shoots which have grown from the base of the main limbs. One of these shoots pushed twenty-eight buds in late summer or early fall. These made a spindling growth of 2 to 4 inches, and are now dead. On the same shoot sixteen additional buds are now germinating. There was no fruit in 1890.

(20) August 10, 1888. Variety, Old Mixon. One limb was removed; three limbs were left. The excised limb bore premature peaches on nearly every branch. One diseased shoot, one-eighth inch long, was pushing through the bark about 2 feet above the cut, and a half dozen others, one-eighth inch to 1 inch long, were visible higher up. There were no others, and the spring foliage was healthy. The remaining limbs were full of healthy foliage and green peaches, which Mr. Price said ought to ripen from 9 to 12 days later.

May 13, 1889. Doubtful. There are some indications of disease near the stub of the excised limb.

September 17, 1889. The tree is now badly diseased. A half dozen rank-growing branched yellows shoots have pushed from the trunk below the excision and from the base of the limbs above it. Feeble yellows shoots are abundant on both main branches of one limb all the way to the ends of the twigs in the top of the tree, *i. e.*, 12 feet above the excision. The spring foliage on this limb is also dwarfed, curled, and yellowish. On another limb the spring foliage is normal, but there is a diseased shoot at its base, and another about 3 feet up. The third limb appears to be entirely healthy. No fruit.

October 11, 1890. The foliage is very red and unhealthy looking, and sickly shoots have grown not only in the top of the tree but also next to the roots and on the base of the limbs; and winter buds are now germinating. The tree bore no fruit this year.

This closes the excision experiments. The results varied considerably, but in no case did the removal of affected parts stop the progress of the

disease. The symptoms appeared again the following season in all but two of the trees, and in these two they came back the second season. Even when the entire top was removed, as by the tornado in G 17, the disease quickly reappeared.

The inference that the disease was really cut out and that all these cases are *reinfections* is inadmissible, because nothing of a similar nature occurred elsewhere in the orchards. To establish this we have only to trace the history of these trees for 1 year from the date of the excisions, and to compare that with the history for a similar period of other trees in each orchard, *i. e.*, those which were healthy when the excisions were made.

In Mr. Greene's orchard 100 per cent of the excised trees showed fresh symptoms of the disease in 1888, but only about 12 per cent of the others became affected; *i. e.*, the new cases in 1888 amounted to only 12 per cent of the whole number of healthy trees. In Mr. Harper's orchard 95 per cent of the excised trees showed fresh symptoms of the disease in 1889, but only about 2 per cent of the others became affected. Most of the excisions were made in these two orchards, and no record of cases in the other orchards was kept for comparison.

In a few instances I have known 50 per cent of the trees of an orchard to become affected with yellows in 1 year, but never 100 per cent, and very rarely more than 15 to 25 per cent, even in the worst affected districts. It would seem, therefore, that the disease persisted in these trees, *i. e.*, that the symptoms subsequent to the excisions were not the result of reinfection.

It remains to ask whether the excisions exerted any retarding influence. One year from the date of the excisions the trees in Mr. Harper's orchard were freer from symptoms of yellows than had been those in Mr. Greene's orchard (Experiment B), and the same relative difference was apparent at the end of the second year. It might not be proper, however, to draw the inference that the development of the disease was slower *on account of the excisions*. There is some doubt as to whether the excisions retarded the progress of the disease, for the following reasons: (1) The trees manifested only very slight symptoms to begin with, *i. e.*, much slighter than the trees in Mr. Greene's orchard; (2) They bore no fruit in 1889 or 1890, whereas the trees in Mr. Greene's orchard experienced the strain of a large crop in 1888, and of a partial one in 1889; (3) The natural progress of this disease is sometimes very slow, requiring a third season for the development of the symptoms in all parts of the tree. It is therefore not impossible that the disease might have progressed in these particular trees with the same slowness, had no limbs been removed. The most that can be said is that the severest excisions, *e. g.*, those in Mr. Harper's orchard, *appeared* to exert a retarding influence on the progress of the disease.

Of course, the results obtained do not preclude the *possibility* of cutting out the disease in some cases. The evidence to the contrary is, however, reasonably conclusive, and sufficient for all practical purposes.

The experiments also throw considerable light upon the nature of the disease but do not settle the question as to whether the disease is latent in the *whole* tree when symptoms appear in any part of it. This will require additional experiments of another kind.

IV.—OBSERVATIONS AND EXPERIMENTS BEARING UPON IMMUNITY.

(1) The question of immunity is a very important one. If we could somewhere find peach trees hardy enough to resist this disease, a great practical problem would be solved. It has been said that seedlings are much less subject to yellows than budded trees. In the localities where I have studied this disease seedling orchards are infrequent, but from what data I have been able to gather I should say that seedling trees derived from budded fruit are equally subject.

On the Delaware and Chesapeake peninsula the belief is also pretty general that budded trees imported into diseased districts from healthy localities are as much subject to yellows as those grown at home, or at least do not escape the disease. On the other hand, I have been told by growers that they have had little trouble from yellows since they have formed the practice of selecting their own buds and stocks. The well-known habit of certain nurserymen to buy trees wherever they can, and sell them again as their own stock, obscures what would otherwise be a somewhat simple problem. In many cases in studying orchards it has been difficult to determine the origin of the stocks, and impossible to learn anything about the location or character of the trees from which the buds were taken. Because nursery stock was grown in a locality free from yellows it by no means follows that the buds came from the same locality. Buds are often procured directly from a distance, or are taken from young trees recently introduced into a neighborhood. In case of new varieties, I have several times known trees to be propagated from young trees recently introduced from localities where this disease is very prevalent. In buying trees much depends upon the integrity of the nurseryman, which is often an unknown factor and sometimes a negative quantity.

The fact that growers in the diseased districts have bought trees from a good many nurserymen with pretty much the same results is tolerably strong evidence, although not entirely conclusive.

A knowledge of these facts led me to plan an experiment in which I should know in advance the character of the stocks and the buds, and be able to watch the behavior of the parent trees as well as the progeny so long as might be necessary.

(2) EXPERIMENT 1.—The trees for this series of inoculations were 1,000 Mariana plums rooted by J. W. Kerr, at Denton, Maryland, in the spring of 1888 from cuttings made in his own orchards. They were divided into five lots and inoculated in August, 1888, with buds taken from five healthy peach trees also in Mr. Kerr's own orchards. These

five trees were carefully located and have been under observation ever since. I examined them particularly May 23, 1890, making the following memoranda :

The character of the trees from which came the buds used in working the peach on plum roots is as follows, all of the buds of one variety having been taken from one tree :

(1) *Old Mixon*.—Exact origin unknown ; set out by T. A. Smith, of Denton ; age, 38 years ; entirely free from yellows ; foliage of a healthy green.

(2) *Crawford's Early*.—Budded by Mr. Kerr from a bearing tree in Caroline County ; set in 1874 ; entirely free from yellows ; foliage vigorous.

(3) *Mountain Rose*.—Budded by Mr. Kerr from a bearing tree in Caroline County ; set in 1876 ; entirely free from yellows ; foliage vigorous.

(4) *Crawford's Late*.—Budded by Mr. Kerr from a bearing tree in Caroline County ; set in 1876 ; entirely free from yellows ; foliage vigorous.

(5) *Beers' Smock*.—Budded by Mr. Kerr from a bearing tree in Caroline County ; set in 1876 ; entirely free from yellows ; foliage vigorous.

These trees are old and broken, but they are not diseased.

The entire orchard was examined at that time. It contains about 500 trees. They remind me of trees in the old orchards at Seaford, Delaware. Like them they suffered severely during the winter of 1881-'82,* and are rough, broken, shaggy with lichens, and frequently two-thirds dead. Here and there a tree is missing. Others have lost their entire top, healthy growths from the trunk having partially taken its place. The foliage on all was green and thrifty. There were no cases of yellows and no suspicious trees. All of the younger orchards on the same farm were likewise examined with a similar result.

This experiment is the only one in which I did not superintend the inoculations personally. At that time other duties engaged my attention, and having entire confidence in Mr. Kerr, I trusted it entirely to him, being assured that all the details would receive his personal attention.

Yellows has never appeared in any orchard on his farm, or in any on the adjoining farms ; was not reported from Caroline County until 1887 is still rare in that county ; and is not certainly known to occur anywhere in the immediate vicinity of Denton. If cases do exist at Denton, they must be sporadic and rare. Otherwise I must have seen them or heard of them. Such being the conditions, I could at the date of these inoculations think of no place where one would be more likely to secure buds free from any taint of yellows.

A hailstorm in June, 1889, destroyed the tops of many of these trees. The remainder were removed from the nursery in November of that

* The severity of that winter killed the dormant peach buds in Caroline County, Maryland,—a thing never known before or since. It also injured the wood of many limbs. The same injuries occurred at Seaford, Delaware. However at neither place did yellows supervene, and the belief that this disease is due to autumn frosts or severe winters is wholly untenable. There is not one fact offered in support of this view which may not be explained equally well in other ways.

year, and were planted in three badly affected orchards farther up the peninsula.

(a) The trees which went to James W. Green, Magnolia, Delaware, were set in the southwest corner of an orchard on his home farm, No. 14, map IV, of my first report. Yellows appeared in this orchard in 1886 and has been very destructive, more than 50 per cent of the trees having become affected. The disease is also very prevalent in neighboring orchards, including a younger one on the same farm. The spot selected was specially adapted to the experiment, because the disease first appeared in that part of the orchard, and speedily involved many trees. In 1889 this corner of the orchard contained very few healthy trees, but none had been dug out, and none were entirely dead. The diseased trees were removed in March, 1890, and the land then received a heavy dressing of barnyard manure, *i. e.*, over 100 loads. The young trees, which had been trenched in over winter, were then set in the spots previously occupied by the affected trees, each being given a handful of phosphate. One hundred and thirty-six trees were sent to Mr. Green (94 Beers' Smock and 42 Old Mixon), but only 124 were set. Some were quite small, but all were healthy. The Smock trees were planted next the highway.

These trees were under observation from time to time during the growing season and were critically examined September 18, 1890. Only 47 had made a satisfactory growth. Of the remainder, 24 were dead and 53 were dwarfed and yellowish as though suffering from defective nutrition. None, however, showed any signs of yellows. These trees received good cultivation, were not shaded, and did not appear to be suffering from root aphides. They had been set very deep, and I was at a loss to account for the appearance of the sickly ones, unless this might have to do with it. Later, I discovered that in all of the dwarfed and yellowish trees the tops had overgrown the stocks, and that in all the vigorous trees the growth of the stocks had kept even pace with that of the tops. The dead trees were killed in spring by the black peach aphid, which sapped and smothered the tender shoots.

(b) The trees which went to F. H. Harper, Still Pond, Maryland, were planted in the east end of one of his orchards on the Howard farm, No. 6, map II, of my first report, in places made vacant by the removal of diseased trees. This orchard also appeared to be a good place to try the resisting power of healthy trees. Yellows first developed in 1886 and is still present, the cases having amounted to over 25 per cent of all the trees. The disease is also very prevalent in other orchards in the vicinity, including a younger one on the same farm.

Mr. Harper received 125 trees—50 Mountain Rose and 75 Crawford's Late. All were healthy, of medium size, and in good condition for planting. Part of them were set in November and the remainder in early spring. In some cases the diseased trees were removed just previous to this planting; in others, they had been out for a year or two.

The peach upon plum were not set in a body, but were scattered among the large trees.

I saw them the last of May, 1890, at which date they looked more promising than either of the other plantations. They were reëxamined October 11, 1890, but many were choked and overgrown by weeds so as to be scarcely visible. Part of them had also been injuriously shaded by the older trees. Some were dead and very few had made a satisfactory growth, but none were suffering from yellows. Their bad appearance was attributable in part to neglect. Young trees set into older orchards require special care.

(c) The remainder of the trees—75 Mountain Rose, 100 Crawford's Late, and 107 Crawford's Early—were set on Dr. W. S. Maxwell's farm, at the mouth of Sassafras River, Kent County, Maryland. The 2 acres selected for this orchard are on a level hilltop, overlooking orchards No. 1 and No. 18 of my first report. This field seemed very well adapted to the experiment, having been already once in orchard and being in the center of a region of diseased orchards. The remnants of the first orchard, about 75 trees in all stages of yellows, were removed in the spring of 1890. They were then 9 years old, *i. e.*, set 9 years, and were the last to become affected. The rest of the trees had succumbed earlier and were dug out at various times, most of them in 1888. The trees had grown vigorously and were large.

The peaches on plum roots were received November 7 and were set the same day, midway between the places occupied by the old trees. Three-fourths of these trees were very fine; the rest were small. They were set shallow with a view to lessening the attacks of borers.

About one pound of unleached, hardwood ashes was distributed around each tree at planting, and tomatoes with phosphate were grown in the field in the summer of 1890.

The black peach aphid appeared upon the tops of these trees in early spring, and destroyed many of them. The remainder were seen as late as the last of May and then promised well.

These trees were reëxamined October 8, 1890. At that time 88 were dead, mostly from the attacks of the black aphid. Of the remainder, 42 were stunted and yellowish like similar trees in Mr. Greene's orchard, while 152 were very thrifty and still bore dark-green foliage. In the former, in every case, the peach top had overgrown the plum stock, producing a distinct bulge. In the latter the stocks had kept even pace with the growth of the tops, and the abundant foliage was still vigorous. In fact I have seldom seen finer yearling trees. Photos 1 and 2, plate XXVII, were made October 18 from representative trees of each group. None of these trees showed any signs of yellows.

The five trees which furnished the buds were reëxamined very carefully July 22, 1891, *i. e.*, 3 years from the beginning of the experiment. They were still entirely free from yellows, or any symptoms suggestive of that disease, and were more vigorous than in 1890, owing to the turning under of a crop of scarlet clover.

Of course, it is impossible to predict the results of this experiment. We must wait and see. I shall continue to watch the parent trees as well as their progeny. I feel reasonably confident that trees with sound constitutions have been secured, and I know beyond a doubt that they are in excellent locations to test their resisting power.

(3) A twice repeated effort to introduce a sound race of peaches from Turkestan has miscarried. It seemed like an easy matter to procure peach stones in quantity through our consul at Teheran, but it has proved very difficult. The second attempt was made in 1889 through the Department of State, but with no better results.

It appears to me safer to import stones than trees. If the latter are introduced, great care should be exercised to avoid the introduction at the same time of animal and vegetable parasites which might prove worse than the yellows. The history of the introduction of the cottony cushion scale into the orange groves of California, and of phylloxera, peronospora, and black rot into the vineyards of Europe ought to be sufficient warning. The danger is a very real one.

In Mediterranean countries and also in Australasia there is a fruit fly (*Tephritis*) which once introduced into this country would work great mischief. It deposits its eggs in the fruit after it is nearly full grown, and these hatch into swarms of maggots, which pupate in the ground. Externally the fruit is said to be fair, but within it is disgusting corruption. The peach is specially subject to this fly, but apples, pears, plums, and other fruits are also attacked. The loss is great and no remedy is known. In Japan there is a codlin moth which is said to affect 90 per cent of the ripe fruit. This insect probably occurs also in China. In the Australasian region there is also a very destructive root fungus, not confined to the peach. The mycelium of this fungus creeps through the soil long distances destroying almost every green thing in its path. There is also an obscure peach disease fully as destructive as yellows and apparently of a totally different character. The orchards of the north island of New Zealand have been almost completely destroyed by it, and it probably occurs elsewhere in that region.

This enumeration by no means exhausts the list of parasites which might be introduced into this country with imported peach trees. As the case stands we have enough of our own without importing any.

(4) Additional experiments will be necessary to determine what proportion of cases are attributable to the careless selection of buds. Yellows is undoubtedly communicated in this way, but it must spread in other ways. I have known many orchards of budded fruit where the trees flourished and bore abundantly for 15 or 20 years, or even longer, before the disease appeared. In such cases, admitting the contagious nature of the disease, we are driven to one of two conclusions: the cause of the disease has entered the tree from without, or has been dormant in it from the time it was budded. The former is reasonable; the latter is absurd, especially in the light of the comparatively speedy results obtained from inoculations.

One of the most striking examples which has come under observation is a tree on the home farm of James S. Harris, near Still Pond, Maryland. Since one case in point is as good as many, I have been at some pains to learn the history of this tree. This tree is 36 years old. It is one of a number of accidental seedlings which came up from stones thrown out in the fall of 1854. It then stood back of an old shop. This was afterwards removed and other changes made so that for quite a good many years the tree has stood in sod ground, in the lawn, somewhat isolated from other peach trees. It was budded by Mr. Harris himself in the fall of 1855, and has been under his observation and care ever since, with exception only of a few years when he did not reside on this farm. The variety is Crawford's Early. The tree has been hardy and productive. Its last crop was in 1888, since when, in common with other trees in that region and owing solely to unfavorable seasons, it has borne no fruit. The tree is about 25 feet high and has a good top; the trunk is nearly a foot in diameter and still quite well preserved. I have seen this tree each year since 1887, and always it seemed to me good for another 10 years. This tree was budded from a neighboring tree when there was no yellows in the vicinity. Some years after, perhaps 10, the disease appeared and gradually destroyed many younger trees upon the same farm, one of the badly affected orchards being within a stone's throw of this tree. The disease has increased from that time to this, and has been very destructive for the last 5 or 6 years in all that region. This old tree, however, kept on the even tenor of its vigor until the summer of 1890. Then for the first time it developed unmistakable symptoms of yellows on one small limb (plate XXVIII). Next year, undoubtedly, the disease will be manifest on other limbs if it does not involve the whole tree.*

Admitting the contagious nature of yellows, and this, I think, can be doubted no longer, I am at a loss to explain the appearance of the disease in middle-aged and old trees except by infection from without. If such be the case, then, of course, every tree which becomes affected is a fresh source of danger, and ought to be removed and destroyed as soon as possible.

V.—CONCLUSIONS.

The intelligent reader will draw his own conclusions. It is not out of place, however, for me to present my view of the case. This is as follows:

FACTS ESTABLISHED.

(1) The disease is contagious. It seems to me that Experiments 1, 2, and 5 settle this point beyond dispute.

* Examined July 24, 1891. The diseased limb and the adjoining healthy one have been removed and the remainder of the tree shows no symptoms. The tree bears green peaches.

(2) It may be conveyed by seemingly healthy buds when these are taken from diseased trees. This is proved by Experiments 2 and 5.

(3) Only a very small amount of infective material is necessary, provided it be in the forms of living cells, which can be induced to unite with the actively growing tissues of the tree.

(4) The disease has a longer period of incubation than we have been accustomed to suppose. (See Experiment 2, especially Table I, columns 5 and 6, and plate XVIII, Fig. 1. See also the Excisions, especially B 16, 18; E 3; G 3, 4, 5, 6, 12, 19; and the note under G 3.)

(5) The death of the entire tree occurs, ordinarily, only after a very considerable period, *i. e.*, several years.

HYPOTHESES RENDERED PROBABLE.

(1) The whole tree is affected when symptoms appear in any part of it. This inference rests upon Experiment 2; a small part of Experiments 4 (?) and 5; and almost all of the excisions, 52 in number. It is hoped that experiments now under way will settle this point definitely.

(2) In some cases, perhaps in many, the period of incubation, *i. e.*, the time between the insertion of a diseased bud and the appearance of the disease, is longer than any yet clearly established. This is suggested by many things, especially by the behavior of some of the Barnard trees (Experiment 4); by the Excisions E 3, G 3, and the Wilson tree; and by Professor Goff's tree.

(3) The disease is also communicated to budded trees in some other way than by bud inoculation. This is probable in case of many young trees, and is almost certain in case of old trees. In some of my experiments the period of incubation was very considerable, and this is one of the striking peculiarities of yellows, but it is too brief to account for the appearance of the disease after the second or third year, except possibly in case of some of the trees budded at Colonel Barnard's. The evidence in favor of outside infection becomes stronger in proportion as a tree gets older. Of course, it goes without saying that additional experiments may demonstrate the period of incubation in some cases, and perhaps in many, to be much longer than any yet established.

(4) The trees are not infected through the blossoms. This is inferred from the result of the excisions, and from the fact that, in some cases, the disease appears to develop between fall and spring, and to stimulate the blossoms themselves to an unnaturally early development. About fifty cases of this kind came under observation during the very mild winter of 1889-'90, and many additional ones in the spring of 1891.

(5) Since diseased trees have been shown to be very full of infectious matter it must be that for unknown reasons much of this fails to find an immediate entrance into healthy trees. Otherwise the peach would soon disappear entirely.

INQUIRIES SUGGESTED BY THE FOREGOING EXPERIMENTS.

Three special lines of inquiry are now under consideration, and will receive undivided attention as soon as the laborious experiments with fertilizers have been completed. These are as follows:

- (1) The period of incubation of the disease prior to its first appearance, *i. e.*, the greatest length of time a tree may be affected before it shows any symptoms of yellows.
- (2) The exact nature of the contagium.
- (3) Its method of spread other than by bud inoculation.

PART II.—PEACH ROSETTE.

I.—INTRODUCTORY.

The second part of this report will be devoted to a peculiar disease prevalent in Georgia, and first referred to as probably a Southern variety of peach yellows,* but since described under the name of *The Peach Rosette*.†

The disease does not appear to be due to any ordinary fungus, or to insects. In some respects it is quite like peach yellows, but in others it differs very materially. This year additional observations have confirmed the belief that it is a disease distinct from yellows, and I shall so consider it until proof to the contrary is forthcoming.

(1) *Plants attacked*.—As stated elsewhere (*l. c.*), the Rosette attacks many varieties of peaches. None appear to be exempt. It occurs in budded fruit and seedlings. The latter do not escape even when growing in fields and thickets without cultivation. This disease is not confined, however, to the peach, but also occurs in plums—budded trees and seedlings, cultivated, uncultivated, and wild, and is equally destructive. I have not seen it in varieties of *Prunus domestica* or in the Mariana, but it occurs in the wild *Prunus Chicasa*, in the Cumberland, and Wild Goose, and also in the Japanese varieties known as Kelsey and Botan. Probably the disease is capable of attacking many other sorts, and requires only a suitable opportunity.

This year in an orchard near Griffin, Georgia, which I know to have been nearly free from disease in 1890, and quite thrifty and well cared for, I counted about 40 bad cases of rosette, divided nearly equally between Kelsey and Botan. These trees were 5 or 6 years old, and the loss must have been considerable.

(2) *Characteristics of the disease*.—As in peach yellows, this disease not infrequently attacks one or two branches only at first, but in a much larger per cent of cases, the whole tree is diseased from the start, and the disease runs its course in a much shorter time. Six months is usually sufficient to destroy a tree, and I have known no cases to last

* Peach yellows: A preliminary Report, U. S. Dep. Ag. 1888.

† The Journal of Mycology, Vol. 6, No. IV.

more than two seasons. Such a thing as the lingering on of a diseased tree from year to year, as in peach yellows, is not known. I have seen trees completely diseased in June and dead in November, which first showed symptoms in early spring and were in apparently perfect health the preceding autumn. This is the common course of the disease.

When a tree is attacked in part, the shoot-axes and foliage of the remaining limbs often appear to be perfectly healthy, but these limbs always develop rosettes, and die the following year. Not infrequently I have observed the disease to progress gradually from the affected side to the healthy, *i. e.*, the parts on the healthy side first to be attacked being the bases of the limbs. The bark of trunk and limbs on affected trees presents no peculiar or symptomatic differences. Undoubtedly there are changes in the cambium cylinder corresponding to the shortening of the terminal shoot-axes, but these are not visible externally.

The following are some of the more noticeable symptoms :

- (a) *Young shoot-axes.*—Commonly the disease first appears in the unfolding shoot-axes, *i. e.*, in early spring when the buds first open. In healthy trees only a small proportion of the winter buds develop into branches. The rest die or remain dormant. In this disease a very large part of the winter buds grow into shoot-axes and also a very considerable number of dormant buds on the older and larger branches. The shoot-axes in healthy trees, especially the terminal ones, generally attain a growth of 6 to 20 inches and develop ten to twenty vigorous leaves with dormant blossom and foliage buds in their axils. As the season advances such shoots ripen their wood, cast their foliage, and remain quiescent until spring invites the opening of their buds and the renewal of vegetative activity. In diseased trees, the shoot-axes push only 1 to 3 inches, lose, almost completely, the ability to develop and ripen wood, and to form dormant buds. The buds on such shoots grow as soon as they are formed, or rather, as soon as they receive the initial differentiation, developing into diminutive soft branches, which frequently branch again, but never attain any good degree of size, vigor, or maturity. It is ordinary to find 15 to 30 primary branches and often some additional secondary ones, on a shoot-axis less than 3 inches long, and not over one-eighth inch in diameter at its base. The tendency of this effort of branching is from below upward, *i. e.*, the oldest and largest branches are near the base of the shoot, but almost always not quite from the base, the buds remaining undeveloped in some of the lowest leaf axils.

(b) *The foliage.*—The leaves on these dwarfed branching shoot-axes are multiplied correspondingly, and the result is compact tufts or rosettes containing 200 to 400 diminutive leaves, and many additional green stipules which are frequently misshapen and abnormal. The older and larger leaves near the base of the shoot frequently reach a length of several inches and are characterized by a very pronounced inrolling of the margins of the leaf, and by a certain stiffness due to a peculiar straightening of the midrib. These leaves turn yellow in early

summer and fall very readily. Jarring causes them to fall by the hundred, as if it were autumn. Very often they are blotched, browned, and dead in places, especially at the ends and margins, from the attacks of various leaf fungi. The younger and central leaves of the rosette remain small and green and free from fungi. They are usually somewhat folded, but seldom rolled. As summer advances these rosettes dry up and die under the attacks of *Scolytus rugulosus* or from the effects of the disease. The foliage of some affected trees is much greener than others. Generally the prevailing color from a distance is yellowish green or olivaceous. The bunching of the leaves is conspicuous and makes the trees noticable at a long distance. There is not enough foliage to give shade or hide the branches.

(c) *Flowers and fruits*.—So far as I can determine by inquiry, the trees which developed this disease in 1891 in Mr. Husted's orchards did not blossom in advance of other trees, but were somewhat tardy. On the contrary, other trees in the same orchard, imported from New Jersey and affected with an entirely different disease, and what appears to be genuine yellows, blossomed ten days in advance of the proper time.

Trees attacked by rosette generally drop their fruit early and while it is still green or yellowish green. In June, 1891, I saw scattering fruits on many diseased trees, and none of them were premature or bore any of the characteristic symptoms of peach yellows. The fruit, even on badly affected limbs, when there was any at all, was small, green, or yellowish green, and often more or less shriveled. Fruits of this kind were also common on the ground under such trees. Plate XXXIII shows two peach twigs bearing green fruits; the right-hand figure was from the healthy-looking side of a tree, the left-hand one from twigs just beginning to develop rosettes, and very close to branches bearing thoroughly diseased and very typical rosettes. Its own buds were also pushing into rosettes above the fruit and below. One yellowish green shriveling fruit remained and another had fallen. In one instance the disease was observed in Alexanders which were full of ripening fruit and affected by the rosette only on about one-half of the limbs. Most of the fruit had already fallen from the diseased limbs, green and shriveled, but a few peaches remained on the healthier portions, and these, like those on the other limbs, were neither premature nor red-spotted, but were ripening at the proper time and in the normal manner. The diseased branches bore hundreds of yellowish rosettes; the healthy ones bore an abundance of dark green, handsome foliage.

My search for premature fruit was the more careful because I had ventured the assertion that it would, no doubt, be found to precede the rosette. In one or two instances only, I heard of premature peaches, but on examination they were clearly attributable to borers and not the sort produced by yellows. In one orchard where the borers had been left undisturbed for several years, I saw fruits prematuring on many trees, but there were no symptoms of yellows. The color and

flavor of these fruits was natural and they were ripening only a week or ten days in advance of the proper time.

(d) *Roots and rootlets*.—Superficially the roots appear to be normal, but the rootlets are dead and shriveled as in peach yellows.

(e) *Gummosis*.—The green and shriveling fruits from rosetted limbs were full of minute gum-pockets, but this symptom was afterwards observed quite frequently in imperfect fruits taken from healthy trees. The "June-drop" from Elberta trees was very copious at Griffin, Georgia, in 1891, and most of these fruits were smooth externally but gummy within, the entire seed-cavity being changed into a gum-pocket in many cases. These fruits were an inch by an inch and a half in diameter at time of dropping.

Many of the roots of rosetted trees were honeycombed by gum-pockets (June, 1891). This symptom was found to be nearly constant; *i. e.*, it occurred on some roots of nearly every affected tree. But it was also observed to a slight extent on the roots of two trees which stand very near diseased ones, but which have not yet developed any symptoms of the rosette. Many of the roots were so gummy as to feel sticky when bruised. By making a clean cut at right angles to the main axis of the root the gum-pockets were frequently visible without the aid of a triplet, especially when the oozing of gum was copious. These pockets were confined generally to the outer part of the wood cylinder, and in several cases, known to have been healthy in November, 1890, the cylinder of gum-cavities was confined to the wood laid down in 1891, or to the dividing line between this wood cylinder and the next inner one, and did not extend into the wood formed in 1890.

These closed gum-pockets involve few to many wood fibers, and frequently include the very resistant cells of the medullary rays. On cross-section they appear like an interrupted ring, or like a necklace of triangular beads, in which each member corresponds to a pocket. The base of these triangular cavities was always nearest the pith. Occasionally two cylinders of gum-pockets were observed, one in wood formed early this spring when the disease first appeared in the trees and the other formed in wood recently laid down. In a few cases they occurred also in the bark. The walls were brownish and irregular, with modified and frequently hypertrophied and projecting cells. These cavities appeared to be free from mycelium and bacteria, and cultures from the walls and the exuding gum gave no positive results.

The roots of about fifty trees were examined for this symptom, but lack of time prevented the examinations from being as extensive and complete as desirable.

(3) *First appearance and present distribution*.—So far as I can learn by diligent inquiry this disease first appeared in Georgia about 10 years ago. It may have existed longer, but satisfactory evidence of this is wanting. It occurs in the middle and north part of Georgia quite generally, but I have not observed it in South Georgia or in Florida, nor in South Carolina or States to the north.

This disease, or one very much like it, also occurs in Kansas. It appeared at Manhattan in 1889, and is now quite prevalent in that locality, but has not been reported from other parts of that State.

The disease is very destructive in both States. Mr. T. C. Wells, of Manhattan, Kansas, lost his entire orchard in 2 years. Mr. R. C. Fryer, of Shiloh, Georgia, has lost several orchards, each in a space of about 3 years. In other parts of Georgia the disease has progressed less rapidly, but no less surely. About Griffin, Georgia, the seedling-peach orchards, and the wild plums have suffered most, but the disease has been in the budded orchards for some time, and is gaining ground every year. Next to peach yellows, I regard it as the most dangerous enemy to peach culture in the United States. In some respects it is worse than yellows, because it runs its course more speedily and is more apt to take the entire tree from the start. Should it become as prevalent in Kansas and Georgia as yellows now is in north Maryland and Delaware, profitable peach growing will be entirely out of the question.

II.—INOCULATIONS.

Experiment 1.—One hundred and twenty-five trees were selected for this series of inoculations. They were grown in 1889 by J. D. Husted, Vineyard, Georgia, and formed part of a nursery of several thousand seedlings, which were not budded that year, but were cut to the ground in the spring of 1890, so as to be suitable for budding the following summer. All of them appeared to be healthy and the shoots of the season were vigorous and in good condition for inoculation. The trees selected were the outer five rows in the southeast corner, and were not different in appearance from the rest of the nursery.

The buds for inoculation came from several 5-year old trees in an orchard on the same farm. These trees were badly diseased in all parts, but were vigorous and free from any sign of disease in 1889. They were dug out and burned soon after the buds were taken, but, judging from the rapid progress of the disease in other trees similarly affected, they would not have lived through the growing season. It was impossible to find dormant buds, so I selected the base of such diseased shoots or rosettes as had pushed only a little way, removing from them all of the foliage. They were cut June 21, 1890, and inserted the same day, two into each tree, in the customary way. The inoculation was skillfully performed, and an examination two weeks later showed that nearly all of the buds had healed on satisfactorily and were alive. As in Part I, Experiment 2, the tops of the seedlings were purposely allowed to remain.

Some of these trees began to show signs of disease in August, *i. e.*, within 2 months, but they were not examined until November 3, *i. e.*, 4 months and 12 days from the date of inoculation. Then a careful examination revealed the following conditions: Of the 125 seedlings which

were inoculated, 57 were healthy, 66 were diseased, and 2 appeared to be dead.

In 6 of the 57 healthy, one or both of the inserted buds had pushed into diseased growths; in the rest, the buds had made no growth (the majority), or only a slight growth of uncertain character. In most cases the bark inserted with the buds was still living.

Sixty-six of the stocks had the same disease as the trees from which the buds were cut. The diseased shoots pushed out indifferently above or below the inserted buds, or from both places. These stocks might have been grouped into four classes according to the severity of the symptoms: (1) Doubtful, 4; (2) very slight symptoms readily overlooked, 20; (3) worse affected than No. 2, but also not likely to attract casual attention, 36; (4) bad cases which no one could overlook, 6. Five of the latter were photographed, and two are represented on plate XXXIV. Some of these growths were as much as 6 inches from the nearest inserted bud. In 39 of these trees the inserted buds did not grow, or grew only slightly, the bark which was inserted with them being yet alive. In 27, one or both of the buds had grown into diseased shoots. All but 1 of the 6 bad cases fell into the second category. The character of these growths was much like yellows, except that the shoot-axes were greatly reduced, making them much more tufted. The winter buds pushed in the same way—prematurely.

The remainder of this nursery was used for comparison, but a careful examination of many trees brought to light no traces of this disease. The orchards on the same farm might also have served for control. This disease occurs throughout the surrounding country, but is not what might be called epidemic. The farm contains about 100 acres of peach orchard of various ages. The disease first appeared on it in 1887, and the number of cases each year has been as follows: 1887, 2; 1888, 5; 1889, 13; 1890, 31; 1891, 47. This year, in which more cases developed than any previous year, they numbered only about one-third of 1 per cent. In the nearest orchards on other farms the per cent of loss has also been slight.

This experiment attracted some local attention, and the trees which furnished the photographs were shown to many persons at a meeting of the Middle Georgia Horticultural Society, November 6, 1890.

The rapid progress of the disease was surprising. Over one-half of the stocks became affected *in less than 5 months*, whereas results were not expected until 1891, if at all.

These trees were re-examined June 3-6, 1891, at the urgent request of Mr. Husted, who desired to get rid of them. The results surprised and delighted me beyond expectation. The diseased trees were distinguishable at a great distance, and at first glance it looked as though every part of every tree was affected. The actual conditions were as follows:

(1) Four trees were entirely free from disease and had made an excellent growth, their average height being about 4 feet.

(2) Two trees were badly diseased, but a few small branches had developed normal, or nearly normal, leaves and shoot-axes, while a few others bore sickly yellowish leaves and no rosettes. These trees were dwarfed, and at least nineteen-twentieths of the branches bore yellowish green rosettes.

(3) The remaining trees, 113 in number, were diseased in all parts, exactly as had been the trees from which the buds were taken. The leaves and shoot-axes were stunted, yellowish green, and bunched into striking rosettes. Out of this large number of trees there was not one which bore a single healthy leaf or a normally-developed shoot-axis. Every part of each tree was completely diseased. The greater number were still alive in all parts, but a few were withering (see left-hand figure of plate xxxv), and a few were already dead. Almost all of the winter buds developed into rosettes in spring, and in some cases these appeared also on the stems above and below the location of the inserted buds (plate xxxv).

A more satisfactory outcome could scarcely be desired for any experiment whatsoever.

Each tree was carefully examined, and notes were made on the condition of each inserted bud. These observations were also verified, at my request, by Mr. W. T. Swingle, of the Division of Vegetable Pathology, so as to leave no doubt whatever concerning their value.

In the four trees which remained healthy the inserted buds failed to unite with the stocks and were thrown off, the bark of the stock having healed over under them. The only uncertainty was concerning a small fragment of the bark of one bud, and the evidence of union in this case was so unsatisfactory that it was entered as "very doubtful." Three of these trees received two buds each, but by accident the other received only one bud.

In one of the 115 diseased trees the evidence of union between the stock and the two inserted buds was also doubtful. In all of the others some part of one or both buds had united with the stock, and in many instances was still living. This was also true of the 6 trees removed in 1890. Often, however, only small fragments of each bud healed on. Occasionally less than one-fourth of 1 square centimetre of the bark of one bud was all of the diseased tissue that had actually united with the stock, and yet this was sufficient to induce the disease. None of the inserted buds pushed over 3 inches, most failed entirely or pushed only one-fourth inch to 1 inch and then died.

The diseased seedlings were noticeably smaller than the four healthy ones. On an average they were about 3 feet high with a proportionate spread of branches.

The contrast between the November and June examinations is noteworthy. In November, when the disease had been acting less than 5 months, only 66 of the stocks showed any symptoms whatever. None of them were wholly diseased; most showed no signs of disease at a distance, and even a large part of the six worst cases was still free from symptoms (plate xxxiv). In June, after the disease had been acting nearly a year, 121 of the original 125 trees had become affected, and 115 so completely that it was almost impossible to find any healthy branches. The only uncertainty is concerning the six which were removed in November for photographic purposes. Their condition,

however, at that time (plate XXXIV) warrants one in believing that they too would have become wholly diseased long before June.

This experiment was the more striking, because in the same field, forming part of the same nursery, and separated from these five rows only by the width of a one-horse cultivator, are about 4,000 Elberta trees, which were budded on the same stocks and at about the same date with buds cut from healthy trees on the same farm. These trees were carefully examined for the rosette, but in the whole nursery there was not one case, nor even one suspicious tree. The line of separation between these healthy trees and the five inoculated rows was sharp as could be desired, and the contrast was most astonishing (plate XXXVIII). Two of these Elberta trees are also contrasted on plate XXXVII with two inoculated and diseased trees from the adjoining row, only about $2\frac{1}{2}$ feet distant.

Plate XXXVI contrasts one of the inoculated and diseased seedlings with one of the four which failed to take the disease. Plate XXXV shows part of one inoculated row with rosettes on some of the stems as well as on all of the terminal growth. The foliage on the left-hand tree had already begun to wilt and shrivel. Plate XXXVIII gives a birds-eye view of the field, contrasting some of the inoculated diseased trees with the neighboring healthy Elbertas.

Naturally, the results of this experiment attracted considerable attention in Georgia, especially the appearance in the spring and summer of 1891. The trees were examined by many persons, including Col. R. J. Redding, director of the Georgia Experiment Station; Gustave Speth, Horticulturist of the Georgia Experiment Station; Prof. J. E. Willet, of Macon; H. W. Hasselkus, of Griffin, and Rudolph Cetter, of Vineyard. A summary of the final results was given before a meeting of the Middle Georgia Horticultural Society June 9, 1891. The matter was also brought to the attention of Mr. Berckmans and other members of the State Horticultural Society.

Experiment 2.—This was also performed at Vineyard, Georgia, on the farm of J. D. Husted.

The 56 trees selected for this series of inoculations were vigorous, well-rooted cuttings of the Mariana plum. They formed part of a small nursery grown in 1889, but not budded that year, being cut to the ground in the spring of 1890, so as to secure fresh shoots for budding the following summer. These trees formed the east end of the south row and were not different in appearance from the rest. All were the picture of health.

The buds for inoculation were taken from the north side of a seedling peach tree which was growing by the wayside near Pomona, Georgia. This tree may have been 4 years old. The south one-half of it was diseased by the rosette, and the remainder appeared to be healthy. Well-matured *terminal shoots* from the healthy-looking branches were selected for use in budding. All of them bore full-grown leaves of a healthy

green, and their buds showed no tendency to germinate. Moreover, all of the foliage on the branches in the immediate vicinity was full grown and healthy, and there were no signs of disease nearer than the base of the main branches, 4 to 6 feet below. The buds were cut July 1, 1890, and inserted the same day—two into each tree—in the usual way. A subsequent examination showed that many of them had healed on and were living. The tops of the cuttings were not removed until some weeks later.

These trees were reëxamined November 3, 1890. At that time only 32 of the 56 stocks bore peach shoots. Upon the rest the buds failed to take or died soon after commencing to grow. In 30 of the stocks the buds had grown into shoots, which were 15 to 30 inches long. In many cases both buds grew. The foliage, which had not yet fallen, was normal, except for slight parasitism of *Puccinia pruni*, Pers., and the shoots were vigorous. There were no rosettes, no winter buds were germinating, nor were there any other signs of the disease. One bud only developed in each of the other two. One had grown only about 8 inches, but was normal; the other had grown only $\frac{1}{2}$ inch and the foliage was reddish and unhealthy. All of the stocks appeared to be as healthy as when the buds were inserted.

The parent tree was also examined at this time. The disease had made considerable progress, but careful search failed to discover any germinating buds or sickly shoots upon that part of the tree which supplied the buds for inoculation. There were signs of disease at the union of the main limb and the stem, but none further up. All large parts of the tree were still alive.

This tree was reëxamined June 8, 1891. It bore no normal leaves or shoot-axes. The limbs which were first to manifest disease in 1890 were now dead in great part, and all other portions of the tree were badly diseased, including the branches from which the buds were taken. Unfortunately the extreme ends of the branches were dead without symptoms of rosette or foliage of any sort, but they were living last November and are now alive to within 1 foot of the cuts, and bear very sickly rosettes.

The peach tops inoculated upon the Mariana plums were again examined June 22, 1891, and the contrast between them and the condition of the tree which furnished the buds was very great. They looked as healthy and vigorous as did the north side of the parent tree when the buds were cut.

Fifteen stocks bore double shoots and 16 bore single shoots, making a total of 46 living peach shoots on 31 stocks. A very few of the remaining Mariana stocks died; the rest grew thriftily and were cut back to the earth at the time of this examination. None developed any symptoms of rosette. The average growth of the peach shoots to date is 3 to $3\frac{1}{2}$ feet, and their diameter at the base where they join the plum is $\frac{3}{8}$ to $\frac{5}{8}$ inch. They show no symptoms of rosette or decline, while the parent tree is now affected in all parts and already half dead.

In another way this experiment establishes the same fact as No. 1, *i. e.*, the gradual transmission of a germ or virus of some sort from diseased to healthy parts. Clearly something is now affecting the tissues of the north part of the parent tree which was not in them one year ago. Otherwise the 46 peach shoots should now be diseased exactly like that part of the parent tree.

It is obvious that some years must elapse before this experiment is complete, but enough has been observed already to make it almost certain that the disease was not communicated by these buds. It is the same kind of an experiment as No. 4 of Part I.

III.—CONCLUSIONS.

(1) The rosette, as now understood, differs from peach yellows in the following particulars :

(a) The more tufted character and somewhat different appearance of the diseased growths.

(b) The much greater tendency of these compactly tufted growths to develop in early spring from winter buds and to appear all over the tree.

(c) A less tendency to develop sprouts upon the trunk and main limbs.

(d) The absence of premature fruit.

(e) The general early fall of leaves and fruit on affected trees, the fruit being small, yellowish green, and more or less shriveled and gummy.

(f) Gummosis of the roots.

(g) The occurrence of the disease in plums.

(h) The much more speedy destruction of affected trees.

(2) The disease is virulently contagious (Experiment 1), and it is probable that something might be done toward checking its increase by the prompt destruction of all affected trees. This should be done in early spring, as soon as the disease appears and before the leaves begin to fall.

(3) The disease may exist for a short time in part of a tree without being in the rest of it (Experiment 2), but it soon involves the entire tree. In other words, it would seem from Experiment 2 that the cause of the disease must enter the tree at some particular point or points and be carried gradually to all parts through the circulation. A comparison of the November and June examinations in Experiment 1 also confirms this belief.

(4) As in peach yellows, the admitted fact that neighboring trees are not always the next to take the disease is no argument against its communicable nature.

(5) This disease has gained a strong foothold and is on the increase, especially in that part of Georgia known geologically as the Archæan.

(6) If Georgia peach-growers would save their orchards and maintain the successful cultivation of the peach, the necessity for prompt and concerted action appears to be very great.

EXPLANATION OF PLATES.

I.—PEACH YELLOWS.

- I. Fig. 1, healthy fruit of Stump the World or Old Mixon, nearly full grown, but still green; Fig. 2, prematurely ripe, red-spotted peach of the same variety, picked the same day from a neighboring tree, affected by yellows. Photo. August 20, 1888, Dover, Del. Natural size.
- II. Growth from the trunk of a diseased tree, showing premature unfolding of winter buds. Photo. December 4, 1890. Upper orchard on the grounds of the State agricultural college, Amherst, Mass.
- III. Fig. 1, represents three shoots taken from the main limbs of a diseased tree in the autumn of 1890. The spring foliage has fallen almost completely, and what remains has developed unnaturally from winter buds. Fig. 2, represents a healthy shoot taken from the trunk of a neighboring tree. The droop of the foliage is due to loss of water after the shoot was pulled and before it could be photographed. Photo. October, 1890, Still Pond, Md.
- IV. Terminal shoots taken from diseased trees in the autumn of 1890. In Figs. 1, 2, and 3, the spring foliage has fallen almost completely, and what remains has developed unnaturally from winter buds. In Fig. 4 some of the spring foliage remains. In Figs. 2 and 4 the disease has induced the autumn development of blossoms. Photo. October 15, 1890, Still Pond, Md.
- V. Terminal spring growths from a tree at South Haven, Mich. Branches very compactly tufted for yellows, and somewhat approaching the Rosette, but believed to be distinct. Foliage removed from one tuft to show manner of branching. All above $\bar{X}$ is the growth of one season. Reduced to one-half natural size. Photo. July 23, 1889.
- VI. Terminal summer and autumn growths from trees in Delaware. Fig. 1 is more advanced than Fig. 2. All shoots above $\bar{X}$ and x' are the growth of one season. In each very little spring foliage remains. This is the common appearance of the disease. Photo. Fig. 1, September 27, 1887; Fig. 2, September 27, 1890; Dover, Del. About one eighth natural size.
- VIIa. A tree in the last stage of yellows. Diseased for several years. Smyrna, Del. Photo. July 21, 1891. Orchard No. 8 of First Report.
- VIIb. Represents a tree killed by yellows in $3\frac{1}{2}$ years' time, and shows branched character of the last feeble growths. The entire corner was full of thrifty trees, but they are now badly diseased, and the orchard has been allowed to grow up to grass and weeds. Formerly it was very carefully tilled. Tree became affected in the spring of 1887 and died in the summer of 1890. Photo. September 30, 1890, Magnolia, Del.

INOCULATION EXPERIMENT NO. 1.

- VIII. First results, year 1888. Three figures showing unusual number of sprouts and the unfolding of the winter buds in autumn. Fig. 1, a and a' are the inserted buds; a failed to grow but, a' grew into a vigorous shoot, on which all the winter buds pushed; bbb are diseased growths from the stock. Fig. 2, a and a' represent growths from the inserted buds. The lower shoots are diseased growths from the stock. Fig. 3, a and a' represent the inserted buds; a failed to grow, but a' grew into a branching diseased shoot, which was cut away; b , b' , and b'' are diseased growths from the stock, most of b having been cut away. All the foliage is from winter buds. Time, 14 months from date of inoculation. Photos. November 3, 1888.

- IX. Year 1889. This plate represents a row of peach trees on the Department grounds. Figs. 1 and 12 are healthy seedling trees, grown from pits, which germinated in the spring of 1888. All the rest are trees 1 year older, but very badly dwarfed and diseased by yellows. Time, 26 months from date of inoculation. These are the ten trees mentioned in the text, and some of them are the ones which furnished the photographs for Plate VIII. They were carefully transplanted in the autumn of 1888 and suffered no injury. Nos. 2, 3, 7, 10, and 11 were already dead at the time this photograph was made. The difference in size is attributable to the dwarfing effects of the disease produced by the inserted buds. The diseased growths in 4, 6, and 9 are principally from the inserted buds; those in 5 and 8 are almost altogether from the seedling stock. Photo. October 21, 1889.
- X. Two trees from same row as Plate IX but enlarged to show certain details of the disease. These are Nos. 8 and 9. Much of the foliage is from winter buds, which unfolded in summer and autumn.
- XI. Year 1890. Contrast of diseased and healthy trees. Same as Plate IX, but 13 months later, *i. e.*, 3 years and 3 months from inoculation; 1 and 12 are still entirely healthy. They have continued to grow, and have shed their foliage for winter. Nos. 4, 5, 6, and 9 are all that remain of the 10 trees moved and also all that remain of the entire 202 inoculated trees; No. 4 is dead, and 5, 6, and 9 are badly diseased in all parts. All the foliage is from winter buds which developed in autumn, Photographed November 21, 1890. These three trees have proved very resistant and are all alive (August 16, 1891), *i. e.*, 4 full years from date of inoculation.
- XII. Part of same row as Plate XI, showing three of the inoculated and diseased trees more in detail (Nos. 4, 5 and 6), also a few branches of No. 1. Photo. November 21, 1890.

INOCULATION EXPERIMENT NO. 2.

- XIII. Year 1889. Two figures showing seedling trees completely diseased; *x* indicates the location of the inserted buds which are now dead. Trees, 27 months old. Diseased buds inserted August 3, 1887, *i. e.*, 23 months prior to date of photograph. Photos. July 1, 1889, Hubbardston, Mich.
- XIV. Year 1889. Same series as XIII. In Fig. 1 the inserted bud was on the opposite side of the camera and was dead. In Fig. 2, *x* grew from the inserted bud in 1888 but died in 1889. Both trees bore yellowish foliage and were diseased in all parts. The living shoots on the trunks are not from inserted buds. Photos. July 1, 1889, Hubbardston, Mich.
- XV. Year 1889. Same series as XIII and XIV. All parts of both trees diseased. In Fig. 1 the healthy-looking part of the tree is the shoot which grew from the inserted bud. In Fig. 2 the inserted bud was dead. Time, 23 months from date of inoculation. Photos. July 1, 1889, Hubbardston, Mich. The trees represented on these three plates were grown by Thos. J. Shallcross, Locust Grove, Md., in 1887. They were budded August 3, 1887; were moved in the spring of 1888 to Michigan, and set at Hubbardston on April 24 of that year. They showed no symptoms of disease until after July, 1888.
- XVI, XVII. Year 1889. Healthy unbudded trees for comparison with those shown on Plates XIII to XV. Trees of same age, *i. e.*, 27 months, from same nursery, removed at same time, and set in same field. Reduction the same. Photos. July 1, 1889, Hubbardston, Mich.

- XVIII. Year 1890. From same series as XIII to XV, but 13 months later. Trees diseased by yellows in all parts and very sickly. Fig. 1 shows the best one of the 210 inoculated trees. Fig. 2 nearly dead. Time 3 years from inoculation. Trees 41 months old. Photos. July 30, 1890, Hubbardston, Mich.
- XIX-XXI. Year 1890. Plates showing effect of inoculations on seven previously healthy trees. Different stages of the disease. Time 3 years. Some entirely dead and others nearly so. Fig. 1, Plate XIX, shows two of a row of healthy trees in the background. The very characteristic branching shoot on the base of Fig. 2, Plate XXI, did not grow from the inserted bud α but from the seedling stock some distance above it. Photos. July 30, 1890, Hubbardston, Mich.
- XXII. Year 1890. Forty trees killed by yellows in less than 3 years from date of inoculation. Pulled and photographed in one group. July 31, 1890, Hubbardston, Mich. Some died in the fall of 1889, others in the following winter, and the small remainder in the spring of 1890.
- XXIII, XXIV. Year 1890. Two unbudded healthy trees of same age for comparison with Plates XVIII to XXII. These figures represent average specimens of all now living (86) of the whole lot set for comparison. Some were larger than those here shown and others a little smaller. These trees were 3 years old from the seed when photographed and have had only ordinary treatment. Photos. July 29, 1890, Hubbards-ton, Mich.

INOCULATION EXPERIMENT No. 4.

- XXV. Year 1890. Barnard tree inoculated in the fall of 1887 from a terminal shoot on the healthy looking side of a diseased tree. Possible long period of incubation. The top here shown was derived from the inserted bud. Photo. January 28, 1891, Delaware.

INOCULATION EXPERIMENT No. 5.

- XXVI. Year 1890. Two seedling trees. In Fig. 1 the growth from the inserted bud was about 10 inches long, and more than one-half of its winter buds had unfolded into feeble sprouts. Photo. October 30, 1890. In Fig. 2 the spring foliage had fallen, but the same symptoms were manifest. Photo. December 13, 1890, Washington, D. C.

IMMUNITY.

- XXVII. Peach on plum. Trees budded on Mariana stock in August, 1888, set November 7, 1889. Photos. October 18, 1890, Still Pond, Md. Fig. 1, healthy and very thrifty. The white spot on the trunk indicates the point of union between the plum stock and the peach top. Fig. 2, tree badly stunted with yellowish and reddish foliage, but no symptoms of yellows. The peach top had overgrown the plum stock and there was a noticeable swelling just above the point of union.
- XXVIII. Resisting power of old trees. Budded peach tree, 36 years old, farm of James S. Harris, Still Pond, Md. The limb marked α developed symptoms of yellows in 1890. This tree has stood in a region of diseased orchards for many years, but it was somewhat isolated and well along in years before the disease appeared. Photo. October 18, 1890. The distance marked off on the trunk is 5 feet.

II.—PEACH ROSETTE.

- XXIX. Fig. 1, budded peach tree, 5 years old, and diseased in all parts by the rosette. This tree was healthy in 1890. It first manifested symptoms of disease in the spring of 1891, and at the time it was photographed did not bear one healthy or full size leaf or nor-

mal shoot axis. Such trees generally die in the summer or autumn of the same year; Fig. 2, healthy budded tree of same age from the same orchard. It might have been only 20 feet distant. Photos. June 3, 1891, Griffin, Ga. Trees about 14 feet high. Part of the left side of each photo is omitted to bring it within the requirements of the plate.

XXX. Terminal branches from a budded tree of bearing age. Fig. 1, still perfectly healthy to all outward appearances. Fig. 2, in first stages of the rosette; Fig. 3, complete, typical rosette. All from the same tree. Reduced to about one-seventh natural size. Photos. July 5, 1890, Griffin, Ga.

XXXI, XXXII. Shoots from a seedling tree of bearing age showing progressive stages of the rosette from appearance of perfect health to complete disease. Fig. 1., perfectly healthy and very thrifty. Foliage smooth and green. Fig. 2, leaves commencing to roll, straighten, and become yellowish; Fig. 3, spring foliage worse diseased than in Fig. 2, and yellowish, rolled, and somewhat injured on the margin by leaf fungi. The winter buds on the upper part of the shoots are unfolding into rosettes. Fig. 4, rosettes developing and fully developed. Photos. July 2, 1890. Tree found in a thicket at Sunny Side, Ga. Reduced to about one-fourth natural size.

XXXIII. Fruit from diseased and healthy looking side of an affected tree. Fig. 1 from a badly rosetted branch. The foliage of this twig was yellowish, and its buds had begun to push into rosettes both above and below the fruit, which was yellowish green and had begun to shrivel slightly but was not strikingly different from Fig. 2. Fig. 2 healthy twig and green, half-grown fruits from same tree. Photo. June, 23, 1891, Griffin, Ga.

INOCULATION EXPERIMENT No. 1.

XXXIV. First results, year 1890. Two of the worst affected trees. Time, 4 months and 12 days from date of insertion of the diseased buds. In both figures the bits of white paper indicate the location of these buds. In Fig. 1 both buds united with the stocks, but neither one pushed, the nearest diseased shoot being from the stock. In Fig. 2 the lower bud grew into *x*, while the upper bud did not push. In Fig. 2 the base of the uppermost diseased shoot was 5 inches above the uppermost inserted bud. The left side of each tree appeared to be perfectly healthy. Inoculations June 21, 1890. Photo. November 3, 1890, Griffin, Ga.

XXXV. Year 1891. Row of seedling trees inoculated June 21, 1890. Photo. June 6, 1891, Griffin, Ga. All diseased throughout and left one drying up. The diseased buds were inserted near the earth and the seedling tops were not removed.

XXXVI. Year 1891. Trees inoculated June 21, 1890. Fig. 1, healthy seedling, two buds were inserted, but failed to heal on. Fig. 2, seedling diseased in all parts; one or both of the buds healed on. Photo. June 6, 1891, Griffin, Ga.

XXXVII. Year 1891. Fig. 1, several trees inoculated June 21, 1890, and now diseased in all parts; Fig. 2, two healthy seedlings inoculated with healthy Elberta buds about the same date. Photo. June 6, 1891, Griffin, Ga.

XXXVIII. Year 1891. Result of inoculations. Part I bird's-eye view of rows of seedlings diseased by the rosette as the result of inoculations made June 21, 1890. Part II bird's-eye view of adjoining healthy nursery of Elberta. Photos. June 6, 1891, Griffin, Ga.

PEACH YELLOWS.

Fig. 1. Healthy fruit.

Fig. 2. Red spotted and premature fruit.

Dover, Del.

YELLOWS—AUTUMN GROWTH FROM WINTER BUDS.

Amherst, Mass.

Fig. 1.

Fig 2.

PEACH SHOOTS.

1. Diseased by yellows. 2. Healthy.

Still Pond, Md.

YELLOWS—AUTUMN GROWTHS FROM WINTER BUDS.

Still Pond, Md.

YELLOWS—SPRING AND SUMMER GROWTHS.

Very unusually tufted.

South Haven, Mich.

YELLOWS—SUMMER AND AUTUMN GROWTHS FROM WINTER BUDS.

Dover, Del.

YELLOWS—THE LAST STAGE.

Smyrna, Del.

YELLOWS—TREE KILLED IN 3½ YEARS.

Magnolia, Del.

YELLOWS—RESULT OF INOCULATIONS.

Experiment 1, year 1888.

YELLOWS—RESULT OF INOCULATIONS.

Experiment 1, year 1889.

YELLOWS—RESULT OF INOCULATIONS.

Experiment 1, year 1889.

YELLOWS—RESULT OF INOCULATIONS.

Experiment 1, year 1890.

6.

5.

4.

YELLOWS—RESULT OF INOCULATIONS.

Experiment 1, year 1890.

YELLOWS—RESULT OF INOCULATIONS.

Experiment 2, year 1889.

YELLOWS—EXPERIMENT 2, YEAR 1889.

Healthy tree for comparison. See Plates XIII-XV.

YELLOWS—RESULT OF INOCULATIONS.

Experiment 2, year 1890.

YELLOWS—RESULT OF INOCULATIONS.

Experiment 2, year 1890.

YELLOWS—RESULT OF INOCULATIONS.

Experiment 2, year 1890.

YELLOWS—RESULT OF INOCULATIONS.

Experiment 2, year 1890.

YELLOWS—RESULT OF INOCULATIONS.

Experiment 2, year 1890.

YELLOWS—EXPERIMENT 2, YEAR 1890.

Healthy tree for comparison.

YELLOWS—EXPERIMENT 2, YEAR 1890.

Healthy tree for comparison.

YELLOWS—RESULT OF INOCULATION—TREE STILL HEALTHY.

Experiment 4, year 1891.

YELLOWS—RESULT OF INOCULATIONS.

Experiment 5, year 1890.

Fig. 1.

PEACH UPON PLUM.
Experiment 10, year 1890.

Fig. 2.

PEACH TREE—36 YEARS OLD.

(Free from yellows until 1890.)

Still Pond, Md.

ROSETTE—DISEASED AND HEALTHY TREE—BODDED FRUIT.

Vineyard, Ga.

ROSETTE—BUDDED TREE.

A healthy branch and two stages of the disease.

Griffin, Ga.

1.

2.

ROSETTE—SEEDLING TREE.

Fig. 1. Healthy Fig. 2. Slightly diseased.

Sunny Side, Ga.

3.

4.

ROSETTE—SAME TREE AS PLATE XXXI.

Fig. 3. Beginning of tufts. Fig. 4. Fully developed rosettes.

Fig. 1. ROSELYN—GRIFPIN, GA.

Fig. 2.

1. Diseased branch. 2. Healthy branch.

Fig. 1.

Fig. 2.

ROSETTE—RESULT OF INOCULATIONS.

Experiment 1, year 1891.

Fig. 1.

Fig. 2.

ROSEMARY—RESULT OF INOCULATIONS.

1. Healthy seedling.
2. Inoculated seedling.

ROSETTE—RESULT OF INOCULATIONS.

1. Diseased Trees. 2. Healthy budded.

2.

FIG. 1.

ROSETTE—RESULT OF INOCULATIONS.

1. Inoculated rows. 2. Healthy rows adjoining.

FIG. 2.

INDEX OF NAMES.

Abbe, Prof. Cleveland, 22.
Barnard, D. P., 21.
Barnard, Norris., 16
Berekmans, P. J., 52.
Brothers, William, 24.
Brown, William P., 23.
Churchill, Mr., 18.
Collier, Dr. Peter, 18.
Davis, George, 28, 29.
Fryer, R. C., 49.
Gildersleve, George, 27.
Goff, Prof. E. S., 18.
Green, James W., 23, 25, 40.
Harper, F. H., 29, 40.
Harris, James S., 16, 43, 57.
Hasselkus, H. W., 52.
Husted, J. D., 47, 49, 52.

Jackson, G. D., 27.
Johnson and Stokes, 23.
Kerr, J. W., 23, 38.
Maxwell, Dr. W. S., 17, 41.
Nicholson, John A., 28.
Nicholson, R. G., 21.
Oetter, Rudolph, 52.
Pierce, Newton B., 11.
Redding, Col. R. J., 52.
Shalleross, Thomas J., 18, 56.
Smith, T. A., 39.
Speth, Gustave, 52.
Swingle, W. T., 51.
Wells, T. C., 49.
Willet, Prof. J. E., 52.
Wilson, J. Frank, 30
Wright, Charles, 23.

INDEX.

	Page.
<i>Ægeria exitiosa</i> :	
Most troublesome on sandy land	34
Yellows not due to	34
Algeria, exemption from yellows in	11
Amherst, Massachusetts, yellows at	14
Aphides, young trees killed by	40, 41
Arkansas, probable occurrence of yellows in	12
Australasia, fruit fly in	42
Bees, popular belief that yellows is spread by	24
Black peach aphid	40, 41
Blossoms:	
Trees probably not affected through	24, 44
Yellows causes premature unfolding of	14, 44, 47
Borers:	
Peaches prematurely by	47
Yellows not due to	34
Botan plum, rosette in	45
Bud inoculation:	
Manner of	16
Rosette induced by	50, 51
Yellows induced by	16, 18, 23
Buds:	
Effect of June budding on	14
Premature unfolding in yellows	12, 14, 16, 20, 24
California:	
Danger of introducing yellows into	12
Exemption from yellows	11
Caroline County, Maryland:	
Buds from healthy orchards in	39
Peach borer in	34
Peach pits from	23
Chesapeake and Delaware peninsula, yellows on	11, 15
Connecticut, observation on yellows in	15
Contagious nature of rosette	54
Contagious nature of yellows	16
Control trees	17, 18, 21, 50, 52
Cumberland plum, rosette in	45
Delaware and Chesapeake peninsula, yellows on	11, 15
Delaware, yellows in	11, 14, 15, 24, 25, 27
Denton, Maryland, experiment at	38
Department of Agriculture, inoculation experiments on grounds of	17, 23
Dormant buds:	
Effect of June budding on	14
Effect of rosette on	49
Effect of yellows on	14

	Page.
Dover, Delaware, excisions at	24
Dry seasons conducive to yellows	33
Excisions	24
Conclusions from	36
Retarding influence of.	37
Successful for a time	28, 30
Experiments with rosette, conclusions from	54
Experiments with yellows, conclusions from	43
Flowers, yellows may cause premature unfolding of	14, 44
Foliage, very early fall of, in rosette	47
France, exemption from yellows	11
Frosts, relations to yellows	39
Fruit, premature, in yellows	12
Fruit flies	42
Geneva, New York, inoculation experiment at	18
Georgia :	
Occasional double growth of peach trees in	32
Peach rosette in	45, 49, 54
Peach yellows in	45, 47
Griffin, Georgia, rosette at	45, 49
Gummosis in rosette	48
Hubbardston, Michigan :	
Inoculation experiment at	19
Peach trees, why set at	19
Immunity :	
Excisions did not secure	37
Observations and experiments on	38
Experiment 1a	40
Experiment 1b	40
Experiment 1c	41
Injuries, yellows not due to	34
Inoculations :	
Rosette spread by	49
Yellows spread by	16, 18, 23
Italy, yellows not observed in	11
Japan, peach codlin moth in	42
Japanese plums, rosette in	45
June budding, effects of	14
June drop	48
Kansas, rosette in	49
Kelsey plum, rosette in	45
Kent County, Maryland, inoculation experiments in	16, 18, 21
Leipsic, Delaware, excisions at	28
Locust Grove, Maryland, inoculation experiment at	18
Magnolia, Delaware :	
Diseased buds from	23
Excisions at	25
Peach on plum at	40
Manhattan, Kansas, rosette at	49
Mariana plum, rosette not observed in	45
Mariana plum stocks, peaches budded on	38, 52
Maryland, yellows in	11, 14, 15, 28, 29
Mediterranean countries :	
Exemption from yellows	11
Fruit fly in	42

	Page.
Michigan, observation on yellows in	15
Mildew on peach trees	21
New Jersey, observation on yellows in	15
New York:	
Observation on yellows in	15
Yellows destructive in western part of.	18
New Zealand, obscure peach disease in	42
Nurserymen, methods of	38
Nursery stock, yellows may be carried in	12, 20
Old trees, hardier than young ones	43
Orchards badly diseased by yellows	15, 25, 29, 40, 41
Pacific coast, danger of introducing yellows on	12
Parasites, danger of introduction with peach trees	42
Puccinia pruni	53
Peach borer, yellows not due to	34
Peach trees, methods of nurserymen	38
Peach yellows inoculations:	
Experiment 1	16
Experiment 2	18
Experiments 3 and 4	21
Experiment 5	23
Peach:	
Abnormal in yellows	12
Description of diseased and healthy	12
Normal habit of growth	14
Plum stocks for	38, 52
Symptoms in, due to rosette	45
Symptoms in, due to yellows	12, 33
Peaches, varieties of:	
Alexander	47
Beers' Smock	24, 25, 26, 31, 39, 40
Christiana	29, 32, 34
Crawford's Early	39, 41, 43
Crawford's Late	26, 39, 40, 41
Elberta	48, 52
Mountain Rose	28, 39, 40, 41
Old Mixon	26, 30, 32, 34, 35, 36, 39, 40
Reeves' Favorite	27, 28, 31, 32, 33, 34, 35, 36
Smock	27, 29
Stump the World	26, 27
Wilkins' Cling	26
Plum, rosette also affects	45
Plum stocks for peach	38, 52
Plum stocks, a disadvantage of	41
Pollen, yellows probably not spread by	24, 44
Pomona, Georgia	52
Premature fruit, great quantities in Maryland and Delaware	12
Premature growth of buds in yellows	12, 13, 14
Premature peaches:	
Absent in rosette	47, 54
Appearance of, in yellows	12, 33
Borers induce one sort of	47
Taste of, when due to yellows	33
Premature pits, healthy seedlings from	17
Pruning, yellows not known to be communicated by	22

	Page.
Prunus Chicasa, rosette in.....	45
Prunus domestica	45
Rainfall, yellows not worse when excessive.....	33
Red spotting of fruit, a symptom in yellows.....	12, 13, 33
Rising Sun, Delaware, excisions, near.....	27
Rosette :	
Cases by years at Vineyard, Georgia.....	50
Conclusions respecting nature of.....	54
Dangerous nature of	49, 54
Flowers and fruits in.....	47
First appearance and present distribution of.....	48
Foliage in	46
Gum-pockets in.....	48
Healthy-looking buds did not produce.....	52
How different from yellows.....	54
How induced	49
Plants attacked by.....	45
Premature fruit absent in	47, 54
Rapid progress in plants attacked.....	45, 49, 54
Roots and rootlets in.....	48
Shoot-axes in.....	46
Small amount of diseased tissue required to produce.....	51
Symptoms of.....	45
Sassafras River :	
Peach on plum at mouth of.....	41
Peach yellows destructive in vicinity of	41
Scolytus rugulosus, rosetted trees attacked by.....	47
Seaford, Delaware :	
Healthy old orchards at.....	39
Peach pits from.....	23
Seedlings :	
Healthy ones from premature peaches	17
Subject to yellows	38
Shiloh, Georgia, rosette at	49
Shriveled fruits in rosette.....	47, 54
Sicily, exemption from yellows	11
Smock seedlings for inoculation.....	16
Sprouts due to yellows.....	13
Still Pond, Maryland :	
Excisions at	28, 29
Inoculation experiment at	16
Peach on plum at.....	40
Sussex County, Delaware :	
Peach borer in.....	34
Peach pits from.....	23
Symptoms of rosette	45
Symptoms of yellows.....	12
Tennessee pits.....	18, 23
Tephritis, danger of introduction of.....	42
Terminal branches :	
Buds for inoculation from.....	22, 52
Diseased growths from.....	14, 46
Texas, probable occurrence of yellows, in northeast part of	12
Turkestan, peach stones from	42

	Page.
United States, yellows native in eastern part of	11
Varieties (<i>see</i> Peaches).....	
Vineyard, Georgia, inoculation experiments at.....	49, 52
Virginia, yellows in	11
Washington, District of Columbia, inoculation experiments in	17, 22, 23
Wet seasons, yellows not worse in	33
Wheat, effect of in peach orchard	21
Wild Goose plum, rosette in	45
Winter buds, premature growth from (<i>see also</i> Excisions).....	12, 13
Winter freezing, not the cause of yellows	39
Yellows:	
Annual increase of cases	15
Bud inoculation not only method of spread	42, 44
Chronic nature of	15
Conclusions from experiments	43
Destructive nature of	11, 15
Due in part to careless selection of buds	42
Duration of affected trees	15
First symptoms of	12, 24
Green foliage, usually found in first stage of	13, 24, 25, 28, 29
Gradual progress of	13, 24
Healthy looking buds may produce	18, 23, 44
How best to deal with	12, 43
How different from rosette	54
Immunity, by careful selection of buds and stocks	38
Influence of locality on	38
Injuries not the cause of	34
Inoculations	16
Parts first affected	12, 24
Period of incubation in	44
Reference to losses occasioned by	11, 15, 18, 24, 25, 27, 28, 29, 40, 41, 43
Severe winters do not cause	39
Slow progress of, in affected trees	15, 18, 21, 24, 37, 56
Small amount of diseased material necessary to produce	18, 21, 44
Symptoms of (<i>see also</i> Excisions)	12
Symptoms of, in early spring	14, 44
Trees affected before symptoms appear	20, 44
Trees seldom or never recover	15
Virulent nature of	18, 20
Where native	11

4237

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53

Saunders

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