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# The Plant World

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TWIGS OF WOODY PLANTS.

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The amateur botanist of the northern states who is particularly interested in field work often regrets that he is obliged to suspend collecting during the winter months. It is true that there is opportunity for him who seeks fungi, lichens, and mosses, depending somewhat upon the amount of snowfall. But the collector of phanerogams sees his most interesting laboratory closed for the season and turns to the lower plants as a temporary pastime to occupy his time until the advent of spring when his serious work begins. Such collectors may busy themselves to advantage during winter by studying deciduous trees and shrubs in their winter condition. I wish to say a few words here to teachers and amateurs who are not familiar with the twig characters of woody plants and who would like to know how such plants may be identified during their dormant period. The twig characters suffice to distinguish readily all except closely allied species. Even of the latter there are very few cases in which the species can not be distinguished by a careful study of the twigs and the aspect of the whole plant.

Space will not permit of the presentation of a scheme of classification, but we may look somewhat in detail at the characters that would be used in such a scheme. A twig is the portion of the growth in length of the woody stem which has taken place during the preceding season; an older portion would be a branch-

let. At the base of the twig is usually found a cluster of scales marking the position of the bud-scales which fell off when the bud expanded. The twig consists of central pith, surrounded by a woody zone. Outside of the woody zone is a zone of soft tissues, a discussion of which would take us too far into anatomy for the purposes of this paper. On the outside is the epidermis which may become ruptured on the older portions by the growth in diameter. Most of this outer zone becomes, in branches, a layer commonly known as the bark. At regular intervals lateral structures, leaves, are produced upon the growing stem, which at the advent of winter, are shed (in deciduous plants) by means of the production of a corky layer near the base of the petiole. The scars thus caused on the sides of the twigs are known as leaf-scars. In the axils of the leaves are normally produced lateral buds or nascent branches. The terminal portion of a twig also usually has a bud which will continue the growth the following season. These parts will now be taken up more in detail. A few representative examples are given in each case.

*Pith.*—The pith is usually solid and continuous, white in color and circular in cross section. The pith is diaphragmed in the walnut and hackberry, that is, though solid in the younger portions, it soon separates into numerous thin, transverse plates. In the grape vines the pith is interrupted at the nodes by woody partitions. The color is brown in the smooth sumac, *Rhus glabra*, and in *Ailanthus glandulosus*. The cross section is rhomboidal in the buckthorn, *Rhamnus*, and in some other distinct 4-angled twigs, and is 5-angled or star-shaped in the oak. *Smilax*, and other monocotyledons have no distinct pith.

*Twig.*—The surface may be smooth, pubescent, glaucous (*A. Negundo*); roughened with lenticels (*Rhus copallina*); or spiny (*Ribes*, *Rubus*, *Smilax*); cylindrical, angled, roughened with corky ridges (bur oak, sweet gum, *Ulmus alata*); various shades of brown, yellow, red, green and gray. In some cases the odor of the bruised bark is characteristic as in sassafras and spice bush.

*Leaf-scars.*—The arrangement of the leaf-scars may be opposite and 4-ranked, or alternate. In a few cases there are more

than two at a node (sometimes in *Catalpa*). Of the alternate arrangement there are two series, 2-ranked and 5- to 8-ranked. Twigs of the latter series are commonly either 5-ranked or 8-ranked, but in most cases both arrangements may be found in the same species, often on the same individual; and even a 13-ranked arrangement may occur.

The shape of the leaf-scars is variable, but varies within fairly well defined limits, so that certain general forms are characteristic of species and often of genera. The catalpa has nearly circular leaf-scars. In the elms, basswood, and in fact most of the 2-ranked genera, the scars are oval or semi-elliptical. The walnuts and hickories have them heart- or shield-shaped. Sometimes the scar becomes narrow and crescent-shaped or U- or V-shaped as in the maples and sycamore. The plums bear oval leaf-scars, while those of the apple are U-shaped.

The vascular bundles which pass from the stem to the leaf are usually aggregated into definite groups which in the leaf-scar present scars or dots called bundle-scars. The arrangement of these is a character to be noted.

In plants possessing well-marked stipules these organs leave a scar on the twig at each side of the leaf-scar. Certain genera are characterized by the stipule-scar encircling the twig. Among our trees may be mentioned the magnolias and their relative, the tulip tree; and the sycamore. The bud scales, being modified stipules, are in pairs encircling the bud. As the bud expands, the scales fall off and leave these scars. The genus *Ficus* and some other exotics also have encircling stipule-scars. Occasionally the stipules are transformed into spines as in the black locust and some other woody Leguminosae. In prickly ash similar spines occur in pairs at the nodes but they are not transformed stipules. Prickles may be aggregated at the nodes to simulate stipules as the triple prickles of certain gooseberries.

*Buds*.—These may be lateral or terminal. The former occur in the axils of the leaves; the latter at the end of the stem. In the ordinary course of development the buds expand in the spring and the growth in length of the twigs takes place rapidly during the time that the leaves are attaining their full growth. The

## DESCRIPTION OF FIG. I.

1. Twig of Hickory (*Hicoria alba* (L.) Britt.) showing strong terminal bud and two superposed lateral buds.

2. Twig of Walnut (*Juglans nigra* L.) showing terminal bud, superposed lateral buds, heart-shaped leaf-scars, and diaphragmed pith.

3. Twig of Oak (*Quercus alba* L.) showing lateral buds clustered at apex.

4. Twig of Ash (*Fraxinus Pennsylvanica* Marsh.) showing terminal bud, opposite leaf-scars, felty-pubescent scales, and a continuous circular bundle-scar.

5. Soft Maple (*Acer saccharinum* L.). Buds opposite, leaf-scars heart-shaped, with three bundle-scars, the angles of the leaf-scars connected by a line on the epidermis.  $\times 2$ .

6. Box-elder (*Acer Negundo* L.). Opposite leaf-scars with a peculiar thin appendage connecting the angles. The portion of the twig just above the leaf-scars is compressed in a characteristic manner.  $\times 2$ .

7. Beech (*Fagus Americana* Sweet). Bud long and slender, with numerous scales. On each side at the base is a stipule-scar.

8. Honey Locust (*Gleditschia triacanthos* L.). Twig showing superposed buds, the uppermost of which develops immediately into a terminal bud. A longitudinal section shows the numerous superposed buds.  $\times 2$ .

9. Tulip Tree (*Liriodendron Tulipifera* L.). Twig showing flattened buds and encircling stipule-scars.

10. Azalea (*Azalca nudiflora* L.). Twig showing terminal flower buds and clustered leaf-buds.

11. Sycamore (*Platanus occidentalis* L.). Twig showing conical buds with a single bud-scale and the encircling stipule-scar. The upper lateral bud continues the growth of the stem. Beside this is shown the scar of the cast terminal portion of the twig.

12. Smooth Sumac (*Rhus glabra* L.). Twig showing felty-pubescent so-called naked buds, U-shaped leaf-scars which enclose the buds, and the base of the well-developed terminal portion which is deciduous.

13. Chestnut (*Castanea dentata* (Marsh.) Borkh.). Twig showing terminal scar such as occurs also in elms, basswood, and other 2-ranked twigs.

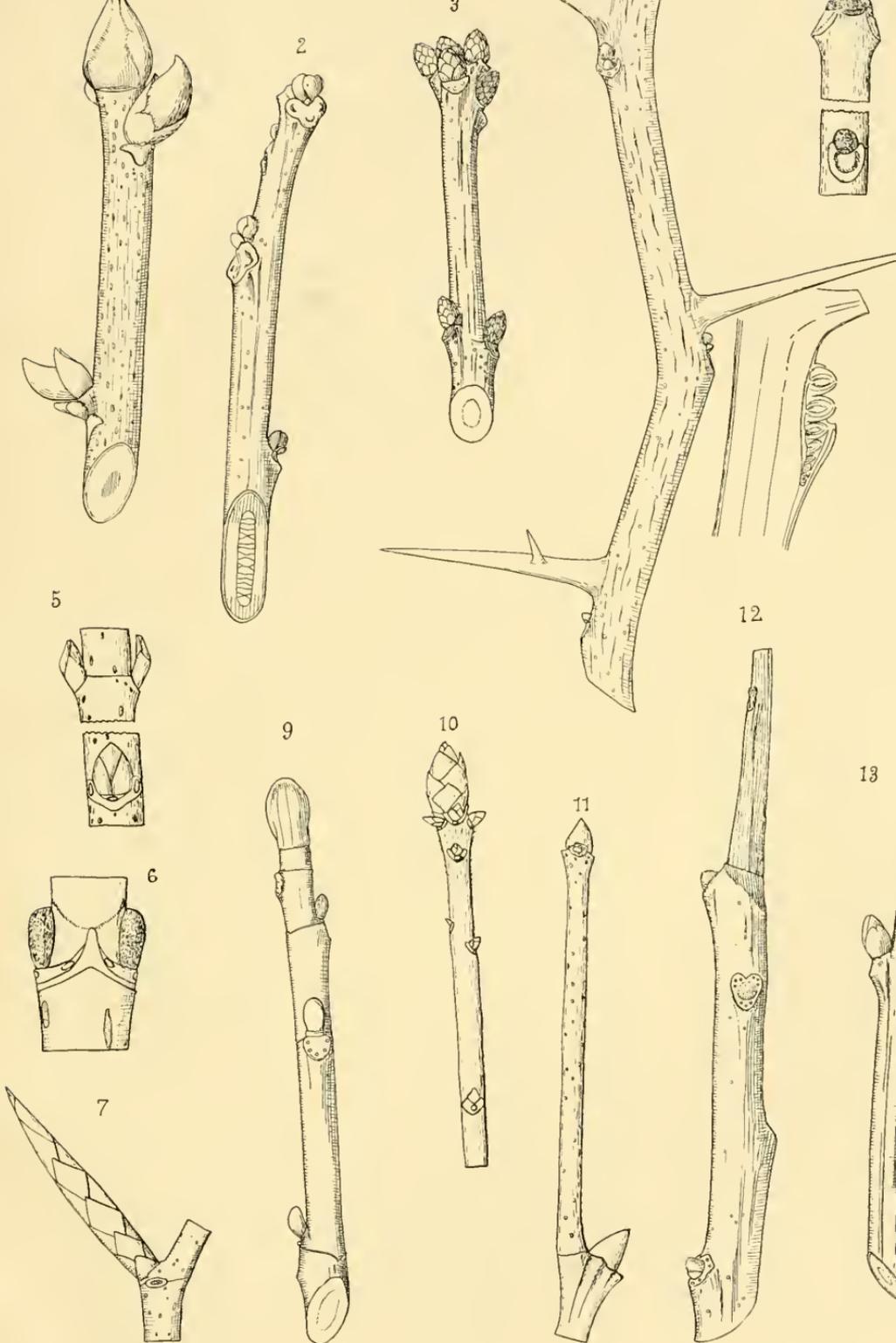


FIG. I.

buds for the following year are formed at this time and growth is finished for the season in May or June, the end of the twig having produced a terminal bud. Such growth is called definite or determinate. The growth in length is not always so definite and may extend through the season until stopped by the advent of cold weather. As examples of this may be mentioned some of the willows and the genus *Rubus*. No definite terminal bud is then formed. Other plants have adapted themselves by an intermediate process which may be termed casting of deciduous tips. The smooth sumac is a good illustration of this. The growth of the twig is indefinite, but in the terminal portion of the twig (some four or five inches) is cast off by the formation of a corky layer in the same way as leaves are cast. The uppermost lateral bud is strong and continues the growth of the twig, while the dead portion falls during the winter, leaving a scar which represents the end of the twig. In other genera this habit of casting has become so pronounced that it takes place early in the season, about the same time as the terminal buds are formed in such plants as the hickory. In these twigs are examined in early summer the dwarfed terminal portion, sometimes an inch or so long, can be seen, but it falls away, leaving a scar. Such casting of the tips is common in the 2-ranked twigs. The elms, mulberry, and basswood all show a terminal scar, usually pushed aside by the vigorous uppermost lateral bud which continues the growth of the stem. The axes of such plants are, of course, always sympodial.

The lateral buds are normally single in the axils of the leaves but may be superposed, that is, two or more, one above the other, in which case the uppermost is the largest. Superposed buds are shown in some of the hickories (*e. g.* *Hicoria minor* (Marsh.) Britt.) and several Leguminosae (the Kentucky coffee tree *Gymnocladus*, the honey-locust *Gleditschia*, etc.). In *Gleditschia*, a longitudinal section through the leaf-scar and twig reveals a row of six or eight buds, the lower successively smaller and hidden by the scar, while the uppermost is usually transformed into a more or less branched thorn.

In some species the flower buds are conspicuous during winter.

and may differ markedly in size and shape from the leaf buds, as in the azalea, red-bud and soft maple.

*Bud-scales.*—In our climate the buds are usually protected by scales, which are modified leaves or stipules. In a few cases the buds are naked (*Rhus*, *Asimina*), the distinction being that in the scaly buds the scales drop off as the bud expands while in the naked buds the outermost protecting leaves develop into foliage and do not fall off. This, however, scarcely holds good with our species as the outer leaves are shaped similar to foliage leaves but fall off easily and do not function as mature foliage leaves. The scales are usually modified leaves or leaf-bases but may be modified stipules. In fact the latter is usually the case in plants possessing stipules. When the scales are stipules they occur in pairs and the transition to ordinary stipules can be traced in the bud, at least at the time of expansion. Many of our genera have stipular bud-scales, as *Magnolia*, *Tilia*, *Ulmus*, *Platanus*, *Quercus*.

The bud-scales may be protected by a pubescent coating, by a gummy exudation (*Populus*) or by being sunken in the bark (*Gymnocladus*).

The above is a mere outline of the subject, presenting facts of common knowledge to botanists and no claims of originality are made. But the amateur or even the professional botanist will find it a pleasing and profitable occupation to classify the local woody plants according to the characters presented in their winter condition.

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On November 11 last, Dr. D. G. Fairchild, of the Department of Agriculture addressed the American Brewing Institute on the subject, "Pure Races of Brewing Barley." The speaker urged the importance, from the economic point of view, of uniformity of barley races, and showed evidence that such uniformity may be arrived at by care in the selection of seed. Before this may be undertaken, however, it is necessary for the practical brewer to decide on the standards of quality desired in the material. It was evident from the address that there remains very much to be done in the directions indicated.

## SUCCESSFUL NATURAL PARKS.

BY WILLIAM PALMER.

A board sign 'To Macleay Park' at the end of the iron bridge leading to Williamette Heights, Portland, Ore., had long been familiar to me during the early days of the late Lewis and Clark Exposition, and I had assumed that it pointed the way to an estate subdivision. Late one rainy afternoon I had an opportunity to explore this narrow ravine leading into the hills. In my portfolio I wandered up the narrow path, collecting a few plants on the way, and passing through a narrow opening in a crude sapling fence, I soon noticed several copies of a placard tacked on trees about a bark-covered teepee. My curiosity was aroused and the following was what I read:

" PICK NOTHING.

" PLEASE READ THIS.

" There being a strong desire on the part of the citizens, through the Lewis and Clark Board and the Park Board to have one wild spot in our city limits that is untouched and untrammelled by the hands of man, the Park Board has therefore selected as that place the Macleay Park and such portions of the Macleay Park trail as come under the control of the board. It is desired that not a fern, flower, leaf, twig, or branch of any name or nature be disturbed. While the Park Board feels that about 95 per cent. of the community are thoughtful and appreciative, still there are a few that are careless and indifferent, and to these few it necessitates the board making stringent laws not allowing any one to pluck or mar anything. A keeper clothed with authority will be constantly kept in the park rigidly to carry out this plan, by arrest or otherwise. A good citizen will confer a favor if they will report quietly to the local keeper any depredation of this kind coming under their notice, and thus assist in keeping this park in its native wild beauty. There is plenty of room for marauders outside the park premises. It is requested that no one carry cut shrubs through the park, as this would give vandals a loophole out of which to escape. The keeper in charge is hereby requested to carry out the spirit of the statement.

" GEORGE H. WILLIAMS,

" T. L. ELIOT,

" J. D. MEYER,

" ION LEWIS,

" L. L. HAWKINS,

" *Park Board.*

" THE PARK BELONGS TO YOU, KINDLY ASSIST IN PROTECTING IT

The possession of my portfolio would naturally have suggested to a stranger that I had botanical intent on the plants,

although it seemed improbable in the drizzling rain that I should meet the keeper, I at once turned back through the fence opening, hid the portfolio under a log, and again returned to explore the character of the place. In a few minutes I met the keeper and spent some time with him learning of the nature of the park. An old resident of Portland had left the ground, less than two hundred acres, to the city on condition that a path should be maintained through its wilderness, but that the natural beauty should not be changed. The Park Board of the city, headed by the mayor, is evidently faithfully carrying out the intent of the donor. The watchman, deeply interested in the matter, keeps the path clear and as dry as possible, cuts partly through fallen logs, so as to permit easy stepping, removes stones, and trims the side of the path where the bank is steep; provides for the drainage across the path, especially where the ground is soggy, but invariably leaves everything untouched except in the narrow winding way.

A few crude log benches have been erected with a bark hut and teepee; in the rocky stream several small dams have been made, the accumulated waters turning crude but picturesque waterwheels and pumps which are constantly in motion to the delight of the juvenile visitors. Outside the park, except in almost inaccessible places, much of the vegetation, especially the larger ferns, are badly broken and trampled, but inside one looks in vain for evidence that anything has been touched. No one can miss seeing the placard, and evidently its warning is rarely, if ever, disregarded. The fence consists of a few uprights driven between trees and supporting slender saplings held by wire. The entrances are openings in this fence, less than two feet wide, between two uprights, yet although a public road borders one side, the isolation of the park is complete. On fine days and on holidays the visitors may number several hundreds; usually a dozen or so visit it every day, and workmen pass through as a short cut between their country homes and the exposition side of the city. The object is a success, the expense nominal.

And when, as is rapidly occurring, forests have been obliterated from the vicinity of Portland, the city may congratulate itself

that the foresight of one individual will permit the people to c  
forever a little of nature's former abundant wilds.

A much grander park, closer to a large and growing city  
containing magnificent forest growths, is Stanley Park at  
couver, B. C. Huge forest trees are abundant here; fern  
everywhere, but the wilderness is marred somewhat by atte  
at horticulture, the bane of almost every effort to set aside a  
of natural wildness. Pathways cross each other in many c  
tions and there are good driveways, with little effort at imp  
ment. It is essential perhaps that at the principal entrance  
natural park there should be erected suitable buildings for  
poses of supervision, but it does seem unnecessary to erect g  
houses and to maintain flower beds. Some member of a  
board at some time or other will persist in *improving*, first  
driveways, then other areas, until finally little is left o  
Natural Park, a monstrosity of landscape gardening costing  
sands of dollars, replacing a bit of nature that in all proba  
the ingenuity of man cannot restore. It is well, perhaps,  
provision should be made for children's swings and for bas  
but the natural wildness should be preserved untouched.

In the city of Halifax, N. S., are two parks. In one a  
Scotch gardener has produced a bit of landscape gardening  
equaled in my experience; culture is evident everywhere, o  
bit of area being maintained in perfection for definite purp  
The whole is superb. On the outskirts of the city anothe  
larger park has been established, a natural park. It has a  
entrance with splendid buildings and a boundary wall, but  
ing more except well-kept drives and paths with the sm  
possible amount of culture. However, little of the park s  
to be of the original forest; yet nature will find her own w  
only man will fix the boundaries and protect the effort.

What has been done in these instances can be done in ot  
There is no reason why every community should not set as  
small or large tract of wild, perhaps rocky, ground within or  
its limits. A few congenial spirits might be associated in a  
any community to carry out such a plan and to cooperate  
some landowner who has more than he knows what to do

or who needs a helping hand to interest him in caring properly for his property. The preservation of wild plant life would thus fall along easy lines and perhaps become a dominant feature.

The writer was one of a few who leased an island in the Potomac river above Washington some years ago. We have built a cottage and some crude narrow paths, yet in other respects, as nature made it, so we leave it—a beauty spot, a bit of nature amidst the surrounding culture, where the botanist, the ornithologist, the entomologist and others may pursue their investigations, but not by destructive methods—a place where we seek seclusion from city cares and which we hope will remain as long as the Potomac flows past our rocky shores.

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## FOREST BELTS OF WESTERN KANSAS AND NEBRASKA.

A BULLETIN OF THE FOREST SERVICE DEALING WITH USE AND MEANS OF EXTENDING THEM IN THIS REGION.

That forests will extend, of themselves, even under disadvantageous conditions, over the moister soils of western Kansas and western Nebraska, and that this natural extension may be fostered with profit, are the interesting facts brought out in Bulletin No. 66 of the U. S. Forest Service, of which Royal S. Kellogg is the author.

The climate of nearly all this region is essentially semiarid, being characterized by light and unevenly distributed precipitation, high winds, excessive evaporation, and great fluctuations of temperature—conditions clearly unfavorable to the thrifty growth of many forest trees. Fortunately, however, most of the scanty rainfall, which would otherwise often prove insufficient, comes during the growing season. As regards trees, the result of adverse climatic factors is that the common hardwoods are confined closely to the water courses or to comparatively wet situations. Even the permanent subterranean water is not sufficient for all species; the excessive evaporation also limits plant distribution. Trees have been killed in seasons of severe drought.

The steps by which forestation begins are often apparently insignificant and unobserved. On the streams, the sandbar willow and the false indigo play an important part, their roots holding the banks and bars from shifting until tree species can get a foothold. After the sand is fixed and other species have started, the willow dies, but its mission has been fulfilled. Its seed is carried by the water as well as by the wind, so that the same flood which makes the sandbar often seeds it with the tree which will redeem it. In heavier soils other shrubs, such as the smooth sumac, the wolfberry, and the wild plum, which grow in clumps and are able to win in the fight against grass, are fore-runners of the forest.

The one thing which, above all others, makes for improved conditions on the plains, and gives assured hope for better tree growth in the future than in the past, is the cessation of fires. Before the country was settled fires were both frequent and extensive. Only the trees along streams could survive, and, at best, make a stunted, scrubby growth. Reproduction was extremely uncertain, owing to the loss of seedlings, and grass gained the ascendancy over all other forms of vegetation. But with the nearly complete stoppage of fires since the country has been permanently settled, conditions are greatly improved. Several tree species have succeeded, despite other most adverse circumstances, in forcing their way into the very heart of the plains by following up the water courses tributary to the Missouri River. It is therefore quite certain that with protection they will in the future steadily gain new territory.

As a result of the study it becomes clear that the forests of this region are much more restricted in area and poorer in character than they need be. That it takes a long time to grow trees fit for any practical purpose is true, yet a region without trees is seriously handicapped, and few farmers can do better for their property than to establish groves upon it. The government is so well convinced of the practicability of growing trees from seeds in this region that it has created two forest reserves, containing 208,000 acres, in the sand hills of Nebraska for this purpose.

# A SIMPLE METHOD FOR EXPERIMENTS WITH WATER CULTURES.

BY BURTON EDWARD LIVINGSTON.

The methods commonly in use for fixing seedlings in jar water cultures usually involve absorbent cotton or some similar material the purpose of which is to hold the plants in place. One of the most frequent causes for the failure of such experiments is the accidental moistening of this material and the subsequent growth of fungi therein, which sooner or later causes injury to the stems at the points of fixation and often result in damping-off. Furthermore, these methods of wedging the plant stems

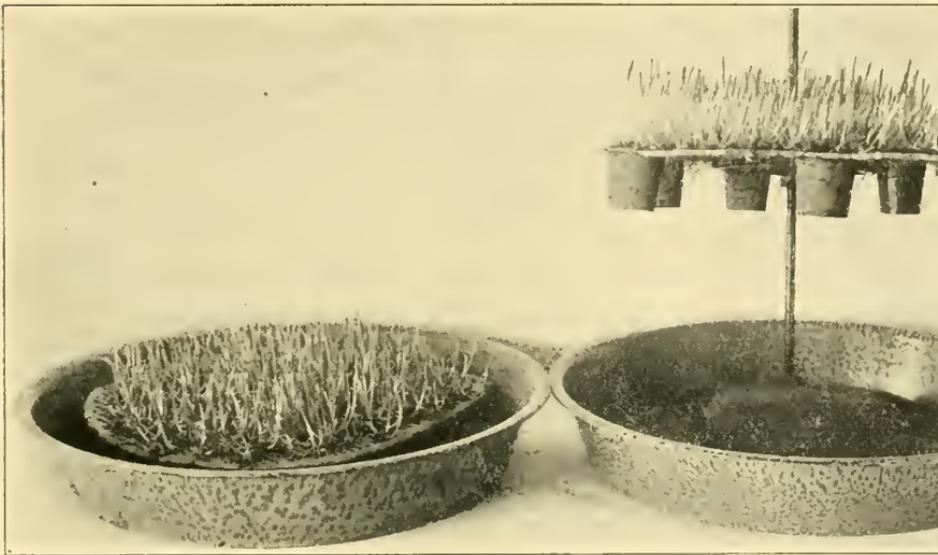


FIG. 2. Method of germinating seeds on paraffin-coated disks floated in water by means of cork stoppers.

openings in cork stoppers or other jar covers always require considerable care in preparation and more dexterity in manipulation than is possessed by the average student of plant physiology at least in beginning classes. For the research worker, the method required for the setting up of such cultures is an important consideration and a method adapted to more rapid work would be the use of more cultures and the accompanying greater accuracy of results.

A method which has been devised in the laboratories of the Bureau of Soils of the U. S. Department of Agriculture is much simpler in operation and in many other ways much more satisfactory for many water culture experiments than any other with which the writer is acquainted. It can be used for cultures of any plant in which the stem does not increase too markedly in diameter during the period of the experiment, and is well suited to such plants as wheat, and the allied grasses, buckwheat, radish, etc. The writer has used it mainly for wheat, a plant which gives excellent responses to all manner of treatments and deserves a more prominent place in physiological experimentation than it holds at present. Seeds of wheat or some similar grain are germinated on paraffin-coated disks of galvanized iron wire netting of a convenient size, having a  $\frac{1}{4}$ -inch mesh, and are floated just at the surface of a pan of water by means of several cork stoppers pinned to the under side of the disk close to its circumference. In coating the disks they are repeatedly dipped in melted paraffin and the openings are thus decreased to a size allowing the needed contact with the water but keeping the seeds from falling through. If, after paraffining, the openings are too small, they may be enlarged by cutting out the superfluous paraffin with a small cork-borer. The water below the disks is from two to three inches in depth. It must be changed often, several times a day in warm weather, to prevent injury to the seedlings from the accumulation of materials which the seeds exude and from the products of bacterial and fungus growth during germination. Fig 2 shows the method of germination. The water has been removed from both pans for taking the photograph. In the pan at the right the paraffined disk is supported on a ring stand in order to show the corks and roots. These seedlings are of the right size for placing in the bottles.

Shortly after the first true leaf has begun to emerge from its sheath the seedlings are removed from the germinating apparatus and placed in the culture bottles. These bottles are wide-mouthed and of a low, broad form, containing eight ounces,\* and

\* The most satisfactory bottle which has been found for the purpose is No. 5677 of Eimer and Amend's catalogue of chemical supplies. It is made of a green flint glass which is fairly free from the objection of being soluble in water.

are provided with flat cork stoppers one-half inch in thickness. Each bottle is covered with opaque black paper or is painted internally with asphaltum varnish or other opaque covering to prevent the access of light to the roots. The stopper is prepared by cutting ten uniformly spaced vertical wedges from its lower surface, these being about one-eighth inch broad and of somewhat greater depth, and extending from top to bottom of the stopper. Each cork wedge, after being cut out, is truncated at its inner angle by the removal of enough cork to allow it to be placed in position after a seedling has been placed in the groove from which the wedge was cut. The stem of a seedling is placed in each of the ten grooves, the seeds being just beneath the lower surface of the stopper, and the wedges are pressed into position. They should wedge the stems into place just firmly enough to hold them when the stopper is inserted in the bottle. After the stems are in position a rubber band is placed around the stopper about one-eighth inch from its upper surface, to hold the wedges in place. The stopper is then pressed firmly into the neck of the bottle, the latter having been filled to the shoulder with the desired solution.

If the culture is properly set up all joints are so tight that practically no opportunity is offered for the direct evaporation of water from the bottle. Either the solution should be renewed or the bottle should be replenished with distilled water every two or four days, according to the character of the experiment. This makes up for loss of water by the transpiration of the plants.

Such cultures of wheat can be continued for three or four weeks or even longer without difficulty. Since the water loss therefrom is only through the plants, the entire cultures may be weighed at each change and the sum of the losses recorded may be taken as the total loss by transpiration of ten plants for the period of the experiment. This total water-loss, being proportional to the area, and hence to the size of the leaves, a convenient method is thus offered for determining the relative growth of several cultures.† At the end of the experiment the green

† Livingston, B. E., Relation of transpiration to growth in wheat. *Gaz.* 40: 178-195. 1905.

dry weights of the tops and the dry weight of the roots may be taken as additional criteria of growth.

The method here described may be used for studies of the nutrient or stimulating value of various substances. A striking illustration of the value of the endosperm to the young seedling may be presented by making two cultures in the same solution, the seedlings of one culture having had the seeds removed at the time of setting up, while those of the other are normal. A single example to illustrate the kind of results which may be ob-

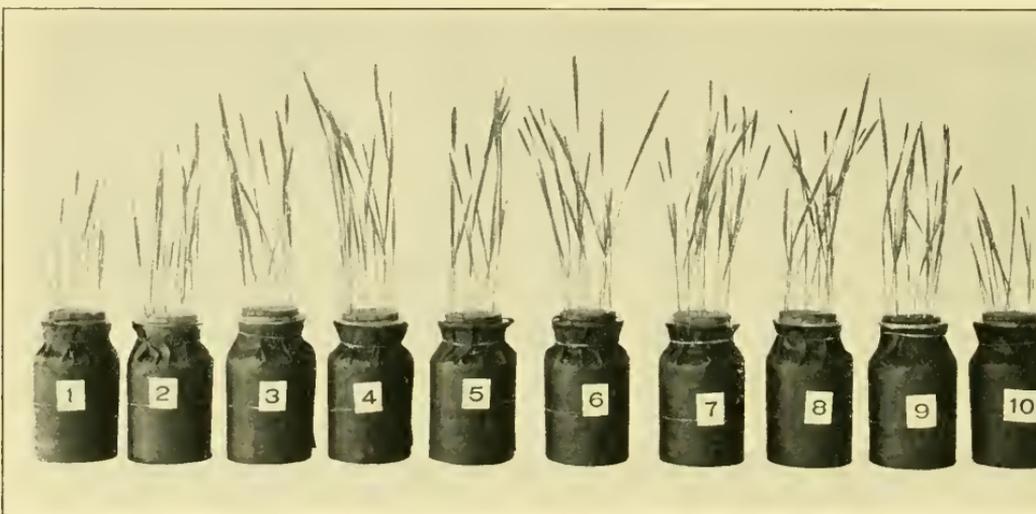


FIG. 3.

tained is given in Fig. 3. No. 1 is in pure water, No. 2 in a Knop's nutrient solution containing 112 parts per million (0.0112 per cent.) of total salts. The succeeding cultures have the same nutrient solution, each one being twice as concentrated as the preceding one of the series. It is seen that the optimum strength lies in the range of concentrations from 224 to 14336 parts per million (Nos. 3 to 9 in the figure), and that variations in concentration within these limits do not markedly effect the growth of the plants. The solution in No. 10, containing 28672 parts per million of total salts, is obviously too strong for the plants.

# THE HOP-HORNBEAM OR IRONWOOD.

*Ostrya Virginiana.*

BY MARY S. VAN HOOK.

A tree that borrows most of its good points from its neighbor and yet succeeds in being individual enough to be interesting, deserves to be noticed. The branchlets of the hop-hornbeam resemble those of the elm, its leaves are very like those of the birch, while the appearance of its fruit, so similar to that of the hop vine, gives the tree its name; yet the tree has its own peculiar charms and piques immediate further study, when once it is observed.

Graceful and dainty in appearance, seldom over thirty feet high, throughout the year the hop-hornbeam attracts attention by its beauty. In the spring the vivid green of its leaves and in the autumn their brilliant coloring, make the tree an ornament wherever it grows. Late into the winter many leaves remain, withered it is true, but still a pleasing brown, and with them hang the pistillate aments, the hop-like fruit clusters, like lanterns on the tree. Each seed, shaped like an apple seed, light colored, is enclosed in a small sac from which it does not escape until spring. On the same tree are the staminate catkins in groups of three, each one, in the winter condition, not more than an inch long, but in the spring stretching out to twice that length.

The wood of the hornbeam is its most characteristic feature. Close grained and very hard, it almost defies destruction and indeed like iron. The ancients employed it in making chariot wheels, and it is now used for the handles of small tools and weapons. In the young trees the bark, smooth and reddish brown in color and marked with short white lines, suggests that of young cherry trees but later on it becomes rough and more like that of the elm.

A near relative to the hop-hornbeam is *Ostrya Carpinifolia*, the bluebeech-hornbeam. Its leaves resemble those of the blue beech and the trunk is often blue or slate color, whence the name.

bark of the young tree is often perfectly smooth with curious ridges upon it and with its peculiar color, the trunk of the tree actually resembles a column of iron in appearance as well as in character. *O. carpinus* grows to be much taller than *O. Virginiana* and prefers the rich woods and banks of streams to the sandy hillsides which *Virginiana* elects. Both trees love to be alone and are never found growing in groves as are oak or beech trees.

## THE DEVIL'S TONGUE.\*

BY OLGA WHITTLESEY.

When the plant first started to grow it was a round, brown, corm with knobs on its hard surface. It was about five inches in diameter. In the middle was a round disk with a little pinky knob in its center which was the plant just beginning to grow.

The plant was placed in a glass jar with a cloth under it and two glasses holding it firmly against the side of the jar. It was only given water a few times. The first eleven days it grew five inches but the next twenty-two it grew two feet nine inches.

As the plant grew the corm became smaller until there was room between it and the glasses to put a finger. Meanwhile the little pinky part grew, first slowly and then very fast. Before it was two inches in height it changed in color, becoming a dark speckled green. It grew in one straight, heavy, stalk with little flaps forming the outside covering. Later it became one smooth stalk with a reddish blade at the end.

In about three days there was a great change in the plant. It had attained the height of five feet six inches and its coloring had changed greatly. The lower part or corm had become wrinkled and the leaves at the bottom of the stalk were very loose. They were a light magenta and the stalk had changed from a mottled green to the light color of the leaves with brown spots. The greatest change of all had taken place in the thick part at the top. From it had come a long tongue-like formation which

\*This is a first-prize competitive essay embodying the original observations of the author (aged 13, a pupil in the Trenton Model School) on the development of the curious aroid *Amorphophallus Rivieri*.—ED.

looked as if it were the flower of the devil's tongue. The tongue and the leaf which enveloped it were a rich magenta in color, giving the whole plant a weird look. Certainly the plant well-named for its flower is remarkably like a huge tongue.

The flower faded when it had been in bloom a few days. The long tongue or spadix withered and both it and the spathe hung down limply. The leaves near the bottom became dry and brittle, the corm became still smaller and the stalk thinner, causing the outside skin to wither. Nothing was left of the gorgeous plant but a dejected looking mass of faded magenta, hanging from a shriveled stalk.

Now that the flower was dying we could pull it apart and look at its stamens and other organs. We found that the stamens were above the pistils, at the base of the tongue. They were reddish brown in color while the pistils were bright red. As the stamens were fastened above the pistils and did not ripen until after them, it was hard to see how the pistils were fertilized. The devil's tongue has no nectar by which to attract insects but it has another device equally good if not as pleasant.

The tongue is hollow and has in it a very bad-smelling secretion. This liquid smells like decaying meat and attracts carrion flies who bring pollen on their legs and wings.

The leaf of the devil's tongue is almost as curious in its growth as the flower. The leaf-stalks grow directly from the corm at the scars, which were on the sides of the corm when the flower began to grow, are left by them. The stalk is dark green in color, mottled with white like the flower stalk when it first began to grow. It is about three-quarters of an inch in diameter and its cells are spongelike and contain a watery liquid.

The leaf is compound. As the stalklet divides a great many times and into a varying number of parts, it is called decapound. The first division of the leaf-stalk is about three feet from the ground. At this point it divides into three parts. The stalklets, from here on, instead of being bare, are bordered throughout their whole length by oval leaflets arranged alternately and connected by a strip of leaf varying from a quarter to an eighth of an inch in breadth. The leaflets are a dark, glo-

green on the upper side and a lighter green on the under side. The leaf is very graceful when growing.

At present the devil's tongue seems like a very useless plant but perhaps it may become a useful one in later years through Mr. Burbank's wonderful experiments.

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## OF INTEREST TO TEACHERS.

EDITED BY DR. C. STUART GAGER.

As stated in the December PLANT WORLD, the U. S. Department of Agriculture is distributing to schools and colleges for use in teaching economic botany and commercial geography, samples of plant fibers, which formed part of the fiber exhibit of the Department at the Louisiana Purchase Exposition.

Such a package, received lately at the Wadleigh High School, New York City, contained samples of five kinds of fibers from different parts of the world—cotton, sisal, Jaumave istle, hemp, and flax. Each sample was plainly labeled with the common and Latin name of the plant, together with a brief description of the method of preparing the fiber, and its commercial uses.

Accompanying the package was a very instructive illustrated pamphlet by Mr. Lyster H. Dewey, Botanist in charge of Investigations of Fiber Plants, Bureau of Plant Industry, entitled "Principal Commercial Plant Fibers." The writer divides vegetable fibers into three distinct classes: (1) The cottons, with soft lint-like fiber one-half inch to two inches long, composed of single cells, borne on the seeds of different species of cotton plants. (2) The soft fibers, or bast fibers, including flax, hemp, and jute, flexible fibers of soft texture, ten to one hundred inches in length, composed of many overlapping cells, and borne in the inner bark of the plants. (3) The hard, or leaf, fibers, including manila, sisal, mauritius, New Zealand fibers, and istle, all having rather stiff, woody fibers one to ten feet long, composed of numerous cells in bundles, borne in the tissues of the leaf or leaf stem. A detailed description of the different fibers has the following interesting introduction:

“ One of the most important manufacturing industries of the country is that which includes the various lines of textiles. Leaving out the silk and woolen mills, which use chiefly animal fibers, there are the cotton factories, the linen and jute mills, and the twine and cordage mills, which use plant fibers exclusively. These number about 1,200 distinct establishments, representing an invested capital of more than \$500,000,000 and giving productive employment to more than 300,000 persons.

“ The source of the raw material required by this great industry is an item of no small interest. Most of the cotton is produced in our southern states, but nearly all the other vegetable fibers are imported. The importations of raw fibers, including cotton, during the fiscal year ended June 30, 1903, amounted to \$46,161,172. These figures cover only the raw fiber. The importations of all the different kinds of textile plant fibers in various stages of manufacture, from yarn and coarse twine to finished woven goods, laces and hosiery, amount annually to more than \$80,000,000.”

M. M. B.

VALUE OF NATURE STUDY.—One of the most gratifying features of our educational progress is the growing interest in nature study. Nature study at the very outset turns the child's inquiring mind to the things near at hand; it is the first step in practical education; the first thing to make the child think of in schooling, not as a foreign, unnecessary accomplishment, but as a vital thing that is to blossom and bear fruit in his everyday experience.

We are more interested in the development of the nature study idea, too, because nature study is the stepping stone, the logical introduction to the study of agriculture. This is the policy favored by our North Carolina school authorities, and the policy which Dr. F. L. Stevens has kept steadily in mind in *Teacher's Bulletin No. 5, "A Course in Nature Study,"* just issued by Superintendent Joyner. Prepared only after the most exhaustive study; clear, practical, and admirably arranged, this bulletin ought to be in the hands of every teacher in the South, and we take it that Professor Joyner will send copies to all applicants as long as the supply lasts.

## NOTES ON CURRENT BOTANICAL LITERATURE.

The very rare little fern, *Schizaea pusilla* has been found by George E. Nichols about two hundred miles northeast of the station reported in 1879 by Mrs. E. G. Britton, at Grand Lake Nova Scotia. The new locality is on Cape Breton Island, about ten miles from Northeast Margaree, Victoria County. In this northern station the plants are dwarfed, being hardly two inches high. (*Fern Bulletin*, 13: Oct. 1905.)

Another interesting find has been made by Mr. A. B. Klugh, in Ontario, that of *Scolopendrium vulgare*, the Hart's-tongue fern. (See PLANT WORLD, Nov., 1905.)

The *Popular Science Monthly* for January contains an article by T. G. Montgomery, University of Nebraska, entitled "What is an Ear of Corn?" As opposed to the generally accepted theory that the ear originated from the fusing together of a number of two-rowed spikelets, the author maintains the view that the ear developed directly from the central spike of some tassel-like structure similar to the corn tassel. The evolution of the ear is traced from a much-branched grass, each branch terminated by a tassel-like structure bearing hermaphroditic flowers, to a central tassel producing only staminate flowers. At the same time, the lateral branches produce only pistillate flowers.

In the *Journal of the New York Botanical Garden* for December, Dr. Murrill has an interesting account of a Fungus collecting trip in Maine, as a result of which he brought back about 1,500 specimens. He found agarics only here and there, while the large woody fungi are exceedingly common, and are very destructive to the elms. Much damage is done by wood-destroying fungi in the lumbering districts of Maine. Most of the wild cherry trees scattered through the woods were entirely dead, and their trunks covered with an undescribed species of *Poria*. Dr. Murrill finds a close relationship between the fungi of Maine and those of the old world, particularly of Europe and Siberia.

Robert F. Griggs has written a monograph of "The Willows of Ohio" as No. 11 of the Special Papers, being volume 6, part 1. Proc. Ohio State Acad. of Science. The paper comprises 5

octavo pages and is illustrated by sixteen half-tone plates. This work should be of interest to students of local floras, and will, no doubt, stimulate the study of these difficult plants, the willows, in the region comprehended in the monograph.

Bulletin No. 89, Bureau of Plant Industry, U. S. Department of Agriculture, is entitled "Wild Medicinal Plants of the United States" by Alice Hengel. This is a full list, so far as the plants are known, giving their scientific and common names, the kinds of places in which they are to be found, and the parts which are used.

The Department of Agriculture will do a good work in educating people up to the cultivation of many of our drug plants for the market. There is in them a source of income yet little appreciated.

H. A. Gleason publishes in the *Ohio Naturalist* (vol. 6, No. 2: Dec., 1905) a revised annotated list of the St. John's wort (*Hypericaceae*) of Ohio.

John H. Schaffner, in the same, gives a key to the Ohio Dogwoods in the Winter Condition, a paper which will be of special use to teachers.

"Free-floating Plants of Ohio" is the title of an interesting little article of biological notes, also in the same journal, by Mabel Schaffner.

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## REVIEWS.

*Wild-Flowers of California.* From water-color drawings by  
ELISABETH HALLOWELL SAUNDERS. \$1.50. Philadelphia:  
William M. Bains.

Under this title is published a collection of twelve very artistic water-color sketches of some familiar Californian wild flowers. Each sketch occupies a separate sheet of heavy paper, interleaved with a tissue on which is printed the popular and scientific names together with a brief description of the plant in question, written by Mr. Charles F. Saunders. The sheets are placed unbound within a heavy folder. Mrs. Saunders' work is especially to be commended for the purity of color and the artistic arrangement.

which has not been permitted to interfere with the accuracy of the drawing. Among the subjects of especial excellence may be mentioned the Mariposa tulips, California poppy, wild pansy and wild heliotrope. The book is a charming gift and an excellent souvenir of California's floral charms. C. L. L.

## PERSONALS.

Dr. Daniel T. MacDougal, formerly assistant director of the New York Botanical Garden, has accepted the position of Director of Botanical Research in the Carnegie Institution. Dr. MacDougal is now at the Desert Laboratory of the Carnegie Institution at Tucson, Arizona, where he will remain for the rest of the winter.

Tucson is to become the residence, also, of two of the Board of Editors of the PLANT WORLD. Professor Francis E. Lloyd has resigned from the Teachers College, Columbia University to accept a position on the Research Staff of the Desert Laboratory. Professor Lloyd will, however, continue to be editor and publisher of this magazine.

Dr. Burton E. Livingston, recently of the Bureau of Soils, U. S. Department of Agriculture, whose valuable article on "A Simple Method for Experiments with Water Cultures" appears in this number of the PLANT WORLD, is now a member of the Staff of the Desert Botanical Laboratory.

Dr. C. S. Gager, who edits the department for teachers in the PLANT WORLD, has resigned his position as instructor in biology in the Morris High School, New York City, to become Director of the Laboratories of the New York Botanical Garden.

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## THE OCCURRENCE OF ICE IN PLANT TISSUE.

BY K. M. WIEGAND,

*Cornell University.*

It is a commonly observed phenomenon that when the temperature falls below the zero point centigrade many plants undergo a change in texture as well as to some extent in form and color. When the temperature again rises these same plants are affected in a definite manner. Either they return to their normal condition, or they immediately wilt and in a short time undergo almost complete disintegration. An examination of the interior of such plants, while still rigid, discloses the presence of ice crystals, usually in large numbers, in some cases appearing to almost fill the leaf, stem or bud, in others occupying certain definite regions in the tissues of these organs—in other words, the organs are “frozen.”

Although the fact that plants freeze and are often killed by freezing is well known to every one, the details of the process are known to but very few, as most text-books give little attention to the subject. It is not the object of this paper to present the results of many new investigations, but to bring together in accessible form what is already known of the subject.

The early Greek philosophers gave the matter their attention in an attempt to account for the death of plants by cold. Not understanding the cellular structure of organisms, they believed the injury due to the rending and mashing of the various organs by the ice-formation, which they correctly discovered often oc-

curred extensively enough to make such injury appear natural.

After the discovery of cell structure in plant tissue De Bary and Du Hamel were about the first to present a definite theory of ice-formation, and consequent death. To them death seemed to be the result of the formation of ice within the cells. Since water when changing to the solid form increases in volume, it seemed to them to suppose that the cell-sap would, on freezing, increase in the same way, thereby stretching the cell-walls until they ruptured. It was supposed that the fluid from the ruptured cells flowed together and froze as one piece. Only in this way did it seem possible to account for the large ice masses found in frozen potatoes, and other thick succulent material. Many other investigators since that time have held the same view, among whom were H. Müller, Strömer, Sennebier, Thonin, Sprengel and Schubler.

Goeppert\* in 1830 seems to have been the first to point out that in some cases ice forms in the intercellular spaces instead of within the cell. Sachs† in 1860 showed that it forms almost always in the spaces. Sachs and Nageli‡ both showed that the expansion caused by all the water in the cell would not be sufficient to rupture the wall. Nageli discovered that cells of *Spirogyra* which had been frozen and thawed still showed some power of osmotic action, which he thought could not have been the case had the cell-wall been ruptured by the freezing. The relation of the protoplasmic membrane to osmosis was not then understood. Both Nageli and Sachs attributed the loss of turgidity accompanying the freezing process to molecular changes in the cell-wall, which they likened to the change occurring in frozen starch paste, whereby the paste-like nature and ability to retain large quantities of water are both lost. This was an important comparison and holds good even now if protoplasm is substituted for cell-

\* Goeppert. Ueber die Wärmeentwicklung in dem Pflanzen, beim Gefrieren, und die Schutzmittel gegen dasselbe. Book 1830.

† Sachs. Krystallbildung Krystallbildungen bei dem Gefrieren und Veränderung der Zellhäute bei dem Aufthauen saftiger Pflanzen. Bericht. ü. d. Verhand. d. Kön. Sächs. Gesell. d. Wiss. zu Leipzig, Wiss. Klasse, 12: 1-50. 1860.

‡ Nageli. Ueber die Wirkung des Frostes auf die Pflanzenzellen. Abhandl. der König. bayer. Akad. d. Wiss. München, 1: 264. 1861.

Since 1860 the studies of Goeppert,\* Prillieux,† Müller-Thurgau,‡ Kunisch,§ and Molisch|| have all shown that, in nature, ice very rarely forms within the cell, and that cells are rarely, if ever, ruptured by ice formation. The cases where the sap freezes within the cell have been found limited to large cells that are very rich in water, containing little protoplasm, and having large vacuoles, as for example, the large internodal cells of *Chara* and *Nitella*, the epidermal cells of *Tradescantia* (Molisch), and a few similar cases. Even in *Chara* and *Nitella* the ice is produced within the cell only when the freezing is rather rapid. Cells that are cutinized nearly all the way around, and which consequently have no external water film in which ice may start, also produce ice within. The cells of various plant hairs are of this nature. Molisch has studied in detail the freezing of *Spirogyra* threads, finding that the water passes to the surface in almost every case, while the cell itself collapses completely. Kunisch found the same true for *Nitella*. Cohn\* claims to have found ice between the wall and protoplasm in *Nitella syncarpa*, and Goeppert the same in *Cladophora fracta*, but no one else has verified these observations. On the other hand, Müller-Thurgau has shown that ice forms exclusively in the intercellular spaces only when the tissue is very gradually brought to the point of ice formation. Fresh

\* Goeppert. Ueber Einwirkung niederer Temperatur auf die Vegetation. Gart. Flora Deutsch. Russ. u. d. Schweiz. 1879.

Ueber das Gefrieren, Erfrieren der Pflanzen und Schutzmittel dagegen. Stuttgart (book). 1883.

† Prillieux. Sur la formation de glaçons à l'intérieur des plantes. Ann. Sci. Nat. ser. 5, 12: 125. 1869.

‡ Müller-Thurgau. Ueber das Gefrieren und Erfrieren der Pflanzen. Landw. Jahrb., 9: 133. 1880 and 15: 453. 1886.

§ Kunisch. Ueber die tödliche Einwirkung niederer Temperaturen auf die Pflanzen (book). 1880.

|| Molisch. Untersuchungen über das Erfrieren der Pflanzen (book). 1897.

Oberdieck. Beobachtungen über das Gefrieren der Gewächse, etc. (book). Ravensburg, 1872.

Dalmar. Ueber Eisbildung in Pflanzen mit Rücksicht auf die anatomische Beschaffenheit derselben. Flora, 80: 436. 1895.

\* Cohn. Report of a paper read before Die Schlesischen Gesellschaft f. vaterländ. Cultur. Bot. Zeit. 29: 723. 1871.

sections cooled quickly produced ice within the cells. The w has found this to be true also of *Nitella* and *Spirogyra* cells. this is probably due the finding of ice within the cells by the authors. In many of their experiments bits of watery tissue usually placed abruptly in the freezing mixture, or exposed directly to outside temperature. In the natural process of freezing however, the fall of temperature is so gradual that ice formation within the cell does not occur.

In considering the structure and arrangement of the ice mass produced when plant tissue freezes it may be best to compare with those formed on the free outside surface of organs.

As shown by Sachs and others, all moist substances, when cooled very gradually and protected from evaporation, at length become covered with an incrustation of ice. This crust possesses a definite structure in that it is composed of innumerable prisms placed side by side palisade fashion, perpendicular to the substratum. Perhaps the most familiar instance of this sort is in connection with the freezing of damp soil. In the cavities underneath boards or other covering which prevent evaporation, we often find in winter ice crusts of considerable thickness consisting of prisms set rather loosely together and often more or less curved. If the soil is well protected, ice crusts often one to two inches in thickness are formed, the individual crystals of which are quite stout as compared with those formed on plant organs. This is largely because the water in the soil is not held with as much force as in plant tissue. Hugo V. Mohl has described an especially fine case occurring in the Black Forest where the outer layer of the earth froze and was afterward removed by an ice crust forming beneath it and drawing its water from the unfrozen earth below. The crystals were from two to five centimeters long, and from the thickness of a needle to that of a goose-quill. Similar cases were described by Müller-Thurgau.

Sachs found that succulent plant tissue such as beets, turn-

\* Hugo V. Mohl. Ueber die anatomischen Veränderungen des Gelenkes, welche das Abfall der Blätter, herbeiführen. Bot. Zeit. 1860.

See also, Monthly Weather Review, U. S. Dept. Ag. 26: No. 5, 217.

potatoes, etc., when presenting a moist cut surface, became coated with an ice crust exactly similar to that produced on soil, but only when protected from evaporation (Fig. 4, C). Exposed tissue usually produced no prisms at all. Good crusts were formed only when the fall of temperature was very gradual, and in such case the prisms often reached the length of several millimeters—always, of course, with one end closely applied to the freezing tissue. Large artificial or abnormal chambers in turnips, etc., also became lined with a similar crust. In the interior of each prism was

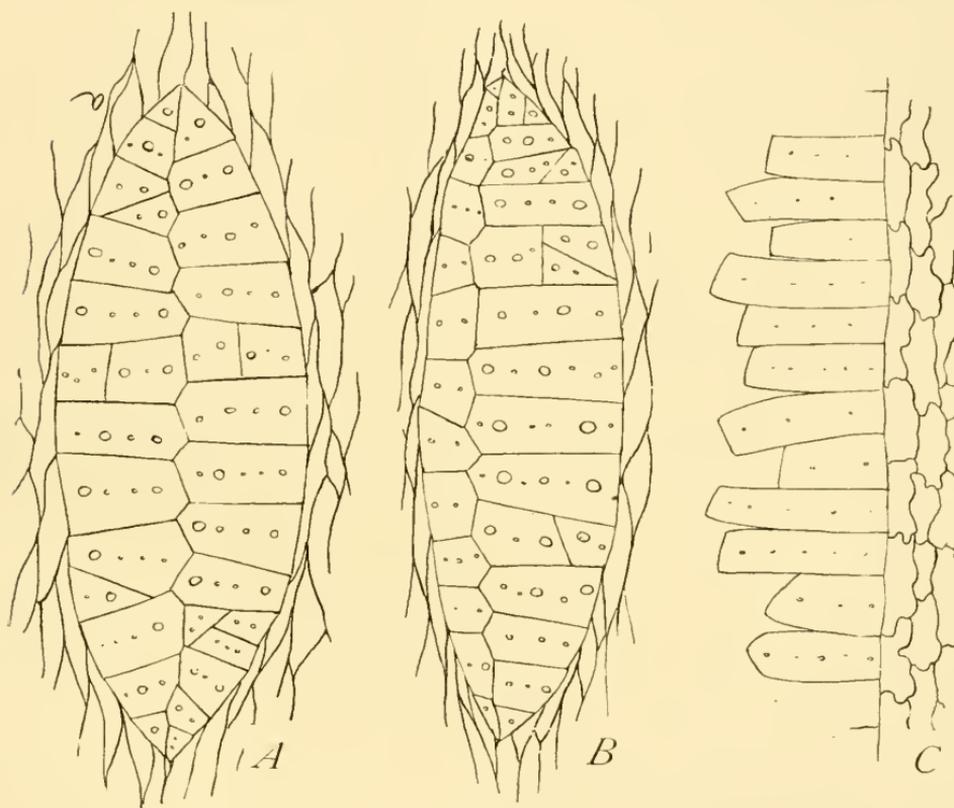


FIG. 4. Diagrammatic representation of ice-masses produced on cut surfaces within frozen beets, potatoes, etc. *A*, in the interior. *B*, near the periphery. *C*, on a freshly cut surface.

usually a chain of minute air bubbles lying longitudinally near the axis. These probably came from air dissolved in the cell sap and separated from it in the process of freezing. On melting, these bubbles remained in the water for a long time undissolved, thus forming a sort of foam.

Such ice prisms grew solely by additions at the end in contact with the tissue, but they showed no obvious relation to the cell upon which they rested. In many cases the cells were much smaller in diameter than the crystals so that one of the latter might cover two or three of the former with no regularity whatever. In other words, the water going to form the crystals seemed to come from the whole tissue in general rather than from any particular cell. Indeed they seemed to form indifferently upon the parenchyma, upon a cross-section of the bundle, or upon a longitudinal section of the latter. The thickness of the crystal depended only upon the molecular force to be overcome, not upon the morphological nature of the substratum. Sachs found no relation between the crystal formation and the structure of the cell-wall, the kind of substances in the cell-sap. Subsequent investigations have fully confirmed these observations. Similar incrustations have been found also on and within animal tissue according to Müller-Thurgau.

For observing the formation of such ice crusts on the surface of single cells where the whole process can be easily followed, the writer has found *Spirogyra* and *Nitella* especially easy and instructive. Filaments were mounted in cedar oil, as first suggested by Molisch. Then by placing the microscope and slide outdoors they were gradually subjected to a freezing temperature while still in the field of the microscope. In this way the formation and growth of the needles could be seen with remarkable clearness. These were produced closely packed side by side over the outer surface of the wall, and the growth of the crystals was so rapid that the increase in length could be easily seen to occur while one looked through the microscope. As this increase continued the cells began to collapse, until finally no vacuole remained, and the walls were almost in contact. The crust did not form all over the cells at the same time, but began at certain localities from which the prism-formation extended rapidly in all directions. The growth of the crystals here is clearly due to the addition of molecules of water at the end in contact with the cell wall, and no increase in thickness of the crystals was observed to occur after their inception. Thus Sachs's observations are sustained.

Regarding the formation of ice within the tissue, one of the first detailed accounts was also by Sachs. In the first edition of his "Lehrbuch" (1868) he described the appearance of ice masses in the petioles of artichoke, *Cynarca Scolymus*. In this plant the bundles of the petiole are somewhat free in the tissue. On freezing, ice cylinders, each made up of radiating ice prisms side by side, were formed around each bundle. The epidermis of the artichoke was usually completely separated from the remainder of the petiole by a subepidermal ice layer, leaving the epidermis hanging about the petiole like a loose sack when the ice had melted.

Prillieux more carefully studied the ice masses within the tissues. His conclusions were, in brief, that the large ice clumps formed in plant tissue were composed of ice-needles placed close together; that the cells were not ruptured, but that often when the quantity of ice was very great and the intercellular spaces were not sufficiently large the cells were forced apart to accommodate the large clumps. Sometimes the epidermis or bark was ruptured and the lamellae of ice were protruded, thus giving rise to the so-called "frost-plants."\* He was also the first to affirm that the sap comes out from the cell in the liquid form. He rightly stated that in the case of hardy plants the separation of the cells by the ice masses ordinarily causes no injury. The regularity of the arrangement of the masses for each species was found very marked both by Prillieux and Kunisch, but this was to be expected since it depended more or less on the tissue configuration.

In most very fleshy structures, as in potatoes, the ice masses which are usually lenticular in form lie irregularly or perhaps more or less parallel to the surface. In beets, however, according to Müller-Thurgau, the masses, although mostly tangential near the surface, are in the interior either tangential, radial, or cross-wise. In *Dahlia* tubers only small lenticular masses were found in the interior, while near the periphery very large ones were present. In the intermediate portion of the tuber only radial masses were found. Sometimes the ice masses in these tissues reach the length of a centimeter, but are usually much smaller.

\* See also MacDougal. Frost plants, a resumé. Science, 22: 351-5 1893.

In succulent stems and petioles the arrangement is usually such that the masses in the cortex are tangential, as also in the outer pith, while in the woody ring they are radial and mostly in the pith-rays. The vascular bundles are in this way more or less completely surrounded by ice.

In leaves, the writer's own observations show that the ice crystals first line the spaces of the spongy-parenchyma, but later, if freezing continues they completely fill these spaces, or in some cases of leaves rich in water, they may fuse into a sheet of ice covering

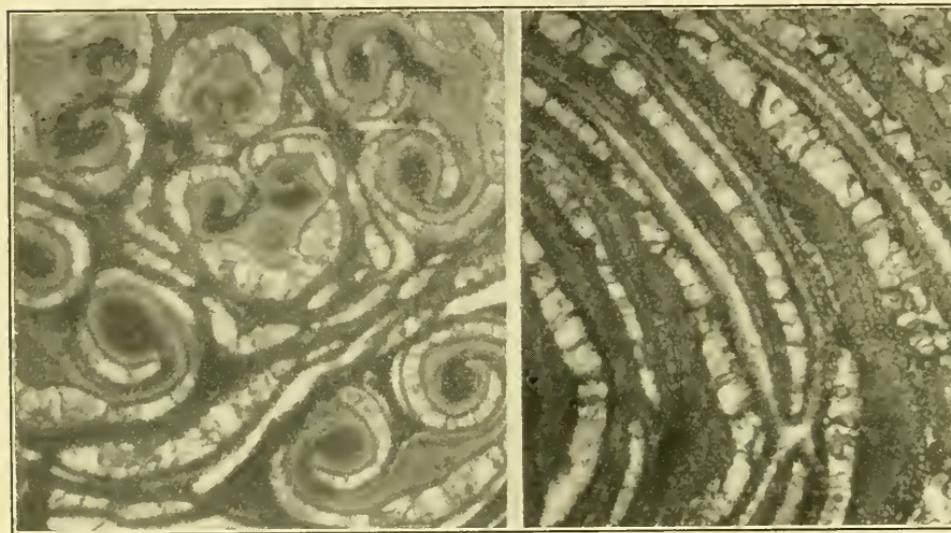


FIG. 5. *A*, section of bud of Lombardy poplar. Note layers of ice around vascular organs. *B*, section of bud of lilac, white layers composed of ice. Temperature —10° F.

completely separating the upper layers of the leaf from the lower. In bud-scales this latter condition normally occurs in cold weather, except in a few species where the scales contain little water. Figure 5 shows the distribution of ice in buds of lilac and Lombardy poplar. The light layers represent the ice. These photographs were taken from free-hand sections with a photo-micrograph apparatus set up out in the open at a temperature of —10°. Under these strenuous conditions the negatives were not of the best.

In twigs there is frequently an ice cylinder entirely around

the stem completely separating the outer layers from the part within. Small ice crystals usually occur within the dead pith cells, within the vessels, and sometimes between the cells of the pith-rays, as Müller-Thurgau has shown, and as the writer has often observed.

The structure of the lenticular ice masses in beets, potatoes etc., when the tissue has been forced apart to accommodate them has been studied by Prillieux and later in more detail by Müller-Thurgau. When examined in cross-section under the microscope they are seen to be composed of two layers of prismatic crystals which in each layer are packed closely together side by side. The prisms are more or less regularly hexagonal, and the majority contain at their axis a chain of minute air bubbles as did those in the free ice-incrustation already described. In case the ice mass comes from near the center of the beet or potato the two layers of which it is composed are of nearly equal thickness (Fig. 4, *A*). If, on the other hand, it comes from near the periphery, then the outer layer of crystals is always much thinner, the separate crystals being therefore much shorter (Fig. 4, *B*). This decrease in thickness of the outer layer continues in proportion as one progresses from the center toward the periphery until in subepidermal masses only the inner layer remains. The transition is therefore gradual from the two-layered structure to the superficial ice crust of Sachs composed of the single series of palisade-like prisms. A similar transition occurs in going from the interior toward the simple ice crusts lining the walls of the large cavities within the tissues.

The cause of this variation in the two layers is probably not due to their position in the organ, but to the amount and source of the water at command. The ice crystals are added to in every case at one end only. Consequently, if the tissues on both sides of the ice mass are filled with available sap then the mass will consist of two layers, and if this water is equally accessible on both sides, that is, requiring the same force to disengage it from the tissues in equal quantities, then the layers will be of equal thickness. Water comes to these masses from quite a distance, hence the character of the tissue round about must be considered.

The cells toward the periphery of the beet or potato gradually become smaller and therefore less rich in water, which in turn is more strongly held by imbibition. Therefore, in an ice cube lying half way from the center to the outside, the water is more available on the inner side, and still farther out the difference is still more pronounced. Near the outside only a few cells intervene between the ice mass and the surface of the organ, and these are small, while on the inside all the large cells through to the opposite side are available. The presence of other ice masses seems not to greatly disturb this relation, but simply to reduce the size of the remaining ice masses in the vicinity. The above conditions obtain typically only when the organ is frozen very slowly. Rapid freezing tends to produce amorphous masses of smaller size, and then occasionally within the cell. Sometimes a few spaces are found entirely filled with ice which shows a crystalline structure even though the cooling was gradual. Probably in these cases the spaces were filled with water before freezing began.

For observing the ice masses in frozen tissue the writer has found the following a very good method if one does not mind the cold. Place a table, microscope, razor, slides, cover glass and a small vial of cedar oil out of doors when the temperature is low ( $15^{\circ}$  F. or lower). Make free-hand sections of the frozen tissue and mount in the oil. When observed through the microscope the location of the ice masses and their structure can be seen very easily. Then, if the slide is carried rapidly to another microscope in a warm room the thawing and sponging out of the tissue may be observed as the water is drawn back into the cells if the tissue is a "hardy" one. The water is not drawn back into the cells to any extent in delicate tissues which are killed by freezing. The writer used this method one winter in the study of the ice relations within the buds and twigs of about thirty species of woody plants with good results. The large ice masses in succulent tissues may be seen with the naked eye. If frozen beets or potatoes are cut in two the lenticular ice masses may be picked out with a needle.

The water of which the ice crystals are composed is al-

pure. If several of these masses of ice from a frozen beet are placed in a watch glass and allowed to melt and evaporate no residue will remain, at least very little; they are almost pure ice. This accords well with the generally established observations in physics that when a solution freezes the water separates from the solute to form almost pure water crystals. It is not always entirely pure, in many cases some molecules of foreign substance being seemingly caught in the ice. The results of experiment by Müller-Thurgau showed only very slight, almost undetectible residue after evaporation of 21.08 grams of ice from the ice clumps in the inside of a large beet. Ice formed on the surface of a piece of beet did not seem so pure, and this was to be expected, because, unlike the former case, the water was not filtered through protoplasm and cell wall, but might contain fragments of either of these structures from the cut outer cells in contact with the ice.

Sachs found that the ice crust of prismatic crystals formed on the cut surfaces of beets, etc., when protected from evaporation, was not pure ice but contained an acid in sufficient quantity to strongly redden blue litmus paper on which it was allowed to melt.

In the case of solutions and water-soaked materials of other kinds the separation of the water from the solid substance has been studied in detail by Molisch. The substances studied by him were as follows: (1) Colloidal substances—gelatine, starch paste, gum tragacanth, gum arabic, egg albumen, *Gleocapsa* gelatine; (2) emulsions—milk of *Ficus elastica*, aqueous carmine solution, indigo solution, caoutchouc emulsion; (3) dye stuffs—solutions of anthocyanin, red-beet sap, nigrosine, methyl blue; (4) salt solutions—potassium nitrate, magnesium sulfate, potassium monophosphate, cobalt chlorid. From all of these nearly pure water separated to form the ice crystals distributed through the substance.

Except in woody structures the cells of frozen tissues are always in a more or less collapsed condition. Since the water is abstracted from the cell when ice formation occurs, collapse must necessarily follow, especially in soft-walled tissue.

Frozen tissue when sectioned shows between the ice mass dense areas composed of the collapsed cell-walls packed close together. Frozen buds and bark of hardy trees show this condition markedly and appear entirely disorganized, but on thaw the cells again expand and become normal. So is it also with evergreen leaves. This extreme shrivelled, shrunken or collapsed appearance of the cells is one of the most marked characteristics of frozen tissue.

In solutions, especially of substances having considerable "affinity" for water, the force with which the water and solute are held together is often considerable. This is shown by the slowness with which certain solutions of colloidal substances are exposed to evaporation, dry out after they reach a certain concentration. The more concentrated the solution becomes the greater is the force with which the remaining molecules of water are held. Considerable water is held in the protoplasm and cell walls by a still stronger force, that of imbibition (molecular capillarity). Here again the retaining force increases as the water is withdrawn. In freezing these forces must be overcome by the ice-forming forces before ice will be produced. The force of crystallization, although strong at the start, increases in proportion to the fall in temperature after the crystal begins to form. Consequently (1) the largest quantity of ice will be formed near the freezing point since then the freezing force is relatively strong; but soon sufficient water is removed from the tissue that the two sets of forces come into equilibrium, after which no more ice is formed only as the temperature falls. (2) The amount of ice formed per degree, as the temperature falls, consequently becomes less and less. In succulent tissue most of the water is frozen out at temperatures but slightly below the freezing point, while in drier tissues, with most of the water held in the protoplasm and walls, a smaller percentage separates out at these higher temperatures. An apple which Müller-Thurgau investigated contained at  $-4.5^{\circ}$  C. 53 per cent. of ice by weight which was equal to 63.8 per cent. of the water content. At  $-15.2^{\circ}$  C. only 79.2 per cent. of the water had frozen. There remained a considerable quantity to freeze at still lower temperatures.

Müller-Thurgau could detect this increase in ice content by simply sectioning various tissues under different temperatures. The writer found it very apparent in the case of winter buds. Sections taken at  $-20^{\circ}$  F. showed very little ice. It was found necessary to work at a temperature of  $0^{\circ}$  F. in order to find the ice content well developed. At this temperature, in the buds of about nineteen out of twenty-seven species of trees and shrubs the ice could be plainly seen and in the majority it was very conspicuous. The remaining eight were sectioned again at  $-10^{\circ}$  F. and all but two showed ice, but in small scattered crystals. The buds of these eight species, butternut, beech, witch-hazel, hickory, ash, oak, hazel and chestnut all contained little cell-sap and small cells with rather thick walls.

It has been found by Müller-Thurgau, Molisch and others cited earlier in this paper that in no case can the death of any plant be traced directly to absolute cold alone at temperatures below the freezing point. At present there seems little if any evidence that death is due to shock, over-stimulation, or any other action of cold which might produce the so-called "cold rigor," although there are several cases yet unexplained by the drying theory. It may well be that in these and other cases additional secondary changes are produced. An unconvincing attempt has recently been made to show that in no case is death due to the amount of ice formation and drying out.† If death were due to shock we should have to assume a special sensitive point at a temperature a few degrees below freezing, which is unlikely, especially since the frequent death at this temperature can be more easily explained in another way. Most plants are killed by the first ice formation within the tissue. If they survive this, a considerably lower temperature is required to kill them, or they may be capable of enduring any degree of cold. It has been demonstrated by means of orchids, the sap of which turns blue when the cell is killed, and *Ageratum*,‡ which gives off a peculiar odor under similar circumstances, that, in the case of delicate tissues at least, death

\* See Pfeffer and Ewart. *Physiology of Plants*, p. 244.

† Mez, C. *Neue Untersuchungen über das Erfrieren eisbeständiger Pflanzen*. *Flora*, 94: 89. 1905.

‡ See Molisch.

occurs when the ice-formation has progressed to a certain extent and bears no relation whatever to the thawing out as was once supposed. Death seems due to the actual withdrawal of water to form ice, not to the cold. The ice formation dries out the cells and the plant suffers therefore from drought conditions. Every cell has its critical point, the withdrawal of water beyond which will cause the death of the cell, whether by ordinary evaporation or by other means. It may be supposed that the delicate structure of the protoplasm necessary to constitute living matter can no longer sustain itself when too many molecules of water are removed from its support. In the great majority of plants this point lies so high in the water content that it is passed very soon after the inception of ice-formation, hence the death of many plants at this period. Others may be able to exist with so little water that a very low temperature is necessary before a sufficient quantity is abstracted to cause death. From some plants enough water cannot be extracted by cold to kill the tissue. This explanation seems the most plausible one so far advanced to account for death by freezing.

In conclusion, the principal points of the paper may be summarized as follows:

The older idea that the ice forms within the cell, and thus causes death by rupturing the wall, has been shown to be erroneous.

Except in a few cases, ice forms invariably in the intercellular spaces, unless the cooling is more rapid than usually occurs in nature.

The ice-masses produced in the spaces are often large lenticular structures. These are composed of ice prisms side by side in thin layers. Superficial ice crusts, and those produced on damp surfaces are similar to those in the tissue, but composed of only one layer of crystals. These crystals grow only by additions at the ends in contact with the tissue.

The water of which the crystals is composed is almost pure.

The cells of frozen tissue, except when strong and woody, are always in a more or less collapsed condition.

Much more ice is separated from the tissues to form ice at temperatures just below where freezing begins than at lower temperatures.

peratures. As the temperature falls the quantity separated per degree becomes constantly less and less.

In rather dry tissues, as some winter buds for instance, a temperature as low as  $0^{\circ}$  F. or even  $-10^{\circ}$  F. may be required before ice crystals can be readily seen in the tissue.

As far as the protoplasm is concerned, this is a drying process, and it seems very likely that death from freezing is usually, if not always, due to the drying out of the protoplasm beyond its critical water content.

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## THE GEORGIA BARK OR QUININE TREE (*PINCKNEYA PUBENS*).

BY ELFLEDA B. TAYLOR.

That a plant of such unusual beauty and reputed usefulness in the past as the subject of this sketch should remain in obscurity is difficult to understand. In life, it is true, the meritorious do not always meet with just reward, and old things, however long and faithful their service, are put aside for new ways and inventions. Year after year, in the depths of the wild woods, the *Pinckneya*, or Georgia bark, as it is commonly called, spread its rose-crowned branches—unsought and comparatively unknown, while the fame of its neighbor on every hand, though of less importance, is spread far and wide. I have learned from good authority that this tree played no small part in the weal and woe of mankind during the Civil War. It was known as the quinine tree, or Georgia bark, and was held in no little reverence by the inhabitants of certain malarial districts where doctors were inaccessible and quinine could not be had. A drink was made from the bark and administered as a substitute for tea. This is an obvious example of the belief prevalent and still adhered to among the negroes that—"bark for tea slips from the tree." In the effort to uproot a small plant, apparently but slightly anchored in the sand, so readily does it slip, the bark is left in hand, while the plant remains stationary, denuded root and branch.

The beauty of the plant seems to have been overlooked in its utility during those strenuous times, or by some chance it would have come into notice and now be valued for ornamental purposes, especially since peace and plenty abound and the aggressive florist is ever on the alert for rare and effective novelties. An exquisite study in pink is the *Pinckneya*!

That the name suggests the color which so conspicuously pervades the plant, is merely a coincidence. It was named in honor of a renowned statesman, General Charles Pinckney, of South Carolina. It belongs to the Rubiaceae or madder family, a family known for its attractiveness as well as for its economic value. Only those familiar with the family characteristics would recognize it as close of kin to *Mitchella repens*, the dear little "key" or "partridge" berry, trailing at its feet, or to *Houstonia* the charming bluets or "blue eyes," which greet us so aptly from the ruts of the wheels. Another of the same family as the *Pinckneya* is *Cephalanthus occidentalis*, frequently found growing with it and blooming at the same time. Unlike our subject it is well known, and the medicinal qualities of the "blue bush" are accepted as "globe flower syrup," "honey ball" and "purple" etc.

The *Pinckneya* is a tree or large shrub of quick, luxuriant growth. The leaves are opposite, large, oval or oblong, entire, hoary and pubescent, with linear deciduous stipules. They are often flaked with dots of pink, and the midrib is sometimes of the brightest hue; if torn, the scar turns red becoming brown—it would seem but natural did the wound become so suggestive of the color is the plant throughout. It is interesting to note the arrangement of the roseate leaves.

Four of the five sepals of the terminal and largest flower of the cluster are converted into floral leaves, two large ones and two smaller. Only one lobe of the calyx on others of the cluster are thus transformed into bright leaves of varying size, the remaining of the calyx being early deciduous (Fig. 6).

The flower of the *Pinckneya* repays close study, revealing wonderful points of beauty, especially as viewed under the glass. The corolla is tubular, with five linear revolute lobes, slight

imbricated in the bud. The five stamens are exerted with long heavy anthers and obtuse stigma. Accurately speaking, there are but four petals, for one is broader than the others with the lines of indentation, but it rarely splits. They are a soft creamy tone in color, thickly dotted with pink and are one and a half inches long, recurving strongly, as paper can be curled by means of a sharp surface—an unfurled flower would measure an inch across the top instead of a half inch. They are covered throughout



FIG. 6. Flower of *Pinckneya pubens*.

with a soft hairiness which holds the dew and gives the appearance of being encrusted with rubies and diamonds. The hairy surface is no doubt a protection against insects, as would be inferred by the tentative steps of a bee as he lights thereon by accident from some nearby flower. The depth of the corolla suggests, too, the necessity of a long bill for its fertilization or the securing of the honey stored so deep. The seed pods are in clus

ters of dark globose papery shells, dotted on the surface with white; they are two-celled with numerous seeds arranged in rows. They add an artistic effect, remaining on the tree from one season to the next and contrasting as they do with the pink. Those who have never seen this beautiful tree and to whom a technical description, however simple, conveys but little, may get a better idea of its unique qualities by recalling the Poinsettia or "Christmas plant" (*Euphorbia pulcherrima*), so popular in city greenhouses for the holiday trade, the beauty of which lies in the gorgeous crimson bracts surrounding the flowers. Imagine each branch surmounted by a superb cluster of pink floral leaves instead of red, ranging through every shade of the La France rose with the same silvery lining and tints of lilac. Only in the bright floral leaves, however, and in the comparative insignificance of the flower does the comparison hold good.

In low pine barrens bordering streams the roots of *Pinckneya* spread in search of moisture, sending up numerous shoots forming dense clumps no taller than *Cyrilla racemiflora* (leatherwood), which, about the first of June, is a study in white. Together they form a mingle, a wealth of radiant white and pink, interspersed with downy balls of *Cephalanthus* (button ball), whose hanging heads heavy with their own sweetness, constantly sway, disturbed as they are by the bees. The air is intoxicating with the fragrance of *Cyrilla*. Swarms of busy bees are seemingly distracted by the wealth and work before them, sifting the white petals like snow on everything near, and like snowflakes they cling to the broad luxuriant foliage of the *Pinckneya*, which, unlike the smooth coriaceous surface of "leatherwood," is pubescent in texture. Near by, *Storax pulverulenta* is hanging thick with drooping green balls instead of white bells. *Magnolia glauca*, "silvery-leaf-bay," has almost finished its season of bloom. Underfoot are the first pure white *Sabbatias* and the dwarf *Rheicodendron* feathery foliage, ranging through many shades of rose and lilac to white, with a lower carpeting of the dainty *Eryngium* studded with blue enameled balls. It is with such surroundings that we find great colonies of *Pinckneya*, producing an effect—a picture—but rarely seen in nature. Very lovely it is, but to be seen

at its best it must be sought in the low river hummock, its favorite habitat, where it reaches the proportion of a tall slender tree with trunk emersed half the year. If seen from a car window when slowly passing over a high trestle, a not unusual point of view, and we look down on the rose-crowned wilderness, swaying with the breeze just after a refreshing shower, when the silvery underside of the foliage is displayed, and the raindrops catch the glint of the sunshine—a spectacle, never to be forgotten, greets the eye. The setting of this tree is but one of innumerable examples where the landscape gardener has an infallible guide in nature.

## FLORAL NOTES OF FOREIGN LANDS.

BY FELIX J. KOCH.

At Ogulin, in Croatia, one finds at their best the “old-fashioned gardens,” with the tall pink phlox, the petunia, dahlia and sunflower, as well as mignonette and coriopsis in long beds. Summer-houses are set out in these gardens and gay-colored glass balls, such as we hang on our Christmas trees, are hung on the ends of short poles and scattered among the plants.

Somobo, in the grape country, is famous for its oleanders, while in the old ruined castles of the vicinity sweet clover, mullein, sweet-fern and wild carrot, as well as the wild-rose, thrive luxuriantly. To these, in the Sissek region, the road-side add the butter-cup and whole fields of yellow *lenum*, as well as a pretty purple flower unknown to us, while in the parks the zinnias raise their many-colored heads.

To the south, in Bosnia, notably at Banjaluka, blossom jasmine that recall the vales of the Arabian Nights' legends. At the railway station at Novi, in this province, zinnias and white roses and castor-beans combine to produce a most pleasing effect. In the fields abound the sun-fern and the yellow daisy, as well as a small purple thistle and the wild carrot. In the coal mines of Banjaluka there are magnificent white fungi, hanging as downy white pendants from the roofs of the galleries, while below them thrive queer mushroom-shaped species.

In this section of Europe the althea and the jasmine and the oleander compete with the osage as hedges to the gardens, and the Trappist monks grace their estates with althea hedges.

In the cañons of Bosnia, toward Rjeka, the wild parsnip and the elder, together with a queer red seed-bearing herb, are almost the sole flora, though inside the old fort at this place the meadow land is filled with flowers, blue and yellow and white and purple. In the gardens, among the vegetables, phlox and sweet william thrive, and among the forests ferns are plentiful. Every house has a little veranda outside its window, and there the Jew-geranium and other plants grow, so that, on entering a peasant house in this place, the housekeeper may present the guest with a little bouquet of this and the ordinary red geranium, together with a very sweet-smelling native herb.

At Sarajevo, the capital of Bosnia, the Turkish seminaries have the oleander thriving in their courts, although during Ramadan the Moslem may smell neither these nor any other flowers. On the Austrian Emperor's birthday each soldier wears in his cap a little sprig of oak leaves.

In the Herzegovina, on the trail to Mostar, one sees the chicory and the wild carrot still, but here, as in France, the poppies thrive in the millet fields, and at Hadjici there are sun-flowers in the gardens. Here, too, there grows the sun-fern, tall almost as in New Zealand, and actually so high that the browsing cattle in the fields are hidden beneath its fronds.

The giving of a little floral gift is quite the vogue in Bosnia. On the Buna the old hermit gives the occasional visitor a white velvety herb, really used for heart troubles, but presented by him because of its beauty. At Ilidje the porters of the hotels prefer to favored lady guests with bouquets. So it goes all over the country. There, again, artistic and practical are combined, for at Mostar the city sand filters are placed in a park that banana plants and kohlia, the coxcomb and other plants may thrive over the covered reservoirs, and at Ilidje the national fish hatchery likewise is in a park with the dahlia and the sun-flower and the morning glory grouped picturesquely together.

In northernmost Turkey, beyond Gorazda, the fields run

with the yellow mullein, the wild rhubarb, wild heliotrope and mint and fern, together with wild roses and clematis and elder in shadier spots. Near Plevlje the magnificent forests present endless varieties of fern, and there is a curious blue-flower with a stalk much like that of our Solomon's seal. The tall yellow dandelion, together with little low daisies, fringe the borders of the forest, while moss covers the *parterre* between.

About Fort Jabuka, where the wild rose and the white clematis do not overhang the train, the wild yellow-pany and the hare-bell rise from the wayside, and the thin-stocked mullein grows aloof. The thistle and the cowslip, the mint and the yellow elyssum, together with a great yellow chamomile, the marguerite, the wild althea and the moth-mullein, and a very tiny white morning glory, greet one on every walk. The tansy and the hare-bell and the passion flower, too, grow wild and in profusion in this land.

*(To be concluded.)*

## THE WILD FLOWER PRESERVATION SOCIETY OF AMERICA.

### *Notice to Members.*

The deferred annual meeting of the Board of Managers was held at the New York Botanical Garden, February 23, 1906, there being present in person or by proxy Messrs. Underwood, Lloyd, Morris, Crawford, Waters and Pollard, the latter occupying the chair in the absence of the President. The need of reorganization along more active lines was pointed out, and the draft of a new constitution, submitted by Mr. Pollard, was read, discussed, and unanimously adopted. Under the terms of this instrument the election of officers for the remainder of the year was then held, and resulted as follows:

*President*, Professor Charles E. Bessey; *Secretary-Treasurer*, Charles Louis Pollard; *Members-at-large of the Board: Terms expire 1906*, Professor L. M. Underwood, Dr. Carlton C. Curtiss, Mr. E. L. Morris. *Terms expire 1907*, Dr. F. H. Knowlton, Professor Francis E. Lloyd, Professor W. A. Kellerman. *Terms*

*expire 1908*, Professor Wm. R. Dudley, Professor S. M. T. Dr. C. F. Millspaugh. The Board then appointed the following executive committee: Messrs. Pollard (chairman), C. Johnson, Morris and Mrs. Britton.

The report of the outgoing treasurer, Dr. Waters, was read, accepted, and will be printed, together with the Constitution and a statement of our plans for the coming year, in a circular which will be sent shortly to all members.

CHARLES LOUIS POLLARD,  
*Secretary-Treasurer*

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## OF INTEREST TO TEACHERS.

EDITED BY DR. C. STUART GAGER.

MEETING OF BIOLOGY TEACHERS OF NEW YORK CITY.—A meeting of the department of biology of the High School Teachers' Association, held on February 3, 1906, the topic discussed was "Is it desirable to give more time to the economic and practical aspects of first year biology, and somewhat less to the purely scientific study of structure and function?"

Mr. Walter H. Eddy treated the topic from the standpoint of botany. He spoke of the necessity of serving more directly the needs of city pupils to whom most of the objects presented in laboratory work or those on exhibition in museums and aquaria are "specimens" only—not in any way connected with the practical life. He emphasized the necessity of doing away with the popular misconceptions as to the uselessness of the science and the strangeness of the objects studied. The only ground of appeal to such pupils and their parents would be the economic value of the subject. Mr. Eddy presented outlines showing how economic interpretations were applied in the High School of Commerce; he emphasized particularly the practical work done with bacteria, the study of agricultural processes in connection with germination, the observations on marketable roots and stems, and, finally, showed how the recitations on these topics were conducted.

Mr. Edward C. Hood spoke from the standpoint of zoology. After a discussion of the aims of the course in biology, Mr. Hood called attention to the fact that a number of the forms required in the present syllabus had a purely scientific value as indicating evolutionary relationships. As such relationships cannot be appreciated by first-year students, such types could with benefit be omitted and things of more practical value substituted. Mr. Hood suggested the substitution of coral for hydra, the omission of study on the earthworm and the more detailed study of such topics as the "economic importance of birds," "lobster fisheries" and the like.

Mr. George W. Hunter, Jr., presented the physiological aspect of the subject. He showed that human physiology, as given to high school pupils, offered unlimited opportunity for the emphasis of the practical side of biology. He believed that most of the morphological side could be omitted in the study of human physiology when the frog is used as a comparative type. He summarized four reasons for adopting a more practical method of teaching first-year biology:

1. Its usefulness to the child in family life.
2. The ultimate trend for the benefit of the race.
3. Its pedagogical superiority.
4. The necessity for satisfying the New Yorker's demand for the practical.

E. M. KUPFER,  
*Secretary pro tem.*

THE CONTENT OF THE HIGH SCHOOL COURSE IN BOTANY.—The discussion at the recent meeting of the New York City Association of Biology Teachers as to whether *less structural and physiological botany*, and more economic botany should be taught in the city high schools, raises again the question as to the proper function of public high schools, and especially of the position which the science of botany should have in their courses of study.

Should the public high school be an educational institution, or largely a training school? And how is the status of botany affected in either event?

A report card recently sent to the father of a pupil in one of the New York City high schools was returned to the teacher with this comment on the back: "I fail to see how the circulation of the blood in the tail of the tadpole has anything to do with the formation of character."

Which is the greater need in a "practical" age and a "practical" community; to teach that only that is practical which brings quick and large financial returns, or to dispel in the next generation such ignorance and narrowness of view as is illustrated in the instance above cited?

It is argued that the pupils are not interested in botany. May it be that if not most pupils, are not interested in algebra. Shall we therefore, teach less quadratic equations, and more mechanical draughting?

We do not mean that high schools should teach nothing useful. There is no objection to teaching in the high school the economic uses of plants, if the pupil is already grounded in the principles of botany. Something of this nature may very properly be included in an elementary course, but not if fundamental principles and scientific habits of thought and work must be sacrificed.

The value of the service which the high school can render to the State must be measured by the increased number of citizens who can appreciate the value of a liberal education for its own sake, and who can see how even the study of the circulation of the blood in the tail of a tadpole, or of photosynthesis and of pollination can make for character and good citizenship.

Botany can never hope to reach and maintain the position which language and mathematics now enjoy in the scheme of secondary education if it is willing to acknowledge that its chief value lies in a certain amount of information it can confer about the economic uses of plants, and that as an educational discipline it has too few claims to entitle it to a position in the course of secondary education.

C. S.

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We have received (February 7) from a botanist in Lake Umbagog, N. J., a fresh specimen of pyxie (*Pyxidanthera barbulate*) in flower. The tiny white blossom of this "flowering moss," as it is also called, is scheduled to arrive in April.

# The Plant World

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TWO MILES UP AND DOWN IN AN ARIZONA DESERT

By WM. A. CANNON,

*Desert Botanical Laboratory, Tucson, Arizona.*

A trip across the Territory of Arizona from the south to the north, or from the west to the east, or an ascent of any of the numerous high mountains, reveals several great floral belts, aggregations of plants, which go to make up the extremely interesting vegetation of this portion of the arid southwest. The belts, for the purposes of this paper, may be roughly classed in (1) the desert belt, having the grease-wood or creosote bush (*Covillea tridentata*), *Franseria dumosa*, the mesquite (*Prosopis juliflora*), and numerous other forms as representative of the vegetal covering; (2) the desert belt, at an altitude somewhat higher than the last, with various yuccas, agaves and the beargrass or sotol (*Dasyllirion*); (3) the higher land or mountain zone with juniper and different oaks; (4) the mountain zone with various pines and cedars, maples, and the beech and quaking aspen; and (5) the highest mountain zone which represents the alpine formations.

This vast range of plant life, continental in its scope, is made possible by the varied topography of the country, which is the last chapter of an interesting geological history. The northern and the eastern portions of the Territory are plateaux and mountains, with altitudes varying from 5,000 to over 12,000 feet above the sea. The southwestern part ranges in altitude from a little above sea level to about 2,500 feet except where isolated mountain ranges carry the elevation 7,000 or 8,000 feet higher.

Geological record shows the higher portions to be very old, they constitute an integral part of the Cordilleran uplift, the lower portions of the Territory are more recent and to the 3,000 foot level were washed by the waves of Tertiary seas. It is not surprising, therefore, that, with so extensive a variation in altitude, with a portion of its territory constituting part of a great plant highway, and with a situation so far south,  $31.3^{\circ}$  to  $37^{\circ}$ , the plant covering of Arizona should be so diverse in character, as, without doubt, it also is in origin.

#### PLANT ZONES IN THE SAN FRANCISCAN REGION.

Perhaps in no region does the succession of plant zones occur in so short a distance as in the northern portion of Arizona. From the summit of the San Francisco mountains, an altitude of 12,600 feet, to the bottom of the Grand Canyon, which Bright Angel creek is about 2,400 feet above the sea, the distance in a straight line is probably not more than forty miles. This great difference in altitude is accompanied by an equally great variation in temperature. Merriam† assumes the mean temperature during the period of reproduction at the altitudes of various plant zones in this region to be as follows:

Arctic-alpine zone, 11,500 to 13,000 ft.....	39.2° F.
Subalpine or timber line zone, about 10,500 to 11,500 ft...	44.6°
Hudsonian or spruce zone, about 9,000 to 10,500 ft.....	50°
Canadian or fir zone, 8,000 to 9,000 ft.....	55.4°
Neutral or pine zone (transition ?), about 7,000 to 8,000 ft.	60.8°
Piñon or cedar zone, about 6,000 to 7,000 ft.....	60.2°
Desert zone, about 4,000 to 6,000 ft.....	71.6°

Thus, in so short a distance as forty miles as the crow flies a vertical one of nearly two miles is crossed during which climate changes and plant zones are encountered which correspond to the temperatures and the plant zones of all of North America outside of the tropics and the extreme north.

\* Privately communicated to the writer by Professor W. P. Blake, University of Arizona.

† Results of a Biological Survey of the San Francisco Mountain Region and the Desert of the Little Colorado, Arizona. U. S. Dept. of Agriculture, Div. of Ornithology and Mammalogy, North American Fauna, No. 32, page 32.

In the summer of 1904 the writer had the pleasure of traveling with Professor F. E. Lloyd, editor of the *PLANT WORLD*, from the southern to the northern portion of Arizona, of ascending the San Francisco Mountain, of visiting the Grand Canyon of the Colorado, and of camping opposite Bright Angel creek by the muddy waters of the Colorado. Although only a general recon-



FIG. 7. Gravelly desert in Arizona. The low shrubby plant in the foreground is *Franseria dumosa*. Giant cactus *Cercus giganteus*, in the background.

naissance of the territory traversed was made, so much of interesting and so much that was suggestive was seen that the writer wishes to recommend the San Francisco Mountain and the Grand Canyon region to some botanist as a suitable and profitable locality in which to pass a delightful vacation. And with this end in view I wish to state briefly how the canyon and the mountains were visited by us in 1904 in the hope that others may repeat the journey and share the pleasure of our experiences.

## THE SAN FRANCISCO MOUNTAIN.

Before going to the canyon we visited the San Francisco Mountain. Flagstaff was our base of supplies. In Flagstaff everything that is needful for the mountain trip, from bacon to burros can be purchased, and, if desired, the trip can be made from that town, but for various reasons we started our burros from Belmont—a way-station nine miles west of "Flag."

Viewed from Belmont, the highest summit of the San Franciscos lies about fifteen miles to the north and about 7,000 feet above, and the way to it is straight and a plain one, since there is no interposing range.

We left Belmont one Wednesday afternoon late in July and directed the course of our three burros straight for San Francisco Peak. At first the way lay through a forest of fine pines (*Pinus ponderosa*) and we did not emerge from the pine forest, in fact, until we reached the very base of the mountain and began our ascent. Wednesday night was passed in an abandoned barn which served better than a tent to keep off the rain, and early the next day we were en route again. By noon we had reached a large meadow which lies so conspicuously on the lower southwest corner of the mountain and which was seen from Belmont. The meadow was skirted by Douglas spruces and aspens. We continued the ascent and were driven to make camp the latter part of the day at about 9,000 feet among firs because of the approach of rains. The rains continued more or less intermittently until Sunday morning, when, lured by promise of a fair day, we shouldered our rüch-sacks and started for the summit. We climbed upward through the forest of spruce and pine (*Pinus engelmanni* and *Pinus aristata*), the trees of which continued to become smaller, until at last we emerged above the timberline and went up on the peculiar debris characteristic of the old volcano. At length the edge of the crater was reached and we stood on a narrow crest with the inside of the crater a few hundred feet below and to the north, and the plateau through which we had come to the south stretching as far as we could see. The general shape of the mountain was then easily made out. A

well known. San Francisco Mountain is an extinct volcano, the northern side of which has disappeared. We were on the southern side, on the rim, and could see the arms of the crest extending to the right and to the left; the latter appeared to be higher and so we walked along the crest in this direction, northwest. At length a large cairn was reached and the crest ended abruptly at the highest point, about 12,600 feet above the sea. After the upper zone (the arctic-alpine) was reached we found small plants hidden between boulders; these numbered, among others, some saxifrage and arenaria, etc., characteristic of the cold and exposed situation. After lingering on the summit a few minutes we left at one o'clock, and returning directly to camp, packed our burros and made our way back to Belmont, arriving there about half-past six the same evening.

This itinerary is given to show that the trip from Belmont or from Flagstaff, both of which are on the Santa Fe Railroad, is in no sense a difficult one, and provided it is made before the summer rains, it may be very pleasant as well as very profitable.

#### GRAND CANYON OF THE COLORADO.

From Belmont we went by train to Williams where we caught a train for Grand Canyon, a three hours' trip from this station.

The journey from Williams to the Grand Canyon was rather monotonous. The railroad runs through a more or less level open country among groves of piñon and juniper. From the train we could get good views of the San Francisco Mountain which was in sight during much of the entire run.

The canyon was reached about sunset and our first view of the mighty chasm, "six feet across"\* (about 12 miles at Grand Canyon), with its sunken world of plateaux, mountains and distant river which looks from the "rim" as it did in 1540, when the first Europeans saw it, was one never to be forgotten.

On account of the altitude the night at the "rim" was cool and our woolen blankets were none too warm, but when we made up our bundles for the descent we took but a single one each and, as a matter of fact, found that no blanket at all was needed.

\* The Journey of Coronado, George Parker Winship. New York, 1904

in the bottom of the canyon. The trip to the river was made on foot and in a leisurely manner. We left the rim early in the morning, taking the well kept Bright Angel trail to the half-house, 3,000 feet below, and there we joined the party of Godfrey Sykes of Flagstaff, and finished the descent on a rough and more precipitous trail which lies somewhat north of the commonly used by tourists. We reached the river's edge by 10 o'clock and quenched our lively thirst with the brick-red water.

After passing the following day and the succeeding night on the Colorado, during which time a crossing was effected, we made the ascent to the rim in a manner quite as leisurely if not as comfortably as when we went down.

It has already been noted that many desert shrubs which might be expected to grow in the lower part of the Grand Canyon are absent there,\* but despite this fact there are many very interesting forms. Along the lower portions of the canyon, by the Colorado River, are plants which are doubtless attracted to that place because of the abundance of water. Notable among them is a species of *Baccharis*. On the "first bench," which is a broad dipping plateau approximately half way between the rim and the bottom of the canyon, there are large plantations of a rosaceous shrub (*Colcogyne ramosissima*), a species of *Ephedra* and several species of cacti. Such are typical desert plants, but they occur in dry situations. Along the streams on this bench may be found quite different forms, among which are catclaw (*Acacia greggii*), cottonwood (*Populus monilifera*) and species of willow. On the dry slopes above the first bench may be found species of yucca and sotol (*Dasylirion*). From the first bench or somewhat above, one meets the trees characteristic of much higher altitudes, as well as those characteristic of the plateau and of the canyon. These include the Douglas spruce (*Pinus dotsuga douglasii*), found on San Francisco Mountain between 8,000 and 9,000 feet, the cedar and piñon (*Juniperus* and *Pinus edulis*) of the plateau, and the fir (*Abies concolor*).

This remarkable range in the flora at the Grand Canyon

\* Desert Botanical Laboratory of the Carnegie Institution, F. V. Coville and D. T. MacDougal, Washington, 1903, p. 23.

made possible by the great variation in climax conditions. The differences in temperature between the altitude of the Colorado River and the rim has already been noted above, and it may be possible that there is also a difference in the actual precipitation as well. Whether the last is true or not, the variation in temperature would bring an unequal total evaporation which is of great importance in determining the desertic character of any place.

Our stay of only three days was far too short to make possible more than the most superficial study of the plants and of their environment. However, it was very apparent that in the canyon there is a rare opportunity, and one which appears to have received scant attention, for a close study of the relation of plants to their environment. Not only does the question of altitude enter, but the effects of exposure, and the substrata of different structure and of varied origin come into great prominence. These various factors are not necessarily confused, but stand out in clear relief and may be definitely measured and possibly their influence as clearly defined. It is to be hoped that some interested botanist will spend his summer vacation, and longer, in the region of the Grand Canyon and especially in the canyon itself, for as Merriam has well said, "the Grand Canyon of the Colorado is a world in itself, and a great fund of knowledge is in store for the philosophic biologist whose privilege it is to study exhaustively the problems there presented."

The semiarid region of the Southwest contains a great number of historic and prehistoric ruins of cliff dwellings, towers, communal houses, shrines, and burial mounds, examples of which are found in the Flagstaff district of the San Francisco Mountains. The question of the preservation of this vast treasury of information relative to our prehistoric tribes has come to be a matter of much concern to the American people, and has received special attention from the Secretary of the Interior. Parts of this region are sufficiently rich in prehistoric interest and scenic beauty to warrant their organization into national parks.

# THE ARTIFICIAL INDUCTION OF LEAF FORMATION IN THE OCOTILLO\*

BY FRANCIS E. LLOYD,

The post-pluvial appearance of foliage within a very short time upon desert plants which remain through periods of drought in a leafless condition is a phenomenon which has very often been remarked. The behavior in this regard is most striking in desert where there is prolonged lack of rain. Although in some regions the rain penetrates into the ground very rapidly, nevertheless it has seemed improbable to many, no doubt, that the absorption



FIG. 8. *Fouquieria splendens*, showing a branch which had been irrigated during four days.

of this water from the soil alone gives the necessary stimulus to leaf formation. Led by this idea, attempts have been made to find in many of the superficial structures of plants the means for the absorption of water, or water vapor, and it may very well be that experimental research will in the future throw light upon

\* This work was done at the Desert Botanical Laboratory, Tucson, Arizona, under a grant from the Carnegie Institution, of Washington during the summer of 1905. Reprinted from *Torrey*, Vol. 5, No. 1, Oct., 1905.

extent of adaptation, as evidenced by anatomical structures, to which plants have attained in this matter. It was during a conversation upon such points with Dr. W. A. Cannon at the Desert Botanical Laboratory that the suggestion was made by him that it would be instructive to see if any light could be obtained upon the influence of meteoric water upon the development of leaves in *Fouquieria splendens*, the ocotillo of the southwest. I accordingly planned three experiments which were carried out upon perfectly leafless plant, all alike in principle, but differing in details. In one case, the only one I shall describe, a reservoir, consisting of a gallon bottle, was attached to the neighboring limb of a "palo verde," and a siphon arranged to lead water to a string of cheese-cloth, which in turn led the water to a bandage of the same cloth tied about a stem of the ocotillo three feet from the ground. The fierce winds several times played havoc with my arrangements, but finally I managed to adjust the apparatus to the swinging of the stems by allowing slack in the cheese-cloth string. The siphon ended in a capillary tube, so that the flow of water was small, and while it ran down the ocotillo stem at times, it did not reach the ground in any case. The reservoir

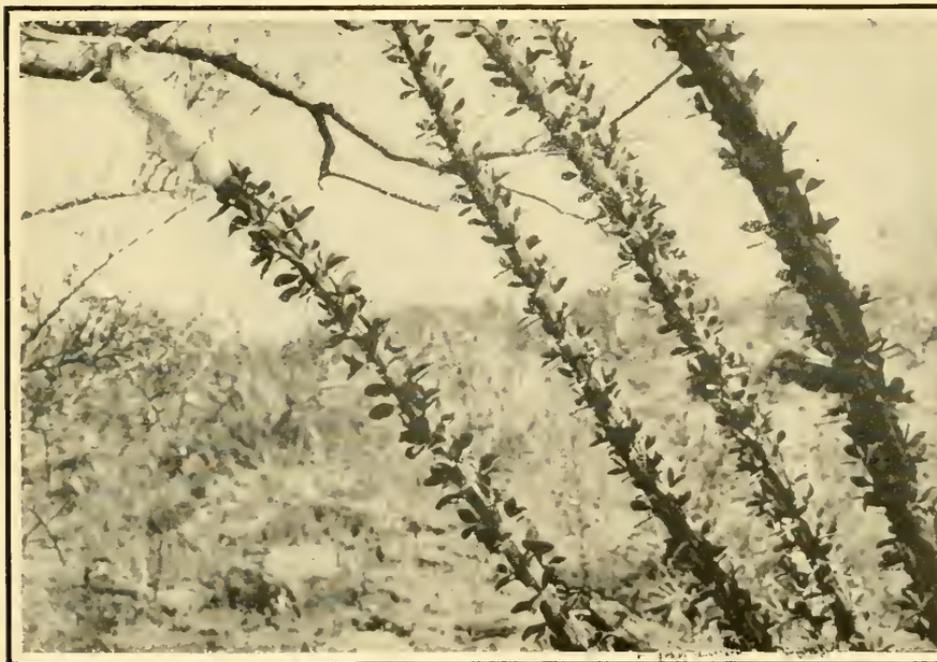


FIG. 9. *Fouquieria splendens*—the same as in Fig. 8, three days after a rain.

was replenished daily, but the flow of water was discontinued. The result was, of course, a closer simulation of the actual occurrences at the time of the rainy season.

The first run of water was applied on the morning of the 4th of July, and this was repeated each day. The stem was thus kept more or less wet for half the time. On the evening of the fourth, the leaves along 12-15 inches of the stem below the damage showed marked development, being 1 centimeter long; by the sixth of July, at three P. M., their length was 1.5 centimeters. On July 9, the largest leaves were 2 centimeters long and the branch in question, together with its neighbors was photographed (Fig. 8). In looking at this picture one may realize that all the stems shown were at first equally leafless. It will be instructive to compare the above facts with those observed after rain.

On July 11, at 5 P. M., we had the first shower of the rainy season, the amount of precipitation being one and one-tenth inch within two hours, drenching, of course, all the vegetation. On the following day (the twelfth) at four P. M., it was quite evident to the eye that the buds had made a start. By July 13, the slender conical buds along the whole extent of the stems were 7 to 8 millimeters long. On July 14 at five A.M., the rosettes of leaves were well formed; the length of the largest leaves was 1.5 centimeters, their size being, however, quite uniform. On July 15, the photograph forming figure 9 was taken. It will be noted that the leaves on the irrigated stem were at that time much larger than the freshly formed leaves, that is, those produced after the rain, as a result of the stimulus thereby given.

It will be noted that the development after the rain was much more rapid than after irrigation, notwithstanding that the water was applied artificially from time to time during the period of growth under observation, while the wetting by rain occurred but once. The fact, however, must not be lost sight of, that following a rain there is a marked rise in the relative humidity, though I regret that I did not take observations on this point at the position of the plant. Then, too, the ground got a good soaking, and it is remarkable how rapidly the soil becomes moist for a considerable

able depth. Undoubtedly this fact was contributory to the rapid growth of the post-pluvial foliage. In the experiment detailed above, the total growth in a few days was due wholly to the water available on the surface of the stem, and the inference is not strained, I believe, if we conclude that, normally, the first stimulus to growth in the leaves is due to the water taken up, probably, at or near the buds. In view of the very thick coating of waxy bark it seems unlikely that the water would find entrance elsewhere though we may be wrong in this, since there are rifts through which conceivably the water might enter.

It may also be noted that the buds of the ocotillo are minute, sometimes indeed scarcely visible, and covered by, at most, a few light-brown, thin, chaffy scales. The repeated loss of leaves at the same place results in a rough area surrounding the base of the bud at which water may, we may well believe, be taken up. There is otherwise no evidence of the presence of any special adaptive structures to this end, and their absence in a very marked desert type of plant is not to be overlooked. That the absorption of water by the stem is of no very great importance, if any, in the economy of the ocotillo, may perhaps well be maintained; while on the other hand we might argue that in regions where the rain is very scarce the very rapid production of foliage would be of some great importance that even the little water absorbed would be equally so. At any rate, the question here barely touched upon is one of a host of similar ones which need elucidation by constant study under just such special conditions as are to be found in the desert.

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## FLORAL NOTES OF FOREIGN LANDS.

BY FELIX J. KOCH.

(*Conclusion.*)

At Belgrade, the capital of Servia, the laurel leaf is employed extensively for decorative effect.

Along the streets of Belgrade on festive occasions, such as at coronation, little red, white and blue poles are erected at set intervals, and these are then joined by garlands of oak-leaves wove by the soldiers.

Most of the homes of this city have potted plants thriving on the sills between the two sets of windows which the bitter cold of this region necessitates. Here the "Jew geranium" is popular.

At a wedding in Servia, in the ride from home to church, the third carriage of the cortege which carries the floral offerings.

In honor of certain religious feasts, or sacraments, a tiny garland of dried tansy, enclosing a small onion, is set over the house-door.

At balls, such as that of the coronation of King Peter, many of the ladies of the nobility wear a slight floral arrangement in their hair. Flowers grace the buffet, too, being interspersed among the platters.

In the suburbs of Belgrade the sun-flower is in frequent use for decorative effect.

At Terpsidor, the royal chateau contains a small collection of wax flowers set in queer slanted cases.

Outside the walls of the cemetery are tables where flowers are sold, while on the graves wreaths of artificial flowers always cover the mounds, each wreath enclosing paper or cloth bouquets inside a center glass casing.

On stated occasions, in the great Greek Cathedral at Bucharest, capital of Roumania, the worshippers bow and kneel, and, on the occasion, are presented with a bouquet by the priest, much as bishops and palm are presented on Palm Sunday in our own Catholic churches.

One of the noted churches of this capital stands in a park with flower-beds, made up of coxcombs, petunia, begonia, pinks, carnations, and kohlias. Before the oldest church in the city a gravel path extends, and in this the portulaca runs riot, together with nasturtium vines.

The handsomer residences of Bucarest, one and all face the gardens, rather than the street, and there asters are abundant.

At the annual agricultural fair here are shown artificial flowers, and, enclosed within, samples of the timber, and the leaf and blossom of the "lumber-giving" trees.

Floral patterns appear in much of the women's work, and there are poppies sewn upon blue silk, and scarfs or roses (each flower of a bit of red silk sewn in petal-like form upon the background) that speak well for the work of the women of this region.

Poor as are the villagers of the Giurgevo region of Roumania in every home, upon a shelf, there will be a cup with flowers, while in the yards, as with Mrs. Wiggs, of cabbage patch fame, an old wash-tub will serve to contain a geranium stock, or a young oleander shrub, and gourd-vines serve to cover its sides.

Among the underground hovels of the gypsies, in Roumania, at departure, the visitor is presented with a dahlia and a sweet smelling herb. Chicory and mullein, as well as dandelion, flourish along the roadsides, and the sun-flowers are set to adorn the burying grounds.

Along the railway between this point and Tirnovo, the grass is set in diamond patterns, in the cuts along the track, that it may present a pleasing appearance while growing, and so that several diamonds may join.

Dandelion and mustard, chicory and the elder constitute the principal flora of the fields.

In the picturesque iron balconies to the homes at Tirnovo oleanders are planted, while on the broad flat roofs there are regular gardens. On the doorstep, too, the jew geranium is set to blossom. School children here bring the teacher bouquets, as they do in our own country.

Rose leaves and the locust petals are cooked in sugar, and served as a confection to offer the visitor.

The pillars of the old churches are frequently hung with flower wreaths which are never taken away, but allowed to dry.

In the windows of many of the homes the fuchsia blossoms all the year around.

On the battlefields at Plevna, Bulgaria, flourish thistles and mullein and dandelion, a queer white flower slightly resembling the elyssum, the chicory, the wild rose and the fluffy wild clematis, and there is only the golden-rod absent to make the October meadows resemble our own.

At funerals, mourners awaiting the cortege at the door of the church, one and all carry flowers, and later, still bearing these, they follow the body to burial. On the left breast, and across the body alone are flowers placed on the dead, a mourner pattering constantly at their arrangement during service, but

elsewhere they are absent. Old floral wreaths are allowed to accumulate in the balcony of the church.

## PARAFFINED WIRE POTS FOR SOIL CULTURES.

BY BURTON EDWARD LIVINGSTON.

Everyone who has ever attempted to grow seedlings or cuttings in small pots of the ordinary form has observed the fact that the first roots developed under these conditions penetrate rapidly through the soil to the wall or bottom of the pot and then develop against its inner surface, often forming a dense web of branches in this region before any considerable branch growth has occurred within the soil mass itself. It is rarely possible in the pots to obtain such a uniform distribution of the root system as is produced by the same plants in the open soil, where, under normal conditions of moisture, the root branches radiate uniformly, and by binding the soil grains together, produce the familiar ball of earth which clings so tenaciously to small plants lifted from the open ground.

This peculiar behavior of the roots of potted plants is probably due to the unusual condition existing where soil and pot come in contact. There is often an appreciable opening between the pot and its contents through which air changes can take place more rapidly than through the pore-spaces of the soil itself, and it is certain that in such pots there is always a better opportunity for gas diffusion along this surface of contact than elsewhere in the pot. Besides this, the porosity of clay pots allows diffusion of gases directly through the walls and may also exert an influence on the growth of the plants through evaporation on the external surface and the accompanying movement of water from within outward. Whether the outward growth of the first roots is a phenomenon of aerotropism or not, it seems quite probable that the greatly accelerated growth and production of branches in the vicinity of the walls is largely due to the better aeration of that region.

In attempting to use potted plants for studies of the relation of soils to plant growth, whether the physical properties of the soil or the chemical nature of the soil solution is under consideration, this peculiar and undoubtedly abnormal growth of the roots has always constituted a serious difficulty, for it is obviously unsafe to assume that the behavior of such potted plants is the same as would be exhibited had they been grown in the open. Indeed it has been found in the laboratories of the Bureau of Soils of the U. S. Department of Agriculture, at Washington, that if two soil samples, one of an agriculturally poor soil and the other of a good one, are placed in 3 or 4 inch pots and wheat is grown there

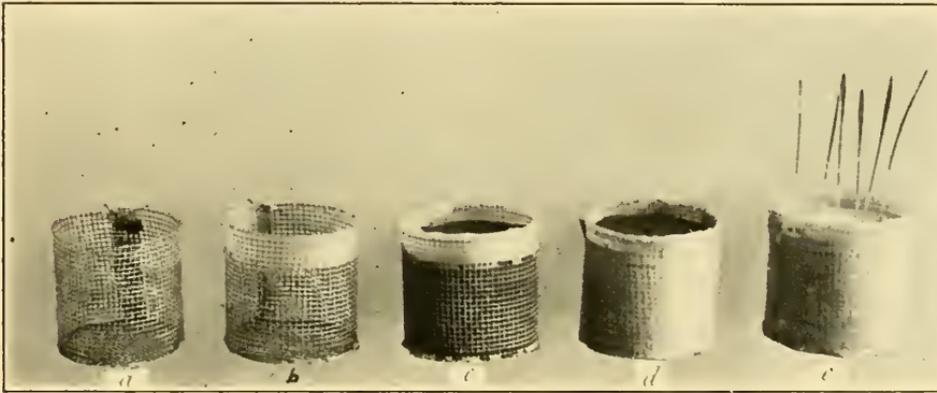


FIG. 10.

in, the plants in the two pots fail to show the relative productivity of the soils and are apt to be quite similar in the two cultures. This is probably on account of the abnormal distribution of roots described above. Roots of plants grown in common pots are not entirely controlled by the soil conditions but are in an environment quite foreign to soil in the open; many of these organs have one side closely applied to the wall of the pot, which is very different from the soil, and a large portion of them are living, if not practically in moist air instead of soil, at least in soil to which an abnormally great access of air is allowed. Thus the growth of plants in these conditions should not be expected to exhibit any marked relation to the nature of the soil which fills the pot.

A new form of pot which completely avoids the difficulties men-

tioned above and which has other distinct advantages over ordinary clay pot for certain forms of experiment, has recently been devised by the Bureau of Soils of the U. S. Department of Agriculture and bids fair to become widely used for determining by the culture method the manurial and other requirements of soils. This pot should prove of great value to anyone wishing to perform physiological experiments on the effect of soil conditions upon the growth of potted plants, for classroom or other purposes, and for this reason the present paper has been prepared.

The pot under discussion consists essentially of an artificial hard-pan of the soil to be studied, in which the cement which binds the grains together is ordinary hard paraffin. It is prepared as follows: A pot or basket (Fig. 10, *a*) three inches in diameter and three inches high, made from galvanized iron wire netting of one-eighth inch mesh, is inverted and repeatedly dipped to a depth of about one inch in melted paraffin, until a firm paraffin ring or zone is formed around the top margin (Fig. 10, *b*). The soil to be studied is then placed in the pot, having been first thoroughly moistened and made up to the desired moisture content, and is pressed firmly against the bottom and sides (Fig. 10, *c*). The pot is filled with soil within about one-half inch of the top. The soil which has been pressed through the walls and bottom is then brushed off and the pot seized by the paraffined zone at the top and plunged into a bath of melted paraffin, being held there until the paraffin has had time to penetrate about one-eighth inch into the interstices of the soil. The length of time needed for this operation varies, of course, with the nature of the soil, a sandy soil requiring a shorter exposure to the hot paraffin than a clay soil, since the interstices are larger in the former. It is then removed and allowed to cool, after which it is again dipped momentarily, this time in cold paraffin (Fig. 10, *d*). The purpose of the second dipping is to form a firm layer of paraffin over the external surface of the walls and bottom, to facilitate handling and lessen the danger of breaking the hard-pan formed by the previous treatment. When the pot presents a uniform, smooth surface which covers the wire netting on the outside, and it can be handled in the same manner

as are clay pots of the ordinary form. Seeds are then planted in the soil and treated in the usual way (Fig. 10, *c*).

It will be observed that the surface of the wire is completely covered with paraffine so that danger of contamination of the soil from the metal of the wire is entirely eliminated. It will also be observed that the surface of contact between the internal soil and the walls of the pot—which really are formed of the same soil cemented into a solid mass by paraffin, the wire netting serving now only as a support to the otherwise fragile walls—is much less definite than in ordinary pots; for the soil mass continues into the

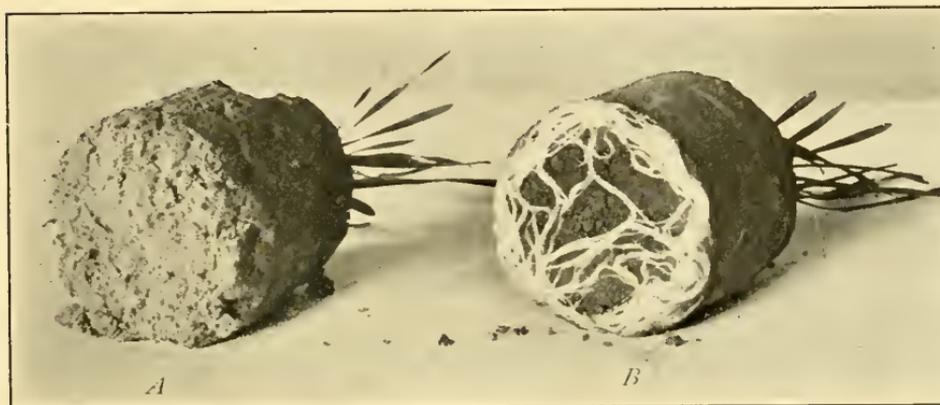


FIG. 11.

walls themselves, the only difference between walls and contents lying in the fact that the spaces which are filled with air in the latter are filled with solid paraffin in the former. It is this fact upon which the peculiar value of this pot depends, for it avoids the objectionable region of better aeration which occurs in the vicinity of the walls of other pots. It also avoids the continuous evaporation from the external surface and its possible disturbing effects.

Where it is desirable to have aeration at the bottom of the pot one or more openings may be made in the wire netting before the soil is placed in position and the paraffin hard-pan and external paraffin layer which afterwards close the openings can be cut away with a knife or other instrument. Wheat seedlings will grow well for six weeks or longer without this aëration. For determini

ing, by weighing, the amount of transpiration from plants in the pots it is only necessary to seal the upper surface with a piece of paraffined paper cemented by means of paraffin to the pot wall, having this fit closely against the stems of the plants. In the case of loamy or clayey soils if water is to be added to the soil from time to time to keep its moisture content uniform, it is well to cover the soil surface with a thin layer of clean sand, which prevents puddling and facilitates the equal distribution of the water added.

Seedlings grown in these paraffined wire pots exhibit a perfectly normal distribution of roots throughout the soil mass. The paraffin is harmless and exerts no injurious influence upon the plants. Fig. 11 shows the soil masses of two cultures of six wheat plants each, *a* having been grown in a pot of the paraffined form, and *b* in a glass beaker of the same size. The points brought out in the discussion are very evident, the soil mass from the paraffined pot showing practically no roots on its surface, while that from the beaker has its lower surface nearly covered. The first soil mass was found to be completely filled with well-branched roots, the second contained very few except near its lower surface. With plants having small roots it is very rarely that these organs penetrate the wall of the paraffined pot. Plants with larger roots often penetrate, however, and thus such plants are not well adapted to this method. Wheat and the smaller grasses succeed admirably, while Indian corn often forces its roots through the bottom of the pot.

The culture method above described appears to offer the best means yet devised for determining or demonstrating the influence of soil conditions upon the growth of seedlings. It may be used for studying the effect of different moisture contents of the soil, for determining the relative productiveness of different soil samples, for studying the effects produced by the presence of various substances in the soil, and for many other lines of experimentation.

In the palm house of the conservatories of the New York Botanical Garden there has recently been placed a palm bearing unusually handsome, fan-shaped leaves. At the base of the plant can be seen what looks to be part of two cocoanuts grown together. It is the huge seed from which was raised, in the propagating houses of the Garden, this specimen of the Coco de Mer, or double cocoanut (*Lodoicea maldivica*).

The home of this rare palm is in the Indian Ocean, several hundred miles east of Zanzibar, and about  $4^{\circ}$  south of the equator on a group of islands known as the Seychelles. Here, in 1742, this palm was discovered by the French who then occupied the islands. The fruits had been known for many years before, for they had often been found floating in the sea around the neighboring Maldivé islands, whence they had been carried by the ocean currents. But the tree itself had been a mystery, and there were many tales afloat regarding it. The Malay and Chinese sailors insisted that it grew on a tree deep down in the water off the coast of Sumatra, but that the tree instantly disappeared when they dived down to see it. The negro priests declared that it grew near the island of Java, its branches protruding above the water, in which a monstrous bird had its home, and from which it made nightly visits to the land, killing tigers, elephants and other large animals. It was further asserted that ships were attracted by the waves which surrounded the tree, and that sailors fell an easy prey to this ravenous bird.

The fruits were coveted by the princes of Hindoostan as an antidote against possible poisoning, and they paid large prices for these mysterious safeguards to their lives. The king of the Maldives turned this superstition to his own advantage, keeping the fruits as his private property and disposing of them at high prices. But upon the discovery of the tree which bore the fruits there was no longer anything mysterious about them, and their value quickly diminished.

\* These facts have been taken from an article, "The Coco de Mer, or Double Cocoanut," by Mr. George V. Nash, in the *Journal of the New York Botanical Garden*, January, 1906.

The native of the Seychelles put this palm to many economic uses. The heart of the crown of leaves is eaten as a vegetable.



FIG. 12. *Lodoicica maldivica* (Gmel.) Pers., the *coco de mer* or *cocoanut*.

the leaves are used in house-building, both for thatching and making walls and partitions; they also furnish material for h

the down of the young leaves is used in filling mattresses and pillows; and the nuts are fashioned into various utensils.

In the Ravine of the Coco de Mer, on one of the islands of the Seychelles, the trunks of these beautiful palms rise to a height of ninety or a hundred feet, and bear aloft a handsome crown of leaves often twenty feet long and ten or twelve feet wide.

M. M. B.

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## OF INTEREST TO TEACHERS.

EDITED BY DR. C. STUART GAGER.

FORESTRY IN THE PUBLIC SCHOOLS. In the September (1905) number of *Forestry and Irrigation* A. Neilson gives some suggestions on how to interest children in the practical side of forestry growth. He advocates that each country school have a small nursery, of about one quarter acre or even less, to be planted with trees and taken care of by the pupils. From two to four hours a week are suggested as being sufficient for the forestry work, which should include the setting out of seedlings, about six inches high, the planting of tree seeds and the care of the nursery. Pupils should collect the seeds and seedlings from the woods. Correlated with this field work there should be "little lectures on tree matters" given to the children in the woods.

"A large number of trees can be grown on a nursery of one-fourth of an acre, and giving three years as the age of removal from the nursery, the plantings should be more than a third of an acre."

EDITOR'S NOTE.—The study of trees is surely becoming more and more a factor in modern botany teaching. The Department of Agriculture is leaving no stone unturned to interest the public in the physiographic and economic importance of trees in general, and the above abstract would seem to be an indication that this work is bearing fruit. Nearly every locality, also, contains trees of individual interest, which are quite unknown to people of other localities, and we are glad to have been able to publish articles such as that on the Hop-Hornbeam, by Miss Mary Van Hook, in the January issue of the PLANT WORLD; and Miss Taylor's account of the Georgia Bark or Quinine Tree, in the February issue. We are indebted to Mr. George V. Nash for the facts contained in the account of a tree of the tropics, the Coco de Mer, a specimen of which is to be seen at the New York Botanical Garden. Next month, Mr. J. C. Blum will tell of an interesting tree of the southwest, the Alligator Juniper. We shall be glad to receive other descriptions of trees in different parts of the world.

the nursery area each year. When the trees, at the end of the years, must be taken up, they can be given to the parents of children or can be sold. If sold the money would go to school to establish a library or for other useful purposes."

It is also suggested that a long time on one day given to work would be better than a short period on several different days.

RELATION OF AMIDES TO PLANT GROWTH.—According to *Nature* Jules Lefèvre gave an account before the Paris Academy of Sciences on November 20, 1905, of experiments showing that when green plants are grown in a soil containing amides, their growth is accompanied by a rapid increase in dry weight, although they are deprived of carbon-dioxide.

C. S. C.

## REVIEWS.

*The Book of the Rothamsted Experiments.* By A. D. H. Pp. xl + 294. London: John Murray. 1905.

The manor of Rothamsted is situated in the parish of Hemel Hempstead, Herts, England. In 1837 John Bennet Lowes, lord of the manor, began experiments in pots with agricultural plants and various manures. In 1843 Dr. J. H. Gilbert became associated with him in this work. The duration and extent of their labors is indicated by the following inscription on a granite monument erected in 1893 in front of the Rothamsted laboratory: "To commemorate the completion of fifty years of continuous experiments (the first of their kind) in agriculture, conducted at Rothamsted by Sir John Bennet Lowes and Joseph Henry Gilbert, A. D. MDCCCXCIII."

As the inscription states, such experiments on such a scale in scientific agriculture had never before been conducted. It was Sir John Lowes who introduced the manufacture of artificial manures, and this alone ranks him as one of the greatest benefactors of agriculture.

The present volume gives a summary in seventeen chapters of part of the experiments carried out during the fifty years of co-operation of Mr. Lowes and Dr. Gilbert. The book is of more

historic interest to the worker in pure science and of practical value to the agriculturist.

C. S. G.

*The Heather in Lore, Lyric and Lay*, by ALEXANDER WALLACE,\* is a small volume full of human interest, if somewhat less devoted to the scientific aspect of the plant. We little realize until we give special attention to such matters how much a pretty little plant as the heather may be interwoven with the life of the people of the countries where it grows. Those who are inclined to the study of the human aspect of botany will find this book well worth reading. It has numerous illustrations, one in colors

*The Wild Flowers of California, Their Names, Haunts and Habits*,† by MARY ELIZABETH PARSONS, illustrated by Margaret Warriner Buck. A popular treatise, dealing with the commoner plants. These are classified according to the color of the flower. Each plant is described under its common, followed by its technical name. The text consists of semi-technical descriptions and general notes. The full-page illustrations are in black and white.

Philadelphia has from the time of Bartram been an important center of botanical study, and there are many students of its local flora. These will be glad to have for their use the "Hand-book of the Flora of Philadelphia and Vicinity,"‡ with keys for the identification of species, compiled by Ida A. Keller and Stewardson Brown. The "local flora" of this type is becoming more and more favored, and will do much toward stimulating an intelligent study of plants—even more in the long run, we dare say than "nature" volumes with an apparently more obvious applicability to popular needs.

*Agriculture Through the Laboratory and School Gardens.*

Manual and Text-book of Elementary Agriculture for Schools.  
By C. R. JACKSON and MRS. L. S. DAUGHERTY. New York  
Orange, Judd Co. 1905.

The above seems to be a good, practical book for normal or high school classes. The teacher of botany will not find it a substitute

\* New York, A. T. de la Mare Printing and Publishing Company, Ltd. 1903.

† Payot, Uphane and Co., San Francisco, 1904.

‡ Philadelphia Botanical Club, Philadelphia, 1905. 360 pp.

stitute for the usual text-book, as there it includes very little on the inner structure of plants and plant types. Osmosis is insufficiently treated (p. 60), sexual and asexual reproduction not *clearly* distinguished (p. 271) and a scientist would state differently the beginning sentence on variation (p. 245).

The paper and print are good, the illustrations clear and references and tables helpful. Soils, insects and other related subjects are clearly and fully treated. The city boy would profit by such a course, but the book seems a direct answer to the needs of our rural schools.

J. E.

## NEWS ITEMS.

THE DIOSCURIDES CODEX.—The Library of the New York Botanical Garden has recently acquired the two volumes of "The Dioscurides Codex Aniciae Julianae picturis illustratus, nunc Vindobonensis Med. gr. I Phototypice editus." The original manuscript, now in the Imperial Library at Vienna, was photographed and the present edition is a phototypic reproduction of the photographs.

This work dates from the year 512 A. D., and is the basis of most of the early herbals. The work is important, not only from the standpoint of botany, but also in the history of the science, for the illustrations are from original specimens of the fifth century. The work was written for the Princess Anicia Juliana, of Byzantium, whose portrait appears in the book.

The two folio volumes are bound in heavy oak, and the plates are said to reproduce the originals with great faithfulness. In addition to the illustrations of plants, there are miniatures of groups of physicians and botanists, and of artists producing pictures of plants.

Two copies of a reproduction were made previous to the present, one of which was used by Linnaeus, and is now in the Library of the Linnaean Society of London. The other copy, now at Oxford, was used by Sibthorpe in preparing his "Flora Graeca."

At the twelfth annual meeting of the Botanical Society of America, held at New Orleans in affiliation with the American Association for the Advancement of Science, January 1-4, 1906, the following papers were presented:

- J. C. Arthur: "Cultures of Uredineae in 1905."
- G. F. Atkinson: "The Development of *Ithyphallus impudicus* (L.) Fries, from France."
- F. E. Lloyd: "Some Physiological Aspects of Stomata."
- B. E. Livingston: "Relative Transpiration."
- G. H. Shull: "Comparative Variation and Correlation in Three Mutants and their Parent."
- G. H. Shull: "Some Latent Characters of the White Bean."
- D. T. MacDougal: "Origin and Heredity of Bud Sports." "The Induc-

tion of Mutation by Artificial Stimulation." "New Mutants of the Evening Primrose."

W. A. Cannon: "Topography of the Chlorophyll-apparatus of Desert Plants."

D. S. Johnson: "A New Type of Embryo-sac in *Peperomia*."

E. C. Jeffrey and Arthur Hollick: "Affinities of the Cretaceous Remains referred to the Genera *Dammara* and *Brachyphyllum*."

B. J. Howard: "The Tannin Cells of Persimmon." (By invitation)

V. M. Spalding: "Some Problems in Desert Botany." (By invitation)

THE PRODUCTION OF OIL OF WINTERGREEN.—While oil of wintergreen was formerly made by distilling an ethereal oil from the leaves of the wintergreen (*Gaultheria procumbens*, Linn.) the cost of gathering this plant became prohibitive. Now "oil of wintergreen" is made by distilling the ethereal oil found in the bark of the sweet birch (*Betula leuta*, Linn.). "The whole chemists refine it and sell it as 'essential oil of wintergreen.' This is the natural oil. 'Artificial oil' is made by a purely synthetic process in the laboratories. Chemically it is exactly the same and being produced at less expense sells at a much lower price." —*Forestry and Irrigation*.

# The Plant World

A Magazine of Popular Botany

APRIL, 1906

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## THE BLOOMING OF AN UNUSUAL ORCHID.

BY R. G. LEAVITT, PH.D.,

*The Ames Botanical Laboratory, North Easton, Mass.*

There has recently bloomed in the greenhouse at North Easton an orchid with a remarkable flower. The plant belongs to the South American genus *Masdevallia*, a group of small orchids, of which there are numerous species. The flowers are curious and often oddly beautiful. The species illustrated in our drawing—*Masdevallia muscosa*, the "mossy" or "mosslike" *Masdevallia*—is found in Ecuador and Colombia, growing most frequently on trunks and thick branches of trees in damp mountain forests (altitude 6,000 to 8,000 ft.), though sometimes on volcanic rocks and walls of lava in the open sunshine. Frequent rains and heavy nocturnal dews offer to its spongy roots copious drafts of water, which are absorbed and stored in its thickened leaves. The golden flowers are lifted singly on pale-green hairy stalks above the tufted foliage. The floral structure may be easily understood from the accompanying drawings. The three outer floral leaves, recurved and produced into long tails, are united below into a shallow, somewhat triangular, chalice. From the center of the flower, but deflected toward one side of the cup, arises the column,—the distinctive character of an orchidaceous flower,—an organ fashioned from the fusion of the stamens with the tips of the carpels. The anther lies upon the end of the column, with its waxy pollen in two compact masses. The receptive spot, or stigma, is on the under side of the column, not far back of the

anther. The two matched petals, long, narrow and curved, beside the column, their extremities projecting and forming an arch, in such a way as to leave a three-sided opening between the petals and anther; while the third petal stands away from the column, the narrow stalk adherent to the calyx, the roughly triangular blade free and pendant from a point within the margin. The unmatched petal, the lip or labellum, of orchid flowers is usually larger and more highly modified in form and brilliant in hue than the petals, and is usually so placed as to serve as a landing stage for visiting insects, often with bosses and ridges to give secure footing, often also with some sac or spur at the base to contain nectar. The lip of *Masdevallia muscosa* adds still another peculiarity; for besides being expanded and hollowed and being furnished with cushions of deep maroon hairs, its blade is irritable and full of lively motion.

When a flower first opens, the tails of the sepals curve inward and the labellum is seen with its bearded tip folded just beneath the arch of the petals. Presently, however, the blade descends, turning by a flexible neck, or hinge, until it stands in the position represented in the right-hand flower of our plate. If the surface is now very gently touched, almost instantly the lip springs up, rising slowly for a moment and then shutting with a snap. The blade fits the walls of the calyx and the curve of the petals, so that a space is enclosed, open nowhere except at one point, where the arched petals extend beyond the column. The highest flower (Fig. 13) shows this aperture as a dark spot. In newly opened flowers in warm moist air the whole operation may take as little as two seconds. After a few minutes—usually fifteen to twenty—the lip again falls, but very gradually, and immediately is ready for a repetition of the performance. A flower on our greenhouse plant responded many times a day without loss of sensibility. In fact after repeated stimulation the lip opened out somewhat sooner than before.

The whole surface of the labellum is not sensitive. Touching anywhere except upon a median ridge, or cushion (*cr.* Fig. 14, *A*), produce no effect. But the lightest brushing of this ridge with a hair suffices to set off the mechanism of movement. H



FIG. 13. *Masdevallia muscosa*.

if an insect lays foot upon the crest, he is quickly raised almost at once thrown forward into the calyx-cup. With labellum shut he finds himself in a shallow box with translucent golden walls, veined with red. When he regains his feet turns about he sees light through a small opening. Climbing he squeezes out past the end of the column (at *c*, Fig. 14). he brushes against the sticky knobs of the pollen-masses, and one or both of them away with him. If he visits a second flower and is entrapped he may leave the pollen of the first flower on the adhesive stigmatic surface of the second, past which surface he must crawl when again escaping. The case is in effect like that of our moccasin flower, or lady's slipper.

The motility of this labellum reminds one also of the snapping powers of barberry stamens, which spring together so suddenly upon having their filaments touched.

It is interesting to find that other stimuli besides contact are capable of springing the lip. I found that moving the lip backward and forward upon the hinge, without touching the sensitive ridge, produces the effect. When the plant was carried out of cold into a temperature of 46° F. the lip immediately closed. When drops of water fell on the lip it closed, probably from sudden change of temperature. A red-hot needle was held near the cushion with the same result. Discharge of electric sparks operated in the same way, but it is not certain—though probable enough—that the effect was a purely electrical one. About an hour after night-fall the lip folded up of its own accord; by daylight next morning (5:30 a. m., December 23) it was open again. This action is periodic and diurnal. Darkening the plant in daytime had no effect.

A side sectional view shows that the movement results from flexure of the neck (Fig. 14, *h*). In fact, as there are no tendons and no transmission of power, the motors must be located in the lip. But the stimulus is received by the crest, which is at a little distance from the hinge. When the surface cells of the crest are pressed by an insect's foot, changes, the nature of which is not known, take place in their contents, which cause changes in underlying cells, and these affect in turn the next cells, an impulse

travelling from cell to cell until the motor tissues of the hinge are reached.

There is no development at the hinge of a distinct cushion or pulvinus such as we find at the base of the leaf in the Sensitive Plant, for the lip is of a very light body and easily moved about. The mechanism of the hinge depends for its operation on the swelling powers of its thin-walled tissues and their capacity for sudden release of watery contents with consequent contraction of the elastic membranes. To make the mechanism clear we may fix our attention upon a single cell (Fig. 14, B). Suppose the cell

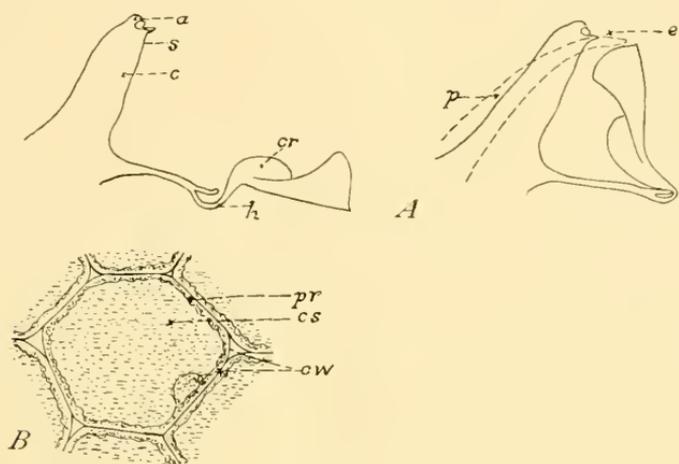


FIG. 14. *Masdevallia muscosa*: A. Side sectional view of lip and column in open and closed positions. *a*, anther; *s*, stigma; *c*, column; *h*, hinge; *cr*, crest of lip; *p*, petal; *e*, point of insects' exit.—After OLIVER.

B. Diagrammatic section of cell in the motor region. *pr*, protoplasmic layer; *cs*, cell sap; *cw*, cell wall.

lying near the upper surface of the hinge to be flaccid, like the other cells in the same vicinity. The lip is now in its raised position, the hinge bent. The selected cell is not filled with water to its full capacity. Its walls are under little or no tension. When the time comes for the lip to be moved downward, the cell begins to absorb water. This happens when the cell begins to produce in the protoplasm soluble substances diffusing into the cell-sap which are unable to escape through the finer-textured protoplasmic layer next the wall. These confined solubles exert an expansive force such as gases exert in a balloon. Consequently the whole

cell is expanded—the walls being somewhat elastically extensible—and water, supplied to the general tissue-mass by the of the lip, enters. The entrance of water is the result of expansive tendency, not its cause. As this cell swells, others so too. The whole upper region of the hinge therefore expands and the hinge gradually straightens, lowering the lip. When cell and its mates have reached the full measure of this expansibility and become fully turgid the hinge is at its straightest—the lip is in position for the reception of visitors. Now a fly foot on the irritable cushion. The irritation travels with rapidity to the neck cells. Coming to our selected cell the is to release the cell sap, so that some of it flows out into the cellular spaces or into the ducts of the veins. It seems that release must be effected through a sudden change in the confining of protoplasm. We may imagine this to relax so that the inv meshes of its finer structure increase in size and allow the molecules of the solubles—hitherto causing distention of the walls—pass through with ease. Solubles and water—the sap—pass together, and the cell contracts by its own elasticity. Others act simultaneously, and the tissue on this surface of the lip shrinks, while that on the opposite side remains turgid. The hinge bends and the lip is raised. The great irritability of cells, including those of the crest and the hinge, is seen when recall the different kinds of stimuli which affect them: to heat, cold, mechanical motion of the parts, and diurnal change illumination. When the lip is down, the protoplasm of the irritable parts seems to be in a state of very delicate equilibrium which may be upset by trifling changes in the physical conditions.

\* For Fig. 13, which so well represents the plant, I am indebted to the delineator, Mrs. Oakes Ames.

# OUR MOCCASIN FLOWERS AND OTHER ORCHIDS AT HOME.

BY GRACE GREYLOCK NILES.

The rarest of all rare blossoms are the Orchids—a family consisting of flowers with strange fantastic forms, and secret and inaccessible homes. Very few species choose dry rocky soil, although these delicate plants readily adapt themselves to their environments throughout a broad and variable continental range.

In May and June a brief glance through the bogs of Berkshire and Bennington and northward will reveal some of the most luxuriant groups of our moccasin-flowers and other orchids to be found in the world. Along the slopes of the Hoosac Highlands are several slowly drained swamps where many moccasin-flowers and tall spikes of *habenaria* flourish. In the Swamp of Oracles, northward in Bennington County, grows the greatest profusion of orchids which the writer has observed in this region, there being represented five species of the moccasin-flowers of genus *Cypripedium*,—an unusual report so far southward in New England.

The orchid family in these states consists of fifteen genera and no less than sixty species. The *Cypripediums*, commonly known as lady's slipper, moccasin-flowers and whip-poor-will shoes, are among the most showy of the orchids. There are only thirteen native *Cypripediums* on the continent, and the finding of five of this number in one small swamp area in the Hoosac Valley region emphasizes the adaptation of the soil to the growth of Orchidaceae.

Our moccasin-flowers, as the name implies, are shoe-shaped, or pouch-like; the grace of the whole plant and the dainty poise of the undulating sepals and petals, give a certain charm to these alert blossoms, nodding in the dense glooms of the boglands, or bordering the rocky edges of the marsh, amid rich piles of decaying logs and brush, where the whip-poor-will rears her young and feeds upon the insects attracted to these orchids. It is not at all strange that they have been deemed the foot-gear of these melancholy birds who haunt the deepest shades of the woodlands.

Beneath the primeval pines bordering the swamp, the ram's head moccasin-flowers (*Cypripedium arietinum*) bloom from the middle until about the twenty-fifth of May. These purple flowers are the smallest of the eastern species of *Cypripedium* and, pouch-shaped, in certain positions suggest a ram's head. The apex of the labellum serves as the nose, and the twisting sepals and petals correspond to the horns of the ram.

The pink moccasin-flower (*Cypripedium acaule*) follows the same date along the damp rocky hillsides near the whip-will's nest. This is the best known of our *Cypripediums*, and is conspicuous for its two basal leaves—it being the only two-leafed moccasin-flower found in eastern North America. It creeps over the mountain plains where the huckleberry loves to grow and adapts itself, also, to the water-soaked hummocks of the swamp lands.

Closely following are its sisters—the two yellow moccasin-flowers—*Cypripedium hirsutum* and *Cypripedium parviflorum*, which bloom so closely associated as to intergrade and conceal their individuality. The homes of these two species are in the open woodlands or in the secret solitudes of the swamp and, despite their being such showy and glaring flowers, they are seldom discovered except by the most alert observer.

Frequently the small moccasin-flower hides among dense thickets of fern and brake giving forth the most exquisite perfume of any of our New England flowers. It is the only truly fragrant *Cypripedium* in eastern America, the others having a heavy, pungent odor. The large yellow species often follows the other moccasin-flowers summitward and delights to bloom along the ridges beneath the shades of birch, chestnut and beech; yet its more common haunt is in the heart of the conifer boglands or the higher hummocks of moss, surrounded with cowslips, spider-beauties, violets and ferns.

About this date, if we closely examine the marshlands, we shall observe the dewy-tipped spikes of the showy moccasin-flower (*Cypripedium reginae*) pushing above the rich leaf-moss and sphagnum. This *Cypripedium* is a full month behind the other, blooming about June 20, and is one of the most regal species

which the world can boast. Queen indeed of the Indian moccasin flowers, it flaunts its alert white petals and dainty wine-tipped slippers in the most choice glooms, at the feet of the tamarac and spruce, or sheltered among tall ferns, brakes and Indian-poke.

The plicate leaves of the *Cypripediums* resemble the foliage of

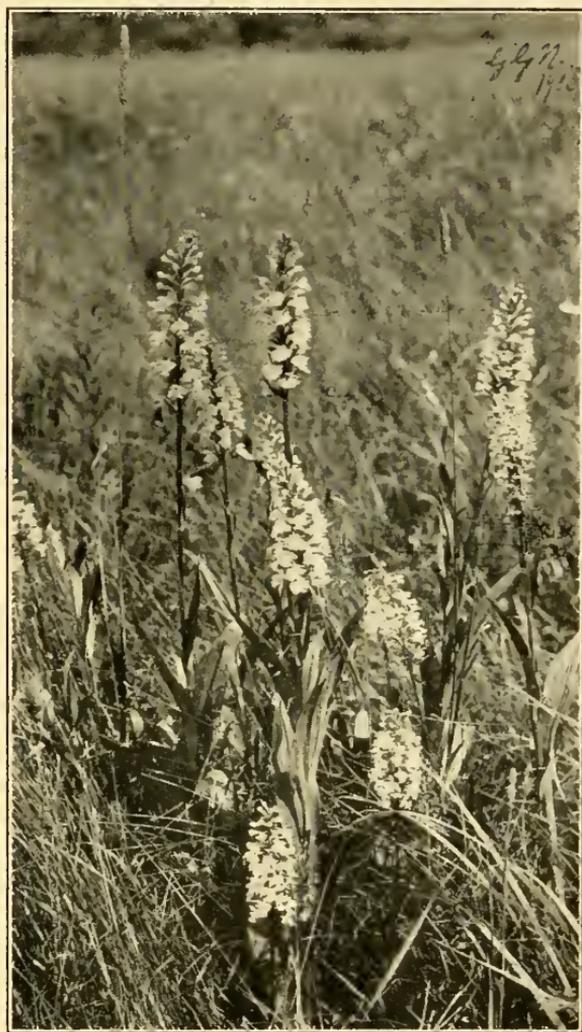


FIG. 15. The Small Purple-fringed Orchis (*Habenaria psychodes*). Closely allied to *Habenaria grandiflora* of New England, and to the English Long Purples (*Orchis morio*) of ancient literature. They are mentioned by Shakespeare in *Hamlet*.

“There with fantastic garlands she did come  
Of crock-flowers, nettles, daisies, and long purples.”

“*Hamlet*,” Act IV., Sc. 7.

Indian-poke or hellebore and they were early confused with plant by the ancients and designated, "false hellebore with a round flower" (*Helleborine Calceolus*).

Later this group of shoe-shaped flowers was known to René Dodoens—a physician to the German Emperor in 1550 or thereabouts—who dedicated these flowers to Marianus—"our lady the Virgin Mary," and they were commonly known as "our lady's slipper" (*Calceolus Marianus*). The generic name, *Calceolus*, signifies "round like a little shoe." Our lady's slipper is the old European name for these flowers, while moccasin-flower is purely American, originating from *Mawcahsun* or *Makkasin-flowers*, the Algonquian Indians having observed the same resemblance to the shoe as did the Europeans.

In 1740-1753 the great Linnaeus revised this genus and dedicated it to Venus, "Our Lady the Divine Mother of the Romans, whose ancient name was *Cypris*, and thus we obtain *Cypripedium*—Venus' slippers or our lady's slippers, as formerly.

One of the early orchids of the bare and leafless woods is the showy orchis (*Orchis spectabilis*), dwelling along the borders of streams, about May 15, until June 20. It is closely related to the early spring orchis of England which Darwin has so much to study.

Soon, now, follow a host of *Habenarias*, each in its turn making the glooms or meadowland gay with strange spikes of greenish-white, yellow and purple-fringed and winged flowers. Space does not permit me adequately to describe them all; a few of the most beautiful types of the group will be enumerated.

The round-leaved orchis (*Habenaria Hookeriana*) is among the first to bloom, coming just as the pink moccasin-flowers and the showy orchis have faded, and choosing much the same haunts, save that they stand out as sentinels along the higher ridges. These plants produce round cool-looking leaves, lying flat or nearly so upon the ground, between which rises a spike of greenish-yellow flowers, ornamented with fantastic spurs, capes and hoods all twisted and tied to the scape. They very much resemble winged insects, and were likened to a strap by the ancient Greeks, the flowers being placed in a "Certain order like to a kind of

band, or the rolling of a gable rope." The *Habenarias* are for this reason known as the rein orchises. Several tall green spikes of this group now appear along the brooksides in the swamplands.

About the open places bordering springs we discover the tall white northern orchis (*Habenaria dilatata*), rarely appreciated save by the flies and moths which are attracted by its rich perfume. A little later in meadows, gracing lakeside solitudes and sluggish streams bloom the gorgeous purple-fringed orchises (*Habenaria psycodes*) and (*Habenaria grandiflora*). One may live a lifetime in the hills and never behold these beautiful fringed blossoms of the meadows. They are similar to the long purples and dead men's fingers which grow along the damp borders of the corn-fields in England (Fig. 15).

Various species of the orchid family dwell in the open meadows such as *Arcthusa*, the beautiful nymph of the fountain; and thousands of *Pegonia* and *Limodorum* dance and wave among the sedges. Approaching the land margins the tamaracks grow larger, and on the higher mounds of moss beneath the pines innumerable plants of the pink moccasin-flowers flourish, interlaced with the evergreen vines of the wolf's claw (*Lycopodium*). Stray plants of Loesel's twayblade (*Leptorchis Loeselii*), the tall white northern orchis, and the small bog-orchis here live in peace and unity.

Closing in about the land margin are the larger tamaracks, pines and spruces, which press upon the shrubs of the interior; beneath these the pitcher plant and the showy queen of the moccasin-flowers are still thriving. Beyond this zone, hemlocks, maples, birch, elm and chestnut are encroaching on the conifers; while far beyond all, over the hills encircling this grave of an ancient lake, the cultivated corn-fields and pasturage of the herds are crowding upon the whole area and in time will fill the unfathomable pool in the heart of the hills. In the slowly drained swamp *Arcthusa* is not to be found, nor is sphagnum so frequent, but many species of fern and shrubs dwell here peculiar to this area.

The last orchids of the autumn are the fragrant ladies' tresses which come with the blue-fringed gentians and stars-of-Parnassus making the marshland of September a gorgeous wave of nodding colors.

## TWO JUNIPERS OF THE SOUTHWEST.

BY J. C. BLUMER.

The following notes are from the Cameron Creek basin, lying on the southern slope of the Pinos Altos Mountains of New Mexico. This region lies only forty miles north of the Gadsden Purchase and seventy-five miles from the Mexican boundary. The rugged and bathed peaks of the Mexican plateau are daily seen to rise like hazy pyramids out of the desert of Egypt. The tract, last year added to the Gila River Forest Reserve, is tributary to the Gila military hospital at Fort Bayard, and has an altitude of 6,000 to 7,500 feet. Here the writer spent the latter half of 1905, in the interest of the U. S. Forest Service.

This far southwestern world offers many interesting things to the student of plants. Among these are two junipers, which constitute a large part of the typically evergreen woods, very dense and orchard-like. The other species comprise four oaks, two pines, mountain mahogany and garrya, a relative of the dogwood. Several other woody species are limited mainly to water-courses.

The one-seed juniper (*Juniperus monosperma*) is a tree, often above apple tree size, though it sometimes reaches a diameter of thirty inches and a height of not over twenty-five feet. The whitish bark, becoming one inch thick, peels off in long shagreened scales. The berries of the pistillate tree, ripening early in autumn, are dark blue, sweet and juicy, of oval shape and about half the size of the berry of *Juniperus scopulorum*. They contain a spongy, bony, ovate-conical seed about the size of a grape seed. The fruit this season was so scarce that not over five bearing trees were found. Birds are probably the chief agents of distribution. While gathering the seed, certain sparrow-like members of the feathered tribe once or twice hovered within arm's length of the picker, in an effort to save their proper share. Its densely clustered leaves of rusty green closely protect the very short branches from the thirsty semi-desert air. Usually half the grotesque appearance of the older trees has been stripped by time and environment, both leaves and bark. But it clings to life with great tenacity. It is the patriarch of the foothills.

Not so its associate, the alligator juniper, known to botanists as *Juniperus pachyphloea* (see Fig. 16). Though often attaining twice the usual diameter of the one-seed juniper, or over four

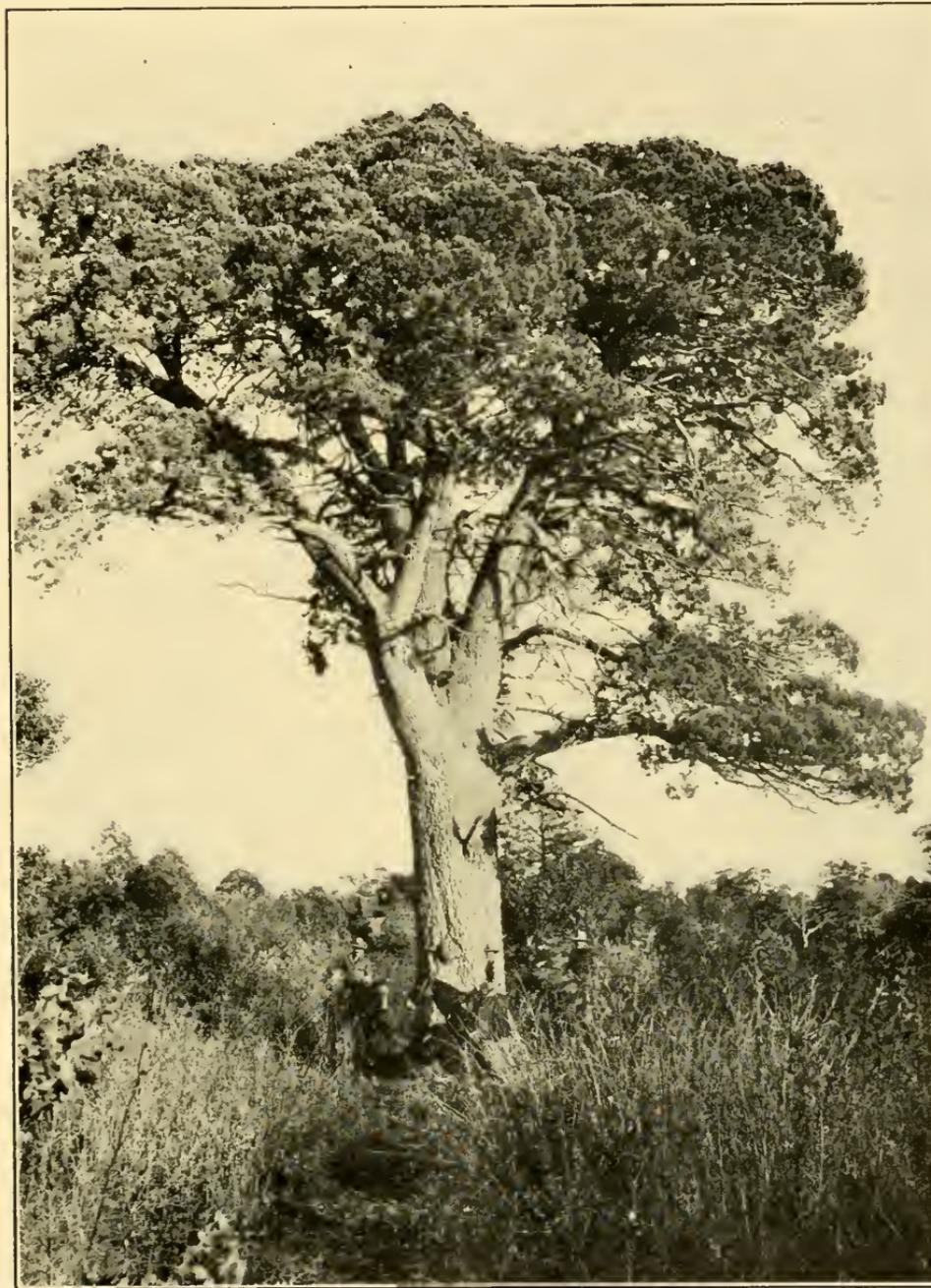


FIG. 16. Alligator Juniper (*Juniperus pachyphloea* Torr.).

feet, a height of about thirty feet and greater age, it presents a full, thickly clad and often beautifully rounded crown, but at the lower altitudes.

As one approaches the mountains from the plains 6,000 feet below, he finds the first tree, cropping up here and there, to be the one-seed juniper. This increases in size, but gradually loses its hold as the dominant species and at about 6,500 feet it disappears. The alligator juniper first appears approximately at a line of best development of the one-seed, and becomes dominant where the latter ceases. On the succeeding steep slopes it is interrupted by horizontal belts of shrubby blue oak, only to reappear as occasional lesser belts to the top of the higher slopes at 7,000 feet, and as extensive orchards on the malpais\* mesas. It occupies a large part of these tablelands at 7,000 feet, to the exclusion of every other noticeable plant except grama and agave. Here, however, our desert alligator becomes as picturesquely deformed as its brother species below. Many trees show less than half their girth covered with new wood bark. This gives rise to the eccentricity of both trunk and limb.

It will perhaps interest physiologists that on such limbs growth is always made on the lower side. The writer measured one that was five inches in horizontal diameter at the crotch, gradually widening to eight inches downward, with a vertical diameter of twenty-eight inches. The pith of the limb was probably over two inches from the crotch.

The dead parts, barring fires, persist for many years owing to the absence of the fungi of decay. The living tree undoubtedly exists to a great age as well. The age of both species is difficult to ascertain. This is due to the formation of two annual rings per year—thus more properly called "semi-annual rings"—brought on by two distinct growing seasons. The winter rains and snow give rise to the first growth early in spring, which is checked by the drouth of May and June. The rains of July and August, diminishing toward October, stimulate the cambium into renewed

\* "Malpais" is of Spanish derivation meaning "bad lands," and is applied to country covered with basaltic boulders, in these parts a very extensive formation. Humboldt, 100 years ago, spelled it "malpays."

activity, which is again quieted by the advent of winter. The process is not always regular, and determination of age is complicated by the formation of sometimes but one, sometimes three or possibly even more, annual rings per year. The age of a young growth of both species, coming up on a cut-over area, and five to twelve feet high, was thus found to be approximately twenty years. During the season of 1905, following heavy snows and rains, a remarkably fine growth was made. The mean of a considerable number of measurements was not far from fourteen inches. A certain stump of alligator juniper upon a ridge, thirty inches in diameter, was found to have been about five hundred and forty years in the making. Another of the same species and size that had grown on bottom-land, was approximately three hundred and seventy-five years old. A conservative estimate of the age of trees double this diameter—stumps of many such are found but are very hard to count—would be seven hundred to eight hundred years. It is not at all improbable that the tree shown in the picture is one thousand years old. In temperate regions at least, the alligator juniper should perhaps be given second place to the famous California sequoia. The writer should be glad to hear of any evidence to the contrary. It means that these trees struck root in the middle ages, that they reared their fragrant crowns to the ozone of the Cordilleran breeze before civilized man dreamed of America.

The junipers are dioecious, *i. e.*, staminate and pistillate flowers are on separate trees. An occasional staminate tree was found that bore a berry or two, thus proving that the tree is sometimes monoecious. Its berries are small cones covered with juicy pulp. It is thus a conifer. On the berries of the alligator juniper are seen protuberances like those on a large green caterpillar. They appear to be the covered tips of the cone-scales. The berries of the juniper take two years to mature.

The globular berries of the alligator juniper run very large, viz., from the size of an ordinary pea to five-eighths of an inch in diameter. One tree was seen that bore fruit as much as three-fourths of an inch in diameter. It contained no good seeds, however, and was clearly abnormal. The fibrous flesh is dry and

insipidly sweet, seemingly without resin, and very unlike the gent sweetness of the one-seeded species. It is eaten by bears, other mammals, as well as by birds. The berries contain one to four bony, angular seeds, usually two or three, of the size as those of its one-seeded relative. Fifty berries that were examined gave a symmetrical curve, *i. e.*:

3	berries	contained	no	seeds.
12	"	"	1	seed apiece.
20	"	"	2	seeds "
12	"	"	3	seeds "
3	"	"	4	seeds "

Unlike its congener, it bore an abundant crop of seeds this season. Several bushels would often hang upon a single tree. The berries form a light blue mass, distributed about the periphery of the crown, giving a strikingly unique as well as handsome effect. This is heightened by myriads of tiny white specks upon the foliage, peculiar to the older trees of this species. These are bits of hardened resin exuded by the single resin duct on the back of each leaf.

The season of ripening seems to be variable. A certain locality was observed, where the berries turned reddish and fell as early as September. Some fell later, but the majority seemed to drop firmly as late as the middle of December.

The bark resembles an alligator skin, and at once distinguishes it from all other junipers. One seeing it for the first time would not question its identity. This cross-wise checking of the bark is characteristic even at tender seedling age. Branches less than one inch thick usually slough off their cuticles in the form of scales, revealing a skin that is perfectly smooth and of a yellowish red. Where both species make young growth together this serves as a secondary distinguishing mark. The primary one naturally will be color, which is quite remarkably constant within the species. The one-seeded species is a pretty olive green, while the alligator namesake is an exceedingly handsome bright blue. The two growing side by side give a color variation not excelled by any other conifers, the Colorado blue spruce included. With age, the blue spruce often acquires much dark green, approaching the constantly green one-seed. In December, the staminate trees of both

species become sprinkled with yellow, due to numberless small flowers, producing pollen despite the snow and frost.

The wood of both kinds is yellowish in color, light in weight, non-resinous, and highly esteemed for fuel and posts.

The tree shown in the picture is a landmark for many miles around, because of its beauty and extraordinary size. It is a little over five feet in diameter and between sixty and seventy feet in height. The ground on which it stands recently fell into the hands of a mining company. A ranchman and ex-cowboy living near rode by the tree one day. The manager for the company had some men on the spot, preparing to cut it down.

"What are you doin'?" said the ex-cowboy.

"Why, I'm going to cut this tree down; it's no use here; it's in the way," replied the manager.

"No, you don't; not while I'm a-crawlin'," broke in the ex-cowboy, his hand instinctively going to his belt. "This tree stood a guide-post to the ranchman and the cowboy of this country before you and your mining company ever thot o' bein' born. And it'll keep on a standin', too!"

With this he rode to town, and the manager prudently desisted. The ex-cowboy spread the manager's intention. For days thereafter talk of six-shooters was rife amongst the neighbors. The manager abandoned his plan, and the noble tree lives on for the guidance and delight of cowboy children yet unborn.

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## THE PERILS OF ORCHID HUNTING.

The strange perils and risks that attend the collecting of wild orchids have been graphically described by Mr. William Fitzgerald in the Sunday magazine of the New York *Tribune* of February 25. The writer tells how, in some of the wildest and most remote regions of the world, in Mexico, Venezuela, Guatemala, Honduras, Nicaragua, Brazil, Burma, in the interior of Assam and the Himalayas generally, in Borneo, New Guinea, and on the west coast of Africa, a certain orchid dealer in London maintains a staff of collectors who often risk their lives in the hunt for the gorgeous epiphytes of the tropical forest.

The orchid hunter starts out from a certain base of supplies, man about to collect on the lower Himalayas, for instance, purchase his outfit and hire his servants in Calcutta. When jungle is reached he puts up a hut, building a broad veranda about it where he can lay out and dry his orchids. Many of these collectors have met with tragic deaths from fever, drowning, or the hostility of savages, or the attacks of wild beasts.

Some years ago a collector voyaging up the malarial Fly River in British New Guinea came upon a sacred cemetery where great masses of a rare crimson orchid known as the elephant mandendrobe were growing in and out among the dead bones of cannibal Papuans. The flowers of this orchid shade from rich crimson to almost pure white, and resemble gigantic moths fluttering on slender stems. The natives of the place, displeased at this disturbance of the remains of their ancestors, menaced the orchid hunters with their poisoned spears, but presents of brass vessels and calico soon won them over, and they finally assisted the collector in gathering the new orchid, insisting, however, that he should leave with the plants a quaint little idol as a propitiation to the disturbed spirits of the departed. The idol was afterwards sold with the plants at a London auction. One specimen of this lot which attracted particular interest grew out of the eye-socket of a human skull and was purchased, together with its gruesome holder, for six hundred dollars.

Fabulous indeed are the sums paid for rare orchids, but so great is the uncertainty that they are generally sold at auction. A plant of *Laelia anceps* was observed by the London dealer to have a ring-mark on its pseudobulb higher up than is usual. The dealer bought it for twelve dollars, and five years later sold the same plant for one thousand dollars. In a consignment of *Cypripedium insigne* was once found one orchid plant with a bright yellow flower stalk instead of the normal brown stalk. The plant was put to one side, and when it flowered the blossom was a beautiful gold. The owner cut the plant in two and sold each half at public auction for five hundred and twenty-five dollars. One of the purchasers divided his also, selling two pieces at five hundred dollars each, and the third piece the original owner bought back

thirteen hundred dollars for the purpose of hybridizing. A plant of *Masdevallia Tozarenensis* was cut up in the same way and its fragments sold for large sums, until a consignment of forty thousand plants from Caracas reduced the price to a mere song.

Mr. Fitz-gerald tells an interesting story of the orchid *Cypripedium Spicerianum*. An English lady, a Mrs. Spicer, sold to an orchid dealer for three hundred and fifty dollars a strange orchid that had appeared in her greenhouse. The dealer divided his specimen and sold the pieces at fabulous prices. Then the London dealer set about to discover the whereabouts of this priceless plant. He knew that it had arrived in a mass of *Cypripedium insignis*, therefore it must be a native of the Himalayas. Mrs. Spicer's son was a tea planter on the confines of Bhutan, and it was he who had found the orchid. The London dealer sent his man to get from the tea planter all he could about the locality in which the orchid had been discovered, and then to set out after it. The orchid hunter "swam and waded through giant rivers, often waist deep in miasmatic mud, or plowed his way through the incredibly dense tropical vegetation, and finally came upon a glade encircled by rocks steep as a wall, and here at last, with a cry of delight, he reached out his bamboo rake and dragged down masses of the gorgeous orchid he had sought so long and so heroically."

The element of gambling begins as soon as the orchid hunter finds his plants. He must bring them to his hut, dry them for four weeks, and then, when they are entirely free from moisture, fasten them to tough twigs and pack them in wooden cases with a liberal allowance of air. They are then transported by coolie, llama, raft or elephant, over land and across the ocean. If they are exposed to sunlight, or are placed too near the boilers on board steamer, they may all be ruined. "Ten thousand plants," writes Mr. Fitz-gerald, "may be collected on some remote Andean peak or Papuan jungle with infinite care, and consigned to Europe, the freight alone amounting to thousands of dollars, yet on arrival there may not be a single orchid left alive."

M. M. B.

## OF INTEREST TO TEACHERS.

EDITED BY DR. C. STUART GAGER.

“COLLAPSE OF EVOLUTION.”—The above caption is the title of an address, delivered under the auspices of the American League, in Boston, in December, 1904, by Professor L. T. Townsend, Emeritus Professor in Boston University.

Professor Townsend quotes from an unnamed Cornell professor the statement that attacks upon the *fact* of evolution “are made only by persons who are not familiar with either the evolution hypothesis or the facts of natural history,” and, “are made for the purpose of bolstering up dogmas and beliefs.” The address and discussion is one of the strongest evidences of the truth of the quotations that has appeared in recent years.

An idea of the author's comprehension of what evolution means, and especially of his acquaintance with standard literature on the subject, may be inferred by his statements that the terms *geoplasm* and *protoplasm* (*sic*) have not for five or ten years “been employed seriously by any reputable writer on these subjects” (p. 12); that evolutionists should be able to show a chain with no missing links (p. 15); that species should generally improve, and primitive forms die out (pp. 16, 17, 19); that evolution means that one species transforms “into another” (pp. 21, 29); that evolution demands the existence of “millions of intermediate forms” (p. 23); that De Vries “appears to have developed mutable species of primrose,” but that, on the contrary, nothing has been accomplished outside of “an oscillation around a primitive center” (p. 28); that De Vries is a believer in special creation (p. 52); that, “There is no evidence whatever of a tendency in nature towards the transmutation of species” (p. 28); that if evolution were true, “classification would be out of the question,” but “the scientist is not embarrassed by any such perplexing conditions” as a difficulty in classification (p. 29); and, finally, that the theory of evolution “is discredited and abandoned by the scholarship of the world.” The same writer is the author of a volume entitled, “Evolution *or* Creation.”

More lamentable than the misconception of facts is the great lack of appreciation on the part of the lecturer of the spirit and point of view of every sincere investigator in science. This is shown, for example, where the author speaks of Huxley's "discomfiture" because the real nature of bathybius was discovered of his "reluctantly" and "mournfully" giving up the bioplasma theory, and of Ritter's studies in deep sea fauna being "troublesome" to the evolutionist (p. 17).

We have given so much space to this address in the hope that the Teachers' notes are read by teachers, and especially by young teachers, who have been prevented by professional duties or otherwise, from keeping abreast of recent or current literature and who might be led into the erroneous notion that scientists are beginning to or already have abandoned the theory of evolution. The suggestion is that the teacher should not waste too much time in reading elementary text-books, nor "popular" books and magazine articles on scientific subjects, but only standard writings. Above all should the young teacher or botanist avoid too much reading of purely theoretical and abstract discussions of such questions until he is thoroughly grounded in the facts, the only true basis of any theory.

REGENERATION IN ROOTS.—The following notes are taken from a review of Nemec's Studien über die Regeneration, in *Naturwissenschaften* for December, 1906.

"It is well known that if the tip be removed from a growing root a new apex is commonly differentiated, growth in length commencing once more when the new tip has been completely formed. The objects of Dr. Nemec's investigation have been to endeavor to throw some light on the nature of the process of regeneration itself, the causes that initiate and determine its occurrence, and the meaning of the physiological events that are associated with it. The methods adopted were extremely simple. The tips of growing roots, chiefly of seedlings, were injured in various ways by making incisions into the region about the apex, and the reactions that ensued were carefully followed and compared.

“ It was found, in confirmation and extension of the less complete observations of Prantl and Simon, that the roots of ferns never truly regenerate themselves as do those of flowering plants. Possibly the difference is to be attributed to the more definite concentration of formative protoplasm in the apical cell of the former, as contrasted with its greater extension as layers in the roots of the latter. At any rate, no regeneration occurs in the roots of ferns, although some attempts at healing the actual wound may be made.

“ The case is different with the roots of phanerogams, although in them, also, the conditions of regeneration are more limited than might have been anticipated. In the first place, no union of the halves of longitudinally cut roots took place; the damaged apex was either replaced by a new one on either side of the slit, or else the regeneration was confined to one half.

“ Lateral incisions are ineffective to bring about the differentiation of a new apex unless the slit has severed at least half the circumference of the pericycle. If this be done, regeneration takes place with the concomitant appearance of statolith starch in the new organ. All the experiments made on the roots of gymnosperms emphasize the great importance of the pericycle in connection with regenerative processes, although it is not from this layer itself that the new layer is differentiated, but from the indifferent pericycle cells within it. The damage done to the pericycle appears to be as an interruption of the coördinative relations between the various parts of the embryonic region as a whole. When this coördination is interrupted the capacity resident in the embryonic protoplasm of giving rise to entire organs, asserts itself, and a new formation thus appears.”

**LABELLING PARAFFIN BLOCKS.**—The following may be noted as new, nevertheless it is an excellent way to keep a record of material embedded in paraffin blocks. On a small paper slip write the name and character of preparation, whether stained or injected, and lay this in the surface of the still liquid paraffin when its embedded material and let it solidify with the block. Or may be the slip on with a hot wire after the block has been cooled.

this way there are no troublesome wrappers and the label cannot get off.—Fred L. Holtz in *School Science and Mathematics*, February, 1906.

## NOTES ON CURRENT BOTANICAL LITERATURE.

*The Garden Magazine* for March contains an interesting account of the finding, in the mountains of Tibet, of the long-lost lady's slipper, *Cypripedium Fairicanum*. "Orchid lovers have been watching for years for the rediscovery of this plant, the actual source of which was unknown. They wanted it, not merely because it had been utterly lost to cultivation, but because it was the parent of many of the most beautiful hybrids we have. . . . *Cypripedium Fairicanum* transmits its high coloring and its peculiar droop of the petals to all its hybrids. The flower of Fairie's orchid, which is borne on a stalk about six inches long, has a remarkably attractive combination of bright colors. The upper standard is white, yellowish green at the base, and is veined with rich purple. The same colors appear in the petals, and the slipper or pouch is reddish green, veined with purple."

Now, when the grape fruit season is at its height, the following notes from an article by Sir Daniel Morris on "Grape Fruit and Shaddocks" in the *West Indian Bulletin*, vol. VI, no. 3, 1905, may be of interest. "During my recent visit to New York I was much interested to notice the considerable demand that existed there for grape fruit from the West Indies. . . . The fruit I saw in New York consisted of various sorts and qualities, and there is little doubt that much confusion exists as to what is really grape fruit as distinct from the allied citrus fruits passing under such names as Pumelo (Pomelo), Shaddock, Forbidden Fruit, etc. The name Forbidden Fruit (from a fancied connection with the Garden of Eden) is tolerably old in the West Indies. The fruit commonly called grape fruit in New York is really the Forbidden Fruit. The true grape fruit (so-called because it grows in clusters like a bunch of grapes) is pear-shaped, and when obtainable at its best, is preferable to the Forbidden Fruit. The fruit shipped

from the Bahamas as grape fruit is usually round, with a polished yellow skin of a silky texture and very heavy. This is probably one of the best of its class and quite equal to the pear-shaped variety. Next comes some excellent fruit from Jamaica, not one of those that already referred to under the name of Forbidden Fruit.

GERMINATION OF ORCHID SEEDS.—When the seeds of orchids are sown, especially those of the *Cattleya* or the *Loelia*, it is often found that the germination, which is quite irregular, is accompanied with the presence at the extremity of the plantule of a number of filaments due to an endophyte fungus. Recent experiments of the French scientist, M. Noel Bernard, have shown that the presence of this fungus is indispensable to the germination of an orchid seed. If the seeds are aseptized, they will not germinate, but if they are put in a pure culture of the fungus, the mycelial filaments of the latter penetrate the embryo; then the germination commences, and is pursued regularly. This observation shows a distinct case of normal parasitism, in which an organism can be developed without the penetration of a parasite.—*Scientific American*.

At a recent meeting of the Torrey Botanical Club Mr. George V. Nash told some interesting facts on the botanical features of orchids. There seems to be a general misconception among naturalists as to just what an orchid is. The uniting in one organ, called the *column*, of the stamens and pistils serves to distinguish the orchid family. Most orchids have thickened stems. In some the stem is very short and much enlarged. Such stems are known as *pseudobulbs*. *Oncidium* and *Odontoglossum* are examples of this sort. In others the entire stem is thickened, as in *Cattleya* and *Dendrobium*. Some orchids have a lateral, others a terminal form of inflorescence, the former arising from the base of the pseudobulb, the latter from its apex. The majority of the orchids represented by the genera *Epidendrum*, *Oncidium*, *Odontoglossum*, *Masdevallia*, and others, have a limited manner of growth; genera such as *Vanilla* and *Angraecum* have an unlimited growth in which the axis ascends continuously.

The orchid family embraces some 6,000 or 7,000 species, more

distributed in tropical regions. In the United States there are about 150 species, representing 44 genera. Nearly all tropical orchids are epiphytic, while in temperate regions they are terrestrial, the soil around their roots protecting them from the extreme cold of winter. As a rule terrestrial orchids have thin leaves for their water supply is not so limited as is the case with epiphytic orchids.

#### NEWS ITEMS.

Mrs. A. A. Anderson has given \$100,000 to Barnard College, Columbia University, toward the establishment of a course in science leading to the degree of bachelor of science.

The published accounts indicate that the meeting of the British Association for the Advancement of Science in South Africa last summer was a very successful and enjoyable one. Of our own botanists only one, Professor D. H. Campbell, of Stanford University, was present.

Of the special features of botanical interest was an exhibit of living South Africa plants, consisting particularly of "desert forms from the Karrvo and a characteristic collection of heather and other flowers from the southwest district of Cape Colony." The interest of the exhibit was extended by a number of photographs, made by Dr. Marlott, illustrating the ecology of Cape Colony. From verbal accounts we judge that the value of this exhibit was very great to the foreigners, especially to American visitors who had acquaintance with the appearance of our North American desert flowers.

The two elements which, naturally, give a characteristic appearance to the desert vegetation of South Africa are the fleshy euphorbias and the aloes, paralleling the cacti and agaves of North America. These, together with the forms of erosion found in certain areas, produce a general similarity to certain parts of our western country which is most striking.

One of the plants of Africa which every botanist knows something about is the remarkable *Welwitschia*. We note with pleasure that Professor Pearson, of the Botanical Department of

the South African College, has begun to carry out research on this unique form. His results, thus far, include the development and germination of the spines. It appears that the state of the country, Damara land, prevented a full collection of material at the time of Professor Pearson's visit. We expect that future opportunity for collection and study will be afforded.

To read the account of many other matters of especial interest to the botanist in the *New Phytologist*,\* from which these are gleaned, makes one humanly envious of the attending visitor. It must certainly have been a rare treat of permanent value.

The following plants are in bloom (April 12) at Lakehurst, the pine barrens of New Jersey: Pyxie, or "flowering mallow," *Pyxidantha barbata*; leather-leaf, *Cassandra calyculata*; low-grass, *Draba verna*; arbutus, *Epigaea repens*; ground hellebore, *Nepeta glechoma*; violet, *Viola palmata*, var. *cucullata*; red swamp maple, *Acer rubrum*; wood-rush, *Luzula campestris*; smooth alder, *Alnus serrulata*; dandelion, *Taraxacum officinale*; sand-myrtle, *Leiophyllum buxifolium* (in bud); sweet myrtle, *Myrica asplenifolia* (in bud).

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#### ERRATA.

The age of the writer of the competitive essay "The Dutch Tongue" which appeared in the January issue, should have been 15 years, not 13.

\* November, 1905.

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## SOME MONSTROSITIES IN TRILLIUM.\*

BY F. M. ANDREWS,

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The genus *Trillium* occasionally shows interesting variations not only in the form, but also in the number of foliar and floral parts. These changes are especially conspicuous in some specimens of *Trillium* found near Bloomington. Of these, some variations worthy of note have been observed. Two plants were found growing within a meter of one another, one of these being *Trillium sessile* and the other *Trillium recurvatum*. In both of these specimens no trace of the usual stamens or pistil was present, all the floral organs being completely transformed into floral leaves which in *Trillium recurvatum* were considerably larger (with the exception of the central ones) than the same parts in normal flowers growing near them. In *Trillium recurvatum* the number of these leaves in the flowers without reproductive organs was twenty-three, and in *Trillium sessile* fourteen. Fig. 17, A, shows such a flower with twenty floral leaves. No gradation from petals to stamens was observed in these specimens, as is sometimes seen in some water lilies. The number of sepals, floral leaves, venation and other features were normal in all of the plants named above.

A third interesting variation was a specimen of the species *Trillium sessile* (Fig. 17, B) in which the various parts were

\* See also Variations in *Trillium* by Lester B. Gary, *Plant World*, vol. 8, no. 10, Oct. 1905, p. 257.

present, but varied in number. To enumerate, there were floral leaves somewhat smaller than in normal specimens, small sepals, four large partly greenish petals, six small stamens and four styles. This change in the size and especially in the number of very close successive whorls of the foliar and floral leaves was also observed in several other species of the genus *Trillium*. The plant in this instance was considerably smaller than the normal specimens.

Some other specimens of *Trillium sessile* and *T. recurvum* showed two sepals and petals partly, or entirely grown together. Here the sepal half was the usual green and the other half, or part, was partly white.

*Trillium erectum* also deviated somewhat from the usual appearance by showing a multiplication in the number of parts in one whorl, and a reduction in the usual number of parts in other whorls. For example, one specimen (Fig. 17, C), had the usual three leaves, the three sepals, but five petals, four stamens and four styles. In all other respects this plant was normal. Some flowers of this species have shown a tendency to unite two or more of the parts.

Some slight deviations in *Trillium nivale* have been observed in the way of a union of the floral parts.

It would be an interesting point to determine whether or not the plant arising from a rhizome showing such changes as those mentioned would appear afterward, or if other and greater variations would occur. Accordingly, experiments of this nature are in progress to ascertain this fact.

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## A DECEMBER RAMBLE IN TUSCALOOSA COUNTY, ALABAMA.

BY ROLAND M. HARPER,  
*Geological Survey of Alabama.*

Tuscaloosa, the seat of justice of the county of the same name in Alabama, is situated about fifty miles northwest of the center of the state, at the point where the Warrior (also known as the



FIG. 17. Variations in Trillium. A, *T. recurvatum*; B, *T. sessile*; C, *T. erectum*.

Warrior or Tuscaloosa) River crosses the fall-line or boundary of the coastal plain. Going up the river (northward) from Tuscaloosa one soon enters the terrane of the Measures (upper Carboniferous strata) at the southwestern extremity of the Alleghanian region, where high sandstone and deep ravines are characteristic features of the landscape in many other parts of the country where the same formations occur. In the other direction from Tuscaloosa the coastal plain a region of very different aspect, stretches away to the shores of the Gulf of Mexico. Although by no means a homogeneous or monotonous region, the coastal plain is pretty sharply differentiated from other parts of eastern North America by the absence of high elevations and the scarcity of steep slopes and rock outcrops; its Cretaceous and Tertiary strata are almost everywhere concealed under a blanket of sand and loam of Quaternary or Tertiary age; and its flora differs constantly and unmistakably (but by no means totally) from that of the other regions farther inland.

So much for the surroundings of Tuscaloosa. My first opportunity to botanize in this part of the state came on December 1905, on which date I went about eight miles up the eastern bank of the Warrior River into the coal region and back by the same route. There was a heavy frost in the morning, some of which remained on the ground all day in shaded places, so flowers were hardly to be expected; but there were enough unfamiliar or unexpected trees, shrubs, and evergreen herbs along the route to make the trip interesting.

Although some outcrops of Carboniferous rocks appear within the limits of Tuscaloosa, the first real cliffs encountered in going up the river are about five miles above the city, near the mouth of North River, a tributary of the Warrior which enters the river on the west side. At about this point I noticed on the cliffs along the river many specimens of what appeared to be *Pinus virginiana*, a species which had never been reported to occur so far south, or at so low an altitude in the southern states (about a hundred feet). A few minutes later my identification was confirmed by finding specimens on the same side where I was.

farther up the river this species became more abundant, until at the point where I turned back there was probably more of it in sight than of any other tree.

At the mouth of the first creek I came to, I stopped to examine the flora of the cliffs more minutely, and found there among other things the lip-fern, *Cheilanthes lanosa*, in abundance; the fern *Woodsia obtusa* and *Asplenium Trichomanes*; stone crop, *Sedum ternatum*, and *S. Neesii*; early saxifrage, *Saxifraga Virginensis*; *Hydrangea quercifolia*; a species of syringa, *Philadelphus Neesiusia Alabamensis*; golden-rod, *Solidago amplexicaulis*, and *Aster Camptosorus*. The *Neesiusia* was discovered somewhere near this spot about fifty years ago by Drs. Neesius and Wyman,<sup>\*</sup> and was known nowhere else until Mr. T. G. Harbison found it a few years ago on Sand Mountain in the northern part of the state.<sup>†</sup> A few specimens of an elm loaded with fruit near the base of the same cliffs could be no other than *Ulmus scrotina* described by Professor Sargent in 1899 and known only from a very few stations in the southern Alleghanies.

At the same place was seen a single specimen of *Prunus Caroliniana*, an evergreen tree which is commonly cultivated for ornament in many of the older cities of the South, but is so rare in the wild state<sup>‡</sup> that one can hardly be certain that the specimens seen in the woods have not sprung from seeds brought by birds from cultivated specimens. Its geographical distribution is consequently very imperfectly understood, but it seems to be normally confined to the coastal plain, like many other southern evergreens.

A little farther up the river the fern *Dryopteris marginalis* was abundant on the cliffs, and with it many specimens of *Viola Canadensis*, which was previously known in Alabama only from Jackson County, where Mr. Harbison found it in 1901.<sup>§</sup> Most of these violets, strange to say, were in full bloom, though at this time the leaves were covered with frost after midday. This particular spot happened to be on a railroad right-of-way, from

\* See Plant World. Sept., 1900.

† Biltmore Bot. Stud. 1: 155. 1902.

‡ See Mohr, Contr. U. S. Nat. Herb. 6: 553. 1901.

§ Biltmore Bot. Stud. 1: 157. 1902.

which the few small trees and bushes seemed to have been cleared within a few months previously, but whether or not this had anything to do with the appearance of flowers at this unusual season I am unable to say.

On the dead stems of a species of *Verbesina* (probably *V. dentalis*) near this place were some magnificent "frost-flow" with ribbons of ice fully six inches long and wide (and this at 1 P. M.). The freezing had evidently commenced in or near the cambium layer, and the ice had pushed the bark completely away for a distance of several inches in each case, usually in one piece.

On the same cliffs, which by this time were seventy-five to a hundred feet high in some places, I found for the first time the cowslip *Dodecatheon Meadia*, which was not reported from any part of the state by Dr. Mohr, though Dr. E. A. Smith tells me that he collected it in this county some years ago. *Bunium lycioides*, a small tree which usually grows on limestone, accompanied it.

Just before turning back I made the most interesting find of the day, one of the Spurge family, namely, *Croton Alabama*. This Euphorbiaceous shrub was discovered in an adjoining county (Bibb) by Dr. Smith in 1874, and for nearly thirty years was known only from that county, where it is said to grow on shaded limestone rocks, and to be confined to a few square miles.† At the new station its habitat is on steep sandstone cliffs well exposed to the afternoon sun. Unlike all its North American congeners, *Croton Alabama* is an evergreen shrub, and I was able to recognize it at once from having seen specimens growing in Dr. Smith's yard. I did not have time to ascertain how far up the river it extends, but hope to do so at some future time.

On the return trip I noticed another interesting plant, which I had overlooked on the way up, namely, *Magnolia macrophylla*. As its name implies, its leaves are very long, sometimes attaining a length of over two feet, and when lying on the ground

\* For an interesting summary of this subject see MacDougal in *Science* 22: 351-352, Dec. 29, 1893.

† See Mohr, *Gard. & For.* 2: 592, f. 150. 1889; *Contr. U. S. Nat. Bur.* 6: 93, 94, 591. 1901; Ferguson, *Rep. Mo. Bot. Gard.* 12: 38. 1901.

their pale lower surfaces uppermost, they attract attention to the tree which would otherwise be easily overlooked in winter, as it is rather small and not at all abundant.\*

Tuscaloosa is probably at present the most convenient point in the eastern United States at which to study the boundary between the Palaeozoic region and the coastal plain, for nearly everywhere east of here the coastal plain is bordered by ancient crystalline rocks (as at all the well-known fall-line cities from Columbus, Ga., to Washington, D. C., and even New York), and west of Alabama there happen to be very few important towns along the fall-line. Here the relations between geology and flora are very striking. Most of the species above mentioned, as well as several others seen on the same day but not mentioned, are not known to occur in the coastal plain at all, though at this point, if not elsewhere, they approach within a very few miles of it. The reasons for this are mostly too complex to be discussed here, but are originally dependent on geological history. While climatic factors may and do bring about profound differences in the floras of different parts of the earth, such factors are rarely responsible for abrupt changes in vegetation such as we see here.

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## THE PASSAGE OF WATER FROM THE PLANT CELL DURING FREEZING.

BY K. M. WIEGAND,  
*Cornell University.*

In a previous number of this journal † the writer has attempted to outline the occurrence and structure of ice masses within plant tissue. The present paper deals with the question of how the water gets from the cell cavity into the intercellular spaces during the process of ice formation, there to be converted into ice. In regard to this point two general theories have been held, which

\* A little later in traveling over the state I was able to recognize this tree from moving trains at many points where if the leaves had all been lying face up I would not have noticed it at all.

† Vol. 9, no. 2, Feb., 1906, p. 25.

may be termed for convenience the "expulsion" theory and "attraction" theory.

The first of these seems to have been the more popular in the past and has been upheld by a number of plant physiologists. In this case it is assumed that, in order to freeze in the spaces water must be in those spaces before freezing begins; in other words, that the cell actively gives up water at low temperature, probably as a protection against ice-formation within the cell. Kerner\* states the theory thus: "In order that the water get from the interior of the cell into the adjoining intercellular spaces a pressing and squeezing is necessary, and the pressure can only proceed from the living protoplasm in the cell-chambers; consequently the process of freezing can be most correctly represented in this way, viz., that the protoplasm becomes stimulated and roused by the lowering of the temperature to transport a portion of the water from the interior to the exterior of the cell by the means of contraction and pressure. What happens then is accordingly not unlike the excretion of watery sap into the intercellular spaces in the stimulated pulvini on the leaf-stalk of *Mimosa*; the advantage obtained by the excretion of water in the two cases is very different. In the cooled leaves the benefit, of course, can be sought for in the fact that the living portion of the cell is protected from destruction as long as possible by the production of ice crystals in the intercellular spaces. If the water were frozen with frozen inside the cells between the groups of molecules of the living cell body and its wall by a few degrees of cold, fundamental displacements and disorganizations of the groups of molecules would be unavoidable. On the other hand, the ice crystals on the exterior of the cells do not produce such destruction."

Whether cells do or do not extrude water is of course no longer a question. It seems fairly well established that such is the case in *Mimosa* and the sensitive staminal filaments of the *Cynanchum* (Pfeffer), and to the loss of turgidity thus caused, is probably due the movement of the various organs. Water seems to be extruded in nectaries, but there osmosis often seems to play

\* Kerner and Oliver, *The Natural History of Plants*, 1: 541.

most important part. It has for a long time been suggested that the cells of root tissue possibly act as pumps, forcing water into the vessels, and thus causing root pressure, but whether such expulsion of water in the roots actually occurs has as yet never been satisfactorily demonstrated. Droplets appear on the surface of some mycelial threads when kept in a damp atmosphere, also on many plant hairs and on the rhizomes of *Marchantia* under similar conditions. To this list might be added a number of other cases (see Pfeffer's *Pflanzen Physiologie*).

Evidence is also gradually accumulating which tends to show that some plants do excrete water at a temperature just above  $0^{\circ}$  C. We have the casual notice of Molisch that in some stamens hairs of *Tradescantia* subjected to a temperature of  $-5^{\circ}$  to  $-9^{\circ}$  C. for six hours the plasma membrane separated from the wall, but no freezing took place until a temperature of about  $-15^{\circ}$  C. was reached. If subjected to a temperature of  $-15^{\circ}$  to  $-20^{\circ}$  C. the separation from the wall occurred immediately. In *Tradescantia Virginica*, according to Kühne,\* the changes before freezing are more marked but take place only when the fall in temperature is abrupt and severe. The separations do not always occur, especially when the cooling is slow, and seem rather to be accidental contractions due to the cold stimulus, than general phenomena.

Greeley† has shown that the reduction of temperature to near zero degrees C. for a few hours will cause the animal *Stentor* to contract and become cyst-like, probably with the expulsion of water. Threads of *Spirogyra* became much plasmolized under similar treatment, and Livingston‡ has shown that when mounted in oil this plasmolysis is accompanied by an extrusion of droplets of water into the oil. The effect upon both organisms is the same as though they had been placed in a strong osmotic solution.

\* Kühne, W. Untersuchungen über das Protoplasma. Leipzig, 1864.

† Greeley, A. W. On the Analogy between the Effects of Loss of Water and the Lowering of Temperature. Amer. Journ. Physiol. 6: 112-120. 1901.

‡ Livingston, B. E. The Role of Diffusion and Osmotic Pressure in Plants. Chicago, 1903 (p. 75).

Such exudations as above described may be accomplished either by the actual contraction of the protoplasm (cold rigor), or more likely by a sudden change in permeability of the membrane to the solute, either over its whole surface or at special points, or perhaps both of these conditions may occur together.

Although from the foregoing it appears that, in special cases, at least, water may be excreted by the protoplasm, and that this excretion may, in certain plants at least, be induced by the apparently stimulating action of temperatures near the freezing point, still there are some important objections to assuming this to be the way in which all water gets out of the cell to be frozen.

In the first place, the fact that a few cases are known in which this particular temperature stimulates the protoplasm in this particular way does not warrant us in assuming that all cells are stimulated in a similar way at the same temperature. Such a universal phenomenon does not seem probable.

The first ice-formation in plant tissue does not take place at  $0^{\circ}$  C., nor even at the freezing point of the tissue, but at a temperature several degrees lower, known as the over-cooling point of the tissue. This point is usually lower in proportion to the inaccessibility of the water. Therefore if the water is already present in the intercellular spaces before freezing begins, the over-cooling point will naturally be much raised or will entirely disappear under such conditions. It seems necessary to assume that the critical stimulating temperature corresponds with the overcooling point of the tissue, and it may even be assumed that the overcooling point is determined by this critical temperature. Since the overcooling point is nearly at the same temperature in the majority of plants, the range of the critical temperature will be still further limited, and therefore the theory becomes much less probable, especially since all these phenomena may apparently be explained in a much simpler manner.

A third objection lies in the fact that similar ice crusts and ice masses form in connection with dead material of various kinds where there can be no question of the activity of the protoplasm in excreting water.

We may now turn to the other theory, here designated for convenience the "attraction" theory.

In ordinary plant tissue containing intercellular spaces the following conditions are present. In the interior of the cell first we find a cell sap of varying concentration, the quantity of which is conditioned principally by the size of the cell. Outside of this is the protoplasmic layer containing a considerable quantity of water, usually from 60 to 90 per cent. This is in direct contact with the cell wall, which in turn contains from 30 to 60 per cent of water. Bordering on the wall is the free atmosphere of the intercellular space.

The water contained in the wall and in the protoplasm is water of imbibition, in the limited sense of the word. The term "capillary water" is usually applied to water of imbibition in spaces large enough to be readily detected, and in which most of the molecules of the liquid are out of range of the molecular forces of the substance with which the liquid is in contact. These extreme conditions are connected by insensible gradations dependent upon the size of the minute chambers in which the water is contained. The forces acting to inject the liquid into the substance are primarily the same in either case, namely, the great attraction of the molecules of the one for those of the other.

The fact that a substance swells implies that the molecules of the liquid have a greater attraction for those of the substance than the latter have for each other, at least than they have for each other in some directions. The result is that the particles of liquid pry and wedge themselves between those of the substance forcing the latter apart. The particles later to enter, however, cannot come as near the substance as did the first ones, and hence their action is less intense. Perhaps the physicist more accurately describes this wedging power of the liquid when he says that it depends upon the concavity of the meniscus at the end of the minute water columns entering the substance. The smaller the capillary canals the more concave is the meniscus, and hence the greater will be the penetrating force. Therefore, as the substance becomes more saturated the force rapidly decreases. A substance that cannot swell is simply one in which the molecules have

greater attraction for each other than they have for water. In a substance that swells only to a limited extent it seems necessary to postulate a difference of attractive force among the molecules in different directions; for otherwise liquid would continue to be injected, though with gradually decreasing force, until the whole substance went into a condition resembling solution. We may say, therefore, that water will continue to be absorbed by such a substance until the attractive forces of the molecules in one direction in the substance in direction of their strongest action equilibrate with the constantly diminishing force of penetration of the liquid. It may of course be assumed that the attractive forces among the molecules of the substance in their strongest direction are stronger than those of the fluid for the same molecules.

From this it follows that the first particles of the fluid penetrate and are held with greatest force. Since the molecular forces in all substances act only through an exceedingly short distance, and the meniscus of the capillary in-flowing streamlets becomes rapidly less concave as the streamlets grow larger, the force of imbibition decreases very rapidly. As quoted by Pfeffer, Rodewald found in a frond of *Laminaria* that while it required but six atmospheres pressure to squeeze out water when the content was 63 per cent., it required two hundred atmospheres to cause the same result when the content was reduced to 48 per cent. This point becomes of very great importance in the theory of freezing, as we shall see later. The force of imbibition for the first molecule absorbed is often enormously great. Rodewald found that for starch was equal to about 2,523 atmospheres. Hales found that swelling peas could lift a weight of 83.5 K. or about 180 pounds. An experiment instituted by Sachs showed the great strength of this force in an impressive manner. He found that if asphalt lack was spread upon a very dry bladder-membrane bibulous paper, and then well dried, it would adhere to the substances with enormous force. An attempt to separate the paper usually resulted in tearing off thin layers of the membrane. If, however, the paper was brought in contact with water so that imbibition commenced, the lack would soon be separ-

in great flakes. The molecules of water force their way between the lack and the paper and literally pry the two apart.

Water imbibed from solutions usually leaves the solute behind and penetrates the substance in an almost pure state. The water contained in the cell wall especially is probably nearly pure. The purity is somewhat proportional to the force required to penetrate the substance.

Not only will an imbibing substance, if homogeneous or nearly so throughout, contain water in the interstices between the particles of which it is composed, but also the same forces acting will cause molecules of water to become attached to the surface particles as well, thus forming a layer of water over the whole surface of the substance. The above experiment with lack and paper constitutes a very pretty demonstration of the presence of such a layer, as does also the fact that the surface of an imbibing body reacts toward oils and resins in the same way as does the surface of fresh water. Oils and resins will not adhere to the surface of a soaked body of this sort. Such a layer of water then covers the surface of both cell wall and protoplasm, but that upon the outer surface of the protoplasm and the one on the inner face of the cell wall when these two structures are in contact, necessarily fuse into one. Since the molecular force in a given substance is constant, it follows that the thickness of the water film will depend upon the quantity of water at command. In general, the more water present the thicker will be the layer and the less firmly will it be held by the substance, since some of the particles are necessarily at a distance from those of the substance attracting them.

The plant cell then is essentially a system composed of the following parts: A film of nearly pure water of varying thickness bordering on the intercellular space; a cell wall filled with water of imbibition, which is continuous with the water of imbibition in the protoplasm; and a cell sap which is continuous with the water in the protoplasm. Normally the whole system forms a complex in a state of equilibrium.\* If water is taken from one member of the series a readjustment will follow throughout the whole.

\* See also Müller-Thurgau. Ueber das Gefrieren und Erfrieren der Pflanzen. Landw. Jahrb. 9: 1880, see page 144 and 145.

When a substance passes from the liquid to the solid state through change in temperature or pressure, in many cases it does so by the formation of crystals. The size of the crystals depends mainly upon the accessibility of the liquid and the rate of fall of temperature, or rise in pressure, being smaller when this is rapid and when the fluid is more inaccessible, and vice versa.

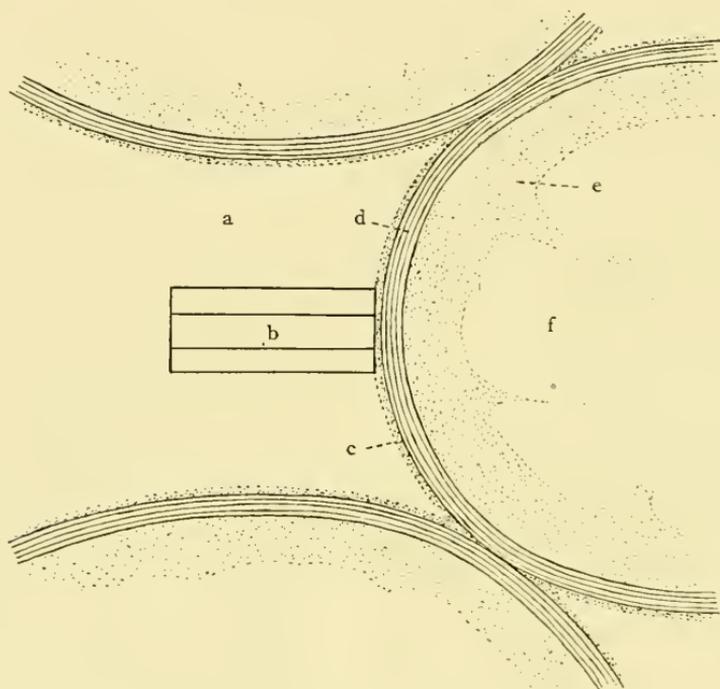


FIG. 18. Diagram illustrating the water-system concerned in the formation of ice crystals in intercellular spaces. a, Intercellular spaces; b, prismatic ice crystal; c, superficial water film; d, cell wall; e, protoplasm; f, vacuole containing cell sap.

The formation of a crystal is accompanied by the exhibition of a considerable force on the part of the molecules on entering into the crystal. To prevent more molecules of the liquid from being applied to the crystal an enormous force is often required. This is nowhere better shown than in the expansive force of newly forming ice which can even rend rocks asunder, break iron bars, etc., when properly applied. This, however, is molecular force, pure and simple, and can act only at an infinitesimal distance from the forming crystal. Material can be drawn to a forming cry-

only very indirectly. The molecular force drawing the fluid particles to the crystal becomes more intense in proportion as the temperature falls or pressure increases. It follows also that any force acting in opposition to this molecular force will tend to retard the crystallization. Such a force acts when a liquid is solvent in a solution, or is water of imbibition in a swollen substance. In either case the molecules of the solute or substance, as the case may be, in one sense exhibit an attraction for those of the liquid, tending to prevent the latter from passing to the crystal. Consequently, crystallization will take place with more ease in pure liquids free from solute or from imbibition. This really means that crystallization will take place at a higher temperature and lower pressure in pure liquids.

We are now in position to determine what will occur when the temperature falls below the zero point centigrade in succulent plants provided with intercellular spaces as are all leaves, stems, tubers, roots, etc. Of the system outlined in a previous paragraph, water film, cell wall, protoplasm and cell sap, the water is held most firmly by the cell wall, less so by the more porous protoplasm, still less so by the cell sap of varying concentration, and least firmly by the surface film of nearly pure water on the outside of the wall and lining the intercellular space. In this layer, as it exists normally adjacent to the free space, only the inner molecules are held firmly by the wall particles. The outer ones are held less and less firmly until the outermost are barely able to maintain their position.

Therefore as the temperature gradually falls crystals will begin to form in this surface film rather than in any other part of the cell. This explains the occurrence of ice only in the intercellular spaces.

The passage of water from the cell to these crystals may be conceived of as taking place in either of two ways:

(a) The formation of the crystal takes water from the surface film with considerable force, thus leaving the surface of the wall without its quota of water of imbibition, and that force will then rapidly increase at that point. Following ordinary physical law

the water will move through the cell wall until this increase in imbibition force is equalized. For this purpose water will be taken from the inner wall layers, thus increasing their power of imbibition. They in turn will be supplied by water from the protoplasm, and this in turn by the cell sap. In other words, a new adjustment of equilibrium will occur throughout the whole system. As crystallization progresses, more and more water will be abstracted from this system until finally the force of imbibition becomes sufficiently strong to equilibrate the molecular force of crystallization, at which time the growth of the crystal necessarily ceases. Not all the water passes from the cell on freezing; only a part of it, depending upon this equilibration of forces. After further freezing will now occur unless the temperature again falls, thus causing an increase in strength of the force of crystallization. More water will then pass to the crystal until equilibrium is again established.

Naturally the greatest quantity of water which will be drawn through the wall to equalize the disturbance in the system will come from the regions where the force of imbibition is least, namely, from the cell sap. Consequently, in freezing, the sap is the first to lose water, then the protoplasm, and finally the cell wall. The quantity of water lost is greatest from the cell sap and least from the cell wall. The quantity of water in the protoplasm will not decrease until the force of imbibition in the cell sap reaches in intensity that acting upon the molecules of water is weakest in the protoplasm. A like relation will exist between the protoplasm and the cell wall. Even after water has begun to be extracted from all these layers the larger quantity will for some time continue to be extracted from the sap and protoplasm. A greater quantity of the water to form the ice crystals in plants therefore comes from the cell sap and the next largest quantity from the protoplasm.

(b) It may be assumed that the crystal actually draws water toward itself. This it might do in this way. The water throughout, not only the cell, but the whole adjacent tissue may be conceived to be a connected whole possessing an adhesion and rigidity

of molecular structure under certain conditions, as is now often assumed in the water-adhesion theory of the ascent of sap. Now if a molecule is taken from this body of water at the crystal surface we may conceive that the whole structure will be pulled along on the molecule nearer the crystal, and so on. This is similar to pulling on the end of a string, thereby moving all the molecules of the string along a similar distance. The greatest objection to this idea that the crystal pulls the water out lies in the doubt as to whether water of imbibition possesses a rigidity similar to that of a column of great diameter.

Either of these views will explain the formation of ice-masses where the water passes to the crystals from a distance much greater than the diameter of the cell, as it does sometimes for a distance of many cells. There may be either a general equalization of imbibition or a pulling on the various strings of water as above indicated.

Either view will also explain the formation of ice-crusts and ice-masses in connection with dead tissue, for the conditions in dead material as regards surface film and water of imbibition are essentially the same as in living tissue.

In the case of living cells, to the force of imbibition in the sap and protoplasm must also be added the osmotic force of the cell. The ice crystal in abstracting water from these two structures must overcome both sets of forces. Since, however, as compared with the force of imbibition in moderately dry substances the osmotic pressure is never very great, this last factor is of importance only at the very inception of freezing. In tender tissue killed by freezing it would disappear very soon.

Normal tissue usually contains a large quantity of water and the series of structures concerned in freezing are nearly saturated with water of imbibition. Hence when freezing first begins very little force is required to abstract the water, but as the process goes on the imbibition-force regularly but rapidly increases until it becomes very great, as we have already seen. With the force of crystallization the increase is not regular. Before freezing begins the force is absent. With the first crystal-formation

rises abruptly and becomes very strong; and with the decrease of temperature thereafter it continues to rise gradually but much less rapidly than at first. The result is that when the water freezes a very large quantity of water is abstracted at the beginning to form the first particles of ice, but with each degree of fall of temperature thereafter only a very small quantity is lost by each cell. This quantity becomes less and less with each degree, and the imbibition force increases at a more rapid rate than the rate of crystallization.\*

In conclusion, then, it may be said that the water comes out of the cell during freezing either through the equalizing action of the force of imbibition following the abstraction of water by the ice crystal from the surface film lining the intercellular space, or through the pulling action of the ice crystal at the end of microtubes but possibly rigid columns of water which extend into the cell. Until the rigidity of this capillary water is demonstrated the former method is the more probable. The extrusion of water from the protoplasm of certain plants at low temperatures can be considered only as an accidental, not a necessary, phenomenon as far as the freezing process is concerned.

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BOTANICAL SYMPOSIUM.—The third annual meeting of the Botanical Symposium will be held from July 2d to 9th, 1906, at Mountain Lodge, Little Moose Lake, Old Forge, N. Y. Through the courtesy of the members of the Adirondack League Club the privilege of occupying the club house for one week is extended to the members of the Conference. Tickets should be bought at Fulton Chain Station on the Adirondack Division of the N. Y. C. & H. R. R. Single fare from New York City \$6.46. Board \$2.50 to \$3.00 a day. Stages will meet the party at Fulton Chain Station. Those expecting to attend are requested to notify Joseph Crawford, Secretary, 2824 Frankford Avenue, Philadelphia, Pa.

\* Cf. Sachs' "Lehrbuch," and Müller-Thurgau's work for accounts of the physics of freezing, in the main similar to the one here given.

## MEETING OF THE SOCIETY FOR THE PROTECTION OF NATIVE PLANTS.

At the fifth annual meeting of the Society for the Protection of Native Plants, held in Boston on March 24th, an interesting address was made by Professor Merritt L. Fernald, of the Gray Herbarium, Cambridge, who acted as chairman of the meeting in the absence of the president, Professor Robert T. Jackson.

Certain important facts were presented regarding the flora of this country; first, the rapid changes from causes which we cannot influence, such as the inevitable destruction of native plants resulting from the building of towns and highways, and the cultivation of large tracts of farm lands. Where, from any cause, woodland disappears, the delicate wild flowers, which flourish only in their native soil of leaf-mould, are also sure to disappear. As soon as we dry out the humus, whether by burning, cutting out, or building, these somewhat fastidious plants have to go, with no hope of return. Plants which like open spaces are more apt to be coarse and showy, unlike the woodland flowers. Many of these, like the golden-rod and asters, are native and spread rapidly into cleared spots, but in the neighborhood of large towns even these coarse and vigorous natives find themselves crowded by the coarser and more vigorous roadside plants of Europe. Such plants come from Europe with the populations which have emigrated, the seeds being brought in clothing, blankets, etc., and having had generations of breeding under hard conditions they find nothing to hinder their growth. Over six hundred of them, familiarly known as weeds, are now among our wild plants, and at no very distant time they will cover the continent. Already, over large tracts of our prairie region, the native flora is vanishing, or has actually vanished, and the wild flowers are of the weed-like type. To check the coming in of the coarse, vagrant type we should encourage the setting apart, for the public, of spots of woodland, where natural conditions can be maintained.

Create a sentiment against spreading rubbish and ashes through the woods and in ravines, which kills all delicate growths and surely invites the coarse. Reach, if possible, the influential people in suburban places, that their aid may be secured against this evil.

The corresponding secretary of the Society in her annual report told of the work that is being done by the hundred or more persons acting as secretaries in different localities. Extracts from their letters were read, which gave interesting experiences and offered the most helpful suggestions. If all of our 1,400 members would constitute themselves such secretaries and make a point of keeping on hand and distributing leaflets, the influence of the Society would without doubt be largely increased and many persons brought into touch with it who otherwise might never have had a chance of helping in this cause.

One leaflet, No. 11, a reprint of an article in *THE PLANT WORLD*, entitled "A Treasure-Spot of Wild-flowers,"\* was issued last year. During the spring and summer leaflets and posters were sent to hundreds of schools, camps, boarding-houses, summer resorts, and in the autumn letters were sent to clergymen, shopkeepers and persons likely to give large entertainments regarding the use of laurel and other evergreen for decoration. Our literature was also sent to Village Improvement Societies, to Women's Clubs in Massachusetts. Publishers have kindly sent out many hundreds of slips in their nature books; and posters have been put up in railroad stations and other public places.

A poster printed on cotton for use in arbutus localities is ready and new leaflets will soon be issued. All literature of the Society will be sent free of charge by applying to Miss Maria Carter, Boston Society of Natural History, Boston, Mass.

Membership in the Society is free. Sustaining members are those who contribute one dollar annually, or a larger sum at one time. It is desired to increase the membership list; and persons interested are asked to send new names to the corresponding secretary.

The following officers were reelected for the year 1906: Literary president, Mrs. Asa Gray; president, Robert T. Jackson.

\* Vol. 8, no. 3, March, 1905, p. 76.

Cambridge; vice-presidents, Benjamin L. Robinson, Cambridge; George L. Goodale, Cambridge; Merritt H. Fernald, Cambridge; George H. Martin, State Board of Education, Boston; Treasurer, Miss Amy Folsom, 88 Marlborough Street, Boston; Secretary, Miss M. E. Carter, Boston Society of Natural History, Boston; corresponding secretary, Miss Margaret E. Allen, 12 Marlborough Street, Boston.

MARGARET E. ALLEN,  
*Corresponding Secretary.*

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## SUMMER COURSES IN BOTANY.

For the benefit of those of our readers who are contemplating summer study, we give a list of the summer courses in botany of which announcements have been received.

WOODS HOLE, MASS. MARINE BIOLOGICAL LABORATORY. JUNE 1 TO OCTOBER 1.

Staff: Dr. Bradley Moore Davis,\* assistant professor of botany, University of Chicago; Dr. George T. Moore, Washington, D. C.; James J. Wolfe, adjunct professor of biology, Trinity College, Durham, N. C.; Lillian J. MacRae, collector in botany.

Courses: *Investigation*: A. Under supervision—*Morphology*, *Plant Physiology*. B. Without supervision—information by writing to Dr. George T. Moore, Cosmos Club, Washington, D. C. *Botanical instruction*: July 5 to August 16. *Thallophytes*. Drs. Moore and Wolf; *Plant Life-histories*, Dr. Moore and assistant.

COLD SPRING HARBOR, LONG ISLAND. BIOLOGICAL LABORATORY OF THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES. JULY 2 TO AUGUST 18.

Staff: Dr. D. S. Johnson, Johns Hopkins University; Dr. E. N. Transeau, Alma College; Harlan H. York, A.M., Columbia University.

\* Absent in 1906.

Courses: *Cryptogamic Botany*, Dr. Johnson and Mr. Yocum; *Ecology*, Dr. Transeau; *Advanced Work in Cryptogamic Botany or Ecology*, by arrangement; *Investigation*.

For further information address Professor Franklin W. Hoopes, 502 Fulton Street, Brooklyn, or Professor Charles B. Davenport, Cold Spring Harbor, Long Island, N. Y.

MINNESOTA SEASIDE STATION. PORT RENFREW, BRITISH COLUMBIA. JULY 8 TO AUGUST 18.

Staff: Professors MacMillan, Tilden, Butters and Rosendahl.

Courses: *General Algology*; for teachers. *Algology*; for advanced students. *Morphology and Ecology of Kelps*, Naudon; *Study, Taxonomy of the Coniferae*, Taxonomy of the *Algae*, *Spermae*.

For further information address Professor Conway MacMillan, University of Minnesota, Minneapolis, Minn.

CORNELL UNIVERSITY, ITHACA, N. Y. JULY 5 TO AUGUST 15.

Staff: Assistant Professor W. W. Rowlee, Dr. E. J. Durand, Dr. K. M. Wiegand.

Courses: *Elementary Plant Physiology and Morphology*, Durand; *Special Morphology of the Higher Plants*, Assistant Professor Rowlee; *Organography and Identification of the Higher Plants*, Dr. Wiegand; *Taxonomy and Embryology of the Bryophytes and Ferns*, Dr. Durand; *Trees and Shrubs*, *Biological Taxonomic Study of Trees*, Assistant Professor Rowlee. *Ecology of Plants*, Dr. Wiegand.

HARVARD UNIVERSITY, CAMBRIDGE, MASS. JULY 5 TO AUGUST 15.

Staff: Dr. Robert Greenleaf Leavitt, Dr. Minton Ascherson, Chrysler, John Galentine Hall, A.M.

Courses: *Introductory Course: Structure, Physiology and Ecology of Flowering Plants*, Dr. Leavitt and Mr. Hall; *Morphology, Histology and Ecology of Flowering Plants*, Dr. Chrysler.

For further information address Dr. M. A. Chrysler, 61 Oxford Street, Cambridge, Mass.

NEW YORK UNIVERSITY, UNIVERSITY HEIGHTS, NEW YORK CITY

JULY 2 TO AUGUST 10.

Staff: Dr. C. Stuart Gager, New York Botanical Garden.

Courses: *Introductory Botany*, Dr. Gager. *Research Course*  
Research work under the direction of the scientific staff of the  
New York Botanical Garden.

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## OF INTEREST TO TEACHERS.

EDITED BY DR. C. STUART GAGER.

MEETING OF BIOLOGY TEACHERS OF NEW YORK CITY.—At a meeting of the New York Biology Teachers' Association, held at the Board of Education, on April 27th, four of the principals in the high schools of Greater New York, upon invitation, presented their views on "Value and Scope of First-year Biology."

Dr. Felter, of the Girls' High School, Brooklyn, was the first speaker. He expressed the opinion that biology is a successful first-year subject. In the first place, the fact that 95 per cent. of the girls like the subject seems a strong argument in its favor. Then biological science trains the powers of observation and expression, and correlates these powers as manifested in laboratory drawings and records; the faculties thus developed are an aid to the pupil in other subjects. Dr. Felter declared it absurd to expect thoroughness on the part of high school pupils; if they are trained to see more things, and more details in each thing, if relations can be seen and the power to classify facts gained through the study of biology, the subject more than justifies its position in the course.

Dr. Wight, of the Wadleigh High School, the next speaker, criticized the course in biology as not developing the same degree of scholarship in the pupil as do the other subjects. The fault lies in the content of the present course which is far too comprehensive and therefore superficial. He advocated the exclusion of human physiology and the relegation of this subject to the department of physical training. The course would be further im-

proved if one subject only—either botany or zoology—taught for the entire year. Dr. Wight advocated botany because of its higher aesthetic value, and because a certain degree of relation with zoology could be brought about in the lower forms—which could then be treated from the evolutionary standpoint—and in the cases where there are interrelations between plants and insects. The objection that plants are farther removed from humanity than animals, and that the zoological side of the subject is thus almost wholly neglected, would be counterbalanced by the advantage of a fuller knowledge of the local flora, and the sounder scholarship which would thus be induced.

Dr. Gunnison, of the Erasmus Hall High School, who followed Dr. Wight, declared that biology has not the same determining effect upon the life of the pupil that the other subjects have. There is always a certain proportion of students who like or dislike more of the other subjects well enough to desire to continue them further in the high school course. This is not the case with biology, as few students profess interest in this science. Dr. Gunnison suggested that the trouble might lie in the fact that the city is the wrong place in which to teach biology. All the excitement which comes from seeking out and finding the desired objects is necessarily lost in the city course; thus the vital force is missing and the subject is not a success.

Dr. Denbigh, of the Morris High School, was the last speaker. He expressed the opinion that it would be well-nigh impossible to make the first-year biology course too simple. This course is successful when it secures three objects—the power of scientific thinking, as wide a knowledge as possible of the animal and vegetable kingdoms, and the development of a permanent interest which will increase the pupil's power of enjoyment in his surroundings. From this point of view, the insistence upon details of structure and elaborate drawings is pernicious; precise scholarship should not be exacted or expected. Dr. Denbigh emphasized the fact that field work can be most valuable in arousing interest, and the importance of learning biology is exactly proportioned to the difficulty of reaching the plant or animal. This subject provides a training which the student lacks and therefore needs;

consequently there is no more valuable cultural study than first-year biology. It fulfills Huxley's requirement of knowledge—that of making a man live more happily and usefully.

In summing up the results of the discussion, Dr. Peabody, chairman of the meeting, called attention to the fact that nobody had opposed the subject as such; and that the lines in which biology seems in need of improvement are in the simplification of the subject matter, in the emphasizing of the development of power rather than of expression of fact, and in the presentation of the threads of unity in the biological field.

E. M. K.

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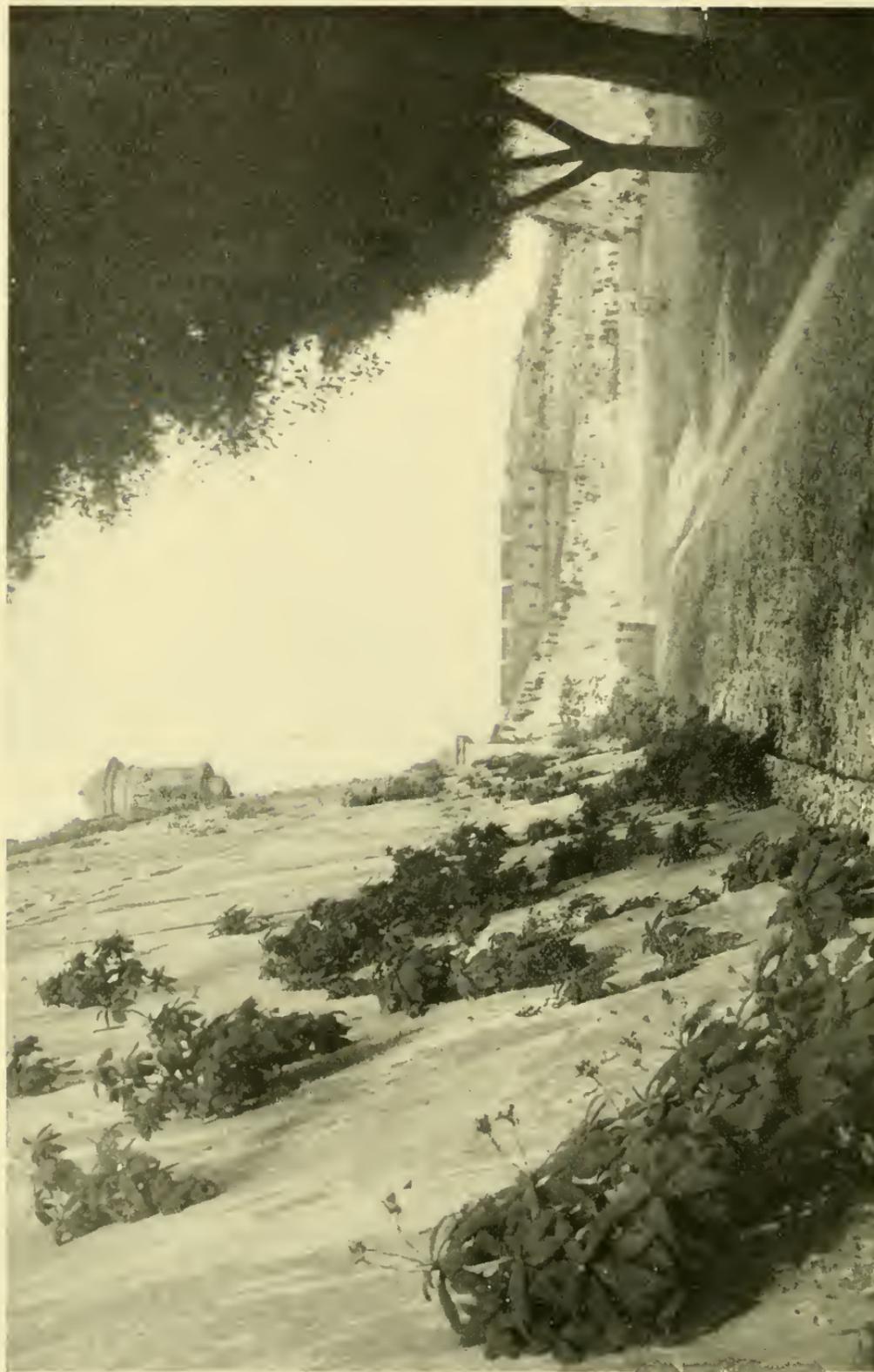
### A CORRECTION.

In the article by Dr. Leavitt on the sensitive lip of *Masdevallia muscosa* in the April issue of the PLANT WORLD, through a typographical error, the word "smelling" appears (page 79) instead of "swelling." In calling attention to this mistake the author writes: "I have no desire to impute to this orchid powers more remarkable than that which it really possesses. The sudden closing of the flower is in no sense to be regarded as a sneeze."









# The Plant World

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## THE DISINTEGRATING INFLUENCES OF TROPICAL PLANTS.

BY MEL. T. COOK, PH.D.,

*Agricultural Station, Santiago de las Vegas, Cuba.*

The literature upon the methods of plant distribution and the influences of plants upon their surroundings is voluminous, and yet much more might well be written on this very interesting and important subject. Wherever the conditions will permit plants are continually migrating into new territory, and they are also continually making their old homes unfit for themselves but suitable for other species. In this work, in connection with frost, and water, and animals, they become one of the greatest leveling forces of nature. They stop the flow and change the courses of rivers; they fill the lakes, converting them into marshes and then into dry land; they inroad upon the ocean coast line and gradually push it out farther and farther; they help to level the hills and to tear down the mountains. Neither are they respecters of the works of man, for they attack and destroy his greatest and noblest structures. His largest castles, temples, and monuments become vine clad, old, ancient, and then historical memories, in rapid succession.

In no part of the western hemisphere is this better illustrated than in the old Spanish fortifications in and around Havana. Here, far south of the frost line, plants become the most important factor in this slow but sure work of destruction; and unconfused with other disintegrating factors, their work is al-

the more conspicuous. The most important and best known of these fortifications are Morro Castle and Cabanas. Built for defence against the "flesh and the devil," Morro only has experienced one siege, and yet both are being rapidly disintegrated through the agencies of nature. Morro is much the older, having been completed in 1597, while Cabanas was begun in 1762 and completed in 1774. And yet Cabanas looks as old or older than Morro. For generations these immense piles of masonry have stood as military scarecrows to all the rest of the civilized world, only to be destroyed by the slow but ever working force of nature.

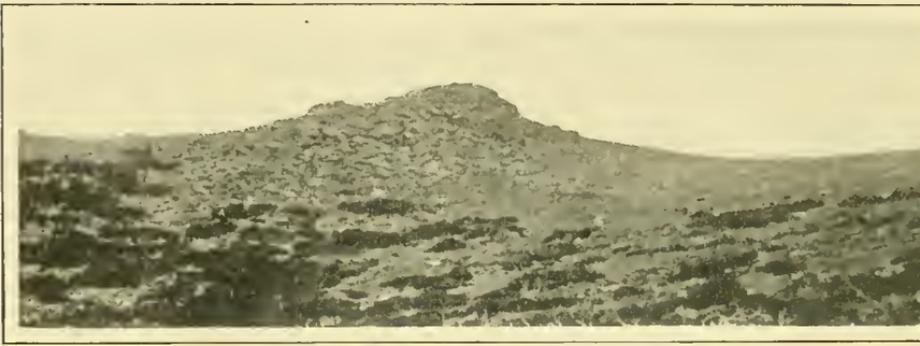
Crossing the harbor from Havana, the visitor lands at the mouth of a covered road which leads up to the south entrance of Cabanas and into "Los Fosos de los Laureles" (the laurel ditches) with its thick walls of masonry forty feet in height. Within the moat are a number of very large laurel trees (*Ficus nitida*) and at various places through this and other moats are numerous plants of many species. Of the trees, the most common are *Delonix regia* (royal poincianas), *Ficus nitida* (laurel) and occasionally some others. Among the smaller plants the following species are very abundant: *Ricinus* sp., *Solanum verbasifolium* and other solanaceous plants, *Ipomœa domingensis*, *Haplophragma patens*, *Momordica charantia*, *Cordia* sp., *Tribulus cistoides*, *Iresine paniculata*, *Bidens lucantha*, *Vachella farnesiana*, *Stachytarpheta jamaicensis*, *Turnera ulmifolia*, *Portulaca* sp., *Strobilium stans* and a number of Compositæ and Gramineæ.

Many of the above mentioned plants grow in holes and crevices of the walls, but by far the most conspicuous of these plants is *Rhytidophyllum crenulatum* (see Fig. 19) which grows everywhere over the surface of the walls. The plant belongs to the family Gesneraceæ, and the genus is restricted to the Greater Antilles. This species, though comparatively rare, grows upon the rocks along the coast. The wonder is how this vigorous plant can secure a foothold and nourishment in these walls, yet it seems to take advantage of every opening, however small, and grows in luxuriant abundance. Its work as a disintegrating factor is undoubtedly very important.

Several grasses, two or three species of small ferns, and many other plants are to be seen helping in this work of destruction, and here and there a small tree may be observed widening the small crevice which gives it a foothold. The leveling influence of the vegetation upon these fortifications is very evident to the most casual observer. Here, practically unaided by any other influence than the vandalism of the tourist, the tropical vegetation is slowly but surely obliterating the pride of Spain's military rule in the western hemisphere, that last outpost against modern progress, the key to the west.

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PHENOLOGICAL RECORDS FOR 1905.—During the past year phenological records were kept showing the dates of certain stages in the development of vegetation in New York State. The forest trees showed first leaves about May 3d to 5th, and the woods were generally green by May 14th. The leaves began coloring September 16th, and began falling from October 4th to 21st according to the kind of tree. The woods were generally bare by November 5th. Of the five principal fruit trees in the State viz., apple, peach, pear, plum, and cherry, the apple showed first leaves earliest, May 3d, and the plum latest, May 6th. The peach bloomed earliest, first bloom showing May 5th and being in full bloom by May 10th; then followed the plum, the cherry, the pear, and last the apple, which bloomed May 16th to 23d. The period of harvest for the cherry was June 29th to July 16th; for the peach, July 26th to October 5th; for the plum, September 30 to 20th; for the pear, September 4th to October 5th, and for the apple, September 15th to October 25th.—*Climate and Crops, New York Section, Jan., 1906.*



## ON THE MOUNTAIN TOP.

BY GEO. E. OSTERHOUT.

Almost every one enjoys mountain climbing and standing on a mountain top, if only for the satisfaction of putting it under one's feet. It is an undertaking accomplished and an aspiration satisfied. I have always enjoyed reaching the summits of the Rocky Mountains, even if these were not the summits of the highest peaks. The debris lying at the foot of the chasms and the partly thawed lakes look as if some of the old world were yet in the making. The boundless range of vision, and the beauty amid the alpine summits is a rare experience.

I wish to write here of two little trips—a day each—when horse-back and alone I rode from Moraine Park to the top of the range to collect botanical specimens. The first trip was a day in July and the second on a day in August of another year. The high mountains, like the plains, have a succession of flowering plants, though the season is short, and I made the change of time to get a greater variety of specimens. Leaving the valley I rode leisurely up an old trail made years ago by miners prospecting for gold on the north fork of the Grand river, and ascended a hill-side to the crest of a ridge. Far below, the waters of the Thompson river coming from the canyon above wound their way through the valley and meadows and gullies and sparkled in the sunlight; and across the valley and beyond the hills to the southward rose the grand proportions of Long Peak. Before me was a valley into which the trail descended

and then continued up it to the timber-line. Through this valley ran a little rivulet, fed by the melting snow-banks on the mountain above. Once the valley and hill-sides had been clothed with spruce and pine, but thirty or more years ago they had been fire swept, and for the most part were now barren and desolate, and the rocks and soil reflected the heat of the summer sun. A few quaking aspens were growing in clumps; a few willows flourished along the little rivulet, and a number of small flowering plants—among them *Pentstemon glaucus stenosepalus*, one of the most beautiful of our pentstemons, found here a favorable habitat. A short distance below where the trail enters the valley ends, and a precipitous mountain side slopes to the park. A glacier once came down the Thompson canyon, leaving a lateral moraine along the mountain side, and this moraine, crossing the brink of the valley, had dammed the little rivulet and made a swampy place which now is mostly covered by willows and several old spruce trees. Just above timber-line the trail turns aside to a spring of the purest cold water. Have not we noticed that all roads and trails have a side-path to the springs?

“ Sometimes there comes a taste surpassing sweet  
Of common things—the very breath I take;  
A draught from some cool spring amid the brake.”

A steep ascent along the zigzag trail brings one out onto the summit of the range, which here is quite broad and comparatively level. It is made of broken rock which has gathered soil and been beautified by nature with such plants as the soil and climate permit to grow. Grasses and sedges form most of the covering, but among them grow many of the higher flowering plants of an alpine sort: the gentian, *Gentiana frigida*; the primrose, *Primula angustifolia*; *Sieversia turbinata*; *Phlox caespitosa*; *Silene acaulis*; painted-cup, *Castilleja occidentalis*; *Tetranneuris acaulis*, *Rydbergia grandiflora*, *Polygonum bistorides*, *Paronichia pulvinata*. Here for the first time I collected *Campanula uniflora*, a little plant which extends from the Colorado Rocky Mountains to the arctic regions. On the July day when I was here a snow bank lay on the level mountain top, and about the snow and growing up through its edges were the large golden

yellow blossoms of the buttercup, *Ranunculus adoneus*. snow which lies on the mountain tops until summer becomes coarsely granular and hard, and it seems strange that this particularly tender and fragile buttercup should push its way through the hard icy snow. I have always found it blossoming close to retreating snow, and have noticed that some other plants blossom under like conditions. The dogs-tooth violet is ordinarily an early spring flower, but I have seen it in full bloom beside a retreating snow bank on the high mountains in the middle of August. No matter what the time of year, it is spring when the snow melts, and early spring beside a retreating snow bank.

While busily engaged in getting some of the *Ranunculus* I was attracted by a slight noise, and looking round saw within a few feet of me a mother Ptarmigan which had hidden at my approach; and looking more carefully I saw several chicks which could not have been many hours out of the shell. Both the mother and chicks were so like the color of the rocks and crevices that it was difficult to see them. I put my hat over my eyes and held in my hand several of the little brown bodies, which were feathered to the toes.

In the middle foreground as I came out on the mountain top is a ledge of rock standing ten to fifteen feet above its surroundings, and on the western edge another ledge. Soil has accumulated in the crevices and on the less precipitous places, and it is about these ledges that I found the most interesting collection of plants, particularly on the eastern side which is sheltered from the west winds. Growing in the crevices was the alpine *Heuchera bracteosa*, which is almost always found in the crevices of ledges; *Oreoxis humilis*, a very small umbellifera with white blossoms in July and reaches the fruiting stage about the middle of August; cinque-foil, *Potentilla nivea*; mountain sorrel, *Oxalis digyna*; *Macronema pygmaeum*; and *Saxifraga cernua*.

About the bases of the ledges, sheltered by large boulders which probably hold the moisture, were several larger plants, such as *Senecio Fremonti*, first collected by Lieut. Fremont and described by Torrey and Gray in their Flora of North America.

columbine, *Aquilegia cœrulca*, a beautiful and showy plant which begins to blossom along the foot-hills in May and reaches the alpine districts in August; *Heuchera parvifolia*, another plant which grows from the foot-hills to alpine heights; *Mertensia Parryi*, a species recently described by Dr. Rydberg, and *Ribes parviflora*. Growing on the western ledge was the somewhat rare cinque-foil, *Potentilla uniflora*. It had been growing here some time, for the decumbent stems were quite long and the bases covered with dead leaves. It trails close to the rocks, and the flowers are large for the size of the plant. Sheltered under boulders under which one must look to find it was the columbine, *Aquilegia saximontana*, and a little farther down among boulders was *Angelica Grayi*—a plant which for some time was called *Archangelica Gmelini*, then described by Drs. Coulter and Rose with some assurance as *Selinum Grayi*, and again by them transferred to *Angelica*, where it now stands. Growing in the more open were such plants as the thistle, *Carduus scopulorum*, *Polemonium confertum melitum*, the large flowers varying from deep to light blue; the dwarf alpine form of the whitlow-grass, *Draba streptocarpa*; the alpine form of *Chamænerion angustifolium*, and *Solidago decumbens*. Here too was *Achillea millefolium*, the common yarrow, which grows from the sea level to the alpine districts.

These high mountains have a fauna as well as a flora. I noticed some alpine butterflies flitting about; there were a few birds of the sparrow family; the little chief hare, of which a glimpse could scarcely be seen, makes its home in the rocks; the ground hog lives in the ledges and there is a little burrowing animal—a mole I suppose—of which I caught a glimpse; often too a hawk may be seen soaring above the peaks.

From the mountain on which I was the view extends on either hand to still higher mountains, on whose sides and summits lay banks of snow. To the north-eastward the slope went into Fall river, and south-westward into the Thompson canyon. For several hundred feet this precipitous side was strewn with boulders, rough and sharp because unsmoothed by the action of a glacier or running water; then to the bottom of the canyon and

up the opposite side to timber line was the dark green of spruce and pine. Across the canyon rose a massive mountain, whose sides were large banks of snow from which ran streams to the river below. I could trace the creeks and see falls of considerable height, but no sound came across the canyon. Was it said something about frozen music?

As the sun declined toward the west, reluctantly I turned my horse's head down the mountain side, taking my botanical specimens, and the memories of a day on the mountain top—a day to be remembered.

“On alpine heights o'er many a fragrant heath,  
The loveliest breezes breathe;  
So free and pure the air,  
His breath seems floating there.”

## THE CHINESE SUMACH, OR TREE OF HEAVEN AILANTHUS GLANDULOSA.

BY HOWARD H. M. BOWMAN.

Although quite common in the vacant lots and outskirts of many of the cities of eastern United States, this tree has of late received the attention it once did and which it so deserves, for it has quite a few points of comeliness if not beauty. Formerly it was extensively planted as a shade tree and the two gigantic trees standing at the entrance to many old country homes testify to its vanished popularity.

It is now escaped from cultivation and has spread rapidly by the suckers from its thick subterranean branches and by the seeds which are borne prolifically. Some old, well-grown trees have something of that pleasing contour seen in certain large, fine-topped trees of southern Italy and many tropical countries, giving the landscape a very picturesque appearance. But really prettier than the mature trees are the young saplings, with their slender stems and spreading crowns of pinnately compound leaves, from a yard in length. A clump of these growing among some native trees gives an ordinary grove that luxuriant tropical appearance.

obtained by no other tree or shrub of our temperate climate, favorite habitat seems to be fence corners or small groves, in company with the locust and the hackberry tree (*Celtis occidentalis*) which bears the "sugar-berry," so eagerly eaten by the children of localities in which it grows plentifully. But the *Ailanthus* grows almost anywhere, its seedlings coming up along the dusty roadside as well as in the soil with potted plants. If a tree is cut down the suckers appear over an area twenty feet in diameter.

*Ailanthus glandulosa* takes its generic name from the Malacca word *ailanto*, or tree of heaven; the specific name, *glandulosa*, referring to the glands of the bark, which if injured exudes a very sticky, resinous gum.

The tree is a native of China and the oriental countries and attains a height of from forty to ninety feet, bearing long petioled compound leaves, from one to three feet long, with about thirty to thirty-five odd pinnate, opposite leaflets ovate-lanceolate in shape and somewhat glabrous. The flowers, which are borne in terminal panicles, are polygamous, small and star-shaped, greenish white in color. The sterile ones have five short sepals, five petals and ten stamens. In June, when these trees bloom, the staminate flowers have an odor which to some people is agreeable, and to others very unpleasant. This lasts but a short time, however, and in other respects *Ailanthus glandulosa* is a very desirable shade tree.

The pistillate trees produce beautiful panicles of one-seeded twisted samaras or keys, light green in color, or sometimes suffused with pinkish red. The broad tops of the trees, bearing many large clusters of these light green, winged fruits, showing brightly against the dark green of the surrounding foliage, make a very pretty sight in mid-summer. These samaras are strung on threads by the children of eastern Pennsylvania, making unique wreaths, necklaces, or other juvenile adornments. The smooth trunks and branches of the older trees are of a soft gray or whitish shade, resembling the trunks of the beech.

The tree belongs to the family Simarubaceae, and is the only representative of its genus in this country, but there are two more species in its native home, China. The tree grows rapidly and

produces a hard wood, but so far as the writer knows it has economic value as lumber. Its bark is used in pharmacy. The properties of the bark are due to an oleoresin and a volatile oil "a nauseant and drastic purgative, constituting an excellent anthelmintic against tape-worm."\* In a certain park of an eastern city a few young *Ailanthus* trees among a clump of other shrubbery produced an effect that was indeed charming and at a little distance greatly resembled, if not rivalled, the palm in grandeur and fullness.

The leaf-buds of this tree do not begin to unfold until the leaves of native trees are well advanced, a trait common in plants introduced from a climate slightly warmer than ours, caused doubtless by the longer period of cool weather in spring which prevents the leaves from pushing off the bud-scales.

It is a worthy addition to a collection of trees and should be planted in localities in which it is not represented or which it has not as yet invaded.

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Closed gentian is a favorite with people who are especially interested in our native plants. It is not as attractive as fringed gentian, but is more interesting, inasmuch as its balloon-like buds never open, but have the appearance of opening to-morrow. Poets and some botanists relegate it to the woodlands, but it is in truth more frequently found in exposed places, low, damp meadows, ravines, and even on hillsides, but if in the woods near where the sun's rays cannot penetrate.

The best specimens are usually found growing in a damp cool soil, thus proving that its natural haunts are wet places. However, it also proves its extreme hardiness by developing in well drained porous soil. Disregarding this natural adaptability to almost any situation, the plant inconsistently refuses to develop in our gardens, for more than a season or two. Many experiments have been made to get this native perennial to develop here and there, but it will only consent to grow in places of its own choosing.—Eben H. Norris in *Floral Life*.

\* Gould, Dict. of Med., Biol., and Allied Sciences.

# APPARENTLY IMPARIPINNATE LEAVES IN CASSIA

BY J. ARTHUR HARRIS,  
*Missouri Botanical Garden.*

As Penzig has pointed out in the general introductory remarks to the Leguminosæ in his *Pflanzen-Teratologie*, the compound leaf of this family is subject to many anomalies. Trifoliate leaves are characteristic of whole groups, while in others only those pinnately divided are to be observed. It is interesting to find that transitions between these types sometimes occur by the division of some of the leaflets and the elongation of the rachis. If the terminal leaflet of an imparipinnate leaf be the one divided an apparently paripinnate leaf may result. Such have been frequently observed for *Amorpha*, *Robinia* (locust), *Caragana*, *Sophora* and *Gleditschia* (honey-locust). The lateral leaflets are also often divided, as in *Robinia*, *Astragalus*, *Coronilla*, *Gleditschia* and others. Transitions between pinnate and bipinnate leaves are occasionally observed. Simple leaves are sometimes seen in species normally with compound leaves. Rarely the terminal tendril of such forms as *Lathyrus* and *Pisum* is found transformed into a typical leaflet or into an ascidium. The development of tendrils in the place of lateral leaflets is also observed in *Vicia* and *Lathyrus*. Foliar and even stipular ascidia are observed.

During the summer of 1904 I observed on plants of *Cassia* *Sophora*, cultivated at the Missouri Botanical Garden, a few perfectly formed imparipinnate leaves. As is well known, the leaf of *Cassia* is regularly paripinnate. The rachis, however, projects slightly beyond the insertion of the last pair of leaflets in a small subulate or filiform process which might appear to the observer to be homologous with a terminal leaflet.

The first supposition in regard to these terminal leaflets was naturally that they represent cases of the development of a typical leaflet in the place of the terminal scale. In common morphological parlance such leaves as these might be spoken of as atavistic, the terminal leaflet being considered a reversion to an

ancestral imparipinnate leaf which preceded the present paripinnate type. It must not be forgotten, however, that we do not know the origin of the cassia leaf and that we are reasoning purely comparative data when we postulate that it was derived from a typical imparipinnate leaf of the type which we now find in so many genera of this family.

Furthermore, the examination of a large series of specimens showed that the origin of the extra leaflet from the terminal process of the rhachis is open to question. Several leaves were found in which the ultimate segment of the rhachis was markedly reduced in length so that the two terminal pairs of leaflets were inserted together as illustrated in figure 20*B*, while in one example one of the leaflets of the ultimate pair was considerably smaller than the other. The terminal process of the rhachis is rather small in *C. Saphera* and some related species, but it could easily be made out at the end near the dorsal surface in the leaf with two terminal pairs of leaflets approximated, and it could usually be detected in those in which there was apparently a terminal leaflet. These facts indicate that the apparently terminal leaf does not originate by the development of a terminal primordium, but that it is simply one of the ultimate pair, one member of which develops, possibly owing to the fact that two pairs occasionally originate together at the end of the rhachis instead of being separated by considerable distance.

In the summer of 1905 many plants of cassia belonging to *C. occidentalis* and *C. Saphera* type were grown, and the same peculiarities were noticed in occasional leaves.

Early in October I had about ten plants of these cassias and the leaves sorted and counted. The plants had grown among many other forms as a border against the outer walls of the greenhouses. They had in many cases been overtopped by their higher companions so that the leaves had fallen from the shaded, lower portions of the stems which were quite woody on several of the specimens. Many of the leaves still on the plants had lost some of their leaflets. All of these imperfect leaves were discarded and the remainder, 2,749 in number, counted. Of these, 2,669 were of the normal paripinnate type, while

had either three terminal leaflets or two pairs very close together. Fifty-two were assigned to the form with three terminal leaflets and twenty-eight to that with four. Almost all of these leaves were typical representatives of these forms as we have described them. Among those with two approximated terminal pairs one was found in which the two pairs were slightly separated, another in which the terminal of the two pairs was of leaves only about half as large as the others, and in a third case one of the two terminal leaflets was only about half so long or wide as the other; but except for these slight deviations all had the four terminal leaflets closely approximated and of about the same size.

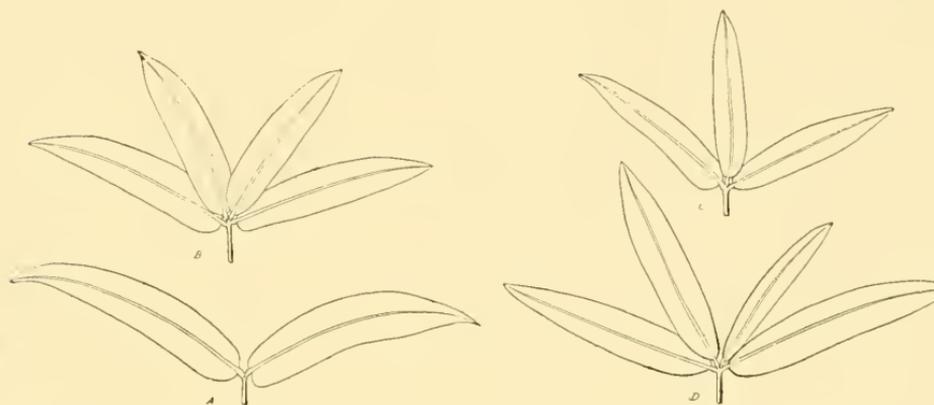


FIG. 20. *Cassia*. *A*, terminal leaflets in a normal paripinnate leaf; *B*, anomalous type with four approximated terminal leaflets; *C*, three terminal leaflets in an apparently imparipinnately compound leaf; *D*, transition form in which one of the two terminal leaflets is considerably reduced in size.

Among those with three leaflets the terminal one was in a few cases much smaller than the others, but generally it was of about the same size. The terminal scale was not always to be seen but could usually be made out. Occasionally there appeared a scar or scale indicating the existence of a primordium for another leaf. The origin of the terminal leaflet could in most cases be determined only from the evidence offered by the identity of the form and insertion of the petioles in those with three and four terminal leaflets, and the presence of the terminal scale. In no case was satisfactory evidence obtained for the derivation of the terminal leaflet from the end of the rhachis.

A point worthy of attention is the relative frequency of two classes. Of the eighty aberrant leaves examined in fifty-two had three terminal leaflets, while only twenty-eight had four. It would seem at first that if the form with four terminal leaflets—two pairs of leaflets closely approximated at tip—be the intermediate stage between the normal and the paripinnate type, it should also be intermediate in frequency, this is clearly not the case. It seems not improbable that mordias for both leaflets are formed, but space and nutrition sufficient for the full development of but one, and the other early disappears.

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## AIDING CITIES AND TOWNS TO NAME THEIR TREES.

### THE FOREST SERVICE WILL IDENTIFY TREES IN STREETS AND PARKS.

The increased interest in forests and forest trees which is a sign of the times has, among other things, led many city and town officials to seek to make known the names of trees growing in streets and parks. Not only are such trees in very many cases now without marks of identification, but in not a few cases they have been labeled with incorrect names. The Forest Service has devised plans by which its coöperation may be secured in correctly identifying the public trees of any community which may care to call upon it.

It is remarkable how little uniformity there is in the use of tree names. Even scientific names, which are, of course, always more exact than the common names, are in many cases unsettled, and common names are often used almost at random. In different parts of the country the same species may be popularly known under very different names, and, on the other hand, the same name is often used in different localities for altogether different trees.

In the effort to assist toward uniformity of usage in scientific names of forest trees, and also to lessen the chaos in the use

common names, the Forest Service has already published "A Check List of the Forest Trees of the United States." This serves as a guide when once a tree has been identified by the botanist. But the first requisite is that the identification should be correct. It is here that difficulty is often met with; and the Forest Service now offers its technical knowledge to city authorities.

There are two ways in which assistance may be given. When the work is on a large scale, a representative of the Service will visit the town or city and identify the tree by examination on the spot. In most cases, however, identification by correspondence will prove entirely adequate. This will require merely that specimens of the trees be sent to the Forest Service, together with a rough sample plat showing their location, the plat and specimen being numbered to correspond.

For such identification a full set of specimens, illustrating mature foliage, and, if possible, specimens of the flowers and of the fruit (as the botanist call the seeds) should be sent. Fruit specimens are very essential, but flowers may be omitted if they cannot be readily secured. Two or three specimens of branches in leaf, ten to twelve inches long, taken from different parts of the crown, so as to exhibit all of the leaf forms common to the species, will answer for the foliage. One or two specimens of the foliage, flowers, and fruit may be placed between sheets of ordinary newspaper or blotting paper about twelve by sixteen inches in size. Thirty to fifty specimens and sheets may thus be piled one on top of another, and the whole bundle placed between two stiff pieces of mill board, pasteboard, or thin picture backing, a little larger than the sheets of paper carrying the specimens. The package must then be well tied and wrapped, when it may be sent by mail, if under four pounds in weight. If, before sending, the specimens are changed to dry sheets of paper once in twenty-four hours, keeping them constantly under a weight of from forty to fifty pounds, they can be thoroughly dried within two or three weeks when they will not be so heavy and will still be in excellent condition for identification.

## OF INTEREST TO TEACHERS.

EDITED BY DR. C. STUART GAGER.

## THE STATUS OF BIOLOGICAL SCIENCE IN THE SECONDARY SCHOOLS OF PRUSSIA.

Apropos of the discussion by three of the high school principals of Greater New York, on the value and scope of high school biology, printed in the last issue of the PLANT WORLD, is the following extract from an account by Professor J. W. A. Young in *Science*, of May 18, of the feeling on the same subject among educators in the secondary schools\* of Prussia.

For over a decade a vigorous agitation has been taking place relative to the teaching of the natural sciences. At the annual session of the Association of German Natural Scientists and Physicians held in Hamburg in 1901, a joint meeting of sections for botany, zoology, mineralogy and geology, and astronomy and physiology, unanimously adopted a set of nine propositions relative to instruction in biology. The first five of these propositions, which soon became generally known as the "Hamburg Theses," read as follows:

1. Biology is an experimental science which indeed goes as far as well-grounded knowledge of nature will at the time allow us to go no further. (*Die Biologie ist eine Erfahrungswissenschaft, zwar bis zur jeweiligen Grenze des sicheren Naturerkennens, aber dieselbe nicht überschreitet.*) For metaphysical speculation in biology as such has no responsibility, and the school no use.

2. *Formally*, instruction in the natural sciences is the necessary complement of the abstract subjects. In particular, biology teaches the art, elsewhere so neglected, of observation of concrete objects subject to continual change in consequence of the processes of life, and, like physics and chemistry, proceeds inductively from observation of properties and processes, to the logical formation of concepts.

\* In Germany called "higher schools." Pupils are admitted at the age of nine, the course of instruction covers nine years, and the normal school graduation is nineteen or twenty.

3. *As to content*, instruction in natural history has the duty of acquainting the growing youth with the most essential forms of the organic world, to discuss the manifold phenomena of life to present the relations of organisms to inorganic nature, to each other and to man, and to give a survey of the most important periods of the earth's history. Upon the basis of the biologic knowledge acquired, the structure of the human body and the functions of its organs, together with the chief points of general hygiene, deserve special attention.

4. *Ethically*, biologic instruction awakens respect for the structures of the organic world, an appreciation of the beauty and completeness of nature as a whole, and thus becomes a source of the purest enjoyment, untouched by any of the practical interests of life. At the same time, he who busies himself with the vital phenomena of nature is led to feel the incompleteness of human knowledge, and to recognize his own limitations.

5. Such knowledge of the organic world must be regarded as a necessary part of the general culture which the times demand; it is not only useful to the future natural scientist or physician as preparation for his professional study, but is equally important for those graduates of the secondary schools whose future occupation does not directly require study of nature.

The remaining four theses relate more specifically to German conditions, pointing out that under the present curricula biologic study is excluded from the later years of the course, in which years alone the pupil is sufficiently mature to understand what is taught of the processes of life and the influence of environment; demanding that biologic instruction should be given, say two hours weekly, throughout the nine years of the school course; and making some specific proposals whereby it is thought this can be accomplished.

A committee was formed to circulate the theses and the support of about eight hundred scientists was secured. At the session of the association in Cassel in 1903 this committee made a report and proposed that the Hamburg Theses be adopted by the general session of the association.

In consequence of the resolution then adopted, the general session of the association at Breslau in 1904, took up the "Report and Debate on the Instruction in Mathematics and Natural Sciences in the Higher Schools." All the questions involved were referred to a commission.

Two of the governing principles which it set up are the following:

I. The commission wishes that instruction in the higher schools be neither one-sidedly linguistico-historical, nor one-sidedly mathematico-scientific.

II. The commission recognizes mathematics and the natural sciences as of equal culture value with the languages and adheres to the principle of specific general culture in the higher schools.

The reports on the natural sciences call for more time in these subjects even in the classical schools, at least while, as at present, these schools far outnumber the others, and consequently the graduates in all influential walks of life furnish the great majority of those taking the lead. The commission calls for three hours weekly throughout five years in physics, two hours weekly for four years in chemistry and two hours weekly for nine years in the biologic sciences (and geology).

C. S.

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## REVIEWS.

*Notes on the Life History of British Flowering Plants*. Lord Avebury (Sir John Lubbock) is a compendious treatise bringing together a large number of observations and results of study by the author who has long been known as a student of the natural history of plants by his previously published works such as *Flowers, Fruits and Leaves, Buds and Stipules*, etc. The field of such studies is one which, while it calls for much critical attitude, is yet one which might very well be cultivated by persons who desire to investigate problems of plant life, but are not situated so that they may use a laboratory. Well as the flora of Great Britain is known, Lord Avebury's book shows

\* 450 pp., 8vo. London: Macmillan and Co. 1905. \$5.00.

how wide and extensive the lacunae in our knowledge of this flora are. This is the more true of the extensive and various vegetation of our own country, and we recommend to the more seriously inclined—those who desire to know plants in a somewhat critical way—the perusal and use of these notes as a means of orientation and as suggestive of much valuable work.

The only general criticism which we may make of Lord Avebury's work is that we see a strong tendency to see in a result a phenomenon the cause of it. This is, of course, the danger of the teleological interpretative method. For example, the author speaks of the spines on the leaves of the holly as a protection against the browsing of cattle, and remarks that "it is interesting that the upper ones which are out of reach tend to lose the spines" and quotes from Southey a stanza which embodies the *post hoc* view completely.

*Elementary Botany*, including a manual of the common genera of Nebraska plants, is a little book of 199 pages designed by the author especially for the use of those who do not have the opportunity for studying botany in the school as well as for those who have. The subject matter is arranged by months, and is put in simple non-technical form. It consists of directions for the observation of the more obvious features of plants throughout the whole kingdom, as does also the manual accompanying. It may be had of the University Publishing Company, Lincoln, Neb.

A series of articles, by Bradley Moore Davis, on "Studies of the Plant Cell" which have appeared from time to time in *The American Naturalist*, have been issued by their author collectively in book form, and are offered by him for sale. The presentation of the subject is scholarly and fairly detailed, and the book will prove very useful to teachers and students, and especially so on the college and university reference shelf. Copies may be had from the author, University of Chicago, Chicago, Ill.

*Window Gardening in the School-room*, by H. B. Dorner\* is a small but very good treatise on a subject worthy of and demanding

\* Published by Purdue University, Lafayette, Ind.

not a little study. Everyone who has tried knows very well why meagre success often follows the majority of efforts of the window gardener, and in view of the success of the average worker of the country who bestows tin-cans and tender care on her plants the more scientific are not seldom victims of chagrin. This pamphlet will help such to whom we would commend also an article by Professor Balfour on "*Physiological Drought in Relation to Gardening*," in the January, 1905, number of the PLANT WORLD.

*Hints and Helps for Young Gardeners*,\* by H. D. Hemery is an attractive pamphlet designed "not only for youthful gardeners, but also for those young in experience," by one whose experience as the Director of the School of Horticulture of Hartford well equips him for the task. How to plan the garden, soil tillage, how to test seeds, to plant, to dig and set trees, to make and use a hotbed, strawberry and asparagus culture and window gardening are the topics treated of in the course of the work. A table of vegetables, showing dates of planting, data of the method of culture, and other pertinent matters, including "what its cultivation teaches," is a useful feature, particularly valuable to those doing school garden work.

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The Journal of the Horticultural Society of New York is a quarterly periodical published for the benefit of the members of that society. The first number appeared in April of this year.

Ecological treatment of considerable proportions of North Michigan has been carried out and a report of 133 pages has been prepared under the direction of Chas. C. Adams. This full paper is published as a report from the University Museum and constitutes a part of the report of the Geological Survey of the State for 1905. The study includes a survey of the fauna as well as the flora, and gives the reader a very comprehensive account of the natural history of the area taken under consideration.

\* Published by the author, Hartford, Conn. 59 pp., 8vo. Illustrations, 35 cents, \$20.00 per hundred.

## NEWS ITEMS.

On the twenty-third of May the Torrey Botanical Club held a special meeting in celebration of the tenth anniversary of the commencement of work in the development of the New York Botanical Garden. The meeting was held in the museum building of the Garden, and the program consisted of an illustrated lecture by the President of the Club, Dr. Henry H. Rusby, on "The History of Botany in New York City." Dr. Rusby traced the development of botanical activity in the city of New York from the time of Dr. Torrey, and previously, to the present. The account of various earlier attempts to establish a botanical garden in the city was especially interesting, as was also the tracing of the growth of the Torrey Club, and the bearing of the Club's work on the establishment of the Department of Botany in Columbia University and the organization of the Botanical Garden.

At the close of the lecture there was an informal reception in the library, followed by an inspection of the laboratories and the museum exhibits.

Bills have recently been signed by Governor Higgins which will save two scenic treasures to the people of New York State—Hook Mountain on the Hudson River, and Watkins Glen, at the head of Seneca Lake.

Hook Mountain rises 730 feet, on the west bank of the Hudson about two miles north of Nyack. It was being rapidly blasted away, and had it been destroyed, one of the most beautiful points on the river would have been marred. Now that the future of this site and of Palisades Park are assured, it is expected that this part of the Hudson will be very popular for summer outings.

Watkins Glen, with its cascades, waterfalls, and deep pools, is one of a great number of picturesque gorges in south central New York, in what is known as the Finger Lake valley region. It is the result, physiographers now believe, of ice erosion. In an article on Watkins Glen in the *Popular Science Monthly* for May Professor Tarr says of it, "From the standpoint of either the geographer, the geologist or the lover of scenery, a visit to any

one of these glens is well worth one's while; but no single one is so easily accessible, nor presents such a variety of phenomena as the Watkins Glen. Nearer centers of population it would be more famous than now, and would be visited by scores of thousands. Waterfalls and gorges in Europe which cannot be compared in beauty or interest with a score of glens in the Adirondack Lake region are far better known to the travelling American than the Watkins Glen. It seems well, therefore, that it should be taken over by the state, made better known, and opened freely to the public.

The American Scenic and Historic Preservation Society has recently been instrumental in obtaining both the Glen and Hook Mountain for the State.

The Editor has received from several quarters expressions of appreciation of the biographical sketch of Wilhelm Hofmeister by Professor K. Goebel, published in this magazine in December last. One of these, from Professor Eugene A. Smith, of the Geological Survey of Alabama, is of interest because of the personal touch, and we venture to reproduce Professor Smith's remarks in part.

"I was a student in Hofmeister's laboratory for two years, 1867-8, with Dr. Müller, Dr. Pfitzer, and Dr. Askenasy, and many others, and am glad to have this reminder of those days. The small carte-de-visite photo which I got at that time is the best almost, if not quite, as that of Professor Goebel's paper.

"I recall with great pleasure the many hours spent in his laboratory, and the microscopic work which we did there. I can still split a thin section by holding it between thumb and forefinger and using a sharp razor, and made many such for Hofmeister. My slides, mounted in glycerine in shellac cells, have mostly gone to ruin, from cracking of the varnish and escape of the glycerine. I had many hundreds of them."





JOHN TORREY, 1796-1873.

# The Plant World

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## AN HISTORICAL SKETCH OF THE DEVELOPMENT OF BOTANY IN NEW YORK CITY.\*

BY HENRY H. RUSBY, M.D.

*Dean of the New York College of Pharmacy.*

### I. EARLY EFFORTS.

Were we to commence with the very earliest botanical history of our city, we should be carried back to a time when, as an important seaport in a new world, it was made the temporary headquarters of visiting botanists, who accumulated here their collections, maintaining some of them in a living condition, until the arrival of a convenient opportunity for dispatching them to the mother countries. Such occurrences as these exerted little influence in the permanent development of a botanical center. Developmental work of the kind that concerns us was active, previous to the close of the eighteenth century, at some points farther south, especially at Philadelphia, and in New England, but none at New York.

The first important event here was the work of Doctor, afterward Governor, Cadwallader Colden and his daughter Jane, who near the middle of the eighteenth century, conducted their studies with the aid of a small botanical garden at their home near Newburgh. Perhaps the most important part of this work consisted

\* Portion of an address delivered before the Torrey Botanical Club at a special meeting held on May 23, 1906, in commemoration of the tenth anniversary of the commencement of work in the development of the New York Botanical Garden. Printed in full in *Torreyia*, Vol. 6, Nos. 6-7, June and July, 1906.

of the correspondence carried on with native and foreign botanists regarding their local flora, and the transmission of specimens. Miss Colden first made known our pretty little *Coptis* gold-thread.

A much more important event was the arrival here, in 1789, of the elder Michaux, who established a celebrated botanical garden at New Durham, N. J., the site of which is now occupied by the Hoboken cemetery. A brief account of this garden may be found in the *Bulletin* of the Torrey Botanical Club, II, p. 1884. In that year I saw growing there a barberry bush which apparently represented the last trace of Michaux's plantings except that the European medicinal shrub *Rhamnus Fran.* which he appears to have introduced, has established itself in adjacent lowlands, and at some neighboring points. Michaux's garden was established especially for the temporary cultivation of plants designed to be sent to France, or to yield seeds desirable for such shipment. Nevertheless, so zealous an investigator Michaux could not fail to utilize this agency for purposes of study, and his great work, *Flora Boreali-Americana*, published in 1803, and other works on North American botany, were materially enriched. Michaux's work in this country was continued by his son, one of whose important publications was *Histoire des arbres forestiers de l'Amérique Septentrionale*, afterwards translated into English as *The North American Sylva*, and this also profited largely by the observations made by his father while maintaining his garden.

During the time when the Michauxs were so active here, Samuel L. Mitchill was assiduously collecting plants in the vicinity of his home at Plandome, Long Island, a catalogue of which was published in 1807. His work is of special interest to us since he was the first professor of botany in Columbia College.

The flora of Manhattan Island was at this time being actively studied by Major John Le Conte, who in 1811 published an important catalogue relating thereto.

It is a well recognized historical fact that up to this time, indeed for a long period following, botanical work proper in this country consisted chiefly in the collecting and naming of plants and the describing of new species.

Writing of the period about 1814, made memorable by the publication of Pursh's *Flora Americae Septentrionalis* and Bigelow's *Florula Bostoniensis*, Darlington says " Botanical works now began to multiply in the United States—and the students of ' the amiable science ' found helps in their delightful pursuit, which rendered it vastly more easy and satisfactory than it had been to their predecessors."

#### DAVID HOSACK AND THE ELGIN BOTANICAL GARDEN.

The next botanical undertaking in this city was of the greatest importance in connection with our study, and calls for our particular attention. The successor of Dr. Mitchill as professor of botany and materia medica in Columbia College was Dr. Dav



FIG. 21. The Elgin Botanical Garden, including what is now 46th and 50th Streets, and Fifth and Madison Avenues. (Courtesy of the New York Botanical Garden.)

Hosack, a man of equal breadth and of great strength and energy. His interest in botany was chiefly medical. Most of the amateur botanists of that day were practicing physicians, and many, if not most of the professionals had received a medical education and training, so that Dr. Hosack's attitude toward the science was not at the time peculiar. This fact reminds us that outside of

the investigation of general and local floras, in their relation to geographical and taxonomic botany, interest then centered chiefly in the medicinal properties and uses of plants. The chemistry of plants was then practically unknown, whereas it is now the basis of medical botany. Since chemistry constitutes at the same time the visible basis of physiology, and physiology brings us as close as it is possible for us to get to the life of the plant, it follows that medical botany, while not entitled to the objective position that it held in the days of Hosack, is concerned with the same phenomena which engage the attention of the very highest workers in botanical science at the present day.

Even in the state of ignorance which then existed, it was clear to such keen reasoners as Hosack that the reaching of sound botanical conclusions requires that the living plant be kept under observation, and he became possessed of the strongest determination to establish a botanical garden adequate to the needs of local botanists and teachers of botany. After long efforts to secure sufficient coöperation, he at length decided to enter independently upon the enterprise, and in 1801 he purchased two acres of land at Elgin, now bounded by 46th and 50th Streets, Fifth and Madison Avenues (or probably of somewhat greater extent), and established the famous Elgin Botanical Garden, better known perhaps as the Hosack Botanical Garden. Besides his hardy plants, many were grown in a large conservatory. The site of this garden was described in 1811 as "about three and one-half miles from this city, on the middle road between Bloomingdale and Kingsbridge."

Hosack announced as its primary object the collection and cultivation of the native plants of this country, especially such as possessed medicinal value or were otherwise useful. He gratefully acknowledges assistance received in starting his garden from Professor Mitchill, his predecessor, from the Hon. Robert Livingston and from John Stevens, Esq., of Hoboken. He soon learned that the successful conduct of a botanical garden is a work of enormous labor and serious responsibility, and that a man, otherwise engaged, cannot accomplish it. With the garden already in actual successful operation, it was not so difficult

enlist state interest, and the legislature was induced to purchase it in 1810, and to provide the necessary funds by means of a lottery. Hosack subsequently enjoyed the classical distinction of all successful promoters of great enterprises, in being assailed by the high-class scum of citizenship. By subsequent legislative action the property was turned over to Columbia College, and its use diverted from that of a botanical garden to that of high-profitable rentals.

#### JOHN TORREY AND HIS CONTEMPORARIES.

We cannot understand the botany of Hosack's time without a brief glance at some of his contemporaries and immediate successors, especially those who exerted local influence. The list includes the names of some of the most honored of American botanists. Foremost of them all was John Torrey. Following Dr. Hosack, he was the third of the five men who, up to the present, have occupied the chair of botany in Columbia College. His characteristics may be expressed in the terms strong personal character, broad scholarship and great intellectual ability. Although best known to us as a botanist, yet thirty years of his life were those of a great teacher and worker in chemistry at the U. S. Military Academy at West Point, in the College of Physicians and Surgeons of this city, in Princeton College, and as State Assayer in the New York Office. Had the necessary facilities then existed in this country, it seems likely that this man, combining such a great knowledge of botany and chemistry, might here have developed important researches in the chemistry of plants. As a matter of fact, his knowledge of botany was acquired chiefly as a recreation in the hours of leisure afforded by his other professional work. Yet Underwood truly writes, "When the annals of American botany are finally written, no name will have a more conspicuous position than that of John Torrey."

Almost before reaching manhood Torrey was one of the founders of the New York Lyceum of Natural History, and was its leader in publishing, through it, a catalogue of plants growing within thirty miles of the city. Five years later he published the first part of his *Flora of the Northern and Middle Sections of t*

*United States*, and later his *Compendium* on the same subject. These important forerunners, in more than one way, of Gray's *Manual*. These accomplishments proved him the great master that he was, and soon his hands were crowded with important work, especially connected with the active explorations of our western territories then in progress. In this work he was a close associate of Torrey and Gray, and probably their most important work was the first part of their *Flora of North America*, published from 1838 to 1843.

Except for the published works of Torrey, most of those of this early period which here concern us were of a somewhat general nature, but naturally including our local interests. Of those that may be mentioned the following: In 1813, Muhlenberg's *Catalogue of North American Plants*, and in 1817 his work on North American grasses and sedges; in 1818, Nuttall's most scholarly work on the genera of North American plants; in 1820, Gray's *Genera*; in 1822, Schweinitz's *Monograph of the Genus Viola*; in 1833, Beck's *Botany of the Northern and Middle States*; in 1834, Schweinitz's work on North American Fungi, and in the same year, Gray's *Monograph of the North American Species of Rhynchospora*. In the meantime, very important works of similar character were being produced in the South, and to a less extent, in the West.

In 1803 there appeared about the first work designed especially for young students, an elementary work on botany by Barton. Writing of 1824, Darlington says: "About this time some of the schools in the Northern States began to make a profession of teaching botany, and a demand for suitable books for this purpose arose. Accordingly, a number, such as they were, soon appeared. Among the most successful was a *Manual*, compiled by Professor Amos Eaton, of Troy, New York." This sort of botanical teaching entered upon its most active stage with the appearance of Gray's *Elements of Botany*, in 1836, a work that is still being sold upon an extensive scale, and this, in your speaker's opinion, very greatly to the advantage of botany, in spite of the many books of different character, the use of which we so greatly enjoy. The publication, for the use of students, of text-books on structural botany, and later on morphology, in con-

nection with manuals on local floras, became very popular, and of incalculable value in interesting people in the study of plants.

#### GROWTH OF THE BOTANICAL DEPARTMENT OF COLUMBIA COLLEGE

We must now pass from this general consideration of local botanical development to the middle of the last century, and follow some special influences proceeding from the growth of the botanical department of Columbia College. During the period when Dr. Torrey was at its head, that department was very actively engaged in educational work, though this was of a peculiarly restricted sort, characteristic of the times. About the time of his death in 1873, his herbarium and library, which he had previously maintained in his home, came into the possession of Columbia, together with the herbaria of Crooke, Chapman and Meissner. To these, collections from various parts of the world and especially from those parts of the United States then being explored, were rapidly added, and a very large and important herbarium soon grew up; but no professor of botany was appointed to succeed Dr. Torrey, and the herbarium was neglected by the curator in charge. A very large part of it was not classified, nor even named, and lay in the form of a small mountain of dusty bundles which were not, and could not be consulted. Botanical instruction was most meager, and was merely a part of the general course in biology. There was not, in fact, a department of botany, the subject being treated as a subordinate of geology, under Professor John S. Newberry. From 1875 to 1879, Dr. Britton was a student at the School of Mines, and was strongly attracted, by natural taste and ability, toward the botanical side of his work. When upon his graduation he was appointed assistant to Dr. Newberry, he appreciated clearly the great value for a botanical department, of the materials in the possession of the College, and he began a careful and systematic examination of them.

A special stimulus to Dr. Britton at this time was his interest in his first great botanical undertaking, the preparation of an elaborate catalogue of the plants of New Jersey, this also being performed subordinately to a department of geology.

this undertaking, an intimate association with the members of our Club and an active participation in its work were prerequisites to success, an illustration of the way in which existing forces worked together in carrying forward our natural botanical development. Another potent influence of a similar nature should be here recorded. At this time considerable botanical material from distant parts of this country, and from other hitherto unexplored regions, was coming to this city for original study, and this made it imperative that Columbia's botanical house should be set in order in the interest of comparative work. With the knowledge and encouragement of Dr. Newberry, but with comparatively little on the part of others concerned in the management of the college, Dr. Britton carried out this work in the interim of his official duties, until at length a great working herbarium existed where before there was chaos. At the same time the botanical instruction was being extended, and, of greater importance, was being modernized. When the Doctor was at length prepared to make the situation known to Columbia, it was not to submit plans for the organization of a botanical department, but to present to it one already made, requiring only to be officially recognized and formally named. New York was now guaranteed as one of the first botanical centers of the country, and later of the world, with Dr. Britton as Columbia's fourth professor in botany.

Thus we see that at every important stage in its development the botanical department of Columbia has owed its prosperity not to the institution as such, but to some earnest worker, ready to make the sacrifice of love. Hosack individually made the botanical garden that afterwards enriched the institution; Torr accumulated the herbarium that became the corner-stone of the later structure; Britton silently—one may almost say surreptitiously—brought about changes which have finally placed it at the vanguard of the world's botanical forces.

The intercourse and personal and professional associations dependent upon the increasing number of persons in and about New York who became interested in botanical work in Torr's time led most naturally and inevitably to a botanical society, first incidental and unorganized, later a formal organization.

The formal organization of the Torrey Botanical Club was undertaken in 1867, and its incorporation occurred four years later, under the name New York Botanical Club, changed the following year to that which it now bears. Within three years of its establishment the Club began issuing a monthly publication, the *Bulletin*, since uninterruptedly maintained. Its prefatory note declared its primary object to be "to form a medium of communication for all those interested in the Flora of this vicinity, and thus to bring together and fan into a flame the sparks of botanical enthusiasm, at present too must isolated. . . . We have chiefly in view the development of a greater botanical interest in our neighborhood, and found our hopes of success as much upon learners as upon the learned."

In the further unfolding of its objects, the *Bulletin* unconsciously states the object of the Club's organization: "An attentive study of plants in their native haunts is essential to the advance of the science, and in this respect the local observer has an advantage over the explorer of extensive regions, or the possessor of a general herbarium. He can note the plant from its cradle to its grave; can watch its struggles for existence, its habits, its migrations, its variations; can study its atmospheric and entomological economics; can speculate on its relations to the past, or experiment on its utility to man." Ecology is thus clearly seen to be the object of study, notwithstanding that the name of it was not generally discovered by our botanical fraternity until about 1890, nor the active and merciless chase of this poor thing by American botanists well under way until about five years later.

From this time up to the establishment of the New York Botanical Garden the history of our Club is practically that of botany in this city, for very little was done that was not directly or indirectly connected with us or, one might say, actually centered about us. This fact is of the utmost importance in our study, since upon it depends the essential character of most of what has since occurred.

(To be concluded.)

## THE PASSING OF THE PRAIRIE FLORA.\*

BY WALTER ALBION SQUIRES,

*Koaskia, Idaho.*

Native plants are doubtless disappearing more rapidly in prairie states than in any other section of the country. Mountains, swamps, forests and sphagnum bogs are often the last strongholds of the wild flowers. Here they linger long, little patches of the wilderness beauty untarnished by the hand of man. But for our prairie wild flowers there are few such places for refuge. Driven by the plow from the sod of their native meadows, and from hillside and hollow by grazing herds, they linger for a time in fence corners and by the dusty roadside, struggling for their lost footholds, choked and dwarfed beneath the dominant hordes of introduced weeds.

A few of our native plants, such as the milkweeds and the compass plant, tend to become weeds and invade the cultivated fields, but all of our rarer and more beautiful species are quietly withdrawing from their native habitat. The sensitive rose, the fringed rein-orchis and the lady's tresses are to be found only where the native sod has been undisturbed. The little white and purple wind-flowers, first of the prairie blossoms to greet the spring, have gladdened the heart of many a settler's child. They were once so abundant in northern Kansas that whole hillsides were colored with them, but I have seen scarcely a dozen blossoms in the last ten years.

Along the brooks and on moist shaded hillsides the star-campion, yellow lady's slipper, wild lily and adiantum fern may still be found but when such places are turned into pasture land they almost invariably disappear within a few years.

We cannot decry the enterprise which has in the last half century transformed the prairies from a grassy wilderness to a land where the hum of industry never ceases, a land that has become the granary of the world, a broad and bounteous land of a million happy homes. But is it necessary that these beautiful products

\* Awarded the second prize of \$10, in the competition of 1905, Stoll fund of the New York Botanical Garden.

of the prairie through which our childish eyes first caught glimpses into the infinite depths of nature, and which some of us have never ceased to love—a universe of unfathomed meanings whose boundary is God—is it necessary that they all be swept away before the advance of industrial progress? There are those who are ever ready to cry down all such matters as weak sentimentalities. Their ideas of the useful seem incapable of grasping other than financial standards. And yet the fact remains that the highest utility resides in that which is able to enrich, like the pocket-book, but the life of man himself, that which lifts him into broader, truer, nobler living, to greater capacity to think, feel, and to love. Is it not worth while then to preserve these beautiful things of nature, small and trifling though they may appear, if through the appreciation of them the American character may be drawn away from a too absorbing pursuit of wealth into fuller and more abundant living?

How may our prairie wild flowers be preserved? Every great movement is psychological in its origin. If we can only arouse in the popular mind an appreciation of the wild flowers and a desire to know them more intimately, I have not a doubt but that the method of preservation will be found without much difficulty. The very fact that they are passing away—if it becomes known—will do much to awaken a sense of their value. It is the same principle to which the director of the New York Zoological Park referred when in speaking of the awakening popular interest in animal life he said: "As the world's great wild beasts are driven further and further into the dark fields from which there is no return, civilized man desires more and more to see them, to touch them, and to know them ere they go." Many of our prairie towns are just awakening to a sense of the desirability of parks and other means of beautifying their streets and surroundings. Instead of using introduced plants almost exclusively, as at present, these might be planted with native flowers and shrubs, many of which would be hardier and more decorative than the introduced species. As the people became more interested in wild flowers they would be more often seen in the private flower garden, for they are not so hard to cultivate as is usually supposed.

posed. A minister in Topeka, Kansas, has several hundred species of Kansas wild flowers, all growing and thriving within the limits of an ordinary city lot.

Finally, we may fall back with almost absolute assurance of success, if we but do our part, upon that institution which more than any other controls our nation's destiny—the public school. Children do not need to be taught to love flowers. Why not make a part of every school yard throughout our beautiful prairie regions a wild flower garden? By so doing we will not only be preserving the beautiful in nature, we will be storing little minds with beautiful impressions. Long years afterward when the skies grow dark over the sea of life, these recollections of a happy childhood will return, bright “angels of the memory” to guide and guide aright.

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SINGED CACTI AS FORAGE.—During the periods of prolonged drouth, to which the southwestern United States is liable, range cattle frequently browse upon various species of cacti common to the region. At the Arizona Experiment Station, Mr. J. Thornber has carried on experiments regarding the utility of this class of forage plants, particularly after the spines have been removed by burning by means of a prickly-pear burner—that is, a gasoline torch similar in principle to that which plumbers use. The spines of about 300 plants of the species of cacti commonly found in the neighborhood of the station, including prickly pears, chollas, etc., were singed, the spines being burned off at intervals for about ten days. The first fifty plants that were singed were literally devoured by the stock, the prickly pears being eaten nearly to the level of the ground, while only the trunks and woody branches of the chollas remained. As the work was continued from day to day, it was evident that the stock (although under unusual circumstances they will eat more or less of the cactus with the spines) were feeding entirely upon the singed plants, and that they readily distinguished them from the unsinged ones. The singeing and close browsing of the cactaceous plants, if continued would surely result in their final destruction, which would be a more distress to what already exists, so that in general not more than one-half of the plant should be singed, leaving the remaining half to restore the growth singed and utilized by cattle.



FIG. 22. Home of the Palo Verde, Laboratory Hill, Tucson, Arizona.  
(Courtesy of the Popular Science Monthly.)

## PALO VERDE: THE EVERGREEN TREE OF THE DESERT.

BY PROFESSOR FRANCIS E. LLOYD.

To the artist and botanist alike the play of colors in the desert is most fascinating, and not a small part in the change of coloration from month to month is taken by the flowers, which develop in great numbers and with remarkable rapidity after the seasonal rains, which occur in early spring and in the late summer. The fact that there are two rainy seasons in our southwestern deserts results in what we may very well describe as two springs instead of spring and autumn. It is noteworthy, however, that the plants which develop into flower and fruitage after the summer rains are not in general the same as those which develop during the spring.

It is my purpose in this article to speak particularly of a plant which, during the latter part of April and early May, supplies the dominant note of coloration in such regions as the desert about Tucson, Arizona. I refer to the palo verde, of which there are three species, known as *Parkinsonia microphylla*, *P. aculeata*

and *P. Torreyana*. According to Sudworth's check list of forest trees of the United States,\* the name *Cercidium Torreyana* (Wats.) Sargent, is given to the last mentioned species, but for reasons of which I shall speak later it would hardly seem justifiable to separate generically *P. Torreyana* from the other species.



FIG. 23. *Parkinsonia microphylla* in Blossom.

I shall describe first the small leaved palo verde (*Parkinsonia microphylla*) (Fig. 23), which is found growing upon the foothills of southern Arizona, California and Sonora, Mexico. This plant is as distinctly characteristic of this habitat as are the Giant cactus or Saguaro, the Ocotillo (*Fouquieria splendens*) and a considerable number of other plants, which in this connection need not be mentioned. It is a small, somewhat irregular tree, ten or twelve feet high, with more or less twisted and contorted limbs clothed with a green bark, this feature being com-

\* Bulletin No. 17, U. S. Dept. of Agriculture, Division of Forestry, 1901.

to all the species, and by which the name "palo verde" is very properly suggested, the name being Spanish for "green tree." The tree usually grows quite plentifully upon the stony hillside and in some places, at the time when other vegetation is less conspicuous than usual, has the aspect of a small apple tree, the whole formation looking rather orchard-like. During the ear

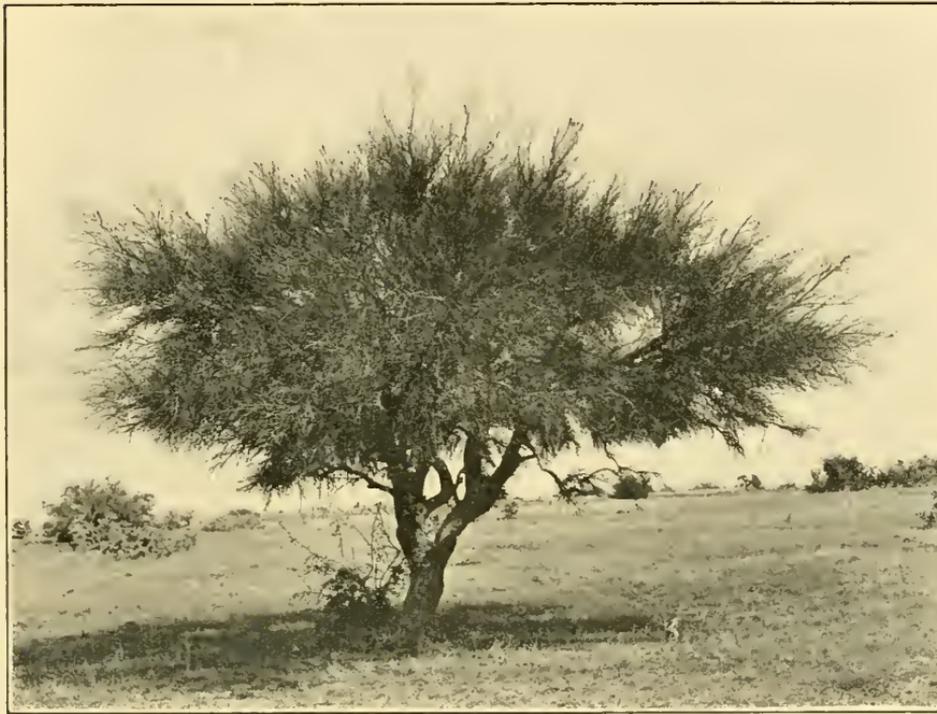


FIG. 24. *Parkinsonia Torreyana*, Sierrita Mountains, Arizona. (After photograph by Prof. V. M. Spalding.)

spring the smaller branches, which are lithe tapering twigs, are clothed with bipinnate leaves of a rather curious character. The single leaf has a very short rachis, so small indeed as to escape observation at first. From this spring two slender pinnae an inch or so long, which bear six or eight minute orbicular pinules, scarcely an eighth of an inch in diameter. So small are the leaves that when they fall, as they do during the latter part of April, very little difference is to be noted in the general aspect of the tree, although of course this will depend upon the density of the foliage, which varies with different individuals. The

leaves, as is true of the Leguminosae in general, are capable of "sleep" movements, the leaflets of the third order folding together upwardly upon the approach of night. When the leaves wither and fall away the pinna as a whole separates from the main, though very small, rachis, the pinnules sometimes remaining attached but usually falling away separately. The tapering twigs are, when young, slightly pubescent and as they mature their ends develop into thorns. On account of the tapering form of the numerous twigs, and their whip-like flexibility, the tree has an exceedingly graceful form. Its delicate evergreen foliage always gives its habitat a note of color, even during the driest seasons of the year when most, if not all, of the remaining vegetation has become more or less neutral in tint.

The flowers, which are borne in great numbers, are almost really symmetrical, the only evidence that the flower is of the type of the Leguminosae being seen in the vexillum or upper petal, which is of a somewhat different form from the rest, being supplied with a longer claw, and white in color, while the rest are light, lemon yellow. The presence of the white petal is sufficient to modify the total color of the flower masses into a rather pale, greenish yellow, distinguishing it at once by this feature alone from other species. The dorsiventrality of the flower is also marked by the unequal stamens and by their position, and also by the form of the pod, which of course is quite true to the family type. As soon as the insect life in the desert is set in motion by the rising sun the flowers are visited by myriads of insects of all kinds, so that as one stands near a tree their buzzing is very loud. The fruit, which develops rapidly during the early summer, consists of a papery pod bearing from one seed to a dozen, each one of which is separated from its neighbor by a marked constriction of the pod, which at its outer end is continued into a slightly curved, rather long beak. The whole of the pod when ripe splits into two layers, the inner of which consists of a narrow strap of tissue which extends throughout the whole length of the pod, and is no wider at any point than is the constriction which occurs between the seed chambers. The outer layer, on the other hand, is the part which gives the form to

pod, and it will be seen therefore that during the ripening the inner layer or endocarp takes no part in the secondary enlargement of the pod, which accompanies the enlargement of the seeds. This feature distinguishes this species and *P. aculeata* from *Torreyana*, in which latter the whole pod develops without constricting between the seeds, and has a form very like that of ordinary pea pod.

*P. Torreyana* (Fig. 24), known also as the green-barked acacia, is a larger tree than *P. microphylla*, with, however, the same general habit of growth, save that the branches are somewhat leafless, twisted and the terminal twigs longer. This tree grows in "washes," and apparently needs more water than its neighbors.



FIG. 25. Twig of Palo Verde. (Courtesy of the Popular Science Monthly.)

It flowers very abundantly, the tree becoming a mass of brilliant yellow when in full bloom. The twigs are usually armed with short thorns, which are very short, leafless branches. The leaflets of this species are considerably larger, and the prominent petiole, which in *P. microphylla* is white, is here yellow dotted with red, though slightly different in form from the rest of the petals. The pod of *P. Torreyana*, superficially regarded, differs materially from that of the other species, inasmuch, as above pointed out, there is no constriction between the seeds, or at a rate, very little, and this not constant. The ovary wall is papery, however, and while similar in general appearance to that of the common pea pod, differs from it in the splitting of the outer and inner layers of the wall. In the region of the seed, where the

pod has undergone a little further growth accompanying growth of the seed, the inner layer, or endocarp, is found to have been arrested in its development, and so is not as wide as the exocarp, and in this the plant is like the other species, differing from them only in degree. The non-adherence of the layers of tissue of the ovary wall results in a lack of tension which is to be found in many other species and which is related to the expulsion of the seeds, the setting free of which in these plants is accomplished by the mere splitting of the pod without any marked twisting of the fruit wall.

The third species, *P. aculeata* is a still larger tree, confined to a somewhat narrower zone from Yuma, through northern Mexico to Texas. The nearest station to Tucson where it has been found by me is on the western slopes of the Baquiveri and Coyote Mountains, about seventy-five miles away to the southwest, although it may of course occur nearer. It is like *P. Torreyana*, confined to the washes, which are the river beds, dry for the greater part of the year. When in flower it has much the appearance, too, of *P. Torreyana*, the flowers being wholly yellow with red markings on the upper petal, which turn brown with age. The pod is very similar in structure to that of *P. microphylla*. The most striking feature of *P. aculeata* is the leaf which conforms to the type described above for *P. microphylla*, but has two pairs of very much elongated pinnae, along the margins of which are inserted a few small, oblong leaflets so small that they are scarcely noticeable at a short distance. The rachis becomes a sharp thorn, and on the rapidly growing shoot the stipules are also in the form of spines. The pinnae are green and strap-shaped and sometimes reach the length of one and a half feet and being persistent they give by their pendulous habit a graceful, willow-like form to the tree.

Another matter that is especially worthy of note in this connection is the fact that plants of this genus are among the few Leguminosae the seeds of which are provided at maturity with an endosperm, and are therefore described in most systematic works as albuminous. This endosperm is reduced, in the ripened seed to two horny, translucent layers lying parallel to the cotyledons.

joined together by a small piece which forms a collar about the caulicle.

From the physiological point of view the green branches of plants in which the leaves are very much reduced, or absent, and so much leaf surface, just as in the cactus, which is entirely devoid of functional leaves, the green tissue supplies their want. Therefore we may regard the green bark of the palo verde as so much leaf surface. A transverse section cut through one of these twigs shows a highly organized system of green cells, having an arrangement quite similar to that found in the leaves of many plants exposed to strong sunlight, as they are in the desert. The stomata are similar in type to those of many cacti, being immersed below the surface, each at the bottom of a pit. Although the twigs are slender and easily bent and so give readily to the wind, they are nevertheless very strong and tough, almost like strands of leather. This is accounted for by the presence of so-called bast, which in this plant is peculiar in that it traverses the pith longitudinally. This, however, is supplemented by similar strands found in the rind.

All three species are well worthy of cultivation, although I believe that the long-leaved species is the only one which has thus far been introduced into cultivation and is known throughout most of the warm regions of the earth.

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THE CLASSIFICATION OF CACTACEAE.—The grouping of the species of cactuses into genera has been one of the most difficult problems of systematic botany, because this classification has necessarily been based largely on the plant body alone, inasmuch as the flowers and fruits of many of the species have either been unknown to botanists or imperfectly understood. It has been known that certain features of structure of the plant body are associated with characters of the flowers and fruits, and that if these were known in all the species, a truly scientific grouping could be established. As everyone who has grown cactuses knows, many plants will remain alive in collections for years without making any considerable growth and without flowering

herbarium species, prepared either from plants in their natural haunts or from those in collections, are in many instances unsatisfactory for study, because they can, at the best, be but fragmentary. Herbarium specimens supplemented by flowers and fruit preserved in formalin, by photographs of the flowering parts and by colored drawings of the flowers, are satisfactory taken in connection with the living plant, and if such series of material for each species can be brought together, it will ultimately lead to a far better understanding of this very interesting family.

The preparation of manuscripts for the "North American Flora," now in course of publication by the New York Botanical Garden, through the aid of the David Lydig Fund, bequeathed by Judge Charles P. Daly, has made it very desirable that a more accurate knowledge of the cactuses of North America should be obtained within the next few years, and the bringing together of the material along the lines outlined has been undertaken in cooperation with Dr. J. N. Rose, of the U. S. National Museum. Greenhouses at Washington and at New York have been set apart for the housing of the plants, and exploration of the cactus-growing regions of North America, including the West Indies and the continent south to the Isthmus of Panama, is going forward and will be continued as rapidly as means for it become available. Professor N. L. Britton, in the *Journal of the Horticultural Society*, N. Y., April, 1906.

## REVIEWS.

*The Principles of Heredity.* By G. ARCHIBALD REID. Second edition. 8vo. Pp. xiii + 379. London: Chapman & Hall.

The second edition of this work differs from the first chiefly in the addition of two appendices. Appendix B deals with "Mendel's Laws and the Mutation Theory of Evolution." The first thing to arrest the attention of the botanist is the statement in the third sentence of this appendix that, "The flower of the pea plant (the pea, *Pisum*) is not adapted to receive the visits of insects . . ." And this not only in the face of the evid-

afforded by the flower itself, but also in the light of the literature on the subject, *e. g.*, Ogle, Farrer, Müller and Darwin.

The sentence, " We may dismiss at once, as obviously in conflict with notorious and indisputable facts, the hypothesis that mutations are stable, and therefore are the materials of evolution because their transmission is Mendelian " (p. 363), is not entirely clear, but there is no doubt of the author's meaning in the following paragraph.

" The mutation theory of evolution is quite impossible. . . . Instead of groping in the comparative obscurity which surrounds wild nature . . . men had turned their attention to the clear, voluminous, decisive evidence, much of it statistical, afforded by their own species, it would never have been propounded."

It is doubtless quite true that, if no one had ever studied variation in a mutating species, mutation, and its bearing on evolution would never have been discovered.

*Lichenology for Beginners.* By FREDERICK LEROY SARGENT. Pamphlet, illustrated. Pp. 20. The Harvard Coöperative Society, Cambridge, Mass. Fifty cents.

This helpful little pamphlet is a reprint from the *Bryologist*, Vol. 8, 1905. The first fifteen pages tell the beginner the nature of the lichen, when, how, and where to collect, and how to preserve and study the specimens, and prepare them for the herbarium. A schedule for analysis is given, and also a brief bibliography. The last five pages are occupied with an artificial key to species. This booklet brings the elements of lichenology within easy reach of the beginning student.

C. S. G.

*New Creations in Plant Life.* By W. L. HARWOOD. 12mo. Pp. xiv + 368, 49 full-page plates. \$1.75 net. The Macmillan Company.

The public has awaited with interest the appearance of this long-heralded book, the first supposedly authentic account of the lifework of Luther Burbank. That it has proven a distinct disappointment seems to be due primarily to Mr. Burbank's unfo-

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fortunate choice of a biographer, although it is of course true that no hearsay account can be as trustworthy as an authoritative statement of personal experience. Inasmuch as the publishers themselves announce that the author of this book "has secured material at first hand, and it has all been approved by Mr. Burbank," it can scarcely be considered unfair if the latter is held to a certain extent responsible for its deficiencies and inaccuracies.

Mr. Harwood's literary style is that of the average writer of "popular" science for the magazines and newspapers, with something more than a seasoning of yellow journalism. He uses a profusion of trite and florid metaphors in the description of the most commonplace natural phenomena; shows a sublime disregard of the proper meaning, usage, and even spelling of well-known biological terms; indulges in fulsome and tedious panegyrics upon Mr. Burbank's personality, his achievements, and his infallibility in matters horticultural; and directs shafts of criticism against men of science who are inclined to ask for the why and wherefore and to demand proofs of categorical statements.

As the book deals wholly with Mr. Burbank's work, the reviews of which it has been the subject have naturally centered upon the nature and extent of his achievements, and have thus inevitably taken on more or less of a personal cast. We are glad to observe that there is for the most part hearty agreement as to the value of his achievements in improving horticultural standards and producing some new varieties of undoubted merit. The fact that he has sought neither pecuniary profit nor personal aggrandizement from his discoveries is also greatly to his credit, and shows him to be in the truest sense a laborer for the welfare of humanity. But in justice to the workers who have preceded and are contemporaneous with Mr. Burbank, we should not permit ourselves to overestimate these services or to be influenced in our judgment by the fulsome adulation of such writers as Mr. Harwood. Blinded by the glamour of Mr. Burbank's truly remarkable achievements, the public is apt to overlook the labors of such men as Vilmorin, Crozy, Eckford, Bailey, Webber, and a host of others whose results are equally important and far-reaching in some instances, indeed, more so.

With respect to some of the chapters in his book, we are forced to the conclusion that Mr. Harwood is indulging in pure romance to call it by the most favorable term, and it is unfortunate that a reputable publishing house should have allowed its imprint to be placed upon a book which disseminates so much misinformation as we find there. It is, moreover, damaging to Mr. Burbank's reputation that he does not promptly disavow it. The harm which is done to the cause of science by irresponsible newspaper writers is immense; for the public has neither the time nor inclination to seek the proper authority, and knowing how many remarkable discoveries have actually been made in recent years it accepts these yarns, not for their face value, but as so much scientific truth. As the statements are repeated by one person to another they descend still further into the realms of fiction, so that we can scarcely be surprised at the amount of existing misinformation on recent scientific achievements.

Mr. Harwood's reference to the annual grant of \$10,000 given to Mr. Burbank by the Carnegie Institution naturally leads to a discussion of Mr. Burbank's methods of work, which are, of course, extolled in glowing terms by his biographer. The grant was given with the specific purpose, not of enabling Burbank to secure new results, but to discover and place on record, if possible, how these results might be attained. In the light of the Mendelian investigations and of de Vries' extensive experiments with mutating plants it was thought that Burbank's exceptional facilities for work would yield results of immense importance. It is therefore a distinct disappointment to learn from this book that he keeps no exact records of what he performs, but that in his hybridizing experiments he neglects the first and paramount essential for success,—the taking of precautions to insure genuine cross-fertilization and to avoid contamination from foreign sources. The pollen of the same species is almost invariably prepotent over that of another species, no matter how closely related. Yet according to his biographer, Burbank takes no pains to insure the purity of a cross. "Mr. Burbank . . . says that it is wholly unnecessary in ordinary plant-breeding to attempt to cover the flower with a screen of tissue paper or gauze." He adds, with

unconscious irony, "If the pollinating has been thorough, nature may safely be left to do the rest." It is hardly necessary to point out that a flower treated in this way may be visited by insects bringing pollen from many different sources, and that the inheritance of the resulting seedlings must remain absolutely in doubt. It is quite true that if these seedlings show the characters which Mr. Burbank is working, the results are satisfactory from his standpoint; but what of their scientific value? What new fact have they added to our knowledge of plant breeding? How can the experiment be repeated? The fact that a new fruit has *been* produced is of general interest; it might never be improved or perpetuated if science did not discover *how* and *why* it originated. The public is inclined to sneer at this profound basis of scientific reasoning; it is interested only in the outcome, and Mr. Harwood, with others of his ilk, caters to popular acclaim. The present generation is interested in the bizarre, the strenuous in every phase of life; it has little use for conservatism or second thought in politics, finance or science. Consequently when Mr. Harwood airily discusses both Mendel's law and Vries' theory as having been thoroughly disproved by Burbank, he may experience the temporary satisfaction of affording the public something to talk about, but he will not enhance Burbank's position among plant breeders, and he demonstrates, on the other hand, his inability to preserve the proper balance between scientific speculation and scientific truth.

C. L. F.

In the June number of this magazine, through an oversight of the reviewer, the author of the *Elementary Botany*, published by the University Publishing Company, Lincoln, Neb., was not mentioned, for which we owe him an apology. The author is Professor Charles E. Bessey, of the University of Nebraska.

# The Plant World

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## THE GYNÆOCENTRIC THEORY AND THE SEXES PLANTS.

BY PROFESSOR BRUCE FINK,

*Iowa College.*

Almost as soon as issued from the press in 1903, a copy of Lester F. Ward's "Pure Sociology" fell into the hands of the writer and was eagerly read. Among many things of special interest, the gynæocentric theory attracted his attention as indicating a departure from generally accepted views regarding the development and the social relations of the sexes. It was the intention at the time of reading to formulate a protest against certain views expressed, but other things were absorbing attention, and the matter was dropped for the time. On seeing an article by Mr. Ward in "The Independent" for March 8, 1906, bearing on the same problem, and the replies two weeks later by G. Stanley Hall, E. B. Wilson and Clark Wissler, the whole matter was again brought to mind.

That the writer of "Pure Sociology" has made a strong argument for his gynæocentric theory is apparent, and no one could doubt, after reading his chapter, that the female sex has, perhaps, played the more important role in the evolution of the complicated sociological conditions found among civilized peoples; but in discussing his theory, beginning with protoplasm, Mr. Ward has made some very obvious errors in the presentation of biological principles, and has failed to elaborate certain facts which, to the mind of a botanist, are well worth stating for

benefit of the student of sociology. From the genetic point of view, sexes in plants bear some relation to the prehuman phases of sociology, which in turn has led up to the human society to-day. So it is well worth our while to consider this matter of the sexes from the botanical point of view.

Surely Mr. Ward is wrong in the presentation of his theory when on page 313 of his "Pure Sociology," after citing the popular notion that an organism that brings forth young must be male, he writes: "Biologists have proceeded from this popular standpoint, and regularly speak of 'mother cells' and 'daughter cells.' It therefore does no violence to language or to science to say that life begins with the female organism and is carried a long distance by means of females alone." The statement may do more violence to *language* than does the saying, "the sun sets" but such use of language does great injustice to science and does not justify the last sentence in Mr. Ward's paragraph, which reads: "In a word, life begins as female." Nor can we subscribe to the first statement on page 314, which runs thus: "The female sex, which existed from the beginning, continues unchanged, but the male sex, which did not exist at the beginning, makes its appearance at a certain stage, and has a certain history and development, but never became universal." Such a distortion of the facts regarding the evolution of the sexes should not go unnoticed, and Mr. Ward has been fairly well answered by Hall and Wilson in their articles in "The Independent," March 22, 1906. But we are constrained to wonder whether we might not, with Empedocles, Spinoza and others, bridge over the chasm, if such exists, between the organic and the inorganic worlds, and also carry the female sex back into the inorganic world. And again we are not sure that, were we to follow the philosophers in ascribing a psychic phase to inorganic life, it might not be more reasonable to see, in affinity and repulsion, the essence of two sexes even in inorganic nature.

Regarding sexes in plants, as given in the "Pure Sociology" we find on page 314 the following: "The simplest type of sexuality consists in the normal continuance of the original female form with the addition of an insignificant and inconspicuous male

fertilizer, incapable of any other function." This statement and others immediately following, would lead one to infer that Mr. Ward regards the sperm cell as the male organism; but if this be done, it must be regarded as an organism within another organism, and if so regarded in lower organisms, must be likewise considered in higher organisms as well. But on reading farther, one finds that the author intends to convey the idea that the degenerate males of many articulates and other lower animals are primitive,—a conclusion that will surely not be accepted by zoologists. Viewed in this way, the theory fails also when applied to plants. Here, as in animals, sexuality originates in the conjugation of morphologically like individuals as in *Protococcus*. Following this we find the conjugation of motile isogametes or like individuals as in *Pleurococcus*, some species of *Ectocarpus*, and many other algæ. In other species of *Ectocarpus*, we find a physiological differentiation of the two conjugating cells, one becoming motionless before conjugation occurs, and being slightly larger than the other conjugating cell in some of the species. Here we have a differentiation of the sexual cells in bisexual plants, and this differentiation of the sexual cells can be traced through such forms as *Dictyota* and *Fucus*. With the advent of sperms and eggs in plants came a gradual change from the bisexual to the unisexual condition. Within certain genera of algæ, as *Ædogonium*, we find both bisexual and unisexual species, this condition indicating that the origin of the male is something very different from a budding off from the female. It is true that we have in some species of *Ædogonium* certain dwarf males, which become attached to the female, but these are probably to be regarded as degenerate organisms, and surely not as primitive, or as indicating anything regarding the origin of sex in plants.

But it is in his discussion of sex among higher plants that Mr. Ward misses the recent view entirely, and writes of male and female flowers and even of whole sporophytes (roots, stems and leaves) as bisexual, or male and female, not recognizing alternation and the sporophytic generation (the plant as we ordinarily understand it), though he does among Thallophytes, Bryophytes,

phytes and Pteridophytes. But after admitting "the true sex stage" (gametophytic) in lower plants, and that this is followed by the spore-bearing or sporophytic stage, he concludes that "this peculiarity has no bearing on the theory under discussion." We must take issue with this view and insist that in the discussion of sexuality among plants we should hold primarily to the gametophytic or sexual generation and not follow the obsolete and erroneous view which holds that the sporophyte of higher plants is a sexual structure as Ward does in his discussion of fertilization (?) by insects and in his discussions of staminate and pistillate plants of *Cannabis sativa* (hemp), *Ambrosia trifida* (weed) and *Antennaria plantaginifolia* (Indian tobacco). We do not doubt that there is a physiological sense in which stamens and pistils may be regarded as sexual structures, as W. F. Gamble has done (*Science*, April 24, 1903), nor do we doubt that pistil-bearing sporophytes are much stronger than the stamen-bearing ones in many plants, but it is the distortion of the facts of plant morphology and physiology that is objected to, admitting that the real female sexual plant is parasitic on the pistil-bearing sporophyte and that the real male sexual plant is likewise first integrated with the stamen-bearing sporophyte and afterward a parasite on the stigma of the pistil-bearing sporophyte.

Whether or not it is true of man, as Havelock Ellis says in "Man and Woman," that the female, being "the mother of the new generation," is of more importance "from Nature's point of view" than the male, this may be truly said of the plant world where cephalization has not wrought wonders and where reproduction and maintenance of the individual and the race seem to be prime functions. Suppose we begin with *Spirogyra*, a genus in which there is no well-marked differentiation of sexes and where there is no alternation of generations, unless we include in our idea of alternation rejuvenescence without segmentation. In *Spirogyra* we find the conjugation of non-motile isogametes and the cell or filament from which the more active gamete passes to the less active through the conjugating tube may be regarded as male. Here we are near the basis of sexual differentiation

plants, and some observers claim to have found that the receptive cells are of slightly larger size, or in other words, that the incipient female is better developed than the male. Whether such differences in size of male and female plants have been observed in higher unisexual, filamentous algæ, where heterogamy prevails, as in *Ædogonium*, the writer is not prepared to state, but doubt not that here the female plant is likewise the better developed.

Passing to the Bryophytes (mosses and hepatics), where there is an undoubted alternation of generations, we find that the adult sexual shoot in mosses is often unisexual (though arising from an embryonic form, the protonema, which often gives rise to shoots of both sexes), and it is a matter of observation in many mosses that the female shoot is larger and stronger than the male. Whether there are instances in which the male moss plant is as well developed as the female, we must leave to the taxonomical bryologist to decide, but the fact is well established that, where the sexual leafy plants are unisexual, the female is commonly stronger than the male. In the lower members of the Bryophytes, the hepatics, the unisexual condition is not so frequently found as in mosses, but in *Marchantia polymorpha* and some species of *Riccia* and *Preissia* which have unisexual gametophytes, the better developed female gametophyte obtains as in the mosses. Of course the better development of the female plant in such instances is related to higher nutrition required for egg-production and to the supporting of the sporophyte, either entirely or in part, while the male plant escapes this work of support, which is in this sense a caring for offspring.

In the Pteridophytes unisexual gametophytes are more common than among the Bryophytes, and wherever the sexes are distinct, the female is better developed than the male, whether among the homosporous members or among the heterosporous. In our common ferns, the homosporous leptosporangiates, the sexes may be governed to some extent in the laboratory, as the writer has done in *Asplenium*, by sowing some spores on clay and others from the same plant on black soil; those on the clay gave rise to small males and those on the black soil to similar females (where crowded) and, where not so much crowded,

plants many times larger, which produced female sexual organs. In those species of the common ferns in which the sexual plants are unisexual, the facts are in accord with Mr. Ward's gynæcentric theory. With the advent of heterospory, the sexual plants have become uniformly unisexual, and much reduced, never coming free from the spores, males developing from microspores and females from macrospores. But here again the females, which the sporophytes are more or less dependent in their early development, are much less reduced than the males, and therefore the stronger plants. This condition is illustrated in the following well-known genera: *Isoetes*, *Marsilia*, *Azolla*, *Salvinia* and *Selaginella*.

Finally, in the Spermaphytes, our common flowering plants, there is a great reduction of the sexual generation. Nevertheless, unisexual plants exist in these highest members of the plant world and the sexes are here uniformly distinct. In the Gymnosperms (conifers for the most part), where the reduction of the male and female gametophytes has not gone so far as in the Angiosperms (herbs and trees and shrubs other than conifers), the female gametophyte is plainly better developed than the male. In Angiosperms there may be some dispute as to what constitutes the female gametophyte, and a new structure, the endosperm (which is perhaps a second sporophyte), comes in to aid in the nourishment of the young offspring (sporophyte) of the female gametophyte. Here not only the male gametophyte, but the female as well, is reduced to little more than reproductive cells, and, consequently, in these highest plants, we may not speak quite so confidently of the superiority of the female over the male gametophyte. And it is just here that Mr. Ward and some other writers bring in the sporophyte, or asexual generation, and regard part or all of it as a sexual structure. We admit readily enough that, in dioecious species, the pistil-bearing sporophyte is often better developed than the stamen-bearing one, and this for the same reason that the female sexual plant is better developed than the male among lower plants, viz., for the nourishment of the sporophyte (here the intraseminal, embryonic sporophyte), which is, for a time, at least largely dependent upon sporophytic (nourishment).

sexual) tissues for food. So it comes about that, in plants, the care for offspring is, finally, largely transferred from the female gametophyte to the dioecious or to the monœcious asexual (sporophytic) plant. And with this transfer of labor, the difference in degree of development in the two sexes in our highest plants seems to be disappearing. Thus, with the progress of plant evolution, sexes have been first differentiated; then the female sex has become better developed; and finally the tendency among the highest plants is toward equality of the sexes, as Mr. Ward thinks is also the case in higher animals. But in plants equality is approached through reduction, the female remaining plainly the dominant sex, at least until the sexes are reduced, as in Angiosperms, to little more than reproductive cells.

There are many interesting facts which cannot be considered in the present brief survey, but it is hoped that enough has been stated to illustrate the relation of the sexes in plants and to show that, in the main, the facts are still in favor of Mr. Ward's gynœcocratic theory.

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A renewed effort is to be made this year for the creation of a great national park in the southern Appalachian Mountains extending through the western portions of Virginia, North Carolina, Georgia, and parts of the mountainous districts of Kentucky, Tennessee and Alabama. Coupled with this proposition will be another for the creation of a very much smaller national forest reservation in the White Mountain region of New Hampshire, the destruction of which is eminent unless some action is taken by the national government. *Floral Life*, August, 1906.

## AN HISTORICAL SKETCH OF THE DEVELOPMENT OF BOTANY IN NEW YORK CITY.\*

BY HENRY H. RUSBY, M.D.

*Dean of the New York College of Pharmacy.*

### II. THE NEW YORK BOTANICAL GARDEN.

So eager was the desire of the early members of the Torrey Botanical Club to observe how plants lived, that many of them, unable to own gardens ignored vegetables and flowers, and maintained little botanical gardens at their homes. As successive decades of extending settlement destroyed the localities which had been so greatly prized, the demand for a botanical garden arose independently in the mind of every botanist, professional and amateur. So early as 1874 the club appointed a committee to act with the New York Pharmaceutical Association in requesting the city to establish such a garden in Central Park.

As the educational side of our work grew in importance, especially in breadth, and as the student body doubled and doubled, the cry for the garden grew equally loud from that direction, and continued until at length it was satisfied. The great value to Harvard and its work of the well-managed plot there utilized in this way was appreciated and often discussed at little meetings which gathered around the old pot stove in Professor Newberry's room during his presidency of the Club.

Under the influence of Columbia's progress, as already described, it appreciated this want as much, probably, as any other of our botanical elements. Its peculiar relation to the former Eden Garden was recalled in the public press. A contributor to the *New York Herald*, of November 26 and 27, 1888, made an earnest appeal for the recognition by the city of this great work. Dr. Arthur Hollick, to whose faithful and self-sacrificing work

\* Portion of an address delivered before the Torrey Botanical Club at a special meeting held on May 23, 1906, in commemoration of the tenth anniversary of the commencement of work in the development of the New York Botanical Garden. Concluded from the July number.





FIG. 26. Palm House of the New York Botanical Garden. (Courtesy of the Garden.) See page 186.

as secretary, our club largely owed its strength for a prolonged period, directed our attention to these articles and proposed to write an official letter to the *Herald* endorsing them. Such a letter was authorized, and it appeared on December 2 following. A committee was appointed consisting of Dr. Hollick, Mr. E. Sterns, and Professor Newberry, to deliberate and report to the club whether it were advisable for us to take any action

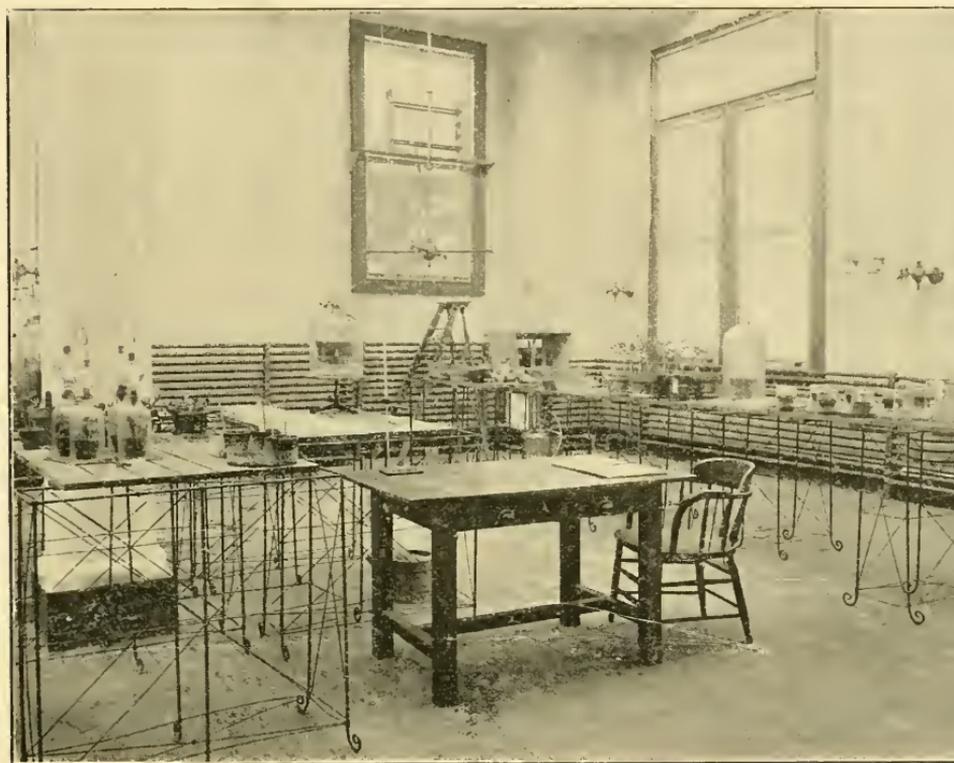


FIG. 27. Physiological Laboratory, New York Botanical Garden.  
(Courtesy of the Garden.)

the furtherance of this movement. The possibility of the realization of our long-cherished hopes now began to take possession of our minds, yet without any very strong hope being entertained. The club had no political influence and little acquaintance with those financial interests the aid of which was rightly deemed to be essential to success. As it resulted, however, some of the men were led to interest themselves in the proposition, largely

through the influence of Judges Addison Brown and Charles Daly, and of Mr. Charles F. Cox and Mr. William E. Dodge. For a long time the idea was regarded with favor in influential circles, but without any definite steps being taken to execute it. Finally, it was remembered that all history teaches that when you have wearied of discussing a project, and are at length really resolved to carry it out, you must call in the assistance of women. So a committee of ladies was appointed and held a memorable meeting at the residence of Mrs. Charles P. Daly, at which some of the men, your favored speaker among them, were graciously permitted to attend. This influence, while but one of many, each of which was necessary to success, seemed to give the final impetus needed. Mr. Cornelius Vanderbilt assumed the financial and executive management of the enterprise, and the stage of organization was reached.

One element in the success of the garden that has already shown itself to possess a value beyond price, and which is certain to increase so with increasing clearness in the future, is the protective influence of its charter. Born of the learning, long and wide experience and ripe judgment of Judges Brown and Daly, and occupying their attention for considerably more than a year before they were willing to regard it as satisfactory, it seems to provide for every important contingency that it was possible to foresee, and promises a safety, permanence and stability that are too often wanting in similar organizations. To enter upon a discussion of the personal credit due in the membership, the boards of managers and of scientific directors, and in the garden staff, would be an agreeable pleasure, but I must confine myself to the very earnestly made remark that the great success of the garden has been due to the love of the institution and its work which has animated all concerned in it. It is this which has lent faithful earnestness and energy and has incited to many acts of great sacrifice. If it could ever be said of any similar institution, we should be able to say of this that it is a monument of loving service.

I dare not enter upon a detailed history of the garden's development, and it has been so often and so recently recorded that I do not deem it necessary. An excellent account of its organi-

tion and of Columbia's relation to it by Professor Underwood, be found in the *Columbia Quarterly* 4 (1903) : 278. Our cha was secured in 1891 and was amended in 1894. It was ag upon that 250 acres of park lands should be set apart our use and \$500,000 appropriated for the museum building conservatories, as soon as an endowment fund of \$250,000 obtained. This fund was completed in 1895. Columbia ma the first subscription of \$25,000. With the election of Dr. N Britton as director-in-chief, and his selection of a working s the preparations were completed and work begun in 1896, event which we are to-day celebrating. This was the yea which was published the first part of Britton and Brown's "I llustrated Flora." Ground was broken for the museum buildin December, 1897, and for the conservatories in 1898. The seum was opened in 1899. In 1898 the bulk of the herbarium Columbia College, numbering nearly half a million specim and of its botanical library, including more than 5,000 bound umes, were turned over to the garden, in trust and for its under certain stipulated conditions. Since then the herbar has been more than doubled, and the library has been enlarge 18,000 volumes. A vast amount of grading has been done, m miles of walks and roadways built, bridges erected, and a g increase in all the collections has been made. Besides the *Ba tin* and the *Journal*, regularly published, the garden has ent upon work of a much more ambitious character. Utilizing David Lydig fund bequeathed by Mrs. Daly, it has begun publication of an elaborate *Flora of North America*, the parts of which have already been published. Provision has b made also for the publication of colored plates of Amer plants.

Among the very important undertakings maintained have b extensive explorations not only in the United States proper, in such distant regions as the West Indies and the Phillipi A tropical station is maintained in Jamaica for the conveni of visiting botanists. At the garden a scholarship fund is m tained by which it is rendered possible for investigators desir to pursue studies here to be supported for a limited per

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Only those who have demonstrated their ability to pursue original investigations are admitted, and these are expected to engage while here in work of that character. More than half a hundred such pieces of original investigation have been conducted here in a single year.

Our Botanical Garden suffers greatly from the want of a larger endowment fund. Its charter provides for the construction and maintenance of its framework, but back of this is the necessity for supporting its higher life, and for this support we must naturally look to its endowment. The two should keep close pace. The crown of the greater tree demands a greater root system for its support. Our plant has increased wonderfully in ten years, both in size and in the intensity of its activity while the endowment has remained stationary. Its increase to the sum of \$1,000,000 has been undertaken, and the amount is none too large and can come none too quickly.

One of the special needs of the Garden, or rather of this part of the country through its garden, is a *department of forest botany*. From an economic point of view, this is by far the most important department of botany at the present time. Our need for increased forest resources is already alarming to every serious political economist. When an attempt is made to provide them we find that we do not know how; that every tree must be known separately, and that until this is done practical operations must fail; and that the acquisition of this necessary knowledge is as slow as the growth of the trees themselves. It is urgently necessary that such centers of investigation should be established in large numbers. Scarcely anywhere is there an institution that combines so many advantages for a successful organization of this kind as here.

EDITOR'S NOTE.—It will be of interest here to speak of the relation of the New York Botanical Garden to public education. Public museums are generally regarded as part of the educational forces of a city, and teachers of natural science frequently avail themselves of the opportunities offered by visiting the collections with their classes. It is not uncommon to have a special exhibi-

for children. Courses of spring and fall lectures on botanical subjects for adults, open to the public without charge, have been a feature of the work of the New York Botanical Garden from the beginning.

In the spring of 1905 a new feature in the educational work was inaugurated by the organization of a course of lectures on nature study subjects to the public school pupils of the fourth and fifth grades. The experiment proved so successful that the arrangement was continued during the fall months and again in the spring.

Twice each week, on Tuesday and Fridays, lectures were given by various members of the garden staff to audiences numbering from five hundred to over eight hundred pupils from the fourth and fifth grades.

The grades were taken separately, and the pupils were accompanied by their teachers. The lectures were amply illustrated by lantern views, and at the close the pupils were divided into groups of convenient size and taken by competent demonstrators to the collections, both indoors and out on the plantations, where the subject of the lecture was more fully illustrated.

By this means the pupils of a crowded metropolis are not only brought face to face with the facts of nature, but are given a breadth of view quite beyond the possibilities of the class room alone to confer.

The following were the subjects of the lectures this spring: Before Grade 5B—I., Woody plants and plants without wood. II., Protection of trees in cities. II., Industries depending on forest products; Plant products. III., Classification of plants. Before Grade 4 B—I., Cultivation of plants. II., Seedless plants.

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There has been in bloom at the New York Botanical Garden a remarkable plant known as Queen Victoria's Agave, the stem of which is out of all proportion to the body of the plant. The latter is fifteen inches high. Above this, the stem extends ten feet, making a total of eleven feet three inches, the upper four feet and a half of which was covered with flowers.

## TROPICAL EPIPHYTES.

BY MEL T. COOK, PH.D.,

*Agricultural Station, Santiago de las Vegas, Cuba.*

The forests have always been, and probably always will be especially fascinating to mankind. In our earliest childhood their mysterious depths have concealed the goblins and fairies, and the love for the first wild flowers of spring have led us on and on until mystery after mystery was explored, but the fascination not lessened.

The early settlers of America clung tenaciously to the forests. Where the soil would produce trees it would produce the desired crops, and so the forests were sacrificed and the prairies left untouched for many years until chance demonstrated their importance. Now we lament the wanton destruction of the forests carried on by our forefathers in their fierce struggle with nature. Now we are beginning to appreciate their importance, not only for their commercial value but also for their general influence upon the surrounding country, and for their great beauty. The forests give special character to the country. The pine forests of the north and south, the redwood forests of the Pacific coast, the oak, maple, beech and hickory of the central states and the live oak forests of the gulf and Pacific states each give specific characters to their respective localities. We have not admired the little spring beauties, dutchman's breeches and other delicate plants that are sheltered in the northern forests, the trailing arbutus of the New England states, the profusion of liliaceous plants of the Pacific coast or the mosses of the southern states?

And if we leave the bounds of our own country and go into the tropics, there we find new and peculiar forests—each sheltering its own host of smaller plants of various kinds. There we find the massive trees covered with numerous epiphytes, chained together in an almost impenetrable jungle by vines struggling upward to the light.

In Cuba, the oldest and the newest of the new world, we meet

with these very interesting forests. A careful study of them has never been made, and they will present problems to scientists for many generations to come. To the casual observer, the most striking features of these forests are the epiphytes which festoon the trees everywhere. The predominant plants among these epiphytes belong to the families Bromeliac



FIG. 28. "Wild Pines" and other Epiphytes.

and Orchidaceae. To the family Bromeliaceae belong the so-called Florida moss, *Tillandsia usneoides*, and also that luscious fruit of the tropics, the pineapple. Many of these tropical epiphytes resemble miniature pineapple plants perched upon the branches of the trees. The Orchidaceae is one of the most interesting families of plants, since it includes some of the most in

esting and beautiful of our flowering plants. It is not restricted to the tropics, but reaches its greatest perfection there. *Blanckenaedia* is said to have been sent from the West Indies to England as early as 1731 and since then, from time to time, various species of orchids have been sent by officers and missionaries to northern countries where they have been grown in glass houses. Their value as ornamental plants was early recognized and many were tempted by the high prices to take great risks of health and life in exploration in search of them. One of the most interesting lines of study has been the special devices of these plants for insect pollination. Aside from their ornamental value the only one of commercial importance is the *Vanilla planifolia* or the vanilla plant of Mexico which is now cultivated more or less in tropical America.

#### MICROSCOPIC AQUATIC PLANTS AND THEIR PLACE IN NATURE.\*

Every piece of water, besides containing large plants and animals which are readily visible to the naked eye, harbours a more or less considerable number of minute forms, which pervade the layers of the water in varying amount, and collectively constitute the plankton or pelagic life. The most important difference between the plankton and the remaining flora and fauna of our waters lies in the fact that all the organisms which compose it are free-floating during the greater part of their life. Practically all the pelagic plants belong to the group of the algae and their minute size, of course, suits them well to a floating existence. A certain number of them are motile (*e. g.*, *Volvox*, *Gonium*, *Pandorina*, etc.), and these are able actively to maintain themselves in their position in the water; but the large majority are non-motile, and all these forms are slightly heavier than water, and consequently tend to sink; they develop diving mechanisms, by means of which their power of flotation is increased. The most important of these are: assumption of a plate-like shape (*Pediastrum*, *Merismopedia*, many desmids) and development of numerous delicate processes from the body of

\* Abstract of a lecture on "The Microscopic Plants of our Water," delivered before the London Institution on February 1st by Dr. F. E. Fritsch.

plant (*Stephanodiscus*, *Richteriella*); arrangement of the individuals of a colony in a more or less stellate manner (*Asterionella*, some *Tabellarias*); assumption of a delicate acicular shape (*Synedra*); formation of fat in the cell (many Diatoms and Cnophyceae), and so on.

In spite of these adaptations, however, most of the non-motile organisms of the plankton sink to the bottom of the containing vessel in the space of a few minutes after they have been collected. How is it that this does not happen in nature? It has been suggested that the continuous currents in the water, due to the wind and other causes, help to buoy up the organisms of the plankton; but it is of course also possible that in collecting such delicate forms they are damaged in some way or other so as to deprive them of that power of floating which makes them so well suited to their natural habitat. An interesting point connected with the development of the diverse floating mechanisms is that in some plants they have been found to be far more strongly developed in the summer than in the winter forms; this is, undoubtedly, in some way connected with a lower specific gravity of the water in summer, although the exact relation is not yet quite evident.

If the plankton of any piece of water is examined from week to week or month to month, we find not only astonishing variations in the quantity of organisms present, but also very marked differences in the specific constitution of the pelagic life. The quantity of the plankton is generally very much less in the winter than in the summer months, and the organisms composing it are quite different in the two seasons. Thus in the Thames there are four well marked annual phases, each characterized by its own peculiar plankton. This periodicity exhibited by the pelagic life stands in close relation to the external seasonal changes; some of the forms prefer cold, others warm water, and consequently they flourish in those seasons which are most to their liking. Some plants are particularly sensitive and consequently only put in appearance for a very short space of time each year. During their period of absence from the plankton these organisms persist as resting spores in the mud at the bottom of the piece of water; when favorable conditions return the spores germinate.

minate, giving rise to a new generation of pelagic organism which by their prolific division are able in a few days to dominate completely a piece of water.

The pelagic plants form the food of the animal plankton; these, again, are devoured by their larger brethren, which are the main source of nutrition for the smaller fishes. The larger fishes are mostly carnivorous, feeding on smaller individuals of the kind. The organic matter of the pelagic plants thus gradually travels from one organism to another until it comes to form part of the body of the large aquatic animals; it passes through a series of incarnations before being returned to the water in the form of excrement or products of decay of dead animal and vegetable bodies. This organic matter is built up by the pelagic plants from simple inorganic salts and from carbon dioxide dissolved in the water, and these latter substances are thus changed into a form which makes them available to aquatic fauna. As for the organisms of the latter, as, indeed, all the animals of the world, are ultimately herbivorous. Without some kind of plant growth a piece of water must remain a lifeless, dead mass, unpopulated, and a thing apart from the living world around it. The presence of vegetation immediately transforms it into a throbbing universe, full of energetic life, exhibiting complex interrelationships, and connects it with the remaining parts of our universe. The most important element of the vegetation from this point of view, however, is the phyto-plankton, and a piece of water with plenty of pelagic plants is sure to form a good breeding place for fish and other aquatic animals.—*Nature*, London, March 2, 1906.

## THE JARDIN DES PLANTES BEFORE AND DURING THE REVOLUTION.\*

In the *Edinburgh Review* for April, 1906, an anonymous writer has given us a charming glimpse into the Jardin des Plantes two centuries ago.

"A long garden, lying low and flat for the most part, planted with inconsiderable trees, it rises imperceptibly from the left bank of the Seine to the further eastern slope of the Montagne Ste. Genevieve; crown

\* From the *Edinburgh Review*.

there by a twy-peaked monticule (not unlike the Dane—John at Canterbury), planted with a labyrinth of cedars and evergreen trees, some of the old and fine. Everyone knows the Jardin des Plantes and has felt its superannuated charm, composed of mouldy retirement and popular daylight. That part of it which butts on the Latin Quarter, with its cedar mount and bronze temple, and a certain homely grace in its eighteenth century buildings (of which not a few remain), is pleasant with its patches of wild flowers and clumps of peonies among the grass. From this point right in front of the handsome modern buildings which house the natural history collections, an avenue of lime-trees sweeps across the flat to the river, dividing on either hand the world of beasts and the world of plants.

The Jardin des Plantes was founded by Richelieu. It was then a garden for the study of medicinal herbs—for botany was then regarded merely as a branch of medicine—under the direction of the king's physician, Guy de la Brosse. He was succeeded by a line of court doctors with no peculiar turn for science, and the garden "dwindled to a desert of dust and disorder." The generation of Louis XIV paid scant attention to the herb garden. They sought Nature rather in the relation between star and star, following the lead of Descartes and Rousseau in France and Hobbes in England.

"With Newton they dropped from the cosmic rush of Hobbes and Descartes to the grass of that orchard where Sir Isaac's apple fell: they rose, with something of a shake, and began to look about them. The humble forms of Nature, after all, are interesting and even pretty! At the second quarter of the eighteenth century in France inaugurated a race of botanists and students of natural history, who one day turned their attention to the long-neglected Jardin des Plantes, began to dream of the chemistry of vegetable life and to turn their attention to the organic structure of a substance which hitherto they had chiefly cultivated as herbs to dry in bunches, or grains to bray in a mortar.

"It was in 1732; Dr. Chicoisneau, the king's physician, had just died leaving behind him a wilderness, a little east of Paris. The Académie des Sciences rose to the occasion, and, pointing out the scandalous state of things, suggested that the post be taken from the hands of the doctors and confided to a man of science. The chemist, Dufay, an academician and a student of Newton, was chosen as director. A man of forty years of age, he was full of plans and projects when, suddenly stricken by a fatal illness, on his deathbed he designated as his successor Buffon."

From 1739 until his death in 1788, Georges Leclerc de Buffon reigned supreme as "Intendant du Jardin et du Cabinet du Roi." During those fifty years the garden remained, as it had been

garden of plants. When Buffon entered upon his duties there he found only an old sixteenth century country-house with two wings; a few greenhouses and sheds; the grounds of no great extent, and hedged in and limited by a monastery. The Royal Cabinet of Natural History consisted of two rooms, one for the herbarium and one for the storage of medicinal plants. Buffon at once suppressed the private apartments of the court physician who had a sort of country-house in the garden, and afterwards he evicted himself as well. He arranged in order the collection of natural objects, which year by year increased in interest, rarity and beauty; he entered into communication with naturalists and travelers all over the earth, and created an order of correspondents of the garden. There were thus introduced into the garden the first hydrangea from China; the dahlia, the sweet acorned oak, the first plane-trees in France, and a quantity of shrubs and flowers.

Later, the greenhouses were remodeled, and the garden was expanded through Buffon's negotiations with the Abbot of the neighboring monastery. And all the time that Buffon was attending to every detail of administration in the garden he was writing his great work, the "Histoire Naturelle."

Buffon's successor at the Garden of Plants was the Marquis de la Billarderie, a courtier who took an interest in nature and science—after the fashion of the age. The new intendant apparently regarded his post as a sinecure, resided at the Tuileries and scarcely occupied himself with the administration of the garden, which was left in the care of André Thouin, the head gardener, while the scientific management of the cabinets and lectures was in the hands of Doctor Daubenton, who had been the friend and co-worker of Buffon. While the Marquis de Billarderie was doing nothing, the doctor was laying plans for the reorganization of the garden and cabinets as a museum of natural history, and André Thouin was laying out the grounds in beautiful mazes and gardens, making of the place the popular resort it has ever since continued to be. "On the fine summer nights of 1790 the Parisians used to stream across the bridge, quitting Paris on the brink of revolution for this green paradise

Meanwhile the Marquis, being an incapable administrator, was getting deeper and deeper into debt. By way of economy he suggested that the chair of mineralogy, occupied by Faujas de St. Fond, might be suppressed; the Chevalier de Lamarck also, he thought, "peut-être utile, mais pas absolument nécessaire." The Marquis was proud of Faujas, the great geologist, and of Lamarck, "who had enriched the cabinet, though he was poor, by his gifts of specimens, engravings, rare plants, seeds, and minerals from Holland and Germany." The officials of the garden rose in revolt and recommended to the king that the useless and expensive intendant be the one dispensed with. In the summer of 1793 the Marquis sent in his resignation.

The next incumbent of this office was Bernardin de St. Pierre, who proved to be a diligent, economical and exact administrator. It was he who suggested a menagerie for the Jardin des Plantes, and he thus became the founder of the French Zoölogical Gardens. About this time the garden officials were elaborating a scheme for the conversion of the royal garden and cabinets into a natural history museum, and in 1793 the scheme was adopted on a plan in which the post of intendant found no place, and Bernardin de St. Pierre was retired on a small indemnity.

The new system provided for twelve professors, directed by a principal annually reëlected; all the lectures free and open to the public. The chair of mineralogy was occupied by Daubenton; botany, A. de Jussieu; horticulture, Thouin; natural history, Geoffroy St. Hilaire; geology, Faujas de St. Fond. Chairs were also established in anatomy, comparative physiology and zoölogy. The chair of botany being occupied, a chair of insect zoölogy was created for Lamarck, who was also commissioned to found a library of natural history.

"Meanwhile the museum inaugurated a new career of laborious and fruitful activity. But the people of Paris continued (and continue still) to call it the Jardin des Plantes, and to love it chiefly for the beasts and birds which Bernardin added to its charms, and for the Swiss valley, which André Thouin laid out on the land acquired by Buffon with so much difficulty."

## NOTES ON CURRENT BOTANICAL LITERATURE.

Shigeo Yamanouchi contributes to the *Botanical Gazette* June a paper on "The Life History of *Polysiphonia Viola*" in which he shows that there is an alteration of generation in this seaweed.

Howard Frederick Weiss, in the same magazine, gives results of a detailed study of the bark of sassafras.

In *Appleton's Magazine* for August, Frank French has a popular article of botanical interest entitled "Plant Kinships." The author writes of the relationship between the skunk cabbage, the jack-in-the-pulpit of the bogs and woods, and the *Anthurium* and calla lily of the florist's window. He describes the tropical pitcher plant *Nepenthes*, of the same family as the American pitcher plant *Sarracenia purpurea*; and compares the gorgon *Medinilla magnifica* of the Philippines with its diminutive relative deer-grass, *Rhexia virginica*.

In the August *Garden Magazine* Wilhelm Miller has written "The Cultivation of Hardy Orchids." He says: "No one really knows how to grow hardy orchids. There are sixty species in the northeastern United States and not one of them will ever become a common garden plant. Most of them are too small, and all require special conditions. Hundreds of people can make them flourish for a year or two. A few people have colonies of a dozen plants that have flowered regularly for five or six years. No one seems to have naturalized them on a large scale. Unless we can simulate those special conditions it is worse than folly to transplant orchids from the woods. It is vandalism." Among the nine best hardy orchids are mentioned the showy lady's slipper, *Cypripedium spectabile*; large lady's slipper, *C. pubescens*; rattlesnake plantain, *Goodyera pubescens*; and the small lady's slipper, *C. parvifolium*.

# The Plant World

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## THE HOPE BOTANICAL GARDENS.

BY FORREST SHREVE, PHD.

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No country twenty times its size can boast as many botanic gardens as does the island of Jamaica. Of the six which are to be found within its narrow borders, one—that at Bath—is neglected although not uninteresting, and two,—the Parade Garden and the King's House grounds,—are primarily show gardens and parks. The other three combine the uses of ornament, scientific interest and practical helpfulness. Hope Gardens are situated near Kingston in the dry Liguanea Plain; Castleton Gardens are at a low elevation in the moist hills of the north side; and the Hill Garden at Cinchona is at a temperate altitude in the Blue Mountains. The happy choice of these locations renders possible the growing of plants from almost every region of the tropics, the warm temperate zones, and the visiting botanist is treated to the sight of the palms and screw-pines of the East Indies, the eucalypts and grevilleas of Australia, the water-lilies of the Amazon, the rhododendrons of the Himalayas and the cacti of America.

As early as 1775 the Jamaican government began to lend a hand to a private garden at Gordontown, near Hope, and ever since that date there has been a more or less intimate association of the ideals of botanical science and agricultural practice in the development of the public gardens of the island, which has been in no small measure due to the fostering influence of the Royal Ga

dens at Kew. Seven years after the government made its grant in aid of the garden of Mr. East at Gordontown, or Admiral Rodney's captains seized a French ship bound Mauritius to Haiti, both then colonies of France, on board were found a large number of living plants. These were brought to Kingston and turned over for the new garden, where they were set out with the original tags, on which were not names but numbers. Among the lot were many trees of economic importance which had never before been grown in Jamaica, notably the mango, the jack-fruit and the cinnamon. "Tree No. 11" proved to be a very delicious variety of mango which is known to-day in Jamaica as the Number Eleven.

In 1863 the desire of Governor Sir John Peter Grant to see what might be made out of the cultivation of Peruvian bark (the cinchona or quinine tree of the Andes), at higher elevations on the Blue Mountains, led to the establishment of the Hill Gardens, which for many years continued to be the headquarters



FIG. 29. At the centre of the Garden. The spreading tree is the Poinciana.

the Department of Public Gardens and Plantations. East India competition eventually made the growing of Peruvian bark unprofitable, and shifting economic conditions rendered it more important that the department give its attention to the development of lowland growths. The old Hope sugar plantation has been used by the department since 1874 as a nursery for sugar cane and teak, and it was selected as a site for the development of a new garden which should be at once the headquarters of the department, a park, a nursery and a botanical garden. With an annual rainfall of but fifty-one inches, it is not an easy matter to maintain a fine sod at Hope or to raise moisture-loving plants, and indeed the freshness and beauty which the garden displays would be impossible if it were not that the water reservoirs for the supplying of Kingston are hard by the garden and can be liberally used.

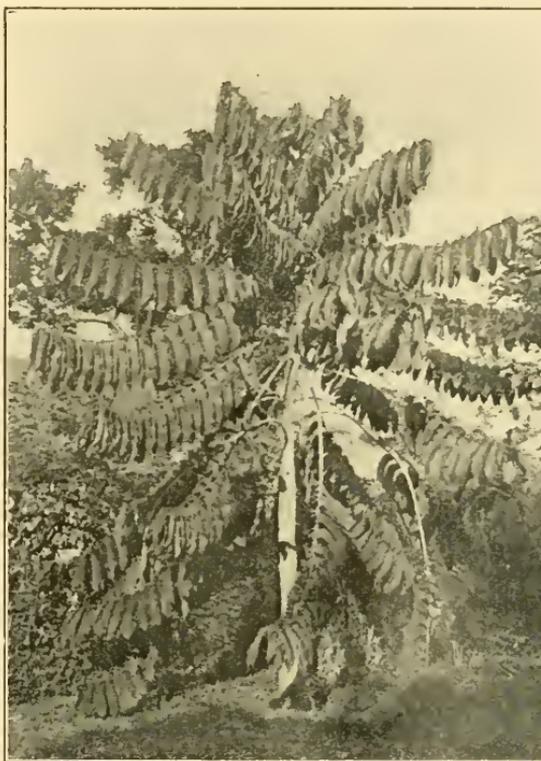


FIG. 30. A Castilloa Rubber Tree in the experimental grounds.

Although the garden at Castleton is more tropical in aspect than Hope, none of the island gardens are more beautiful. A forty-minute trolley ride from Kingston brings us to the main entrance of the Hope gardens, where we traverse a long avenue of *Cassia Siamea* to reach the proper entrance to the grounds. From this spot where the garden first bursts upon the eye it is seen at its best, and there are few visitors who do not pause there in surprise and admiration. Stretching away toward the cent

of the grounds is a broad expanse of well-kept sod traversed by a driveway bordered with palms. The lawn is set about the house with beds of showy-flowered plants or masses of shrubbery and annuals, displaying a pleasing variety of foliage. Above the borders are seen the tops of the trees in the further parts of the garden, strange in form or gay with bloom, and above them in turn rise the grass-clad hills which quite encircle the garden and over the further summits of which fleecy clouds are often rolling down to vanish in the dry air of the plains. The passage of the seasons works but little change in the appearance of the gardens; in winter the Poinsettias are at the height of bloom, a little later the papilionaceous tree *Erythrina umbrosa* is a conspicuous object with its gigantic clusters of scarlet flowers, and it is closely followed by its rival in showy beauty, the Royal Poinsettia or "Flamboyante" of Madagascar. Both the purple and the brick-red varieties of the Bougainvillea are grown, and may be counted on for a display of color throughout the greater part of the year. With them, as with the Poinsettia, the flowers the

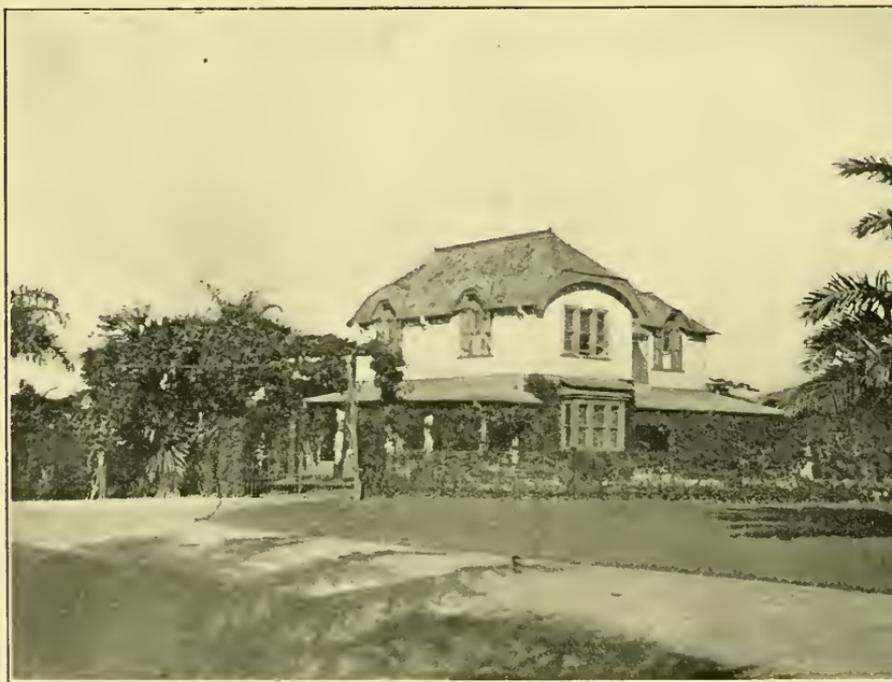


FIG. 31. Residence of the Director of Public Gardens and Plantations.

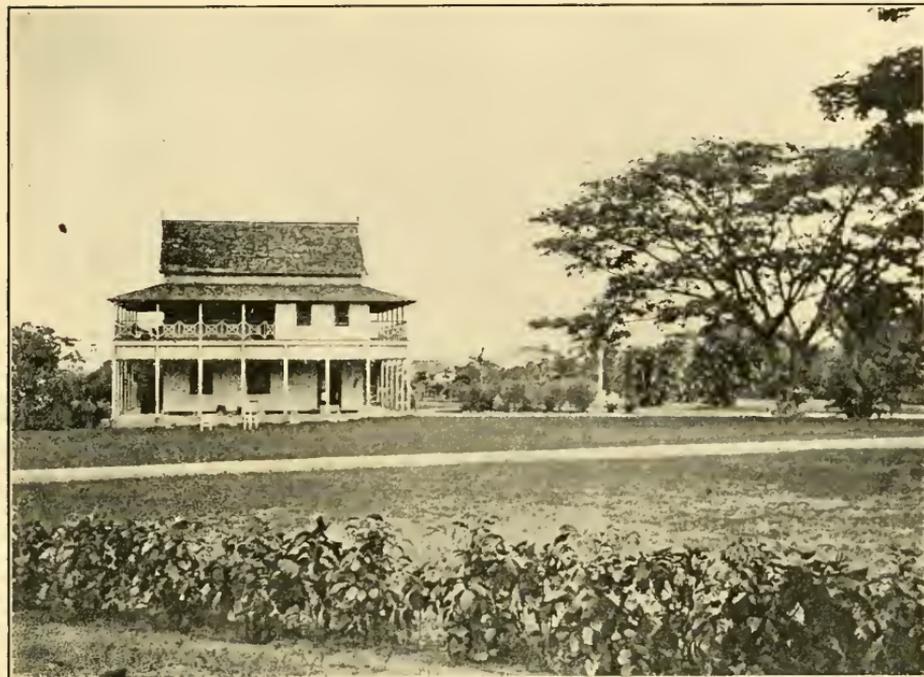


FIG. 32. Administration Building. The tree at the right is a Guango.

selves are small and inconspicuous and the showiness is due to the brightly colored leaves or bracts.

Let us now make an orderly round of the grounds beginning with the collection of cacti, which is sure to catch the eye from the main entrance. Here are gathered examples of the "dildo cactus" (*Opuntia Swartzii*) which is extremely common on the south side of the island; the spiny opuntia (*O. spinosissima*); the climbing cereus (*C. triangularis*) which is frequent as an epiphyte; and other species of cereus, Melocactus, Mamillaria, Agave, Euphorbia, Gasteria and other succulents. Near the cacti is a showy and interesting plant, *Norantea Guianensis*, a native of Trinidad and Demerara. With foliage somewhat like that of the mango grove, this plant has long racemes of flowers which are themselves very inconspicuous but are subtended by long honey-suckle of a bright orange-red hue, constituting in color and content very efficient organs of attraction for insects. Here are some native trees of interest,—notably the lace-bark (*Lagetta lintearia*), endemic to Jamaica, the inner bark of which is capable of being

shredded out into a beautiful and strong lace-like fabric, from which many things are made to attract the tourists' shillings. The guango tree (*Pithecolobium Saman*), which is common about the gardens, is a splendid example of the spread flat-topped type of tree characteristic of dry savanna regions world over. Similar to it in appearance is the Albizzia, the "woman's-tongue," another mimosaceous tree the ripe pods of which, filled with loose seeds, have suggested to the imagination of a black man his name for the tree. Here, too, are the "umbrella tree" (*Cecropia umbellata*), used in parts of Jamaica as a shade tree for coffee, and remarkable for its hollow stems, which like some of its South American congeners have an opening in each internode, inducing the cohabitation of ants; the "sand-box tree" (*Hura crepitans*), with a very spiny trunk; and the "anchored pear" (*Grias cauliflora*), which is notable for its unbranched trunk directly out of which grow flowers and fruit. Beautiful indeed on a breezy day is the "star-apple" tree (*Chrysophyllum Cainito*), for its leaves are dark green and glossy above, while beneath they are silken and rusty brown. If you should be deceived to a native he will tell you: "Yo' two-face' like a star-apple."

Passing toward the centre of the garden we find a collection of trees which are mostly exotic,—a row of date-palms, a group of olive trees, ravenalas, myroxyllons, *Casuarina equisetifolia*, and a double row of *Caesalpinia coriaria*, the "divi-divi" or "monkey's-ear-ring tree" of Africa. In the shaded walk between the divi-divi trees is arranged the collection of orchids, which may be one of the finest in America, as it has been built up by years of exchange with all parts of the world, and embraces many rare and magnificent species. Such is the interest which the public takes in the orchids that a list of the species in bloom is published every morning in the Kingston papers. Most interesting to the morphologist are those forms in which the shoots have undergone transformation into absorbing organs, losing their foliage leaves and most of the chlorophyll, and developing a velamen, but nevertheless the less continuing to bear the flowers.

The greater part of Hope Gardens is taken up with the ex-

mental grounds and nurseries. Here may be seen plots of guinea-grass (*Panicum maximum*), the chief forage crop of Jamaica; cassava (*Manihot utilissima*), one of the most valuable sources of starch; and the ippi-appa palm (*Carludovica gracilis*) from which hats similar to panamas are made. Some notion of the diversity in tropical agriculture may be had from the large variety of economic plants grown here, all of which are to a greater or less extent planted in various parts of Jamaica, the number including sugar-cane, coffee, bananas, pimento (allspice), oranges, limes, grape-fruits, shaddocks, tobacco, chocolate, vanilla, kola, mangoes, pine-apples, sisal-hemp, rubber and ginger.

Much of the work of the Public Gardens consists in supplying planters with young plants of coffee, chocolate, nutmeg, etc., at a price which is merely nominal, and since there are no nurseries on the island, this is a very important service. The plants are rooted in bamboo pots, which are made by cutting stems of *Bambusa vulgaris* of about three inches diameter into sections about seven inches long, in such a manner that the partitions at the nodes of the stem form the bottoms of the pots. In these cheap receptacles the plants are readily handled and shipped.

In the centre of the garden stands the administration building in which is the office of the Director and the library of the Department. The library is quite complete in works on tropical agriculture and systematic botany; is well filled with all the texts and general works in the various fields of botany; and has a good representation of the leading journals. On the lower floor is a small museum and the herbarium of the department. The herbarium cases are all made of different native woods and are an interesting exhibit in themselves. The sheets which they contain bear a very complete collection of Jamaican flowering plants, ferns, mosses and hepatics, including types or co-types of all the more recently described species of higher plants native to the island, together with a representation of the flora of the neighboring islands.

## OUTLINE STUDY OF SEEDS AND SEEDLINGS

BY DR. C. STUART GAGER,

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The following paragraphs were written for the use of grade teachers in a city where school gardens had been introduced, and the work here outlined was correlated with the out-of-door work in the garden. The studies are only a suggestion as to the kind of work essential to secure the most desirable results from the work in the garden.

It is a great pity that so much school botany formerly considered the plant apart from the soil and air in which it grew. It were as great a pity to cultivate plants in the school garden without studying the elementary facts of physiology and ecology which are necessary to their intelligent care.

To make a successful garden one must know that the plants need to be a certain distance apart. But if the object of school garden work is something more than merely to train gardeners, if it is to have sufficient educational value to justify the time it takes, then it becomes vitally important for the pupils to know why the plants must be a certain distance apart—to understand the fundamental needs and nature of the plant that make necessary all that he does in his garden.

While nature study is not a science, and while a course in nature study is non-scientific, it should never be unscientific in either its content or its method. Especially should the pupil begin to acquire a scientific habit of thought and work. This aim is antagonistic to the acquisition of a love of and sympathy with nature. Both objects should be attained if the subject is to justify its place in the course of study.

The surest foundation for the teacher, so far as plants are concerned, lies in a clear understanding of the principles of botany. The best preparation for teaching nature study is, not to have "taken" nature study one's self, but to have had thorough inductive laboratory courses in botany and zoology.

The outlines suggest a way to take up with grade pupils the topics indicated. The questions may either be asked of the class vocally, or each pupil may be supplied with a specimen and a mimeographed copy of the questions. Or the questions may be written on the blackboard. The main point is that the pupil shall proceed as independently as possible in his observing and thinking. The "Notes," of course, are for the teacher only.

About a week may profitably be spent on the structure of seeds. At the beginning of the study, seeds of the bean, pea, corn, squash and castor-oil should be planted in boxes of soil after being soaked in water over night.

About three days before needed, seeds of the same kinds should be soaked over night and placed to germinate in moist sawdust, sphagnum, or between blotters.

### THE STRUCTURE OF THE BEAN SEED.

#### *Outside Parts.*

*Material.*—Three or four dry bean seeds for each pupil.

*Observation.*—Observe and describe the shape of the seeds. Are they all practically the same shape? How many times as long as broad? How many times as broad as thick? Make drawings four times as large as the seed to show the shape as seen from (a) the side, (b) the edge, (c) the end. Describe the color of the seeds. Do you find any differences in color? If so, describe them. Observe a seed that has been soaked over night. Does it differ in any way from the dry seeds. If so, how? Do you find any parts or marks (besides differences in color) on the surface? If so, tell all you can about where they are, and their size and shape. Make another drawing, enlarged four times, to show the parts you have observed. Write a paragraph telling clearly and accurately all you have learned about the structure of the bean seed.

*Note.*—This is not a memory exercise and the pupil should not be given any technical names of the structures observed. The aim is to teach the pupil to see the natural object *as it is*, and to describe it as seen in as clear and accurate a manner as possible. In the process the pupil acquires a knowledge of the seed structure.

ture, but this is of secondary importance. Nothing should be told by the teacher that can be found out by the child himself by observing the specimen.

He should have observed the *scar* (hilum), or place where the seed was fastened in the pod; the little hole, micropyle, at the side of the scar, and on the opposite side a small knob (strophiole), somewhat heart-shaped. (Oftentimes the ends of seeds are somewhat flattened, due to crowding in the pod.)

Little is gained by giving the scientific terms. Not because they are hard (hilum is as easy as scar), but because they do not add at all to the clearness of the child's idea. Young pupils are apt to confuse ideas with their terms, and to think that they know a thing when they know only its name. The knowledge of scientific terms is an absolute hindrance to the child in an endeavor to describe.

#### *Inside Parts.*

*Material.*—Provide for each pupil, one soaked seed with the cotyledons carefully separated, the seed coat still adhering to the halves, and the hypocotyl and plumule still intact. Cut the skin so as not to injure any of the structures on the hilum end.

*Observation.*—Observe the half of the seed to which the skin is not attached. Is the bean covered with a skin or *seed-coat*? Is this coat tough or very delicate? Is the coloring of the skin *on* the coat or *under* it? Is the inner surface of this half flat or cup-like? Is the surface of the other half the same? Can you think of any reason why the cup shape is a better one for a seed than a flat surface would be? Was this half attached to the other in any way? If it was, describe where. On the other half do the knob, scar, and little hole belong to the seed-coat, or to the parts under the seed-coat? Is the peg straight or curved? What part of the seed-coat is over the *tip* of the peg? Is it the same in all bean seeds? What is on the opposite end of the peg from the pointed end? Is it composed of parts? If so, how many? What is their color? Are they in a straight line with the peg, or do they make a curve with it? Is the peg attached to this half of the bean? Can you see any signs of its having been attached to the other half? Make drawings (X4) showing

(1) the halves of the seeds as they were placed at first, only with the seed-coat removed; (2) only the peg with the leaves attached. Write a paragraph describing all you have learned concerning the inner parts of the bean seed.

*Note.*—This exercise teaches the importance of little things and the need of care and accuracy. The pupil should be made to feel that the bean seed must not be handled carelessly or picked to pieces merely because it is a common object. The children must not be permitted to poke the specimen with pencils, knives or pins.

Insist that the drawings be enlarged by the amounts indicated. Allow no shading. Every line in the drawing must represent some structure of the seed.

The pupil should have observed:

1. The relatively tough character of the seed-coat.
2. The fact that all the external features belong to the seed-coat.
3. The more or less *concave* inner surfaces of the two halves of the seed, giving room for the *peg and especially for the tender leaves at its end*.
4. The position of the tip of the peg *always directed under the little opening or hole*.
5. The peg curved and the leaves at the end making a little arch with the peg.
6. The attachment of the peg to both halves of the seed.
7. The leaves, two in number, and folded one within the other.

Each half of the bean seed being roughly cup-shaped is termed a *cotyledon* (little cup). The leaves at the end of the peg form the *plumule*.

### THE STRUCTURE OF THE PEA SEED.

With this exercise the teacher will doubtless meet such questions as: "What ought I to find?" "Ought there to be a little knob on the pea seed?" etc. The treatment of such questions in observational work marks the difference between the wise and the foolish teacher. In observation it is not a question of "ought," but a question of fact. Not "ought" there to be a little knob, but *is* there one.

This point is dwelt on because there is none more important in observational science than this. From the standpoint of *educational*

tion it means acquiring the habit of independent thought and work, or else a blind, unintelligent following of authority. From the standpoint of *science*, it means valuing facts as they are, above preconceived notions of things as we imagine they are or ought to be. From the standpoint of *knowledge*, it means clear ideas obtained at first hand, instead of vague indefinite notions secured at second hand.

From this study of the outside of the pea seed, the pupil will learn its globular shape, the absence of the little knob (strophion) and the possession, in common with the bean seed, of the scar and little opening. Usually some indication of the peg shows through the seed coat. If so, pupils should determine for themselves whether the little hole is directly over the tip of the peg.

A study of the inside of the pea seed, made as directed above for the bean seed, will show the tough seed-coat, the peg, farther than in the bean seed, not as long, and not curved so much.

The pupil will observe the much swollen plumule here, and not in a straight line with the peg, but making an arch with the latter. Are the cotyledons cup-shaped?

Drawings (X4) should be made of one view of the outside showing the scar, little opening, and peg (if it shows through the coat); of the inside, similar to the one made of the bean seed.

In what ways are the bean seed and the pea seed alike? In what ways do they differ?

Write a paragraph telling all you have learned about the pea seed, and another paragraph telling all the ways in which the two seeds are alike and in what ways they are different.

#### THE CASTOR-OIL SEED.

The knob at the end is similar to the little knob on the bean seed. Here it is much larger and fleshier, and it is directly over the little opening which may be seen extending down through the seed coat. The scar is not prominent, but is close up under one side of the knob.

Make drawings (X4), one showing the seed as seen from the side, another to show the end view with the knob (here called the *caruncle*). Do not give the pupils the term.

The study of the internal structure of the seed is very difficult for young pupils. The teacher should have several well-soaked seeds dissected to show the pupils, and plain drawings on the board. Call attention to the hard brittle seed-coat.

Notice the short, straight peg. The fleshy halves of the seed are not cotyledons, but food for the young plant. This may be very carefully removed, showing the white, leaf-like, delicate cotyledons. The plumule is too small to be easily seen.

#### GERMINATION.

*Material.*—In boxes of convenient size, containing garden soil or, preferably, clean sand, plant six or eight seeds of the common white bean, the pea, corn, squash, having first soaked the seeds for twenty-four hours. Plant about a week before the study how they break through the soil is taken up.

The successive steps in germination may best be followed by allowing seeds to germinate behind glass. For this purpose, use a Wellsbach chimney with a tube of blotting paper, setting the end of the chimney in sand or soil in a flower pot or box, and fill the chimney with moist saw-dust to keep the blotter close to the glass. (If this device is not convenient, an ordinary tumbler may be used. The shallowness of the tumbler, however, does not permit of very extensive root development.)

Have the children place five or six seeds of each kind mentioned above in water to soak over night. On the following day the pupils will observe that all the seeds have swollen. *This is the first step in germination* and the point should be made at this time.

Now place these seeds between the blotters and the glass so that they may be seen, and placed so that the tip of the peg of some of the seeds points vertically downward, of others upward, and of still others horizontally. Be sure that the corn grain is placed with the embryo side next the glass. Keep the seeds moist but not immersed in water, and, if possible, put in a dark place to develop. Lead the children to see that this would be best by questioning them concerning the light conditions under which the seed germinates naturally in soil.

*Observation.*—What part of the seed first breaks through the seed-coat? Is this the same for all the seeds? Is it better for the root to grow first? Would it not be just as well if the stem and leaves came out before the root grew? Why?

Do you see any special growth on the peg of the squash seed that helps the young squash plant get out of the seed-coat?

Does more than one root come through at first? Is this the same in all the seeds? In what direction does the first root (or roots) grow? Does the root grow downward in the seeds where the peg was placed horizontally or pointing vertically upward? Would it not be just as well if the roots grew vertically upward or sideways? Why?

Would the gardener's or farmer's work be any different if roots did not always grow downward in germination? Explain how.

After a time does the root begin to branch? If so, in what direction do these side roots grow? Would it not be better if they grew directly downward just as the first root grows? Why?

Can you see any fine white hairs (root-hairs) growing on the surface of the root? If so, do they cover all the root? Do they grow up to the very tip? What do you think they are for?

What part of the seed first appears above ground? Does the stem part appear before or after the branch roots have begun to grow? Is this the same in all the plants?

Drawings and written descriptions as above.

*Note.*—In these exercises the pupil begins to study the plant in action. It is doing something. The value, as in the study of seeds, consists in practice in observation, expression, and interpretation. That the first root grows vertically downward is a fact worth knowing. It is of infinitely more value to have reason made out, even in the most elementary manner, the meaning and significance of this. Here, also, is emphasized the fact that observation is something more than merely looking at an object. It implies an active attitude on the part of the pupil in which *definite questions are put and their answers sought in the object studied.*

Besides the educational discipline secured, the pupil will learn the following facts:

In the germination of a seed, the first part to begin growth is the root. The squash plant is helped out of the seed-coat by means of a little knob. One root only always appears first, and no matter in what position the seed lies, the root will take a course vertically downward. After the appearance of the main (or tap) root, the stem begins to grow. Branch roots do not grow downward like the main root, but more nearly horizontally. The root is covered in a definite region with numerous root hairs which never extend quite to the tip of the root.

By careful questioning on the part of the teacher, the pupil should be taught that the greatest need of the plant is water, that the most abundant supply is in the soil, and that the plant needs to be held fast where it can get water. Therefore, the best good of the plant makes it necessary for the root to grow downward first to hold the plant fast, second to absorb water for the plant. If the root did not grow downward (curving when necessary) no matter in what position the seed is placed, then gardeners and farmers would have laboriously to plant every seed root downward or else many would perish on germination.

By growing laterally, the branch (secondary) roots hold the plant more firmly in the soil, and at the same time enable the plant to secure water from a wider area.

The fine white root-hairs are parts of the root by which it absorbs the water from the soil. If they grew at the very tip of the root, they would be liable to injury, as the root pushed its way through the soil during growth.

#### HOW THE STEM LIFTS ITSELF INTO THE AIR.

Watch carefully for the first signs of the planted seeds breaking the surface of the soil. How does the bean seedling break the ground? Does the *tip* of the stem appear first? Do all the different seeds planted break through the soil in the same way? Describe. Do all the seeds of the same kind break the ground in the same manner?

Rule a horizontal line across a sheet of pad paper to represent the surface of the soil, and at the left make a drawing to show how the bean seedling breaks through the ground. Save the

space at the right for the successive stages of growth and be similar records for the pea, corn and squash.

Observe from day to day the different stages by which the stem becomes erect in the air, and represent them, as observed, in a row from left to right along the soil line as directed above. Represent five stages in each plant. Are the halves of the seed raised into the air in any of the plants? Written description as above.

*Note.*—It is best not to try to explain *why* some plants break through the soil in the form of an arch, while others do not, or why some lift the halves of the seed, while others do not. It is doubtful if the true significance of the fact is known, and a child is too young to discuss theories.

### THE PARTS OF THE PLANT.

*Material.*—Young seedlings of the common white bean, 2 to 3 inches high. (Any other variety will do.) The plant will be cleaner to handle if grown in moist sawdust instead of soil. Carefully remove the plants and clean the roots in water. It will be desirable also to have a plant or two grown in soil or sand for the purpose of showing how closely the soil clings to the roots.

*Observation.*—Can you easily distinguish the underground portion, *the root*, from above-ground portion, *the shoot*? How do you tell them apart? What part of the embryo has grown into the shoot? Can you recognize the plumule in the seedling? Have any of the parts changed color since leaving the seed-coat? If so, what parts and how have they changed?

*The Root.*—Is there a main *tap root*? Is the root branched? Which is longer, the root or the shoot? Which is the most branched? Do you think this is an advantage to the plant? How? What might be the result if the young shoot showed a branch more than the root? Does the soil cling very closely to the roots? What advantages result to the plant from the branching of the root?

*The Shoot.*—Observe that the shoot is composed of the stem and the leaves. Does the stem have branches? If so, describe them. Are the leaves opposite each other on the stem? If not, describe how they occur. What do you find at the tip of the shoot?

the cotyledons are raised above the soil, describe any changes you can see in their appearance. Are they opposite each other? Is the stem any bigger below the cotyledons than above them? Are there any leaves below the cotyledons? Do the cotyledons begin to shrivel up? What do you think makes them do so?

*The Leaves.*—Observe the first leaves above the cotyledons. Is there a distinct *leaf stalk* and a broad, thin, flat *blade*? Do you find any *swelling* at any place on the leaf stalk? If so, where? If possible examine plants that have grown in a window. Have the leaves turned toward the light? If so, where did the bending take place? The tip of the blade is the *apex*, the place where the blade joins the leaf stalk is the *base* of the blade? Can you find two little wing-like parts on the leaf stalk at the base of the blade? Are there any where the leaf joins the stem? Is there a *joint* in the leaf stalk at this place?

Does the stalk extend up through the blade toward the apex forming a *midrib*? Does the midrib branch into *veins*? Can you see an unbroken line of vein extending around the blade parallel to its edge? Of what advantage is this to the leaf? How can you tell the upper from the under side of the blade? What purposes do you think the veins serve? Are the two opposite first leaves alike? Make labeled drawings.

The other leaves above the first pair are *compound* leaves. How many blades has each? Each of these blades is a *leaflet*. Has each leaflet a stalk? Is there a joint where each leaflet joins the leaf stalk? Does each leaflet have a pair of little leaf-like bodies near the base of its blade? Is there a pair also where the leaf stalk joins the stem? Is there a joint in the stalk at this place? Are the stalks of the lower leaves longer or shorter than those of the upper ones? If the lower stalks were shorter could the lower blades get the sunlight as well? If the upper blades were divided into three leaflets, would they shade the lower leaves more than now? Make labeled drawings and write descriptions.

The cotyledons have shrivelled because the food that made them thick has gone to nourish and feed the growing seedling. The first leaf of the bean is not a true simple leaf. It is what is known as a *unifoliate compound* leaf, that is, a compound leaf with one

one leaflet. This is shown in part by the joint at the base of the blade, and by the wing-like outgrowths (*stipules*). These outgrowths are seen at the base of the blade of each leaflet in the other leaves. The similar outgrowths at the base of the stalk are *stipules*. Elongation of the lower leaf stalks carries the blade off from under the upper leaves so that it gets better sunlight than it otherwise would. To observe this fact and reason out its meaning is more important than to learn the name of the stalk (*petiole*). The leaves above the first pair are *trifoliate compound leaves*. This branching of the blade permits more sunlight to penetrate to the lower leaves. To recognize this fact is more important than to learn that the leaves are *pinnately compound*.

This work gives a basis for the study of any other plant in the garden. It shows the *kind of facts* to look for and question about. All other plants in the school garden will be seen to be modifications, more or less profound, of the bean type.

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#### OUR IMPORTATION OF VEGETABLE FIBERS.

In 1905 the United States imported \$48,000,000 worth of vegetable fibers. Of this amount cotton makes up \$9,000,000. Of the 61,000,000 pounds imported 52,000,000 was consigned from Egypt. The reason for this large import of cotton from Egypt is its use in the making of the finer grades of cotton cloth. The two fibers which excel cotton in the value of the imports are manila and sisal grass. In 1905 the value of the former was \$12,000,000 and the latter \$15,000,000. In 1905 the Philippine Islands furnished 56,511 tons of the total 61,562 tons of the manila imported and Mexico 97,698 tons of the total 100,301 tons of sisal grass. The only other fiber imported in large quantities is jute and jute butts, of which India consigned 93,843 of the total 98,215 tons imported in 1905.—Report of the U. S. Dept. of Agriculture.



FIG. 33. Haunt of the Filmy Fern, Jamaica, B. W. I.

## THE FILMY FERNS (HYMENOPHYLLACEÆ).

BY WINIFRED J. ROBINSON,

*Vassar College.*

The delicate maiden hair, the fragile woodsia, the slender bladder-fern seem to us as exquisite as possible in the way of fern structure, but nothing in our northern latitude can compare in delicacy with the filmy ferns which are represented by only a few species in the southeastern part of the United States and by numerous species in the tropics and sub-tropics.

In size they vary from *Trichomanes pusillum*, which is less than half an inch long and bears but one sorus, to *Trichomanes scandens*, which is about eighteen inches long. They are only one layer of cells in thickness, except at the veins, which give them their peculiar filmy character. Whether they have the light green color of *Hymenophyllum asplenoides*, or the dark green of *Trichomanes rigidum*, or the rusty bronze of *Hymenophyllum lanosum*, they form an exquisite drapery upon the trunks of trees or the banks of humus, where their short, wiry stems are buried. There are a hundred upon the trees to one upon the ground, but some of the more hardy may be found upon limestone rocks.

The life-history of the members of the filmy fern family resembles that of the common brake (*Pteridium*) of our roadsides, but varies in certain details. Along the margins of the fronds at the

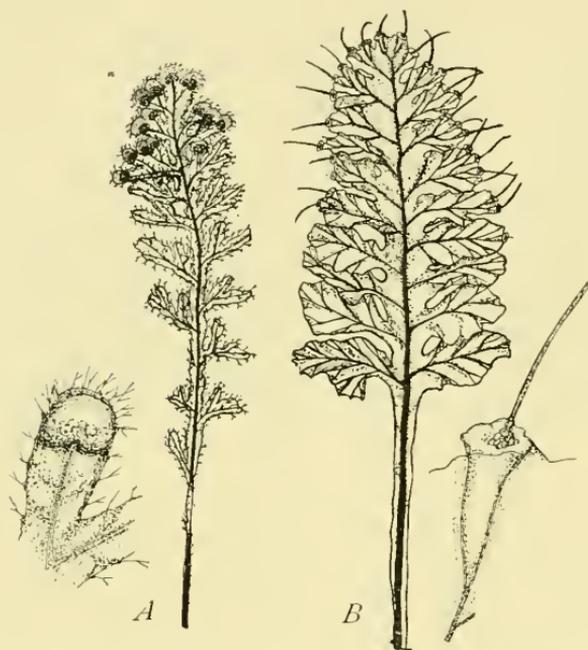


FIG. 34. Filmy Ferns. *A*, *Hymenophyllum asplenoides*; *B*, *Trichomanes rigidum*.

The spore-cases are encircled horizontally by a ring or annulus (fig. 35, *a*) of thick-walled cells, and burst vertically downward. The spores are green, and are spherical or triangular in shape in different species. They often begin to germinate while they are still within the sporangium, though the later development is often extremely slow. They do not produce a heart-shaped prothallus like that of the brake, but in the genus *Hymenophyllum*, at least, a slender, tapering structure which bears the sexual organs at its base; the male, or *antheridia* (fig. 36, *a*), and the female, or *archegonia* (

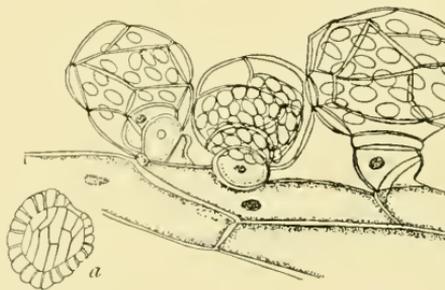


FIG. 35. Sporangia and Spores.

ends of the veins are the receptacles or sori within which the spores are borne. These sori are flattened in the genus *Hymenophyllum* (fig. 34, *A*) and have the form of a two-valved capsule. In the genus *Trichomanes* the sporangia are attached to the protruding vein and the sorus has a vase-like form (fig. 34, *B*). This elongation of the veins beyond the margin gives this genus *Trichomanes* its name (Greek, *thrix*, hair).

Fertilization takes place in the usual way; an antheroxoid escapes from the enclosing antheridium and swims to the neck of the archegonium by means of the small amount of water which

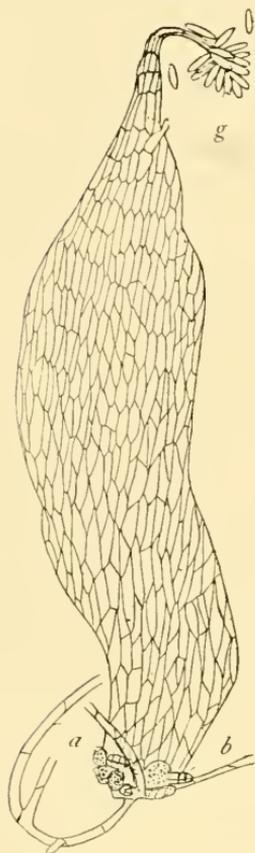


FIG. 36. Prothallus. (a) antheridia. (b) archegonia. (g) gemmae.

always present in the soil where they grow. It makes its way down the canal of the archegonium (fig. 37, c) and unites with the egg-cell at its base and from this union a young fern plant arises. Occasionally in the genus *Trichomanes* the sexual organs appear upon a filamentous prothallus, instead of upon the strap-shaped form.

Various forms of asexual reproduction occur. Figure 36, g, shows a cluster of brood-bodies or *gemmae* which have formed at the apex of the prothallus. One of these bodies, enlarged, would show the nuclei and chlorophyll granules within its cells.

About 160 species of the Hymenophyllaceae have been described. They are the arist

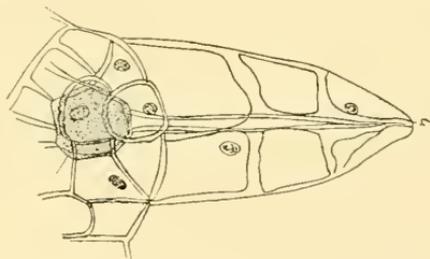


FIG. 37. Archegonium. (c) canal; egg-cell at its base.

crats of the fern world. Unable to accommodate themselves to variations in heat and humidity, their favorite habitats are the warm, moist forests of the tropics, but in these restricted localities they produce forms of such rare beauty as to make any fern lover feel that he has been well repaid for the pains of a pilgrimage to their haunts.

## REVIEWS.

*The Physiology of Plants.* A Treatise upon the Metabolism Sources of Energy in Plants. Volume III. By Dr. PFEFFER. Second fully revised edition. Translated by FRED J. EWART. Large 8vo. Pp. 451, with many illustrations. Oxford: The Clarendon Press, 1906. 21 shillings.

Every student of botany knows so well the character and usefulness of Pfeffer's *magnum opus* that criticism would be quite beside the mark. The translation has been long expected and is at last welcomed. To the translator belongs no small amount of praise and congratulation—praise for the excellence of the labor, and congratulation on its completion. But for universal acknowledgment accorded the author and his work a brief notice would ill fit the great value of the book.

*Mosses with Hand-lens and Microscope.* A non-technical Handbook of the more common Mosses of the Northeastern United States. By A. J. GROUT. Part III. Quarto. 167–246. Richly illustrated. Published by the author, Lenox Road, Brooklyn, New York. 1906. \$1.25.

It will bear repeating that the author of *Mosses with Hand-lens and Microscope* deserves the thanks of students of the mosses of this country for the work of which the third part is now to hand. It contains, besides many other very clear and useful illustrations, about twenty full page plates reproduced from the *Bryologia Europæa* and Sullivant's *Icones*, thus to this useful extent bringing original literature to the use of the person interested in these plants, but who is removed from the privileges of the large library. Dr. Grout's treatment is generally stimulating, and the book will certainly further greatly the wide study of the mosses. The earnest elementary student will get from it a very great deal of the help that he needs. The typography is excellent.

*Species and Varieties, Their Origin by Mutation.* Being Lectures Delivered at the University of California. By H. DE VRIES, Professor of Botany in the University of Amsterdam. Edited by Daniel Trembly MacDougal, Director Department of Botanical Research, Desert Botanical Laboratory, Carnegie Institution of Washington. Second edition, corrected and revised. Cloth, 8vo, pp. 18 + 847. With a Portrait of the Author. Chicago: The Open Court Publishing Co. Price \$3.00. 1906.

This most important work of Professor de Vries in the English language presented a no inconsiderable task to the editor, to whom, nevertheless, to the illustrious author, are thanks due for bringing this work to the Western continent. In the previous volume of this magazine, *Species and Varieties*, on its first appearance, scarcely a year ago, received a lengthy review which served to indicate very fully to our readers the scope and treatment. These remarks remain unchanged, but there are so very many corrections and emendations that the second edition will needs be in the hand of every student of evolution in its contemporary form. The portrait which was taken by Dr. W. A. Cannon and the reviewer during Professor de Vries' visit at the Desert Botanical Laboratory, we venture to say, a valuable addition from the human point of view, and will be highly appreciated by the admirers of the author. It is informal in its treatment, but the more it shows the man's kindly soul in the spontaneity of the expression.

L.

*How Ferns Grow.* By MARGARET SLOSSON. With forty-seven plates by the author. New York: Henry Holt & Co., 1906.

As several good books on ferns have appeared within the last few years, one naturally looks for something unusual in Margaret Slosson's book, *How Ferns Grow*. The author has treated the subject entirely from the standpoint of the development of the fern leaf, showing by detailed description and illustration the successive aspects, in respect to form and venation, taken on the sporophyte from the youngest stage through to the mature frond, including the modifications which a frond may assume.

becoming fertile. Eighteen species of ferns of the northeast United States are discussed in as many chapters, with an introductory chapter on the development of the fern leaf. The treatment of the subject is both original and scientific. The illustrations are of the kind that "really illustrate," and are an attractive feature of the book.

M. M. B.

# The Plant World

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## THE PAIRED SEEDS OF COCKLEBUR.

BY PROFESSOR J. C. ARTHUR,

*Purdue University.*

The cocklebur (*Xanthium*) is a common native weed throughout the central and eastern United States, especially along sand river bottoms and in corn fields. The seeds are enclosed in a hard, spiny covering, two in each bur. The spines undoubtedly assist in the distribution of the seeds by clinging to the rough coats of animals. Unlike many other seed pods, they do not open to discharge the seeds, either at maturity or by subsequent changes of moisture or temperature. Not only is the bur indehiscent, but it does not readily disintegrate, and after a number of years in the soil may appear little changed. From this hard unyielding bur the young plantlet frees itself at the time of germination by first pushing out the radicle and then pulling out the seed leaves, while the bur retains its usual appearance.

There is quite a common belief among farmers that one of the seeds in a cocklebur germinates the first year after maturity, and the other seed not until the year following, thus accounting for the persistency of the weed in cultivated fields. The truth in this theory was not tested, I believe, until a few years ago, when the writer took up the matter and made some preliminary trials which led to a study of the subject extending through seven years, and which established the essential correctness of the farmers' opinion.

First there were planted 75 cockleburs in a garden bed in May and by the middle of June 64 seedling plants had made their appearance, and in only one instance did two seedlings come from the same bur. I was able to identify 14 of the burs which had sent out one seedling each and upon opening them found that they contained only the remains of decayed seeds, and the other two had a good seed in each bur. Eleven of the husked seeds, having been destroyed in removing it, were placed in a germinating pan in the laboratory, with the result that two of the seeds grew in two days, one in three days, one in nine days, one in twenty days, one in twenty-three days, one in forty-two days and one in fifty-six days, while the two remaining seeds had the plump fresh appearance for nearly three years, when by accident the germinator was allowed to become dry and the seeds were killed. The other 61 burs of the experiment, which remained in the garden bed over winter, produced 20 seedlings following spring, but whether from burs that had already given one seed, was not ascertained.

This preliminary trial gave considerable coloring to the farmers' theory, which, however, was somewhat neutralized by the rapid prompt germination in the laboratory of eighty per cent. of the seeds that failed to start in the ground. Nevertheless, the facts remained that out of 75 burs only one gave a pair of seedlings the first year, while twenty produced single seedlings the second year.

In May of the second year of the study a quantity of burs were placed in germinating pans and out of these 100 were selected from which a seedling each had emerged. These burs that were known to contain no more than one seed each were planted in the garden bed. No further germinations were observed that season. The next year the bed was not very carefully watched, but five seedlings were noted; the year following there were eighteen seedlings observed. This experiment, although not complete, gave further credence to the farmers' theory, and improved upon it, as some seeds may evidently remain in the ground for more than two years in a growing condition.

Trials on a larger scale were made to ascertain the frequency with which both seeds of a bur germinate at the same time. 137 burs placed in the germinating pans at one time, only 6 gave twin seedlings. Another year, 1787 burs produced 1 twin seedlings, the largest percentage obtained in any trial.

It is unnecessary to give in detail the numerous observations which finally led to the confirmation of the popular belief. From the data obtained it is possible even to extend the statement. In round numbers, one may assume that out of every hundred apparently good cocklebur, one-fourth will not grow, owing to various causes, especially the depredation of insect larvæ and a failure to properly mature. Of the remaining three-fourths, about five burs will produce two seedlings each, and about seven one seedling each. In the year following about thirty seedlings will appear, in the third year about five, and two or three in subsequent



FIG. 39. Cocklebur. *A*. Vertical section showing one seed a little higher than the other. *B*. One side a little more convex than the other.

quent years. Thus it seems that the farmer is amply justified in his dislike to these pestiferous weeds with their adaptation to a prolonged occupancy of the soil.

Following upon the establishment of the fact that the two seeds in a bur behave differently under like conditions for germination, came a still more difficult task—the discovery of the reason for it. Although the two seeds appear to be exact counterparts of each other, some difference must really exist either in the seeds or in the protecting bur. A careful microscopic examination of the seeds brought out no differences. The comparative weight of the twin seeds was then obtained. Thirty-five perfect burs were opened and the seeds accurately weighed on an an-

lytical balance. The thirty-five heavier seeds of each pair gave average weight of 65 milligrams, while the thirty-five lighter seeds gave an average weight of 46 milligrams, a difference of 19 milligrams. This promising result appeared to be of no significance, however, when the seeds were placed in the germinating pan, for the two lots showed no difference in rate of germination.

As study of the paired seeds revealed no recognizable feature to account for the difference of behavior, attention was turned to the enclosing bur. It was thought that perhaps one side of the bur was not pervious to water until partly decayed. To test this, burs were placed in chemical solutions and colored liquids. But on cutting them open, however short the immersion, both cavities of the bur were found equally and abundantly affected. A little further examination showed that the opening in the apex of each half of the bur, through which the style once protruded, was still in the ripe fruit an opening large enough to admit a needle, and that, furthermore, a considerable channel existed at the base of each half, closed only with loose fibrous material. This structure permits liquids to penetrate through both ends of the bur without hindrance, and to pass into both seed cavities with equal readiness.

At the beginning of the sixth year of the study an important discovery was made. In dissecting the cockleburs it was necessary to make longitudinal sections, and in this way attention was attracted to a difference in position of the two seeds; one seed was placed a little higher in the bur than the other, see fig. 1. This slight but significant difference seems to have escaped the illustrators, for a considerable search through standard and miscellaneous botanical books has failed to bring to light any cuts showing the seeds otherwise than exactly side by side. Further examination made it possible to tell without dissection on which side of the bur the higher or the lower seed lay. The unsymmetrical position of the seeds causes a slight curvature of the bur, see fig. 2, and the lower seed lies on the inner or less convex side, while the higher seed lies on the more convex side. Here was the key to the situation. It was now possible without injury to the burs

detect and compare corresponding seeds in each, and further study of the subject was taken up with renewed interest.

With this new information at hand a lot of cockleburs were placed in wet sand to germinate. Out of 223 from which one seedling appeared, it was the lower seed which grew, except in fifteen burs. Upon cutting open the fifteen exceptions, eleven were found to contain no viable lower seed, and should consequently be excluded. This trial, therefore, gave ninety-eight per cent. germination for the lower seed against two per cent. for the upper. The result was in general confirmed by further observations of the same nature.

Comparison of the weights of the upper and lower seeds was now undertaken; when the lower seed exceeded fifty milligrams the upper proved to be lighter, but when the lower seed fell below fifty milligrams the upper was heavier. It is clear that when the burs are well developed, the lower seed will be larger and stronger than the other, and is the one that will grow quicker. This was found to be true even when the seeds were removed from the burs and placed in a germinating pan. A number of weighed seeds were thus tested, and after three to four months twenty per cent. of the lower and also heavier seeds remained in viable condition and over ninety-two per cent. of the upper and lighter seeds. A number of trials of this sort were made with fairly uniform results.

Comparing the various observations, both those where accurate data were recorded and others less complete and exact, the general statement appears to be warranted, that as a rule the lower seed in a cocklebur is better developed, sensibly heavier, and will grow sooner than the upper one. If burs are planted in the soil, the lower seed usually grows the first year after maturity, and the upper seed grows the second or some subsequent year. When removed from the bur and placed under conditions for germination, both upper and lower seeds grow more readily than when in the bur, but still differ considerably, the lower growing sooner than the upper.

This rule appears to hold good for all species of *Xanthoxylum*. The one most employed in the above experiments was *X. Pennsylvanicum*.

*panicum*, Wallr., but *X. glabratum* (DC.) Britton and *X. s. nosum* L. were also used. In the last named species the b have very thick indurated walls and the curvature is not v marked, making them less satisfactory for study. Outside genus *Xanthium* there are no seeds which behave in a sim manner, so far as can be ascertained, and no fruits of structure.

A number of grasses have two seeds in a spikelet, the lo seed usually being the larger and more vigorous. In the case oats careful tests show no difference in time of germination tween the upper and lower seeds of a spikelet. But in the sa bur (*Cenchrus tribuloides* L.) the two seeds of the spikelet enclosed in a spiny covering which keeps them from rea separating, and thus bear some superficial resemblance to cocklebur. In a trial in which sandburs were placed in a germinating pan the upper seeds grew somewhat more slowly t the lower ones, but in ten days practically all that were via had germinated, that is, 89 per cent. of the upper seeds gr against 99 per cent. of the lower. These have been the m favorable seeds for such a study, outside the genus *Xanthium* that have so far come under observation.

In this study of the behavior of the paired seeds of cockle it has not been possible to show that any structural or mechan difference exists, either in the seeds themselves or in their cov ings, which would account for the fact that while the lower s in a bur germinates normally the upper only grows after rest one year or more. To be sure, it has been shown that the lo is usually slightly larger and more vigorous, but this in itself co not be the primary cause of difference in behavior. But, h ever the phenomenon is brought about, it is clear that by this v serviceable adaptation the cocklebur has solved the problem giving each plantlet the utmost freedom for development, incidentally has increased the chances for the perpetuity of species. So far as the two seeds in each bur are concerned, i an instance of distribution of the plants by time rather than space, a seemingly unique character for the genus *Xanthium*

## THE PROBABLE ORIGIN OF KEY-FRUITS.

BY H. TULLSEN.

In late autumn and in winter, long after the leaves have fallen, we are apt to see still clinging to the trees some of the foliaceous seed-vessels—called samaras, or key-fruits—of certain maples and ash-trees. These trees are not closely allied, but in the external structure of the fruit, *i. e.*, the wing, is much the same in the one case as in the other, indicating that the function thereof is identical in both. The wing is present for the purpose of serving as a sail against which the wind shall act and blow the seed away to be planted in new soil. The fruit of the ash consists of one samara, while that of the maple consists of two, and these are ultimately separable.

There are about one hundred species of maples (*Acer*) and about forty species of ash (*Fraxinus*). All have winged fruits. We may be certain that this peculiar form of fruit was not developed independently in each of these numerous species. In order so to believe we should have to expect too much of chance. In the case of the maples it was inherited from some ancient aceriform progenitor, which, through natural selection, had taken to the production of winged fruits; and an old-time fraxinoid tree, also bearing this sort of fruit, was the ancestor of our present-day ash-trees.

The direct action of the environment can have done nothing towards the development of the foliaceous fruits of the trees under consideration. It would be hard to conceive of any other factor than natural selection as having wrought to produce them. Natural selection, we know, can operate only where there prevails a fierce and keen struggle for existence. So, in some great struggle of the past, we may conclude that the production of winged seed-vessels, by insuring the wider territorial distribution of the trees that bore them, saved the ancestors of the maples, and those of the ash, from extinction.

That this is true, it may at first be somewhat difficult to apprehend. The ashes and maples, it may be said, grow peacefully, and in their tranquil shade there is nothing that smacks of struggle. And when contemplating one of our ash-trees, red maples, box-elders upon the fertile soil of one of our central states, along the roadside or in the meadow, where any spot, almost, where a seed might chance to fall, would furnish the proper conditions for germination and growth, it is hard to believe that in the past the ancestors of these trees were subjected to severe hardships owing to overcrowding upon small tracts, and through natural selection, were driven to produce the winged fruits by means of which the species might become broadly dispersed over wide regions, and thus escape extinction. It may be held that even a gentle breeze can waft an actually wingless fruit to a suitable spot. But he who argues thus is thinking of present and local conditions only.

Now let us look at one of these trees under another and a different environment. Upon the great Pine Ridge Indian reservation in South Dakota, for example, are numerous streams and "draws" or "coulees" (which are nothing more or less than ravines or gulches free of water except in time of flood and rain) which, as a rule, are far below the general surface of the adjacent country, and are often miles from one another. Upon the flood-plains of such streams, and in the "draws" grow ash-trees and box-elders in company with trees of a few other species. Nowhere on the high, dry hills do they or any other trees, except pines, grow, although I have often found their wind-tossed samaras there; and if germination takes place, the seedlings are doomed to perish. Along the draws and other water-courses all the various kinds of trees that grow in such places are crowded together in dense and tangled masses; wherefore it is to the advantage of a given species that its seeds shall be carried to a "draw" or creek-plain where the chances of life are more favorable. Now let us suppose the ancestor of our box-elder and maples, on the one hand, or that of our ash-trees on the other, growing in an isolated "draw" on a vast hill barren of deciduous trees and unfavorable to their growth. Its fruits as yet are wingless, but often vary toward

producing a minute winglike appendage on the end or margin, is in reality the case with the fruits of many plants. Violent winds, such as sweep perennially over such regions, carry a few of the nascent key-fruits out of the ravine where the parent-tree grows, and perhaps, after being borne through the air for a considerable distance, a few fall upon the fertile and unexhausted soil of another draw, or flood-plain, which is as yet unpeopled by trees. The unappendaged seed-vessels, unable to fly far with the winds, perish in the tree-crowded coulee or upon the barren hills. Plants that spring from the seeds of such fruits, by virtue of the laws of inheritance, will themselves have a tendency to bear fruits lacking the incipient wing, and growing as they do in impoverished soil, will stand but an unfavorable chance in life, and so will their descendants also. Likewise, the trees that spring from the seeds of appendaged fruits by heredity will tend to produce this kind of seed-vessels themselves. Thus year in, year out, the selection and elimination goes on, and it can easily be understood how, in time, first a samaroid and later a fully-winged fruit may be evolved. Sometimes among hundreds of perfect ones we find a maple key-fruit the wing of which is very short and rounded, that is, has been arrested in its growth. Such partly-developed samaras illustrate an early stage attained ages ago in the evolution of the typical specimens.

Without a wing of some sort, countless thousands of such fruits would annually be stranded amid the unproductive hills, and even as it is I have often found samaras of ash-trees and box-elders inextricably entangled in dense mats of buffalo-grass.

To support the idea that the ancestral trees may have been driven to develop this peculiar form of seed-vessel in order that their seeds might be carried from one productive spot, in an arid or semi-arid country to another, I may adduce the fact that plants indigenous to desert regions often have special means of insuring the transportation of their seeds across the barren wastes, to more fertile tracts. Says Lubbock, "The *Anastatica hierochuntica*, or 'Rose of Jericho,' a small annual with rounded pods, which frequents sandy places in Egypt, Syria and Arabia, when dry curls itself up into a ball or round cushion, and is thus driven about

the wind until it finds a damp place, when it uncurls, the pods open and sow the seeds." In this plant the contrivance through which dispersal is effected differs from that of the maples, but the result to be attained is identical in both.

Easy conditions of life cannot have impelled the ashes and maples to develop key-fruits. Great difficulties have in the past been encountered, and the trees that were enabled to establish new means of dissemination survived in the struggle for existence. But the barriers to be passed over may not have been in all cases hills. Sir John Lubbock finds that the only trees that bear winged fruits are forest-trees, which fact would seem to indicate that such fruits in many instances have been evolved in order to be carried over vast tracts of dense woodland. The theory here set forth remains unshaken, and is really thus supported, for the principle is the same, namely, that there were areas so conditioned that germination and growth thereon were impossible or unusual, and these unproductive tracts must be traversed so that at length the seeds might find a resting-place in propitious and fertile soil.

To sum up: It is certain that key-fruits were developed in a country where they became of far greater service to the trees which bore them than they appear to be to the ash-trees and maples in many regions of our eastern United States and elsewhere. But I do not wish to insist that the barriers to be surmounted were necessarily hills. They may have been broad plains, or forest-growths of other kinds of trees, or even bodies of water—it all depends upon the nature of the region where the changing form first grew.





# CHILDREN'S GARDENS AND THEIR VALUE TO TEACHERS OF BOTANY AND NATURE STUDY.

BY HENRY GRISCOM PARSONS,

*Assistant Director of Children's School Farm, DeWitt  
Clinton Park, New York City.*

The widespread interest that is being taken in children's school gardens is, in a measure, due to the fact that wherever the work has been taken up, some side of it finds lively appreciation in the mind of every beholder. It is eminently practical, because what is learned is of immediate use in the child's daily life, at home as in the school room. Teachers quickly see how the garden work can be made to vitalize some of the at present "dry" subjects. Properly administered, a school garden can be made a source of inspiration to the whole curriculum, and the time is coming when such gardens will be connected with our schools wherever possible.

In a subject like botany the lessons often become mere groups of troublesome words, soon forgotten; but for the child to learn of the plants in his own little garden, plants whose very existence he feels sure are largely due to his care and labor, is a progressive pleasure. The child, having a garden of his own, is inspired with a strong personal interest in the plants, which takes from the teacher's shoulders a large share of the burden of instruction; but this interest of the pupil will be made as nothing unless the teacher is endowed with that sympathetic wisdom which makes him understand that the child wants to know about his own plants. In any study, let the teacher create in the class a personal interest in the work and then there will be no need of pushing the pupils; instead they will have to be restrained to enable the teacher to keep up with them.

If the child prepares the soil, plants the seeds, cultivates, waters and weeds, and for the time owns the plot of ground and all it contains, no matter how small it is, this sense of ownership, combined with the labor he has put upon it, creates the strongest ki-

of personal interest. The child that has worked with his hands in the earth making the seed bed, planting the seeds and covering them with fine soil, removing stones and breaking lumps, preparing the surface here or loosening it there for different results, has a real and definite knowledge which can never be effaced; and when the teacher of botany calls upon such a child to suggest reasons why a fine seed bed is desirable for small seeds his answer is made after calling upon his five senses and several centers of information of his body. His feet remember the difference between the spaded and unspaded plot; his hands remind him of plots where one could run the fingers deep into soil like flour, and of others where one's whole strength could make no impression on the hard cracked surface. His eyes remind him of how different were the final results in growth on these two kinds of soil. And so, as the questions are asked by the teacher, the child answers from a memory stored with experiences which are clear-cut, well defined, usable.

A plot of ground a foot square can be made to furnish material for a dozen sciences, geography, composition, arithmetic; almost every subject can be taught with the garden as a text. The earthworm in the ground; the butterfly hovering over the plants; the caterpillar eating the leaves; the aphid sucking the sap; the lady-bug eating the aphid; the beans "backing up" from the soil; the onions coming up doubled as though they were threaded through a darning needle; the flies "going to roost" at night; the spiders catching the flies; everything is of the utmost interest to the small gardeners.

To the teacher of botany the pupil's garden plot will be a very great help, and an introduction to a wider range of study easily arranged through the weeds that come in. In one garden a specimen of each different weed found was relegated to a weed plot, and soon there were several wild cousins of the tame plants. Some of them were the following:

Tame.	Wild.
Tomato	Jimson weed
Portulacca	Pusley
Buckwheat	Smartweed
Radish	Mustard

The United States Government issues a bulletin on weeds useful in medicine, most of which are very common, and this knowledge adds much interest in becoming acquainted with them. The hardness of weeds, their manner of bearing seeds, their prolificacy, and means of distribution are all more interesting when we come into the closer relationship which the garden work gives. Even here we find that a weed or strange plant coming up in the child's own plot will receive close attention and he will want to know about it, when the same plant growing elsewhere he does not care about. And it is this stimulated interest which comes through the child's garden which makes the garden valuable to the teacher.

Another item of great importance to the teacher: the garden can be made to save many weary trips afield in search of material for the class-room. Many earnest teachers to-day rob themselves of hard-earned hours of freedom while collecting material for botanical or nature-study lessons, and then, perhaps, give their class plants or insects to study which the pupils in their daily life will seldom come in contact with. Would it not be wise, and would not material be more accessible, if our common vegetables were used more in the class-room, and would not the resulting knowledge of more lasting benefit to the pupils?

In the children's garden the whole life history of plants and insects can be presented objectively, and this fixes the knowledge, as no other means can.

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Mr. Howard H. M. Bowman, in the June number of the *PLANT WORLD*, speaks of the specific name of the tree of heaven as referring to the glands of the bark, which, he says, exudes when injured a very sticky, resinous gum. Professor William Trelease, in answer to a question addressed to him from the editor, writes

"I have not the original description of *Ailanthus glandulosa*, but extracts from it, published in Usteri's *Annalen*, immediately after its appearance, show that the *leaf glands* are repeatedly referred to, sometimes by way of contrast with glandless things, and I do not think there is any question as to what character the specific name was intended to refer."

WILD FRUITS AND SHRUBS OF THE PRIEST RIVER  
VALLEY.

BY J. C. BLUMER.

The extreme northwestern part of Idaho consists of a valley some fifty miles in length and eighteen miles in width. In the center lies Lake Kaniksu, or Priest Lake, extending across three townships in its length, and across one at its greatest width. It is fed and is fed by the Priest River, which drains the basin in its southward course and empties into the Pend O'Reille. The Cabinet Mountains, attaining a height of 8,000 feet in places and forming the eastern boundary, extend from this river northward to the Canadian boundary, where they unite with the Pend O'Reille Hills, which form the western boundary and attain a height of 5,000 feet. There are perhaps two townships of comparatively level country, consisting of white, yellow, and blue pine forest and swampy meadows, while the remainder of the basin is filled with high slopes and spurs, where the western balsam, red fir, and yellow pine flourish. The valley is well watered and well forested, except about the lake, where the fire-fiend has wiped out both the forest and the possibility of a young growth for many decades to come.

This interesting region contains a number of wild fruits, some of which are of horticultural as well as botanical interest. The following notes were gathered while spending here the season of 1901 in the interests of the United States Forest Service.

The Oregon grape (*Berberis repens*) is not a grape but a holly berry. It is a low bush 6-10 inches high, quite common on the ridges. The leaves are 1½-2 inches long, oval, thick and glossy, with spiny margins. The blue, globular fruit, ⅓ inch in diameter, is borne in small, grape-like clusters, and presents the typical bloom of the grape. It is extremely acid, but it is observed to loosen the parched tongue and quicken the sluggish limbs when climbing a long slope.

The service-berry or June-berry (*Amelanchier alnifolia*) occurs somewhat commonly in some localities on open slopes. It is a shrub 3-5 feet high, with small, alder-like leaves, as the name implies. The calyx is persistent on the fruit, which is of the same size as the Oregon grape, and borne in racemes. It is bluish black in color and sweetish, sub-acid in taste. When hung on the way to camp, we often regaled ourselves with this excellent fruit. It yields itself readily to cultivation and improvement.

The wild strawberry (*Fragaria* sp.\*) is a smaller plant than our *F. Virginiana* and *F. Illinoensis* of the east and middle west. It grows nearly everywhere on open ground, to the top of the highest hills. Its fruit is elliptical,  $\frac{3}{8}$ - $\frac{1}{2}$  inch in length, with three conical achenes or seeds, not borne in pits as our eastern wild strawberry, but on the surface, as in *Fragaria vesca*, the European strawberry. It is both juicy and aromatic. Color and taste need no description, for the strawberry is known and welcomed with delight wherever found.

The thimble-berry or salmon-berry (*Rubus nutkanus*) frequently forms a dense ground-cover of the slightly open forest on semi-moist slopes and hills. It is 2-3 feet in height, with the leaves of the raspberry, but six inches in diameter. Its flowers are the size of our wild rose, and a dense thimble-berry patch in June often presents a beautiful appearance. The flattened fruit is about  $\frac{3}{4}$  inch across, and when ripe, it can easily be shaken from the broad, flat receptacle. It is bright crimson, pleasant sub-acid, but somewhat insipid.

The red raspberry (*Rubus strigosus*) is not common. It likes to spring up in burnt areas on hillsides, where it occasionally forms dense patches that make excellent picking. It resembles our cultivated raspberry very much, both in plant and fruit. To eat out of hand it is equal to or superior to the best cultivated raspberry of the middle west.

The black-cap raspberry is another fine fruit, but somewhat rare. It is probably a western form of the variable *Rubus occidentalis*. It seems to find congenial foothold about the log cabins.

\* This is probably Sandberg's No. 508, collected here in 1892 (Cont. S. Nat. Herb. III., 4). No specific name is given it in this reference.

and in the corners of the rail fences. Its long, purple, arc canes are hung with an oblong berry of like color and good s tender texture, and delicious flavor, superior to our cultiv varieties. Under selection and cultivation something fine m be made out of several of these fruits.

The wild plum (*Prunus subcordata*) is quite rare. The w only saw it six or seven times in a four months' sojourn i valley. It is a small, slender tree not over 6 or 7 feet in hei with few spines and small oval fruit, otherwise resembling ty *Prunus Americana*.

The wild cherry (*Prunus demissa*) occurs sparingly as a slen shrub 2-12 feet high. Its fruit is not black and small as seen Nebraska, but  $\frac{1}{2}$  inch in diameter, bright red, sweet, astring with a globular pit.

The hawthorn, probably allied to *Cratægus rivularis* or *Dougl* is a small tree 8-12 feet high, with smooth white bark and u sharp spines  $\frac{3}{4}$  of an inch in length. More than once they ceremoniously detained us and subjected us to a painful pa The fruit is of the shape, and of slightly more than the size, of service-berry. As with the latter, the calyx is persistent on fruit. It is found sparingly on the borders of swamps.

The huckle-berry or blue-berry grows from six inches to f feet in height, and botanists may make two or more species of t delightful fruit for that locality. In the large form, perhaps *Vaccinium uliginosum*, the fruit occasionally reaches  $\frac{1}{2}$  inch in dia eter. It is globular in form, dark blue to jet black in color, a dented on top when fully ripe. The opposite leaves are oval a mostly acute, thin, smooth, whitish beneath, and serrulate or fin toothed. In the small form, which is perhaps *Vaccinium myrti* or *caspitosum*, the berry is  $\frac{1}{4}$  inch in diameter, dark red to bla with a bluish tinge. It frequents the drier and more open gra slopes, while the tall form occurs in dense and flourishing patc upon what the forester calls fresh slopes. These are moist, sha usually north slopes with a heavy stand of forest. It was o experience to find the best huckleberry patches associated w the finest timber, indicating a deep, good soil and plenty of mo ure with good drainage. These patches constituted our El Dora

Many were the sidelong looks and grasps as we passed through them. After lunch was eaten, we would supplement it with several times its bulk of this most luscious of wild fruits, nor would supply give out, or desire grow less.

The bearberry (*Arctostaphylos uva-ursi*), growing from 6 inches to one foot in height, is the most common shrub in the valley. It often completely carpets the more open hills and slopes with a thick mat of its recumbent stems, rich, green leaflets, and a profusion of its round, purplish-red berries. The leaves are  $\frac{1}{2}$  to one inch in length, oval, glabrous and fleshy, with smooth margin. They form the tobacco of the red man. He constructs a small stone kiln, places over it a piece of matting made from willow and alder sticks, woven together with osier or buckskin after the fashion of a slat fence. Upon this he puts the gathered leaves of the kinnikennik, by which cognomen the bearberry is universally styled in that country. When dry to a certain degree he sacks it up, and smokes it. The flavor is very mild in comparison to our commercial weed, yet the smoking members of our party would often prolong their waning supply by drying and mixing kinnikennik with their Bull Durham, Duke's Mixture, &cetera. The fruit is  $\frac{3}{8}$ - $\frac{1}{2}$  inch in diameter. The rind reminds one of the crab-apple in taste. The flesh is mealy, acid-acrid, sometimes bitter, but not unpleasant. It contains from 4-6 seeds, of size and shape of those of the rose. It has a persistent, 5-parted calyx at the base.

*Pachystima myrsinites* is a very abundant and characteristic shrub of the woods of medium density. Having no common name of its own, it is probably included with the bearberry. It attains a height of 6 inches to 2 feet. Its sessile, evergreen leaflets greatly resemble those of the bearberry, except that they are sharply toothed, serrate around the upper two-thirds.

The buffalo-berry (*Lepargyrea canadensis*) is a fine shrub of about 3 feet height, one that would be an ornament to any lawn. It is somewhat rare. Its foliage is not unlike that of some willows, and presents a silvery appearance. The fruit is from  $\frac{1}{4}$ - $\frac{1}{2}$  inch in diameter, of bright, crimson color, thin, shining skin and juicy pulp. The first taste is pleasant acid, the after-taste bitter.

acid. The twigs bear peculiar, 3-5 fold buds closely clustered below the leaves.

The wild rose presents two or more species. The first is similar to our eastern woodland rose (*Rosa blanda*), both in leaf and blossom. It is not common, and grows only in the more open places, upon the moister soil. It commonly grows to a height of 2-3 feet. The writer found one specimen, however, in a copse on the banks of the majestic Peud O'Reille River, that measured 8 feet in height. This may have been *R. californica* or an allied species.

The small form grows only in the shade of the forest, but is visited but now and then by a speck of sunshine. It grows from 6 inches to 3 feet high. Its blossoms are  $\frac{3}{4}$ -1 inch in diameter and its hips are correspondingly small and oval. It is very probably *R. gymnocarpa*. Its leaves are small and, like those of most forest plants, are very thin and delicate. One may observe that the whole scanty flora of the dense forest shades extends its foliage horizontally, in order to catch every precious bit of sunlight. This is in marked contrast to the greater or less perpendicularity of the prairie foliage, which thus avoids the burning summer sun.

The meadow-sweet (*Holodiscus discolor*). This is the beautiful shrub that lends to the many hilltops of the Priest River Valley their exquisite, park-like attraction. The ponderosa crowns of the bull pine wave in the breeze above, on every hill are copses of young red fir, of fresh and lively green, among which the trail of the deer leads us over grass-covered plots here and there in nature's inimitable way with this handsome, richly-scented shrub. It grows from 4-10 feet high. Its light green, triangular leaves are 3-lobed and toothed, and possess prominent veins. The small, creamy-white, 5-petaled flowers are borne in dense, compound panicles, or grape-like clusters. The 3-5 sub-panicles extend at right angles to the main axis which attains a length of 5-10, or sometimes 12 inches. This shrub, where hardy, is worthy of extensive planting on lawns and parks.

Its cousin (*Spiraea betulifolia*, var. *rosea*) is a shrub locally known as the hardback. It is somewhat smaller, growing from 2- feet high. Unlike its relative, it inhabits and dominates the smaller swamps, and forms almost impenetrable thickets along the borders of the larger ones. Consequently we never loved it like its cousin, the fair maiden of the hills. Its pretty, rose-colored blossoms are borne in a thyrse, or dense oblong cluster, about half as large as the looser panicles of *H. discolor*. Occasionally a thyrse presents a partly upright sub-cluster. The small leaves are ovate-lanceolate to lance-shaped, with the upper half serrate.

The alder (*Alnus incana* var. *virescens*) is found in considerable numbers as a shrub and small tree to 20 feet high, following brooks and edges of swamps. The leaves are 2 by 3 inches in size, smooth, oval, doubly toothed and feather-veined, which is prominent beneath. The catkins are  $\frac{3}{4}$ -1 inch in length and  $\frac{1}{2}$  inch thick.

The only species of maple occurring in the basin is the *A. glabrum*. It is a shrub and small, straggling tree occasionally reaching the maximum height of the alder. Its diameter is never more than 5 inches. Its leaves are either 3- or 5-lobed, circular in outline, thin, and horizontally placed. The twigs and leaf stalks are of pink or reddish tinge. It inhabits somewhat sparingly moist spots and "draws" on the higher slopes.

The elder (*Sambucus racemosa*) occurs sparingly in moist spots at altitudes of 4-5,000 feet, in company with the maple. Its compound leaves and bright compound cymes of scarlet fruit are ornamental wherever seen.

The buckthorn (*Rhamnus Purshiana*) is a shrub and small tree to 15 feet in height, and somewhat scarce, occurring in low places. Leaves 2 by 3 inches, oval, acuminate and serrate. The inedible black fruit is  $\frac{1}{2}$  inch in diameter, and of unpleasant bitter taste.

The snowberry is probably either *Symphoricarpos racemosus* or *S. oreophilus*. It is a small shrub to 2 feet tall, quite abundant in a few places. The leaves are  $\frac{3}{4}$ -1 inch in length, thin, smooth, oval, and borne on whitish stems. It bears white, watery, inedible fruit of huckleberry size, placed in the axils.

Buckbrush is the largest constituent of the brush of the valley. There are at least two species, of which *Ceanothus velutinus* is the most attractive. It possesses thick, oval to circular leaves. Its foliage is so refulgent that it gives at all times of day the appearance of being covered with a heavy dew upon which the sun shines. The fruit, borne in a corymb, resembles a buckwheat in shape and size. It attains a height of 2-5 feet, and readily takes possession of "burns," often to the exclusion of everything else.

*Ceanothus sanguineus* differs from its relative in smaller size, that lacks altogether the remarkable reflective power of the latter. It more often takes possession of the steeper burnt slopes. It has a habit of reclining down hill, and its exceedingly dense growth forms a barrier, to surmount which tries the strength and fortitude of the forester to the utmost. Is it a wonder that the tender seedlings of a fire-killed forest perhaps never again gain a foothold?

The nine-bark (*Opulaster monogynus*) is perhaps even more prevalent than the foregoing, growing everywhere except in swamps and the densest shade. But by reason of its smaller size it is less obtrusive. Its leaves resemble those of the gooseberry. Its inconspicuous flowers are borne in small flat clusters or corymbs.

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## THE GERMINATION OF THE MORNING GLORY

BY MARY ELLEN TAYLER.

An article in the *Botanical Gazette* for August, 1905, by Professor Beale, suggests certain germination experiments which were undertaken by the writer upon the seeds of our common morning glory, *Ipomoea purpurea* (L.) Roth, in connection with the study of the development and morphology of that species. In the unripe seed the embryo is bright green, but as the seeds ripen the embryo becomes yellowish or whitish. Characteristic structures, such as palisade parenchyma and stomata, are present in the cotyledons before germination. Large spherical cavities

filled with latex are found in the parenchyma, as has been reported for *Convolvulus major* by Turnbull. Whether the chlorophyllous cotyledons with their leaf-like structure and the storage of latex are ready for germination without further maturation and a period of rest is a question which can be answered only by experimentation. To obtain some light upon the subject, seeds of the morning glory, varying in age and maturity, were planted in garden soil and observations were recorded upon their germination. The table below sums up these experiments.

Condition of the Seeds.	Number Planted.	Number Germinated.	Days in Germination.	Per Cent. Germination.
Fresh and green.....	104	41	26	39
Green, air dried until white.....	58	16	22	27
Mature, but no period of rest....	90	76	15	83
Dry, after a period of rest.....	60	17	8	28
Immature (1903) rest of 8 mos.	25	16	8	64
Mature (1903) rest of 12 mos....	100	97	8	97
Mature (1893) rest of 10 years..	100	25	8	25

Further, plants grown in a green-house from immature green seeds blossomed earlier, had shorter stems and produced fewer seed-pods by about one-half than did those raised under the same conditions from seeds having no chlorophyll in the embryo. When the plants so grown from immature green seeds had ceased to blossom, those raised from mature colorless seeds were thriving and still forming buds and maturing flowers and fruit. Both kinds of seeds were planted at the same time.

From the facts demonstrated above, certain conclusions may be drawn. (1) Giving a resting period to the fully ripe seeds shortens the time required for germination. (2) Drying green seeds shortens their period of germination. (3) Dry, mature seeds having no chlorophyll germinate more quickly than fresh green seeds. (4) Fully matured and rested seeds germinate in eight days or less, whether the period of rest be eight months, a year, or ten years. (5) Twenty-five per cent. of matured seeds retained their vitality for ten years. (6) The highest per cent. of germination occurs in seeds one year old. (7) Seeds ripened earlier upon plants grown from unripe seeds, but the vegetative parts are more scanty and the amount of fruit less than upon plants grown from matured seeds.

## REVIEW.

*Entomology, with special reference to its biological and economic aspects.* By JUSTUS WATSON FOLSOM, instructor in entomology at the University of Illinois. 8vo, pp. 7 + 485. Five plates (one colored and 300 figures). Philadelphia: P. Blakiston Son & Co., 1906. \$3.00.

This is a book which does not belong to the how-to-know class, but which, nevertheless, may be suspected to be of value to the learner in entomology, and will lead him, if real knowledge is sought, to more than the superficial view of insects, such as so many may have in spite of many years of diligent "pinning." The treatment is biological, and as so much has been learned about insects in the last few years which has not got into the books, the author has had a rich harvest to draw upon. The reviewer is not an entomologist, but is enough interested to feel that the book has a real value for him and infers this to be true for many others at least as far as the large body of information is concerned. The treatment of the speculative aspects of the science which, in natural sciences, are those which it shares with the other, particularly the physical sciences, is hardly as lucid as it might be, and these may have been sacrificed to a fuller and more satisfying discussion of other matters. It is to be feared that the usefulness of the book, good as it is, has been curtailed by the desire for completeness. The world from the entomological point of view is too large a subject for one work. A large and presumably fairly, if entirely exhaustive, bibliography covers nearly sixty pages, and this will be of permanent usefulness to the student. The taxonomy of the subject is left to the other well-known works. Of the treatment of Packard's "Insects," but brought down to the present, it might serve in the place of this well-known work.





FIG. 40. Grove of *Cryptomeria* in the Botanical Garden at Tokyo. The trees are handsome conifers resembling our cedars and redwoods. From a photograph by the author.

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## THE TOKYO BOTANICAL GARDEN

BY PROFESSOR FRANCIS RAMALEY,  
*University of Colorado.*

In America, where botanical gardens are few, where one must often travel a thousand miles or more to find one, we do not appreciate how much they mean for the advancement of botanical knowledge. Our universities might well copy from Europe the plan of having such gardens, even if they can not be large. A botanical garden not only serves as a place of instruction where young men may study, but it may also become a place of historical interest.

The botanical garden at Tokyo is one which every botanist should be glad to visit. In it may be seen plants very different from those cultivated in Europe and America—the native plants of Japan and the far East, with, of course, a sprinkling of European and American species. Whoever sees the great Ginkgo tree, now historic through the work of Hirasé, carries with him a picture long to be remembered.

This large tree is about two hundred years old and is in prime. Ginkgo trees are much planted all through Japan, especially in large parks and in the vicinity of temples. The tree

\* Material from this tree was used by Hirasé in his researches on fertilization in this species. Through his work the botanical world first learned of motile spermatozoids in gymnosperms. Later Ikeno found similar structures in *Cycas*, and, in our country, Webber's studies brought the knowledge of fertilization in *Zamia*.

grow to a great age and around some of them are clustered memories of episodes important in Japanese history. At the Tenno Shrine of Hachiman, in Kamakura, is a fine specimen with trunk eight feet in diameter. Behind this in the year 1218 it is said the assassin of the Shogun Sanetomo lay in wait for his victim. In fact the Ginkgo, or "icho" as the Japanese call it, takes the place of oaks and elms in English and American history. The foliage of the Ginkgo reminds the observer of the leaf segments of the maiden-hair fern and Europeans sometimes call it "maiden-hair tree." In autumn the leaves become a brilliant golden yellow and add not a little to the beauty of many a Japanese scene.

A few years ago the present botanical garden belonged to the family of the Japanese aristocracy. With the downfall of the feudal system in 1868 came the relinquishment to the state of many valuable private estates, and in this way botanical garden and institutions became possible. The present botanical garden with its well-equipped laboratories and many students is about twenty-five years old. It is under the jurisdiction of the Imperial University.

The garden is located about a mile from the University campus in the northern part of the city of Tokyo. Its position is officially described in the University calendar as "Hakusan, Gotemma, Koishikawa, Tokyo." In size the garden is not large, there being about forty acres, but most of this area is in a high state of cultivation. There are about three thousand species of living plants. In the main part of the garden the arrangement is by families according to the system of Engler and Prantl. Besides this part there is a group of medicinal plants and also an ecological section of plants which grow in shady situations. A green-house of European construction is provided for the tropical species. In addition to this a number of plant-houses and arbors in native style offer opportunity for the display of the well-known Japanese taste in floral arrangement.

Although the garden is attractive, it is by no means a mere show-place. Students in botany, entomology and pharmacy are required to spend certain hours in study there and those in science lines gain a great amount of practical experience in this way. The high degree of specialization in the courses of the university

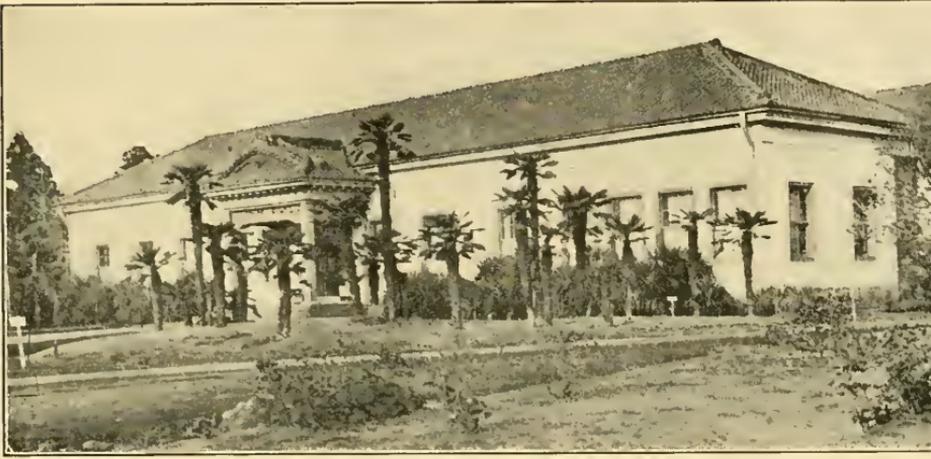


FIG. 41. The Botanical Institute Building, Tokyo Botanical Garden. From a photograph by the author.

requires that students give most of their time to the major subject and those who specialize in botany come to look upon the botanical garden as almost home to them.

The botanical garden, as an organization, is a part of the "Botanical Institute of the College of Science." The director of the garden is the head of the department of botany, Professor Matsumura.\* Students of botany go into the garden every time they go to the laboratory, for the institute building is well within the garden. Even the narrow specialist who spends his time looking down a microscope tube must see something of the garden and thus gain a larger view of botany in general.

If the reader should imagine that the laboratory building is strictly modern with hardwood floors, steam heat, high ceilings and fine equipment generally, he would be much mistaken. When a Japanese from one of the smaller cities is asked to name the best building in his town he says "the school building." So, I doubt not, the average Japanese would think the botanical institute building a very fine one, but it does not compare favorably with ordinary college and university buildings in America. It is warmed by stoves—I had almost said heated, but that would

\*The writer is under great obligation to Professor Matsumura for information about the garden and for a number of the photographs reproduced as illustrations in this article.

untrue—and such furniture as is there is very cheap in its construction.

But if the building and furniture are not of the best, there is a good equipment in instruments and chemicals. The men of faculty and the advanced students are indefatigable workers and offer an example of industry to the young men studying in the department. True, the students need much encouragement because theirs is a hard path to travel. In America and Europe a student finds it hard enough to become acquainted with a subject so bound up in terminology and nomenclature, but it is much more difficult for a native of Japan.

To the Japanese boy all difficulties are increased on account of the foreign tongue and foreign alphabet employed by botanists. Gray's "Lessons in Botany" is much used by beginners, although the more modern works are now gaining recognition. Nearly all the species mentioned in the text-books are unknown to the Japanese student. Usually he has almost no knowledge of Latin or Greek. So the technical terms, partly self-explained to the classical student, must be learned separately. Instruction is given through the medium of the Japanese language, yet the lecturers make continual use of English words, especially in describing physiological processes. While the student takes his notes in Japanese he must very often put down a word or phrase in another language written with different characters and having a totally foreign appearance.

Some very good morphological and physiological work has been done in Tokyo, but it seems to be along taxonomic lines. The most energy is directed at present. An attempt is being made to gain a good knowledge of the native plants of the empire, and extensive herbarium collections have been made in recent years. The marine algae have received most painstaking attention from Mr. K. Yendo\* and others. The seed plants have been studied by Professor Matsumura and his associates. Although the Japanese have not spent much time in hair-splitting discussions

\* The writer wishes to acknowledge his indebtedness to Mr. Yendo for information on many points of interest concerning the botanical gardens and also many other things Japanese.

nomenclature they have really done very close and careful work in the description of species. Some of the publications of the Botanical Institute are very handsomely printed and illustrated.

Japanese botanists have an interesting flora with which to work. The very moist climate permits the northward extension of many southern forms. To the botanist Japan is a land of contrasts. At one glance he may see bamboos and camphor trees and fields of rice, all reminding him of the tropics, while with a turn of the head he may have brought to his mind his American or European home with the sight of barley and wheat fields or groups of pines and maples. Japan has been well characterized as a "kingdom of magnolias, camelias and aralias." These genera and their allies are well represented in the botanical garden. One of the most striking features noted by the present writer on the occasion of his first winter-day visit to the garden was a large bed of *Fatsia japonica*, one of the Araliaceae, in full leaf. At the same time a few of the *Camelia* flowers, a little more hardy than the rest, were open to view. The *Magnolia* buds also, though it was early January, had swelled enough to show their cream-colored petals.

The people of Japan are fond of "gardens" and so the botanical institute must needs have a Japanese garden for show purposes. While the principal part of the botanical garden is given up to beds of herbs and shrubs in European style—or rather lack of style—there is this charming little plot of ground arranged with the most exquisite native taste. Here are no geometric walks, no ill arranged flower masses, no array of stiff sign-boards. Instead there are winding walks, stepping stones through glistening pools, rustic bridges, dwarfed trees of symmetrical form and handsome dark-green shrubs trimmed in rounded masses.

A true Japanese garden is something to delight the eye in its daintiness and good taste. The foreign botanist enjoys this exhibition of horticultural art so unknown to him, and he admires the skill of the gardener who makes his trees and shrubs grow just as he wants them to grow. He admires, too, the curious and unfamiliar trees and shrubs which are there. Flowers there are none. To most people a garden without flowers suggests Hamlet.



FIG. 42. Landscape garden in pure Japanese style. From a photograph furnished by Professor J. Matsumura.

with Hamlet left out. Nevertheless there is no sense of incompleteness in looking at a Japanese garden. Such a garden is a whole landscape in miniature, and it is intended by its arrangement to give an idea of largeness which it does not possess.\*

The particular garden which we are considering is not more than over two acres in extent. The ground is rolling, and there is a deep basin with a small pond. In this "landscape garden" the visitor sees nothing of the outside world, which is adroitly hidden by the massing of trees and shrubs along the higher ground. It is this landscape garden which makes the Tokyo botanical garden different at all seasons from all other gardens in the world. Of course the cherry blossoms and other special features are more conspicuous at certain seasons, but the landscape garden is beautiful at all times.

While the Japanese delight in gardens without flowers, yet they enjoy flowers too. Everyone knows about Japanese "cherry blossom gardens."

\* The writer wishes to acknowledge his indebtedness to Mr. Chamberlain's "Things Japanese" from which he has taken certain points used in this paragraph.

blossoms," but few people have any idea of their beauty or of the number of trees planted in the cities of Japan. These blossoms are pink and some are doubled to a great extent. Of course they do not bear edible fruit.\* In the botanical garden at Tokyo there are great rows of these trees flanking the open spaces. During blossom-time thousands of visitors come to the gardens who would not think of coming at other times. Doubtless some may see only the cherry blossoms, but some may become interested in other things as well. In Japan, as in the western world, science can be made popular by using appropriate means.

In such an account as this it would not do to omit mention of the *Cryptomeria* grove in the garden. These trees are handsome conifers resembling somewhat our cedars and growing very tall and straight. Visitors to the sacred city of Nikko in northern Japan are always impressed with the "cedars," but the trees at Tokyo are quite as handsome although smaller. The writer of this article holds no more pleasant memories than of strolling



FIG. 43. Cherry blossoms (*Prunus yedoensis*) in the Tokyo Botanic Garden. From a photograph furnished by Professor J. Matsumura.

\*Two or more species of *Prunus* are cultivated by the Japanese for ornament.

through this little grove. Each day in the garden one can walk beneath the Cryptomerias and find new pleasure and satisfaction.

On the whole the botanical garden at Tokyo is not a great institution, but it is one of which any university might well be proud. It answers the purposes of study very well. It is so arranged that the most satisfactory results are obtained with comparatively little money outlay. For native students of botany it is of the greatest importance since it enables them to become acquainted most readily with their own flora.

Every student of botany should be a traveler. Every traveler who would appreciate the country which he sees should know something about plants. The easiest way to gain an introduction to Japanese botany is by study in the botanical garden at Tokyo. American botanists especially should know something of the "land of the rising sun" whose plant life can here be so easily studied.

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## LICHENS: THEIR ECONOMIC ROLE.

BY PROFESSOR BRUCE FINK,

*Miami University.*

Far back in the very distant past some fungi took to a method of life very different from that of the great majority of closely related species. That peculiar digression was an intimate association with certain algae, green or blue-green. The symbiotic relationship entered into was doubtless at first accidental, but proved beneficial to fungus or alga or both, and has been perpetuated. When the first such association of algae and fungi took place will never be known, but some undoubted fossils of lichens have been found as far back as Tertiary times,—perhaps 2,000,000 years ago. Since the time of first association of alga and fungus in a symbiotic relationship, that relationship of the chlorophyllous plants and fungi entering into the symbiotic partnership has become more and more intimate as age after age has passed, and now some investigators regard lichens as autonomies or morpho-

logical units rather than symbiotic colonies of algae and fungi growing together.

But it were folly for us to enter at length into a controversy that has filled volumes. Whether the lichen may be regarded a plant in any true sense or not, we may speak of the "lichen plant" in order to avoid unnecessary circumlocution. Also, certain mycologists consider witches' brooms, burls, swellings, due to fungus infection, etc., as individuals, at least in a physiological sense, and if this view is well founded, lichens have surely added to definite function constancy of morphological characters a feature that may as reasonably be considered autonomies, both physiological and morphological.

While we may not regard as settled the question of the nature of lichens, there are many questions regarding the morphology and physiology of these, at least so-called plants, that are of very great interest to the biologist, and it is worth while to recall the relation of lichens to other things in nature from the point of view of utility or detrimental effect. In giving this popular statement the present writer can do no more than bring together once more some of the facts that have repeatedly appeared in print.

Lichens, like the higher chlorophyll-bearing plants, take large amounts of  $\text{CO}_2$  from the air in the processes of nutrition; they build up lichenin, a carbon compound very similar to starch, and return to the atmosphere as free oxygen the portion not needed in the production of the lichenin. It is estimated that the higher plants take half of their food thus from the air and the other half from the earth through the roots. It was formerly supposed that lichens took a very small proportion, if any, of their food from the substrata; but that view is certainly incorrect, at least regarding many lichens. However, it is quite likely that most lichens take a smaller proportion of their food from the substratum, and a larger proportion from the air than do the higher chlorophyll-bearing plants. The algal cells of the lichen-partnership do the work of building up lichenin, while the fungal portion of the lichen furnishes protection to these algae and also takes more or less of crude or elaborated food materials from the substratum. Thus the lichens, in the ordinary processes of nutrition, pur-

the air by extracting  $\text{CO}_2$ , the oxygen of which will not answer the purposes of respiration so long as it remains in combination with the carbon, and give back to the air a portion of the oxygen in the free condition. Therefore there is some ground for the old notion that the air is especially pure where lichens are abundant. Even travelers in wild regions have sought such places for camps and resting places over night, and certain it is that lichens are very sensitive to conditions of the atmosphere. They tend to disappear in places where man congregates in large numbers, and are becoming scarce near our cities and larger towns. This is due partly to the disturbance of substrata, but it is also true that the dust and impurities of the air about cities are in some way unfavorable to the lichens. Doubtless the dust fills the pores of the thallus and interferes with the passage of gases, while some impurities interfere with nutrition or breathing or both. It is not the intention to give the impression that lichens are great conservators of atmospheric purity, but rather that they contribute their share of work toward this end and that it would be to our advantage if they could be induced to grow more abundantly in and about cities.

It is also well known that certain crustose lichens are the first plants to attack rocks, and that they aid greatly in the reduction of rocks to soil. It would seem from superficial observation that some lichens might begin to grow on perfectly firm rock, and, after gaining a foothold, reach their full size and produce fruit while the rock is still in a firm and wholly undisintegrated condition. For instance, on the very hard Sioux quartzite in northwestern Iowa and in southwestern Minnesota, the writer has found lichens growing on perfectly smooth surfaces supposed to have been polished by wind before, or shortly after, the close of glacial time. Yet this rock shows to the eye or lens no evidence of disintegration and is, macroscopically, in exactly the same condition under the lichens as elsewhere. But in spite of this, it is not generally supposed that the rhizoids of the lichens ever penetrate perfectly firm rock, but rather that the lichen gains a point of attachment perhaps in microscopic openings, and then begins to secrete an acid which slowly disintegrates the rock, the rhizoids penetrati

deeper and deeper as the work of the acid makes a way for them. In many other regions where the rocks have not yet been disturbed may be found crustose lichens growing on rock that has not yet fallen to fragments, though so rotten for several inches below the surface that it can easily be ground to fine particles under foot. Thus the work of rock disintegration is aided in its early stages by the lichens and especially by the crustose forms. Here again we do not intend to convey the impression that the lichens are the only agents of rock decay, but merely that they are the first visible organic agency and really play an important part in the process. Atmospheric agencies as rain, winds, changes of temperature, etc., are certainly not to be disregarded. As the disintegration goes on and the rock at the surface is gradually reduced to small fragments and soil, the lichens decay and add their quota of humus. Then on this bit of prepared earth, in some crevice or flat surface of rock, the foliose and fruticose lichens and certain mosses begin to appear and carry on the work begun by the crustose species. Then in turn, appear some ferns, herbaceous seed-plants and finally shrubs and trees, first in the crevices and finally spreading until the whole surface is covered and the lichens are largely replaced by larger vegetation. All this may be most beautifully seen in many places in Minnesota, Wisconsin, Michigan, New England and in other parts of America.

Let us consider the uses of lichens as food. It is doubtful whether even the wild animals eat lichens to any considerable extent so far south as the pineries of northern United States, the reason that there is too much of other available plant food. But it would not be surprising if some careful observations in winter would show that the moose, caribou and deer of the northern regions eat the "reindeer moss," *Cladonia rangiferina* and other large *Cladonias* to some extent; for these plants are common and luxuriant. But farther northward the reindeer moss and some other lichens are surely important as food for both man and lower animals. *Cladonia rangiferina* and two or three closely related species really form the principal food of the Lapland reindeer and become there as important as some of the grasses of our prairies. This happens for the reason that larger plants

not drive out the lichens so effectually at the north, so that the "reindeer moss" and some other lichens literally cover large areas as do the grasses in other places. Some suggestion of the wonderful lichen growth may be seen in northern Minnesota, Michigan and Wisconsin, where patches of such lichens may be found covering an acre or more of ground, and in more northern regions, both in America and Europe, the reindeer and other wild and domestic animals depend more or less upon these lichens for their food supply.

*Lecanora esculenta* grows loosely attached to the rocks in high places in northern Africa, is carried long distances by the wind and falling in areas where food is scarce, is eaten by the inhabitants, both man and lower animals. This species is supposed to have been the manna of the children of Israel. Nor is this the only lichen commonly eaten by man, for *Cetraria islandica*, a plant found in northern United States, forms an important part of the food of the people of Iceland, and is eaten also by the domestic animals. This plant is especially rich in the peculiar starch-like compound so commonly built up in lichen tissues. Also some of our *Gyrophoras* and other common lichens as *Ramalina calicaris*, *Parmelia physodes*, *Peltigera canina*, and *Evernia prunastri* have been used for food by man. From some of these and certain other lichens may be extracted a substance very like gum-arabic. The nutritive qualities of the lichens is due mainly to the lichenin or starch-like material already mentioned as being built up in the processes of nutrition. But there is a bitter substance also found in lichen tissues, which often gives an unpleasant taste and is irritating to the digestive tract. This may be removed by thorough washing in water or some alkali, when the plants may usually be eaten with impunity. Arctic explorers, northern hunters and trappers, the inhabitants of such countries as Lapland, Labrador, Greenland, Iceland, Norway, Sweden and Finland, as well as travelers in the deserts of Africa, are very glad to have such food for themselves and their domestic animals. When grains or potatoes are at hand, the lichens may be powdered and mixed with these articles of food, and a very palatable bread may thus be made; or the bitter principle may be removed

and the lichen thalli boiled and eaten in milk without mix with grains or potatoes.

Quite a number of lichens have been used for medical purposes but few of the supposed medicinal qualities have been able to stand the test of modern medical examination. Thus the "dog lichen," our common *Peltigera canina*, was formerly supposed to be a curative of hydrophobia, hence the specific name. Like our *Sticta pulmonaria* was supposed to cure pulmonary disease while the well-known *Usnea barbata* was supposed to promote the growth of hair and to be a sort of cure-all. And as the name *canina* came from the Latin for dog, so we have in *Evernia prina* a specific name derived from *vulpes*, the Latin for fox, though the plant is said to have been used mixed with other substances to poison wolves rather than foxes. Lindsay, in his "Popular History of British Lichens," states that *Cetraria islandica* furnished preparations which were to be found in the drug stores of England at the date of publication of his volume, 1865, as cures for dyspepsia, and we still find *Cetraria* given as a remedy in our latest dispensatories. It is the bitter principle of the lichen that is supposed to give the medicinal value, and it has been used in fevers as a tonic and as a purgative as well as in the other ways mentioned above. Also alcohol has been frequently made from lichenin by fermentation.

But turning from the use of lichens in medicine, it may be said that their use as dyes is more worthy of our attention. Dyes of various colors have been extracted from lichens and are now being used in various ways. These colors are usually reds, purples, or blues, and they are used for coloring cloth, wood, paper, etc. In Europe these dyes have been quite largely used for coloring homespun cloth and yarn, our common *Parmelia saxatilis* being commonly used and producing various colors according to the method employed in making the dye. In *Evernia prina* the yellow coloring matter is ready-formed in the thalli and the same may be said of the beautiful yellows and oranges of our *Theloschistes* and *Placodiums*. Brown colors are also readily formed in many lichen thalli, are easily extracted and have been used for home consumption. But most of these are not to be

in sufficient quantity to manufacture the dyes in large quantities for the markets. However, *Roccella tinctoria*, a lichen found on our Pacific coast and on various coasts of the old world, produces a pigment which has been known, by one name and another, since the earliest historic times. Orseille is one of the names applied to the dye, and litmus is another name for it. This is no doubt the "blue and purple" of the Old Testament, and in more recent times the same dye was extensively used in France for coloring silk. At the present time paper is colored with a neutral solution of the dye and used commonly in chemical laboratories as litmus paper. This paper forms a delicate test for acids and alkalis, the acids coloring it red and the alkalis restoring the blue color. Litmus is also found in the market as a carmine powder and as an indigo-blue. In obtaining these lichen dyes, the thallus is pulverized, and then some alkali is applied to extract the dye. Litmus is made chiefly in Holland.

In closing, something should be said regarding the relation of lichens to trees. In France and other countries of Europe foresters have supposed that lichens are injurious to the trees and have to a limited extent practiced scraping the larger ones from the bark, along with certain large fungi. However, it will be seen readily enough that it would be difficult to accomplish much in this way in large forests, even were it known that the lichens were very injurious to the trees. In our own country M. B. Waite, while experimenting with fungicides on fruit trees, noted also that the Bordeaux mixture killed the lichens very effectually. He was not at all certain that the lichens were injurious to the trees, but thought that they might at least interfere with the functions of the bark. It is true that the more conspicuous foliose and fruticose lichens are more common on unhealthy trees than on thrifty ones, but the question still remains as to whether the lichens have worked injury to the trees, or whether the unhealthy trees are more easily penetrated by the rhizoids of the lichens. Also it may be that the unhealthy trees furnish for the lichens some food material not present in the healthy trees, or not so easily obtained as from the unhealthy ones. In short, it probably is not worth while to take the time to re-

move the lichens from trees, cultivated or in forests, for sake of saving the trees from injury.

We have considered briefly the uses of lichens, and it is evident enough that these plants are of some economic importance. Apart from direct interest in economic problems, it is hoped that this brief presentation may add somewhat to the more important aspects of lichenology, viz., taxonomic, morphological, ecological and physiological. An excellent statement regarding the uses of lichens may be found in Lindsay's "Popular History of British Lichens," and the briefer statement in Schneider's "Guide to the Study of Lichens" is also very interesting and instructive.

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## THE VEGETATION OF BALD KNOB, ELMORE COUNTY, ALABAMA.

BY ROLAND M. HARPER,

*Geological Survey of Alabama.*

Wetumpka, the county-seat of Elmore County, Alabama, is situated on both sides of the Coosa River, just at the fall-line (inland boundary of the coastal plain), and about 200 feet above sea-level. The river crosses the fall-line at such a small angle that it is almost tangent to it in going through Wetumpka, the old part of the town, on the east side of the river, is in the crystalline or metamorphic region, while the newer part across the river is in the coastal plain, the demarcation between the two physiographic provinces being very sharp at this point. For several miles west of Wetumpka the country is quite level, as in many other parts of the coastal plain, but immediately east of the town a steep hill of quartzite and gneiss, known as Bald Knob, rises rather abruptly to a height of some 100 feet above the river.\* The highest summits of this hill are thickly strewn with angular fragments of quartz, with the

\*These topographic features are plainly shown on the U. S. Geological Survey's topographic map of the Wetumpka (erroneously spelled tumka) quadrangle, published in 1903.

turned edges of almost vertical strata of rotten gneiss exposed in places. The slopes are similar but are covered with more soil and humus, and are furrowed with numerous ravines.

A stay of two or three hours on Bald Knob on December 1905, revealed some interesting examples of succession of vegetation, with almost all gradations between the most xerophytic and the most mesophytic types. The vegetation of the whole hill, except a portion of the lower slopes close to the town, is practically in a state of nature, and therefore in excellent condition for study.

Although the flora of the dry summits passes by imperceptible gradations into that of the rich ravines, the whole can be grouped into three fairly definite habitat elements, namely, the vegetation of summits, dry slopes or radial ridges, and ravines. In each of the three following habitat lists the component species are separated into trees, shrubs and herbs, and the members of each of these three structural classes are arranged in order of abundance, as nearly as could be determined with such a brief examination.

On the highest summits the following species were noticed: TREES—*Pinus palustris* Mill., *Quercus Catesbaci* Mx., *Q. Marylandica* Muenc. *Q. brevifolia* (Lam.), Sarg.; SHRUBS—*Vaccinium nitidum* Andr., *Syringococcus tinctoria* (L.) L'Her., *Gaylussacia dumosa* (Andr.) T. & G. *Ceanothus Americanus* L.; HERBS—*Pteridium aquilinum* (L.) Kuhn. *Azelia cassioides* (Walt.) Gmel., *Cracca Virginiana* L., *Chrysopsis graminifolia* (Mx.) Nutt., *Andropogon argyraeus* Schult., *Gerardia* sp., *Lespedeza hirta* (L.) Ell., *Smilax pumila* Walt., *Sericocarpus linifolius* (L.) BSP., *Polygala Curtissii* Gray ?, *Corcopsis major* Oemleri (Ell.) Britton.

Of these *Pinus palustris* greatly exceeded in bulk all the rest of the vegetation combined, but itself made a very open stand, so some idea of the sparseness of the floral covering (from which the hill doubtless takes its name) can be had. (See Fig. 44.)

On the dry slopes, or ridges between the ravines, the following species prevailed: TREES—*Pinus cchinata* Mill., *Quercus Marylandica* Muenc. *Q. prinus* L., *Q. velutina* Lam., *Q. minor* (Marsh.) Sarg., *Hicoria* sp. SHRUBS—*Batodendron arboreum* (Marsh.) Nutt., *Ascyrum hypericoides* L. ?, *Gelsemium sempervirens* (L.) Ait. f., *Callicarpa Americana* L. HERBS—*Chrysopsis graminifolia* (Mx.) Nutt., *Andropogon scoparius* L., *Solidago odora* L., *Aster patens* Ait., *Meibomia* sp., *Chamaecrista* sp., *Aristida purpurascens* Poir., *Koellia incana* (L.) Kuntze, *Elephantopus tomentosus* L., *Eupatorium aromaticum* L., *Mitchella repens* L., *Antennaria plantaginifolia* (L.) Richards., *Solidago petiolaris* Ait. ?, *Panicum Port*

*rianum* Nash ?, *Sericocarpus asteroides* (L.) BSP., *Sporobolus jun*  
(Mx.) Kunth.

This vegetation is much denser and somewhat richer in species than that of the summits.

In the shady ravines, where humus was naturally abundant, the vegetation was chiefly of the familiar type which can be seen in rich woods on bluffs almost anywhere in the Eastern United States. The following species were observed: TREES—*Quercus alba* L., *Fagus Americana* Sw

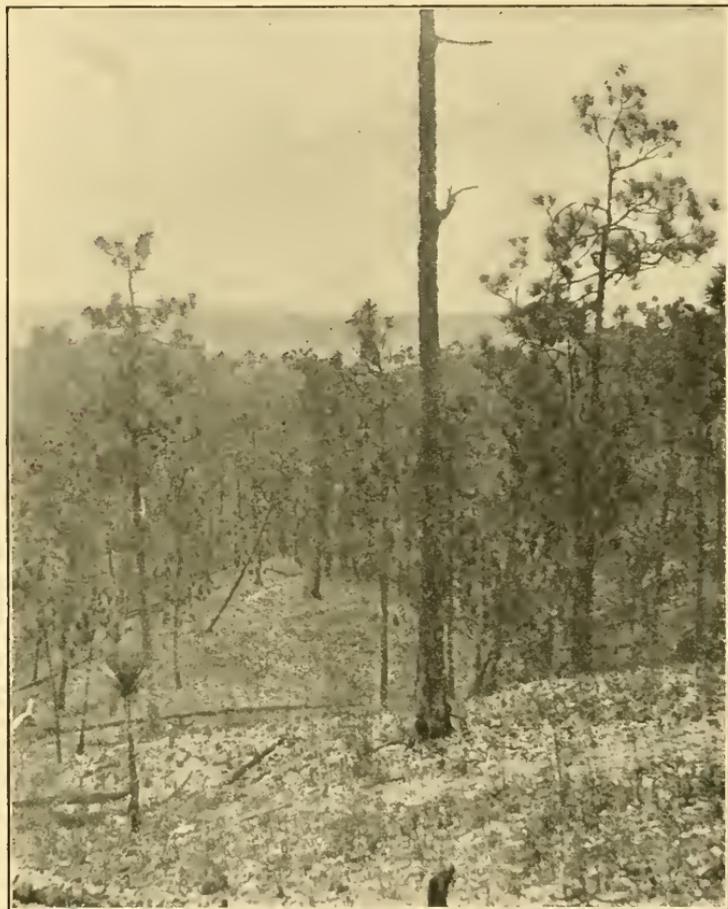


FIG. 44. Scene near highest summit of Bald Knob, showing sparsity of vegetation. Trees nearly all *Pinus palustris*.

*Liriodendron Tulipifera* L., *Quercus Prinus* L., *Ilex opaca* Ait., *Cornus florida* L., *Oxydendrum arboreum* (L.) DC., *Tilia* sp., *Liquidambar*, *Styraciflua* L., *Acer leucoderme* Small; SHRUBS—*Hydrangea quercifolia* Bartr., *H. arborescens* L., *Philadelphus* sp., *Kalmia latifolia* L., *Bignonia crucigera* L., *Hamamelis Virginiana* L., *Smilax lanceolata* L., *Berberis scandens* (Hill) Trel., *Callicarpa Americana* L.; HERBS—*Polystichum acrostichoides* (Mx.) Schott., *Adiantum pedatum* L., *Asarum arifolium*

*Mitchella repens* L., *Aster Camptosorus* Small, *Smilax pumila* W. & A., *Tipularia discolor* Nutt., *Solidago caesia* L., *Epiphegus Virginiana* (L.) Bart., *Heuchera Americana* L., *Uniola laxa* (L.) BSP., *Arisaema D. contium* (L.) Schott, *Woodsia obtusa* (Spreng.) Torr.

In the ravines there were very limited areas of rock outcrop and of stream-beds, but these were so small that their flora was not worth mentioning here.

If now we examine the characteristics of the three habit groups above defined and of their components we shall find some interesting relations between them.

Taking first the total ranges of all the species in each group we find that nearly all of those growing on the summits are common inhabitants of the pine-barrens and other parts of the coastal plain; and a few of them are so nearly confined to the coastal plain that I had never seen them outside of it before. The plants on the dry slopes can also nearly all be found in some part of the coastal plain, either in dry pine-barrens or in dry woods in the Eocene region farther inland, but the majority of them are likewise common throughout the Piedmont region of the southeastern states (at the extreme southwest edge of which Bald Knob is situated) as well as on the southern slopes of the Blue Ridge. Few of the species growing in the ravines are pine-barren plants, though nearly all of them occur locally in hammocks or on bluffs in some parts of the coastal plain. With few exceptions they have a pretty wide distribution in the Alleghanies and Piedmont region, and several of them range as far north as Canada.

Looking at the vegetation of Bald Knob from the standpoint of historical development, it is pretty evident that as the level is gradually lowered by erosion, and at the same time humus accumulates on the slopes, the summit flora must be gradually giving place to that now inhabiting the dry slopes, and the latter to that of the ravines, thus furnishing an excellent example of natural succession. The same reasoning, in connection with the discussion of ranges above, strengthens the evidence already gathered from other sources that the vegetation of the pine-barrens represents a pioneer or transient type, while that

the much older metamorphic region approaches the "mesophytic climax" condition described by Dr. H. C. Cowles\* and subsequent writers. While the xerophytic extreme (for Eastern North America) is pretty well exemplified on the summit of Bald Knob, the ravines still lack considerable of reaching the mesophytic climax condition, as is shown by the considerable number of evergreens (about one-third of the list), which can hardly be considered typical of the climax forest. All this perhaps indicates that Bald Knob has been submerged or otherwise cleared of vegetation at a considerably later period than most of the Piedmont region, which possesses one of the most ancient floras in existence.†

Similar examples of succession can be found on many other hills in various parts of Georgia and Alabama, both in the mountains and in the coastal plain,‡ as well as at intermediate points though I have come across no other which exhibits such a xerophytic extreme as Bald Knob. This tends to support Dr. Cowles's contention that the character of the vegetation of any locality is to a considerable extent independent of the geological formations; a hypothesis which however is still subject to many limitations, which it is not necessary to discuss here.

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### RICCARTON BUSH.

Riccarton Bush is especially noteworthy as being the sole remaining portion of that vast forest which, at one time, must have occupied much of the country near the coast of Canterbury, New Zealand. Notwithstanding its small size, the bush is still in remarkably good state of preservation, and shows admirably many of the peculiar characteristics of a New Zealand forest. The dominant tree is the kahikatea; but while this gives the stamp

\* Bot. Gaz. 31: 78-82, 178-180. 1901.

† See Torrey 5: 207-210. 1905. The lists of plants observed on Bald Knob are too incomplete and not representative enough (owing to season at which they were made) to be of much use for calculating percentages of monocotyledons, as was done in the paper cited.

‡ For a description of one such place see Torrey 5: 56. 1905.

the physiognomy of the forest, other large trees are not wanting. Such are the totara, the matai, the hinau, and the pokaka. There are plenty of other smaller trees and shrubs. The tarata, with its beautiful glossy leaves, the curious lancewood, the elegant ironwood tree, the milk-tree, which exudes a white fluid from beneath its bark, the true matipou with its red twigs, the pepper-tree with its blotched leaves, the lovely white-flowered kaikomako, the charming lacebark—to mention some of the commoner plants—are all there. Climbing plants, which give such a tropical aspect to the New Zealand forest, are in profusion, the various classes, such as twiners, tendril-climbers, scramblers and root-climbers, being all represented.

Many of the plants exhibit the remarkable phenomenon of passing through two distinct forms in the course of their development, the juvenile and adult plants looking like distinct species. The pokaka illustrates this admirably, and in the bush the distinct juvenile and adult forms are much in evidence, while one very old tree has produced from its naked trunk a large growth of the juvenile stage. Many of the trees have buttresses at the base of their trunk, another reminder of the tropics.

Nor is there any danger of the forest dying out. Apart from its present vitality, seedlings are abundant in many places, and it is especially pleasant to record that those of the kahikatea are particularly numerous.

Finally, it may be pointed out that no other city in New Zealand possesses so near its center a piece of pine forest, primeval so far as its large trees are concerned; and not merely this, but the last piece of primeval forest of its kind upon the face of the earth!

A timely movement has been started in New Zealand to preserve the Riccarton Bush. A committee has been appointed to further the proposal to acquire the forest as a Public Reserve, and the government of New Zealand has voted £1500 toward its acquisition.

## A BOTANICAL GIFT TO THE UNIVERSITY OF CALIFORNIA.

Through the generosity of Mr. and Mrs. T. S. Brandegee, of San Diego, the botanical department of the University of California has been enriched by nearly 125,000 specimens of the flora on the Pacific coast, and by a library of over a thousand volumes. As a result of this munificent gift the facilities for research work at the university are practically doubled, and it now possesses the most complete representation extant of the flora of this region.

Mr. and Mrs. Brandegee have for years given their time to the scientific study of the plants of western America. During that time their herbarium has steadily grown in size and importance, specimens having been obtained by means of collecting trips, by purchase, and by exchange. Nearly all of the more important sets of plants from the southwestern United States and from Mexico have been acquired, among which may be mentioned most of the types and duplicate types from the Orcutt and Cleveland collections; a set of Bebb's willows; nearly all of the Mexican plants distributed by Lemholtz, by Palmer, by Pringle, Parry, "Manzanitas and Chorizanthes," and many others no longer obtainable. Another marked feature of the collection is its richness in sole remaining duplicate types, the originals of which were lost in the recent San Francisco disaster.

The botanical library comprises, besides five hundred sets of "Zoe," a biological magazine published by Mr. Brandegee, many rare volumes—Lindley's "Botanical Register," in thirty-three volumes of colored plates, Hooke's "Icones Plantarum," a complete series of "Linnaea," and many books on Mexican botany.

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### REVIEW.

*Handbook of Flower Pollination, based upon Hermann Mueller's work, "The Fertilization of Flowers by Insects."* By Dr. PAUL KNUTH, translated by J. R. AINSWORTH DAVIS. Vol. I., Introduction and Literature. Pp. 19 + 382. Large 8vo. Illustrated. Oxford: The Clarendon Press, 1906.

This book, which is gracefully dedicated to the memory of the

founders of this aspect of plant biology, Christian Konrad Sprengel and Hermann Mueller, is a rich treasure to the student, professional and amateur alike, and should give a new impulse to the study of the subject with which it treats and, what is still more to be valued, should direct the student into a far more critical attitude than is, regretfully, usually characteristic of the average observer of the interactions of flowers and insects. The chapter on methods of research is, therefore, especially welcome in such a volume, because it not only shows how it is to be done, but that it may be done, and that with little special technique or training. It is a field in which, with this book for reference, the earnest amateur may find himself at home. The introduction, which follows an historical review of the subject, is an analysis of the facts at present understood, both from the botanical and zoological point of view. A most stupendous bibliography occupies 161 pages, and it must be confessed that the relevancy of the works cited is not equally obvious. "Better, however, "the excess than the defect."

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## THE TOUMEY CACTUS GARDEN.\*

BY PROFESSOR J. J. THORNER,

*University of Arizona.*

The Toumey Cactus Garden is one of the most unique features to be found on the grounds of the university at Tucson, Arizona. However tame and insignificant it may appear to the native who is acquainted with boundless areas of like plants, the garden represents to the botanist a group of most interesting species growing under essentially the same natural conditions that have contributed for ages to their present highly specialized adaptations. It is not too much to state that outside of the southwest the maintenance of so representative a collection of xerophytes is impossible in our country, except at enormous expense.

Planting in this garden was begun during the years 1894-1899 by Professor James W. Toumey, then botanist of the Arizona Experiment Station. Its location on the university grounds is nearly central, being immediately in front of the main university building and adjacent to the principal approach from the west. In general outline it is heart-shaped, and in area somewhat less than an acre. In addition to the rather prominent location which it enjoys, it is rendered more striking by the contrast which obtains between its spiny, and for the most part, leafless desert forms and the refreshing green lawns, shrubs and trees.

\* Illustrations, by courtesy of the *Popular Science Monthly*, from an article by Professor F. E. Lloyd, entitled "A Botanical Laboratory in the Desert," February, 1905.

on either side. For this reason it has been referred to not advertently as "a desert in an oasis."

The surface, sloping noticeably to the west, is ridged, thereby dividing the ground into many small areas a few to twenty



FIG. 45. Ocotillo.

in extent. It will be interesting to note here that the soil for this purpose was necessarily hauled in, the cover in the garden averaging but twelve inches in depth below which there is a more or less impervious calcareous deposit several feet deep known locally as "caliche." By virtue of the small ridges already noted, the excess water from the torrential summer showers and the less frequent winter rains is prevented from running off. Thus all the annual rainfall which averages about twenty inches for Tucson, and which is usually sufficient for the normal growth of these plants, becomes available for them. The garden is, however, irrigated occasionally, *i. e.*, during periods of lessened precipitation or of prolonged drought, the intention being always to supplement rather than supplant the scant rainfall. As a matter of fact it has never been found needful to water the garden oftener than once or twice a year, notwithstanding that periods of six months will pass with a precipitation of two inches or less.

About six hundred numbers have been planted, representing one hundred and fifty species from Arizona, California, Texas and a few from Mexico and South America. Most of these plants from the two latter countries, and some from higher elevations have died out, owing, perhaps, to unfavorable conditions. The loss is apparent, however, only when a study of the garden is made, since new ones have been added from time to time

many of the older plants have grown to several times their original size. In addition to the cactaceæ there are in the garden other equally interesting xerophytes—the agaves, yuccas, sotol, ocotillo, creosote bush, and palo verde.\*

The saguaro or giant cactus (*Cercus giganteus*) is easily the most striking plant, and is, perhaps, the best known to the visitor so far as it is possible for one to become acquainted with plants through literature. The larger of the specimens in the garden are about fifteen feet high and as yet unbranched, though in the foothills about Tucson mature candelabrate branched ones three feet or more in height are very common.

The rather large cream-white flowers of the saguaro are produced in abundance toward the tips of the spiny, fluted, columnar



FIG. 46. Saguaro flower and fruit cut longitudinally.

like trunks during portions of May and June. The fruit, which is ovate and about the size of a hen's egg, begins to mature early in July, the ripe ones dehiscing from above, thus exposing to the birds' delight their juicy, crimson though somewhat incipid contents, studded with many small black seeds. At this stage the fruit with its split, reflexed pericarp, the inner wall of which is also bright red, suggests to one a showy pomegranate flower. In passing it will be interesting to note that the saguaro flower was adopted as the territorial flower by a recent Arizonian legislature.

The ocotillo, candle flower, or coach-whip cactus (*Fouquieria splendens*) is another equally interesting and distinctively southwestern species. It is abundant enough in most of the foothills

\* For a description of the palo verde see PLANT WORLD, vol. 9, p. 7, July, 1906, p. 165.

country of southern Arizona to give decided character to the landscape. Its scarlet flower, produced during the spring months in terminal contracted panicles six to nine inches long, suggest many burning candles. Its numerous, spiny unbranched stems diverge at quite uniform angles from a common base, thus giving to the plant the characteristic, sharply outlined, obconical form. During the flowering period it appears at some little distance as a green, inverted cone with a bright red base. With a reasonable



FIG. 47. The biznaga, or barrel cactus contains a good deal of water at all times.

rainfall its stems become clothed with many delicate green leaves which turn yellow and fall off at the approach of another dry period. The first young leaves have been noted on the plants in the garden forty-eight hours after watering.\* The classification of *Fouquieria* has given taxonomists no little concern. The recent authorities, Engler and Prantl, regard it as a member of the

\* F. E. Lloyd, "Artificial Induction of Leaf Formation in the Ocotillo *Torreya*, Vol. 5, No. 10, October, 1905. Reprinted in *The PLANT WORLD*, vol. 9, no. 3, March, 1906, p. 56.

tamarisk family; others have classed it with the phlox family, the purslane family, the orpine family, and with the Frankeniaceae.

The native night-blooming cereus (*Cereus greggii*) is a worthy of brief mention. This plant is quite unique among cacti in that it develops some distance underground a fleshy root six to twelve inches in diameter and two feet or less in length, from which proceed one or more inconspicuous, stick-like stems. Thus *Cereus greggii* stores in unprotected, subterranean structures what other cacti collect in their spine-coated stems. During the latter half of June or the early part of July the large cream-white flowers, the handsomest and most fragrant among Arizona cactus flowers, open in the evening hours and close shortly after sunrise.

Other plants of special interest are the chollas or cylindrical cholla and the biznagas or fish-hook cacti, the barrel-shaped bodies of which almost without exception lean southward. These plants are virtual reservoirs scattered here and there over the arid mesas, from which the thirsting traveller may obtain water in times of need. From the large fleshy interiors of these plants is made the delicious cactus candy, the "cubierto" of the local markets.

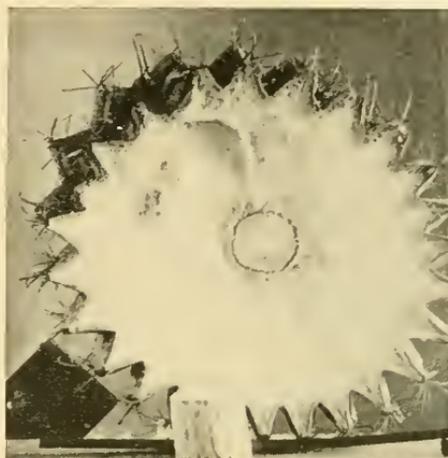


FIG. 48. Biznaga, or barrel cactus, cut across to show the thick, white, water-bearing tissue. The small center is the wood and pith.

## PREPARATION OF SPECIMENS OF OPUNTIA

BY DAVID GRIFFITHS, PH.D.,

*U. S. Department of Agriculture.*

We fancy that difficulty of preparation accounts in the large measure for the dearth of specimens of the genus *Opuntia* in our large herbaria. That the preparation of specimens difficult there can be no question, but it is not true that good ones can not be prepared; indeed the different species lend themselves to the collector's art much more readily than do the succulents in general. The impression should not be given that no collectors have made specimens of these plants, for some have prepared beautiful ones, but poor material or none at all is the rule. Our large herbaria are beautifully supplied with other easily prepared plants with which these grow, but the dearth of material in this and allied groups is appalling. Some botanists have contented themselves with forwarding cuttings to some garden conservatory,—an admirable plan so far as it goes—but this form of record is not a permanent one. From these specimens, sometimes supplemented by a few meager notes by the collector, descriptions have been drawn which in many cases do not describe. The cuttings have failed to grow, or growing for a time, have lost their identity and have had their labels shuffled in the processes incident to all cultural work, or they have "gone the way of all living," so that in any case there is no type specimen which botanists may refer questions of doubt. As an illustration of this point we might mention the case of *Opuntia treleasii* published in 1896. Even with the care exercised in such an admirably conducted institution as the Missouri Botanical Garden, the type of this species has disappeared. It is true that we know the type locality, and the collector remembers much about the characteristics of the plant, but the species is very variable in the immediate type locality so that it is difficult even now to determine the exact form which was originally described. Descriptions of specimens should, therefore, back up descriptions of new species.

in this group of plants as in all others. The difficulty of preparation is no excuse for not having them. They are always of more permanent and certain value than living material.

The most important collection of the genus *Opuntia*, and doubtless of other cacti in this country, is that in the Engelmann Herbarium in the Missouri Botanical Garden, but, aside from this collection, the garden, like other repositories, contains but little material. The Engelmann specimens came to him largely through some of the western surveys and in many cases consisted of one or more joints dried in the open air without pres-



FIG. 49. An arborescent prickly pear, *Opuntia Engelmannii*.

sure. These are stored in boxes, but pressed specimens mounted upon sheets in the ordinary fashion are also numerous.

There are several ways in which these plants may be preserved and each way has some advantages over the others. On the whole, a specimen of *Opuntia* properly prepared and pressed between blotters is the most satisfactory. There are some characters which can not be perfectly preserved by this method, it is true, but no herbarium specimen shows living characters perfectly. In all cases it is an approximation only.

In many succulent plants boiling before being put in preservation is advocated but this is not at all satisfactory with *Opuntia*.

the first place it is cumbersome and inconvenient, if not quite impossible to prepare specimens in this way, and in the second place my success in several trials has not been flattering. My plan now almost invariably is to cut the joints in half with a sharp knife, then remove the greater part of the succulent tissue, after which the specimen is put in press between thin sheets of paper and ordinary driers, like any other plant, except that where possible much more pressure is used. Ordinarily, one can use any amount of pressure from 100 to 300 pounds, and the latter gives more satisfactory results than the former. It is not a pleasant task at all to prepare the specimen for the press. A long, stout-bladed knife is to be preferred, but I use an ordinary jack-knife. The joint is split in two, parallel to the flat side. Specimens can be dried in this way but it takes a long time. My practice has been to scrape out the pulpy mass, leaving little besides the palisade cells attached to the epidermis. The scraping out is usually much more easily done if the vascular reticulation is first removed. If the joint is an old one, this can be done almost perfectly by cutting the vascular system loose at the constriction between the joints for a distance of an inch or two on the depth of the knife blade. By holding the epidermal portion flat and bending the vascular bundles back, they may be pulled out complete and much of the pulpy interior will adhere to them. Then by a little scraping with the knife blade the remainder of the pulpy parenchyma is easily removed, when the specimen is ready for the press. These directions appear formidable, no doubt, but the process is simple enough.

All who are familiar with the prickly pear will question the comfort of the collector in the preparation of specimens. Of course, the spines and spicules are always present and usually some of them find their way into one's hands, which is very aggravating, especially inasmuch as the hands are usually at the same time slippery and slimy with mucilage from the plant. But this is one of the penalties of having anything to do with the plants and must be put up with. However, a few precautions and a little care will enable one to minimize the annoyance.

One can, in the majority of species, avoid the spines very much by choosing his method of grasping the joint, but it is very difficult to keep away from the spicules if the joints are touched at all. A few thicknesses of paper or one thickness of pasteboard doubled in the left hand will enable one to handle almost any species with impunity.

Both young and fully matured joints should be put up with as little pressure as possible. The young joints in the growing season will show the leaves beautifully and these should always be preserved. The young joints for several weeks after growth begins are very tough and leathery, making it a very difficult task to split them neatly. Experience and a long knife blade to enable one to keep away from spines and spicules which are very easily separated at this time, are the only requisites to success. No scraping is necessary with these for they usually dry without scraping and as quickly as the older joints do after being scraped.

When possible, it is a good plan to leave the prepared joints to dry in the sun for several hours before being put in the press. They can then be subjected to heavy pressure for about two or three hours. When the driers are first changed the cut surfaces are firmly attached to the papers. This prevents rapid evaporation of moisture. The joints should, therefore, be loosened from the sheets each time the driers are changed until the cut surface becomes dried so that it will not stick. After being under heavy pressure until well shaped, the specimens may then be placed in a time between driers without pressure, but when they begin to buckle and curl the pressure should be restored again. I often find it convenient, especially when in a hotel or other room at night, to take my *Opuntia* specimens out of the press entirely and spread them over the floor to dry, as they will at night, and placing them under a heavy pressure again in the morning.

But all this relates to joints alone. Flowers and fruit may also be preserved if they are to be found. The flowers of *Opuntia* may be made into specimens as successfully as almost any of the large and showy flowers. The only difficulties involved consist in determining how best to prepare them so as to show the maximum of characters upon a flat surface. Very successful flowers

specimens can be made by cutting off the top of the ovary just below the outer petals or, better still, in many cases just below the upper leaves on the ovary. The flower is then put in press face down. Of course, this cuts off many of the stamens and the style is severed in every instance, but the relation of the style to the ovary is best shown in longitudinal sections, which should also be made. If the flower is not too deep, simply



FIG. 50. *O. versicolor*, with yellow, brown or magenta flowers.

pressing back the petals a little is all the preparation that the flower needs after being removed from the ovary. When the species is one with a deep flower the specimens will not stay put but will buckle in the center when pressure is removed and when it is restored again the petals will be wrinkled and doubled. In this case it will be advantageous to cut the flower from the center outward at a single point, giving it a chance to spread outward into a segment of a circle. A few extra pistils should always be put up, for they are likely to be severely mashed by the heavy pressure given the other parts. Unless the material is abundant flowers should always be mounted upon the herbarium sheets in envelopes so that both sides can be readily examined. Contrary to what was said about the joints, it will be found better not to examine or disturb the sheets between which the flowers are placed until they are fairly well dried, because when wilted the petals do not lend themselves well to handling and if once out of position it is very difficult to restore them again to their proper shape. Neither do they require as much pressure as the joints. Care should be taken never to allow one flower to overlap another in press, for when dried they can not be properly separated. When dried, the flowers, unlike the joints, are not difficult to remove from the papers, for there is a minimum of cut surface.

The fruit is best put up in longitudinal sections one fourth inch

thick. Outer sections can then easily be pressed down on the edges and the soft rind cut out with a knife, leaving little or nothing of the dished epidermis, which when flattened out shows much of the tubercular and areolar arrangement. The sections from the center show the relation of the pulp and rind rather imperfectly, it is true, but still they give characters of value.

Tracings of the fruit should always be made when they are put in press. The fruit is cut through the middle lengthwise. It has been my plan to lay this cut surface on the page of a notebook and trace its outline with a pencil and then, with the specimen before me, draw in a line representing the outer margin of the seedy pulp. Often a section is cut out of the center instead of simply taking half of the fruit for the tracing. A pencil point can then be punched through the edge of the paper at three or four points so as to guide one in outlining the periphery of the center. This tracing, easily made, shows graphically and accurately the outline of the fruit, the shape of the apex, the relative thickness of the rind and the exact color, which is transferred to the paper as the tracing is made. With a little additional care the stain on the sheet can often be made to show the relative density of color of rind and pulp, all of which are of taxonomic importance.

All of this relates to specimens intended for the herbarium sheet. Of course, fruits can be preserved for a time and some species indefinitely in fluid, but the colored parts lose all of their color, the liquid must be changed occasionally, and it is a constant source of annoyance and inconvenience.

A large part of the old survey material consists of joints of plants in the open air without pressure. This is a very slow process and while satisfactory so far as showing the spine arrangement is concerned, the specimens must be kept in boxes, flowers must be separated from their joints in the herbarium, and the color is scarcely so well preserved as in pressed specimens.

Of course, the more field notes one can take the better. Whenever time permits, it is my practise to write quite as full a description as the condition of the plants will warrant. These field notes are always much more satisfactory than any drawn

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fragmentary herbarium specimens. Even these are imperfect, for all taxonomic characters are seldom shown by a plant at one time. For instance, flowers and mature fruit are seldom found together.

To the uninitiated it is always questionable what to take note on. What are the differences which these plants present one with another? There never were better descriptions than those of Dr. Engelmann, which are reasonably accessible. These usually characterize the plants fairly well and they can be relied upon for a scale of points which should be noted. Color characters are especially fugacious and these should be noted in the field. This should include color of the general plant body, flower, its parts, and the fruit.

These plants are usually considered an epitome of variation, but in spite of this, little space is devoted in any of our literature to a characterization of this variation. Authors have generally contented themselves with a description of the material before them, which was often fragmentary, and we are therefore in blissful ignorance regarding the limits of variation of any character in practically all of the species. That they are variable there is no question, but I believe, after devoting considerable time to a study of them for the past six years, that the variation is of such a character that it can be defined. But this must be done in the field. No amount of herbarium investigation will do the work thoroughly, although laboratory studies and laboratory materials are an indispensable adjunct. The study of conservatory living material often does not suffice, for there are comparatively few of the species that grow normally in such situations. Even when grown together out of doors some species are perforce out of their natural environments and the forms are often so modified as to be scarcely recognizable. I believe that my confidence in my own sense of sight never received such a shock as in connection with one of these plants out of its natural habitat. It was on the coast of southern California under the influence of the sea breeze that I found a specimen of *Opuntia fulgida*, a plant perfectly familiar to me. When I asked Mr. C. R. Orcutt, than whom few are better acquainted with this

form of desert life, regarding the identity of the species, one can imagine my surprise at being told "I should expect *Opuntia fulgida* to assume that appearance under these climatic conditions." Specimens of perfectly familiar species in Mr. Orcutt's own collections subject to accidental abnormal conditions are absolutely unrecognizable.

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## OF INTEREST TO TEACHERS.

EDITED BY DR. C. STUART GAGER.

At a meeting of the Biology Section of the New York High School Teachers Association at the High School of Commerce on November 3, 1906, Dr. A. J. Grout, of the Boys High School, Brooklyn, read a paper on "A POSSIBLE WAY OF OBTAINING IDEAL CONDITIONS FOR HIGH SCHOOL BIOLOGY IN LARGE CITIES."

The tendency of population to concentrate in cities both removes the people from the opportunity to become acquainted with living animals and plants at first hand, and also makes them devoid of sympathy with agricultural pursuits and interests. There is a grave social danger in these conditions, and a general knowledge of plant and animal life would go far to remedy the condition. At the same time no satisfactory teaching of Nature Study and Biology is possible when the material is limited to dissectible specimens. The ideal conditions for teaching these subjects are right on the soil. A plan that will combine the use of out-door methods with our New York City school organization is the following: the city should own a large tract of land within one hour of the high school by the most rapid means of transportation; the pupils should be carried out to the park in special constructed trains, in charge of teachers, that the travelling time may be used as regular school time; the biology work should be done on the plots assigned to the pupils, and in a building fitted up with museum, laboratories, breeding rooms, etc. Some such arrangement Mr. Grout believes feasible, and one that will of itself create ideal conditions for teaching biology to city pupils.

B. C. GRUENBERG,  
*Secretary*

A meeting of the New York Association of Biology Teachers was held at the High School of Commerce, on Friday evening December 14, 1906.

The subject of the evening's discussion was, "HOW CAN TEACHERS OF BIOLOGY IN SECONDARY SCHOOLS MAINTAIN SPIRIT OF INVESTIGATION WHILE ENGAGED IN TEACHING?"

The speakers of the evening were Dr. C. Stuart Gager, Director of the Laboratories of the New York Botanical Garden, and Dr. M. A. Bigelow, Head of the Department of Biology at Teachers College.

Dr. Gager distinguished between *research* and a *spirit of research*. Every high school teacher should have a spirit of curiosity directed toward high ideals, but he will not necessarily be a better teacher because he has added some fact to the sum of human knowledge. The world needs teachers more than it needs new facts. There is a vast field of research for the teacher, practically as yet untouched, in the pedagogical problems connected with his subject. "While the pupil studies the subject the teacher should study the pupil." Research and publication are not synonymous, and much good research work is never heard from. Research should never be a thing apart from the teacher's work, but should grow out of his work. A man may gain much from the study of problems already known, provided he gets his information at first hand, and such study may prove a great source of inspiration and rest from drudgery.

Dr. Bigelow started with the assumption that a teacher has the spirit of research when he enters upon his work of teaching and considered the question, "*how can a busy teacher keep up his interest in problems which shall add new facts to the sum of knowledge—facts which shall be worthy of publication.*" Practically, a man must decide to what he will devote his energies to teaching or to research work—for if he gives his energy to teaching he will not have time or strength for successful research work. We are coming to realize that research in the line of biological education is as valuable as the solving of strict biological problems. The teacher should keep in touch with periodicals and books relating to his subject, and with the various

scientific meetings. In these ways a man may keep in the spirit of research while doing little because of lack of time.

A discussion followed in which the following points were emphasized:

Research problems should be of such a nature that they stimulate to abstract thinking, and they ought to have some definite relation to human life.

Important problems are those connecting the subject and the pupil as, "What parts of the subject are best to give the pupil?" "In what order can they best be given?" "How can the subject be made most impressive."

As much will be done in the next fifty years in studying new methods of teaching biology as has been done in the last fifty years on strictly biological problems.

MYRA S. CHATTERTON,  
*Secretary.*

## OBSERVATIONS ON THE VEGETATION OF THE WALLULA GORGE.\*

BY A. S. FOSTER.

The vast zone between the Rocky Mountains on the east and the Sierra Nevada and Cascade ranges on the west, and extending from the Arctic Ocean to the plateaux of Mexico, is an immense region, the different parts of which have received various names. That part to which this paper more particularly refers is known as the *Columbia Plateau*. The Columbia River winds through this region, and after breaking its way across range after range and flowing through a succession of basins, it finally turns westward in latitude  $46^{\circ}$  north, longitude  $119^{\circ}$  west, until it is finally lost in the "fountain of all waters." At an altitude of 327 feet the Walla Walla River empties into the Columbia just as it enters an immense gorge known as the Wallula Gorge.

This particular gorge—for there are many—is about eight

\*Abridged from a paper read before the *Oregon State Academy of Sciences*, June 16, 1906.

miles long, one and one half miles wide, 1800 feet deep on the Washington side, and 2500 feet deep on the Oregon side. The mesa, or table-land, is composed largely of loess, a decomposed lava dust; the contour of rolling hills and dales is formed by this wind-drift carried by and in the direction of the prevailing winds. This drift is from 90 to 150 feet thick where attempts have been made to reach water by digging. After the surface moisture has been penetrated, none other is found. In a few basins temporary ponds are formed after a winter rain. The soil has an alkaline impregnation, as is indicated by *Chenopodium album*, which grows in these depressions. The winds, in giving a roundness to the contour, often dig out "sand-blows," which are the analogue of "pot-holes"; in other places "dunes" may travel over a ridge to disappear on the lee side, all of which seems to have a marked effect on the character of much of the life of the region.

The annual rainfall varies from seven to eleven inches; one third of this is in the form of snow, while a small portion comes from the rime and frost which accumulates on every available object during the prevalence of a severe northeasterly wind accompanied by its usually attendant fog which, freezing, forms acicular points of hoar-frost even to two or three inch crystals. These "Walla Walla winds" are cold and penetrating, in winter bringing dust storm, snow storm or blizzard. During many days this gorge is filled with fog, while the mesa is clear and sunny. The current of this river of fog is determined by the wind. This body of dense fog hovering over the body of water keeps up the general temperature of the gorge, and this may in part account for the variety of rock-loving lichens therein.

The plant-life of this region occurs in three distinct vertical zones: (a) The mesa and "breaks," (b) face of cliffs and talus, (c) the margin of the rise, or littoral. There are no bottom or alluvial lands. The following observations thereon extend over a period of nearly six months, from October 17, 1905, to April 10, 1906.

On several basaltic reefs extending well out into the river and but six or eight feet above water at low stage, was found

*Scouleria aquatica* in abundance but not fruiting. This moss is always found on the "up-river" side of rocks where currents strike strongest. On the upper surface an aquatic lichen, *Entocarpus miniatum*, was found in quantity; also a few strands of *Scleropodium obtusifolium*, a moss usually associated with *Scoulerias*.

The shore line seems to be the habitat of most of the immigrants transported hither by this all-water route. Mullein was found, also purslain, *Portulaca oleracea*; cockle bur, *Xanthoxylum spinosum*; Russian thistle, Shepherd's purse, and one or two mustards of very hardy habit in bloom on December 10 and again February 15. Well down the banks, below the flood line was *Marsilia vestiva* with tomentose rhizocarps, fruiting freely among the shifting sands. Where some bold wall reached down to the moist sands a few plants of Scouring Rush, *Equisetum hyemale*, are likely to be found.

Among the woody plants of this narrow margin is the Desert Juniper, *Juniperus scopulorum*, having migrated apparently down the gorge of Juniper Cañon from the flanks of the Blue Mountains. Of the willows, a cluster of three *Salix amygdaloides* and a patch of *S. exigua* were found along the exposed bars. The chief tree or shrub is *Crataegus columbianum* Howell, rooted in the shifting sands, crowded with peculiar "galls" and often encrusted with a lichen, *Theloschistes lyoni*. A few shrubs of wild cherry, *Cerasus emarginata*, always associated with *Rosa nutkana*, and the Golden Currant, *Ribes aurcum*, said to be the same as the cultivated currant of Missouri.

Among umbelliferous plants, *Oreogenia fusiformis* is the earliest to flower, its white blossoms contrasting later with the yellow ones of *Pucedanum grayi*, both in abundance along the flood line, with an occasional *Allium douglassii* (sp.?). *Nicotiana attenuata*, or a similar tobacco, found here, is said to have been cultivated by the Indians.

*Artemisia ludoviciana*, with its densely white leaves, and another sage brush, *Artemisia dracunculoides*, some fifteen feet tall, grow on the talus. The latter is the host of its parasite *Orobranche ludoviciana*.

The boulders are covered with a blackish moss, *Grimmia*, in dense cushions, while *Orthotrichum laevigatum* prefers the combined shade of boulder and brush. *Montia rubra* is found along the water line, and *M. Siberica* higher up. The Great wood, *Cercocarpus intricatus*, called Mountain Mahogany, an intricate much-branched low shrub, with sparse, small, green leaves, is found straggling along the bank. Still further accentuating the arid appearance of the vegetation is the cactus *Opuntia polyacantha*.

Along the ledges of the gulches *Audibertia nicana* seems to thrive best. Upon distillation these leaves yield a volatile oil, pleasant and penetrating, with a lasting aromatic odor. The *Audibertia* is related to the "honey sage" or "white sage," so called, of the mesas of Southern California. Along the terraces with a northeastern exposure may be found a few colonies of the delicate fern, *Woodsia oregana*, the only fern of the region. In the upper gulches *Lithophragma tenella*, with its peculiar glandular pubescence and lacinate petals, grows in comparison with *Montia siberica*, the Indian lettuce. Here also are *Hebechera* and *Tiarella*, their old stems filling up their niches. In the upper stretches, clambering over the coarse talus, several vines of *Clematis ligusticifolia* (sp.?) were seen at the foot of a 500-foot bluff. In a gulch with some appearance of seepage there was one lone specimen of *Rhus diversiloba*, perhaps near its northern limit east of the Cascades. Nearby was that beautiful moss, *Anacolia Menziesii*, not fruiting, but always abundant in its preferred habitat. The floor of this gorge was patched with *Grimmia montana*, growing in closely mottled green cushions, turning a reddish brown as the season closes.

Here the lichens, some twelve species, give color and distinction to the different buttresses,—*Lecanora chlorophana*, painting the walls with a rich chrome-yellow, to be distinguished for two or three miles when contrasted with the red of *Placodium elegans*, shading off into another *Placodium ferruginea*; then re-touched in another section with the bluish-gray of *Lecidea caerulea*, which in turn is brightened by *Lecanora rubina*.

Other thalloid lichens, as *Peltigera canina*, were plentiful

usually on the surface of rocks, *Parmelia prolixia* occupying better part of a square yard of the upper surface of a block of lava in the shade of a sage brush. *Parmelia conspersa* and *caperata* were on the ledges, contending with the *Grimmias* for a share of moisture. *Umbilicaria phara* generally stuck to rock surfaces, so situated that the disintegrating material could not get behind the thallus to pry it from the hold-fast. Of the fruiting lichens *Cladonia fimbriata* was the only one seen.

Besides *Grimmia calyptrata*, with long, pointed leaves, we also found *G. alpestris*, *G. leucophea* and *G. tenerrima* in sea-facing cushions; *Tortula ruralis* and *T. aciphylla*, generally loosely on or in slight niches of the ledges, while along the edges, on small lumps of humus, *Encalyptra vulgaris*, the Extinguisher moss, was sparingly scattered. West of the mountains the calyptra is fringed, hence *Encalyptra ciliata*. The *Tortulas* sometimes grow in the upper stretches on soil of sand gulches. On the sands, under sage brush, *Desmatodon thobius* sends up its yellow seta to fruit quickly and die. The scarcest, though most interesting moss, is *Pterigoncurum ciliatum*, with its abnormally large capsules and abundant reddish brown spores.

The higher plateaux are occupied by *Artemisia tridentata* which gives its peculiar hue to the "Sage Plains." On the hills, among this sage brush, *Gila gracilis* is among the first to put forth its tiny blue flowers, although the yellows always dominate. Among the most beautiful and hardiest of the Compositae is *Aster amethystinus*, growing along fence rows, flowering continuing into December. Another, not so large, with the basal leaves 5-7 lobed and smaller violet rays, seemed to be *Aster fremontii*.

On the hills, *Bigelovia graveolens* offers some "brousi." In the Nevada plains it is called "Rabbit brush," as it affords about the only covert for the little cotton-tail, *Lepus bairdii*.\*

\* For the determination and verification of the phanerogamia as well as the cryptogamia the writer is indebted to his numerous friends who are specialists along their several lines. In consultation a free use has been made of *A Flora of the Palouse Region*, issued by the Washington Agricultural College, Portland, Oregon, June 9, 1906.

## CERTAIN RELATIONS OF RAINFALL AND TEMPERATURE TO TREE GROWTH.

Under the above heading Mr. Henry Gannett, in the *Bulletin* of the American Geographical Society for July, 1906, states that temperature and rainfall are the two factors which determine whether trees can grow, and, if so, what species. Other factors such as seasonal temperatures, seasonal rainfall, atmospheric humidity, wind and slope exposure, angle of slope, and texture and depth of soil, are secondary factors which have a modifying effect.

The paper "is designed to show how much and what information our present knowledge of the climatic elements develops concerning tree growth in the western United States." The records are derived from a little over four hundred stations having a rainfall record of more than five years. "The distribution of these stations is not, however, by any means what could be desired, the great majority of them being situated in towns and cities, and therefore in low and open or non-timbered country; and very few of them are high up in the mountains, so that in those parts of the West in which the timber is confined to the mountains the timbered regions are not well represented."

The author's results are tabulated. "The table relating to yellow pine shows that the greatest number of stations is found where the temperature is between 50 and 55 degrees, while the entire range of the species, as indicated by the stations, is from 40 to 65 degrees."

"Nearly all the stations in the red-fir region are found between 50 and 55 degrees. Indeed, outside of this group the stations are but scattering."

"In the red-wood region all the stations are between 50 and 60 degrees."

From the results of this study and those published in a former paper on "The Timber Line," in the *Am. Jour. Sci.*, 1882, p. 275 the author concludes that the timber line has a mean annual temperature of approximately 30 degrees, so that the location of this isotherm is a simple matter.

In regard to rainfall, the table shows that the average in the open country is 13 inches, with a range of from 7 inches in Nevada to 18 inches in northern California. Yellow pine grows under an average rainfall of probably over 34 inches, with a range of from 19 inches in Wyoming to 44 inches in northern California. Red fir in Oregon and Washington grows under an average rainfall of 56 inches, the redwood of 46 inches. Desert species grow under a range of from 15 inches in Arizona to 30 inches in northern California, with an average for the entire West of 25 inches. There are indications that the lower limit of the yellow pine is at or just below 20 inches of rainfall. For the redwood the lower limit is at or about 30 inches of rainfall, with apparently no upper limit, as the species abounds in regions where the rainfall exceeds 100 inches annually. The isohyetal line of 30 inches appears to be the lower limit of the redwood, as only one station in the redwood strip in California has a rainfall of less than this amount.

C. S. G.

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## REVIEW.

*Principles of Botany.* By JOSEPH Y. BERGEN and BRADLEY J. DAVIS. Pp. 8-555. Small 8vo., with many illustrations. New York, Ginn and Company.

The present volume is a partially rewritten form of the earlier "Foundations of Botany" of the first named author. It is distinctly modern in its spirit, and presents the whole subject in a fair and adequate representation. The success of the previous works which have led up to the "Principles," being as it is a measure of their adaptability to the high school student, will be still further justified in the new volume, which deserves a first place in secondary schools. It is certainly a first class text-book for the elementary student of the subject. Especially pleasing are the etched illustrations which are made after the photographs which they happily replace. The use of the colored plate (illustrating the structure of the lichens) is an innovation in American textbook making, and one which should be welcomed.

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