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TWIGS OF WOODY PLANTS.

By A. S. Hitchcock,

United States Department of Agriculture.

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

Pith.—The pith is usually solid and continuous, white in co and circular in cross section. The pith is diaphragmed in walnut and hackberry, that is, though solid in the younger p tions, it soon separates into numerous thin, transverse plates. the grape vines the pith is interrupted at the nodes by woo partitions. The color is brown in the smooth sumac, *Rhus g bra*, and in *Ailanthus glandulosus*. The cross section is rho boidal in the buckthorn, *Rhamnus*, and in some other distinc 4-angled twigs, and is 5-angled or star-shaped in the oa *Smilax*, and other monocotyledons have no distinct pith.

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

Leaf-scars.—The arrangement of the leaf-scars may be posite and 4-ranked, or alternate. In a few cases there are m 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. 1.

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

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

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

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

5. Soft Maple (*Acer saccharinum* L.). Buds opposite, leaf-scar shaped, with three bundle-scars, the angles of the leaf-scars connecte a line on the epidermis. × 2.

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

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

8. Honey Locust (*Gleditschia triacanthos* L.). Twig showing s posed buds, the uppermost of which develops immediately into a t A longitudinal section shows the numerous superposed buds. × 2.

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

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

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

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

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

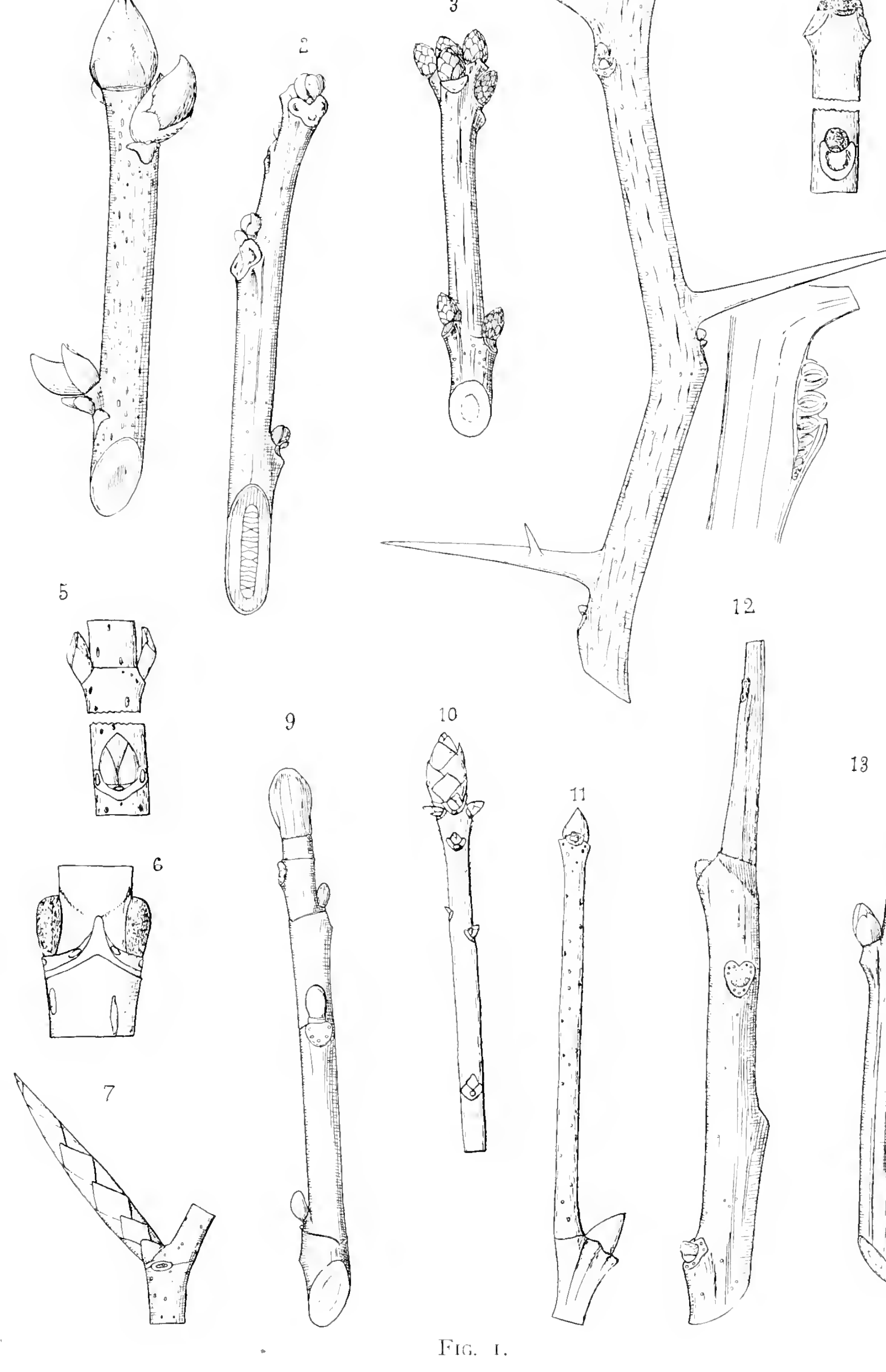

FIG. 1.

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 the casting of deciduous tips. The smooth sumac is a good illustration of this. The growth of the twig is indefinite, but in the fall 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 fixed that it takes place early in the season, about the same time that the terminal buds are formed in such plants as the hickory. If these twigs are examined in early summer the dwarfed terminal portion, sometimes an inch or so long, can be seen, but it soon falls away, leaving a scar. Such casting of the tips is common in the 2-ranked twigs. The elms, mulberry, and basswood, etc., 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 in the largest. Superposed buds are shown in some of the hickories (*e. g. Hicoria minima* (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.

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 h leading to Williamette Heights, Portland, Ore., had long familiar to me during the early days of the late Lewis and Exposition, and I had assumed that it pointed the way to a estate subdivision. Late one rainy afternoon I had an o tunity to explore this narrow ravine leading into the hills. my portfolio I wandered up the narrow path, collecting a plants on the way, and passing through a narrow opening crude sapling fence, I soon noticed several copies of a pl tacked on trees about a bark-covered teepee. My curiosity aroused and the following was what I read:

"PICK NOTHING.

"Please Read This.

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

"George H. Williams,
"T. L. Eliot,
"J. D. Meyer,
"Ion Lewis,
"L. L. Hawkins,
"*Park Board.*

"The Park belongs to <u>you</u>, kindly assist in protecting it

The possession of my portfolio would naturally have sugg 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 e
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; ferns
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 d
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*, firs
driveways, then other areas, until finally little is left o
Natural Park, a montrosity 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 an
Scotch gardener has produced a bit of landscape gardening
equaled in my experience; culture is evident everywhere, e
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 al
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.

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 forerunners 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 ascendency 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 WIT WATER CULTURES.

By Burton Edward Livingston.

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

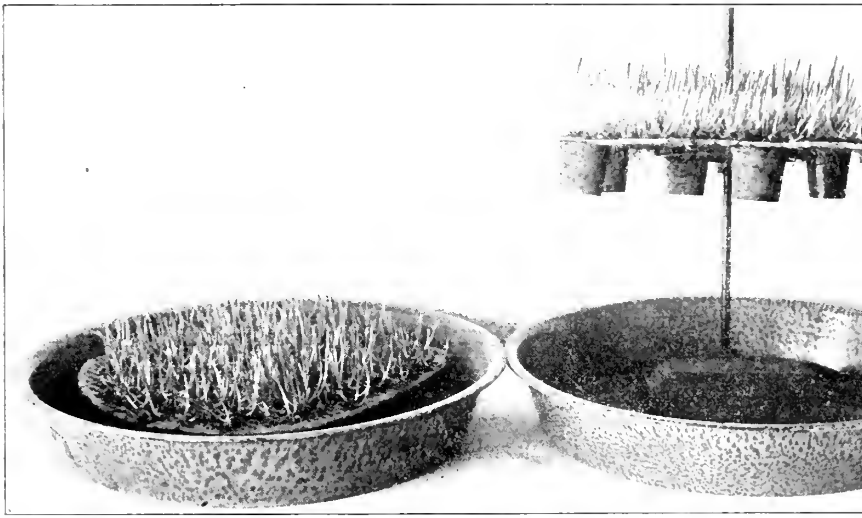

Fig. 2. Method of germinating seeds on paraffin-coated disks floa means of cork stoppers.

openings in cork stoppers or other jar covers always require siderable care in preparation and more dexterity in mani tion than is possessed by the average student of plant physic at least in beginning classes. For the research worker, the required for the setting up of such cultures is an important sideration and a method adapted to more rapid work would the use of more cultures and the accompanying greater acc 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 ¼-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 thickn
Each bottle is covered with opaque black paper or is painted
ternally with asphaltum varnish or other opaque covering to
vent the access of light to the roots. The stopper is prepare
cutting ten uniformly spaced vertical wedges from its la
surface, these being about one-eighth inch broad and of so
what greater depth, and extending from top to bottom of
stopper. Each cork wedge, after being cut out, is truncate
its inner angle by the removal of enough cork to allow it to b
placed in position after a seedling has been placed in the gr
from which the wedge was cut. The stem of a seedling is pl
in each of the ten grooves, the seeds being just beneath the l
surface of the stopper, and the wedges are pressed into posi
They should wedge the stems into place just firmly enoug
hold them when the stopper is inserted in the bottle. Afte
are in position a rubber band is placed around the stopper a
one-eighth inch from its upper surface, to hold the wedge
place. The stopper is then pressed firmly into the neck o
bottle, the latter having been filled to the shoulder with
desired solution.

If the culture is properly set up all joints are so tight
practically no opportunity is offered for the direct evaporati
water from the bottle. Either the solution should be ren
or the bottle should be replenished with distilled water every
or four days, according to the character of the experimen
make up for loss of water by the transpiration of the plants.

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

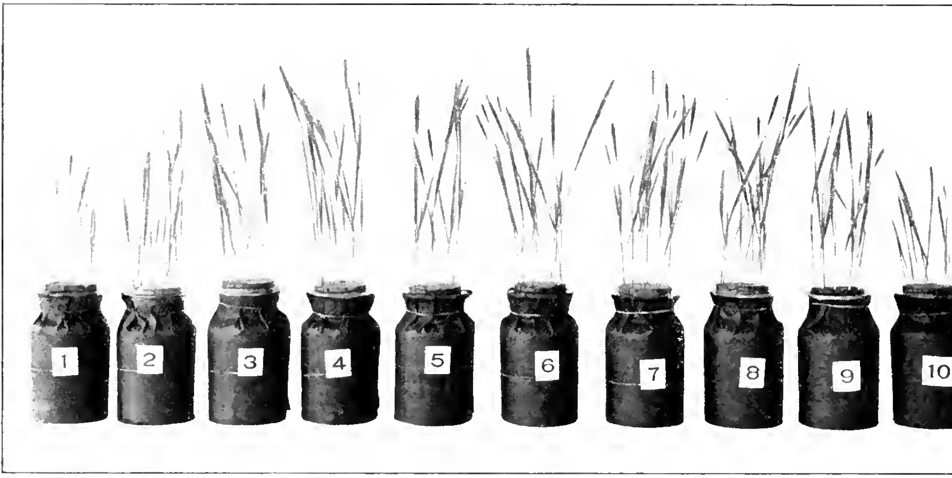

Fig. 3.

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 neig and yet succeeds in being individual enough to be intere deserves to be noticed. The branchlets of the hop-hornbea sembles those of the elm, its leaves are very like those o birch, while the appearance of its fruit, so similar to that c hop vine, gives the tree its name; yet the tree has its own pe charms and piques immediate further study, when once it i served.

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

The wood of the hornbeam is its most characteristic fea Close grained and very hard, it almost defies destruction a indeed like iron. The ancients employed it in making ch wheels, and it is now used for the handles of small tools weapons. In the young trees the bark, smooth and re brown in color and marked with short white lines, suggests 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 Carpinus* bluebeech-hornbeam. Its leaves resemble those of the b 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 tong
and the leaf which enveloped it were a rich magenta in co
giving the whole plant a weird look. Certainly the plant w
well-named for its flower is remarkably like a huge tongue.

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

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

The tongue is hollow and has in it a very bad-smelling sec
tion. 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 grov
as the flower. The leaf-stalks grow directly from the corm a
the scars, which were on the sides of the corm when the flov
began to grow, are left by them. The stalk is dark green
color, mottled with white like the flower stalk when it first beg
to grow. It is about three-quarters of an inch in diameter a
its cells are spongelike and contain a watery liquid.

The leaf is compound. As the stalklet divides a great ma
times and into a varying number of parts, it is called dec
pound. The first division of the leaf-stalk is about three f
from the ground. At this point it divides into three parts. T
stalklets, from here on, instead of being bare, are borde
throughout their whole length by oval leaflets arranged alt
nately and connected by a strip of leaf varying from a quarter
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 sid
The leaf is very graceful when growing.

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

OF INTEREST TO TEACHERS.

EDITED BY DR. C. STUART GAGER.

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

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

Accompanying the package was a very instructive illustrate pamphlet by Mr. Lyster H. Dewey, Botanist in charge of In vestigations of Fiber Plants, Bureau of Plant Industry, entitle "Principal Commercial Plant Fibers." The writer divides vege table fibers into three distinct classes: (1) The cottons, with sof lint-like fiber one-half inch to two inches long, composed of singl 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 lengt composed of many overlapping cells, and borne in the inner bar of the plants. (3) The hard, or leaf, fibers, including manil sisal, mauritius, New Zealand fibers, and istle, all having rathe stiff, woody fibers one to ten feet long, composed of numerou cells in bundles, borne in the tissues of the leaf or leaf stem. A detailed description of the different fibers has the following in teresting introduction:

"One of the most important manufacturing industries of t country is that which includes the various lines of textiles. Le ing out the silk and woolen mills, which use chiefly animal fib there are the cotton factories, the linen and jute mills, and twine and cordage mills, which use plant fibers exclusiv These number about 1,200 distinct establishments, represent an invested capital of more than $500,000,000 and giving p ductive employment to more than 300,000 persons.

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

Value of Nature Study.—One of the most gratifying f tures of our educational progress is the growing interest in ture study. Nature study at the very outset turns the child's quiring mind to the things near at hand; it is the first step practical education; the first thing to make the child think of schooling, not as a foreign, unnecessary accomplishment, but a vital thing that is to blossom and bear fruit in his every experience.

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

NOTES ON CURRENT BOTANICAL LITERATURE.

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

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

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

In the *Journal of the New York Botanical Garden* for Decem ber, Dr. Murrill has an interesting account of a Fungus collectin trip in Maine, as a result of which he brought back about 1,50 specimens. He found agarics only here and there, while th large woody fungi are exceedingly common, and are very de structive to the elms. Much damage is done by wood-destroyin fungi in the lumbering districts of Maine. Most of the wi cherry trees scattered through the woods were entirely dead, an their trunks covered with an undescribed species of *Poria*. D Murrill finds a close relationship between the fungi of Maine an those of the old world, particularly of Europe and Siberia.

Robert F. Griggs has written a monograph of "The Willow of Ohio" as No. 11 of the Special Papers, being volume 6, part Proc. Ohio State Acad. of Science. The paper comprises 5 octavo pages and is illustrated by sixteen half-tone plates. Th work should be of interest to students of local floras, and will, n doubt, stimulate the study of these difficult plants, the willows, i the region comprehended in the monograph.

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

The Department of Agriculture will do a good work in edu cating people up to the cultivation of many of our drug plant for the market. There is in them a source of income yet littl 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 Dog wods in the Winter Condition, a paper which will be of specia use to teachers.

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

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 artisti water-color sketches of some familiar Californian wild flowers Each sketch occupies a separate sheet of heavy paper, interleave with a tissue on which is printed the popular and scientific name together with a brief description of the plant in question, writte by Mr. Charles F. Saunders. The sheets are placed unboun 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 accurac[y of]
the drawing. Among the subjects of especial excellence ma[y be]
mentioned the Mariposa tulips, California poppy, wild pa[...]
and wild heliotrope. The book is a charming gift and an ex[cel-]
lent souvenir of California's floral charms. C. L. [...]

PERSONALS.

Dr. Daniel T. MacDougal, formerly assistant director of [the] New York Botanical Garden, has accepted the position of Dire[ctor] of Botanical Research in the Carnegie Institution. Dr. M[ac-]Dougal is now at the Desert Laboratory of the Carnegie Inst[itu-]tion at Tucson, Arizona, where he will remain for the rest of [the] winter.

Tucson is to become the residence, also, of two of the Boar[d 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 Laborat[ory.] Professor Lloyd will, however, continue to be editor and [pub-]lisher 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 " app[ears] 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 biol[ogy] in the Morris High School, New York City, to become Directo[r of] the Laboratories of the New York Botanical Garden.

The Plant World

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FEBRUARY, 1906

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 occurred extensively enough to make such injury appear natura

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

Goeppert* in 1830 seems to have been the first to point out in some cases ice forms in the intercellular spaces instea within the cell. Sachs† in 1860 showed that it forms al always in the spaces. Sachs and Nageli‡ both showed tha expansion caused by all the water in the cell would not be suffi to rupture the wall. Nageli discovered that cells of *Spiro* which had been frozen and thawed still showed some pow osmotic action, which he thought could not have been the had the cell-wall been ruptured by the freezing. The relati the protoplasmic membrane to osmosis was not then unders Both Nageli and Sachs attributed the loss of turgidity accom ing the freezing process to molecular changes in the cell- which they likened to the change occurring in frozen starch whereby the paste-like nature and ability to retain large qu ties of water are both lost. This was an important compa and holds good even now if protoplasm is substituted for cell-

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

† Sachs. Krystallbildung Krystallbildungen bei dem Gefrieren Veränderung der Zellhäute bei dem Aufthauen saftiger Pflanzent 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. 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 Schutzmittle dagegen. Stuttgart (book). 1883.

† Prillieux. Sur la formation de glacons 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 expose
rectly to outside temperature. In the natural process of free
however, the fall of temperature is so gradual that ice form
within the cell does not occur.

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

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

* Hugo V. Mohl. Ueber die anatomischen Veränderungen des
gelenkes, welche das Abfall der Blätter, herbeiführen. Bot. Zeit. 1
1860.

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

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

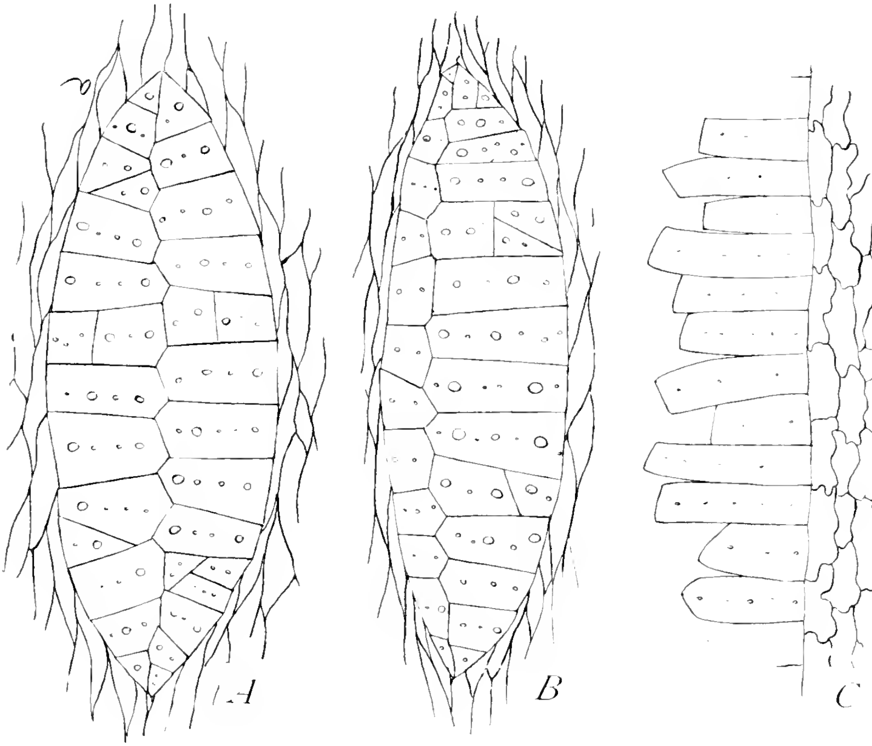


FIG. 4. Diagrammatic representation of ice-masses produced on o within frozen beets, potatoes, etc. *A*, in the interior. *B*, near the periphery. *C*, on a freshly cut surface.

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

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

For observing the formation of such ice crusts on the surf of single cells where the whole process can be easily followed, writer has found *Spirogyra* and *Nitella* especially easy and structive. Filaments were mounted in cedar oil, as first sugges by Molisch. Then by placing the microscope and slide out doors they were gradually subjected to a freezing temperat while still in the field of the microscope. In this way the for tion and growth of the needles could be seen with remarka clearness. These were produced closely packed side by side over the outer surface of the wall, and the growth of the cry was so rapid that the increase in length could be easily seen occur while one looked through the microscope. As this incre continued the cells began to collapse, until finally no vacuole mained, and the walls were almost in contact. The crust did form all over the cells at the same time, but began at cert localities from which the prism-formation extended rapidly in directions. The growth of the crystals here is clearly due to addition of molecules of water at the end in contact with the c wall, and no increase in thickness of the crystals was observed occur after their inception. Thus Sachs's observations are s tained.

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

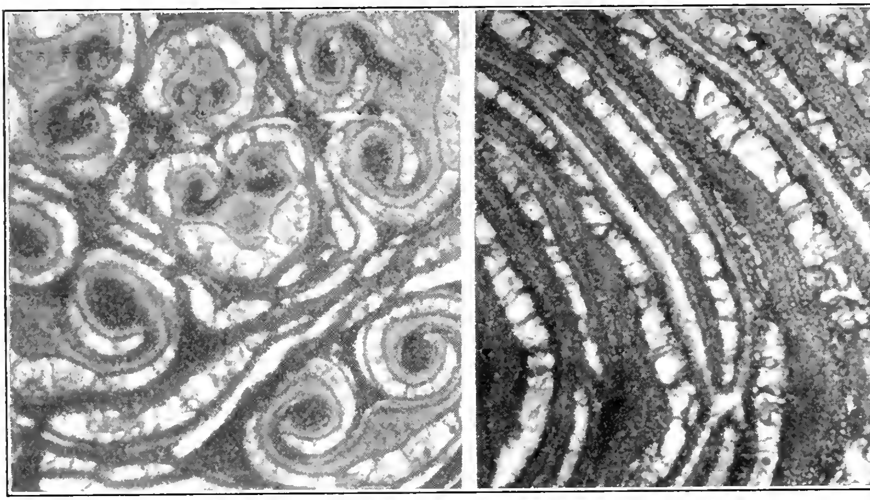
Prillieux more carefully studied the ice masses within t tissues. His conclusions were, in brief, that the large ice clum formed in plant tissue were composed of ice-needles placed clo together; that the cells were not ruptured, but that often when t quantity of ice was very great and the intercellular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

In most very fleshy structures, as in potatoes, the ice mass which are usually lenticular in form lie irregularly or perha more or less parallel to the surface. In beets, however, accordi to Müller-Thurgau, the masses, although mostly tangential near t surface, are in the interior either tangential, radial, or cross-wis In *Dahlia* tubers only small lenticular masses were found in the i terior, while near the periphery very large ones were prese In the intermediate portion of the tuber only radial masses we found. Sometimes the ice masses in these tissues reach the leng 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 su
that the masses in the cortex are tangential, as also in the ou
pith, while in the woody ring they are radial and mostly in t
pith-rays. The vascular bundles are in this way more or le
completely surrounded by ice.

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



A B

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

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

In twigs there is frequently an ice cylinder entirely aro the stem completely separating the outer layers from the parts 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 gradu
become smaller and therefore less rich in water, which in t
is more strongly held by imbibition. Therefore, in an ice cl
lying half way from the center to the outside, the water is n
available on the inner side, and still farther out the differe
is still more pronounced. Near the outside only a few cells in
vene between the ice mass and the surface of the organ, and tl
are small, while on the inside all the large cells through to
opposite side are available. The presence of other ice ma
seems not to greatly disturb this relation, but simply to red
the size of the remaining ice masses in the vicinity. The al
conditions obtain typically only when the organ is frozen
slowly. Rapid freezing tends to produce amorphous masse
smaller size, and then occasionally within the cell. Someti
a few spaces are found entirely filled with ice which shows
crystalline structure even though the cooling was gradual. P
ably in these cases the spaces were filled with water be
freezing began.

For observing the ice masses in frozen tissue the writer
found the following a very good method if one does not m
the cold. Place a table, microscope, razor, slides, cover gla
and a small vial of cedar oil out of doors when the tempera
is low (15° F. or lower). Make free-hand sections of the fr
tissue and mount in the oil. When observed through the mi
scope the location of the ice masses and their structure ca
seen very easily. Then, if the slide is carried rapidly to ano
microscope in a warm room the thawing and sponging out of
tissue may be observed as the water is drawn back into the c
if the tissue is a "hardy" one. The water is not drawn back
the cells to any extent in delicate tissues which are killed by
freezing. The writer used this method one winter in the s
of the ice relations within the buds and twigs of about tl
species of woody plants with good results. The large ice ma
in succulent tissues may be seen with the naked eye. If fr
beets or potatoes are cut in two the lenticular ice masses ma
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 experiments 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 mas dense areas composed of the collapsed cell-walls packed clos together. Frozen buds and bark of hardy trees show this c dition markedly and appear entirely disorganized, but on thaw the cells again expand and become normal. So is it also w evergreen leaves. This extreme shrivelled, shrunken or collap appearance of the cells is one of the most marked charactris of frozen tissue.

In solutions, especially of substances having considera "affinity" for water, the force with which the water and sol are held together is often considerable. This is shown by slowness with which certain solutions of colloidal substances exposed to evaporation, dry out after they reach a certain conc tration. The more concentrated the solution becomes the grea is the force with which the remaining molecules of water held. Considerable water is held in the protoplasm and walls by a still stronger force, that of imbibition (molecular ca larity). Here again the retaining force increases as the wa is withdrawn. In freezing these forces must be overcome the ice-forming forces before ice will be produced. The fo of crystallization, although strong at the start, increases in p portion to the fall in temperature after the crystal beg Consequently (1) the largest quantity of ice will be formed n the freezing point since then the freezing force is relativ strong; but soon sufficient water is removed from the tissue that the two sets of forces come into equilibrium, after wh more ice is formed only as the temperature falls. (2) T amount of ice formed per degree, as the temperature falls, c sequently becomes less and less. In succulent tissue most the water is frozen out at temperatures but slightly below freezing point, while in drier tissues, with most of the water the protoplasm and walls, a smaller percentage separates ou these higher temperatures. An apple which Müller-Thurgau vestigated contained at —4.5° C. 53 per cent. of ice by weig which was equal to 63.8 per cent. of the water content. —15.2° C. only 79.2 per cent. of the water had frozen. There remained a considerable quantity to freeze at still lower te peratures.

Müller-Thurgau could detect this increase in ice content b simply sectioning various tissues under different temperatur The writer found it very apparent in the case of winter bu Sections taken at —20° F. showed very little ice. It was foun necessary to work at a temperature of 0° F. in order to find t ice content well developed. At this temperature, in the buds about nineteen out of twenty-seven species of trees and shru the ice could be plainly seen and in the majority it was very co spicuous. The remaining eight were sectioned again at —1 F. and all but two showed ice, but in small scattered crysta The buds of these eight species, butternut, beech, witch-haz hickory, ash, oak, hazel and chestnut all contained little cell-s and small cells with rather thick walls.

It has been found by Müller-Thurgau, Molisch and others cit earlier in this paper that in no case can the death of any pla be traced directly to absolute cold alone at temperatures belo the freezing point. At present there seems little if any eviden that death is due to shock, over-stimulation, or any other acti of cold which might produce the so-called "cold rigor," althou there are several cases yet unexplained by the drying theor It may well be that in these and other cases additional seconda changes are produced. An unconvincing attempt has recently bee made to show that in no case is death due to the amount of ice fo mation and drying out.† If death were due to shock we shou have to assume a special sensitive point at a temperature a fe degrees below freezing, which is unlikely, especially since t frequent death at this temperature can be more easily explain in another way. Most plants are killed by the first ice formati within the tissue. If they survive this, a considerably lower te perature is required to kill them, or they may be capable of e during any degree of cold. It has been demonstrated by mea of orchids, the sap of which turns blue when the cell is kille and *Ageratum*,§ which gives off a peculiar odor under simil circumstances, that, in the case of delicate tissues at least, dea

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

† Mez, C. Neue Untersuchungen uber das Erfrieren eisbestandig Pflanzen. Flora, 94: 89. 1905.

§ See Molisch.

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

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

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

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

The ice-masses produced in the spaces are often large lenticu
structures. These are composed of ice prisms side by side in t
layers. Superficial ice crusts, and those produced on damp s
are similar to those in the tissue, but composed of only one la
of crystals. These crystals grow only by additions at the e
in contact with the tissue.

The water of which the crystals is composed is almost pu

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

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

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° F. or even —10° 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.

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
of its utility during those strenuous times, or by some ch
it would have come into notice and now be valued for ornam
purposes, especially since peace and plenty abound and the
gressive florist is ever on the alert for rare and effective n
ties. An exquisite study in pink is the *Pinckneya!*

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

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

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

The flower of the *Pinckneya* repays close study, revealing
derful points of beauty, especially as viewed under the g
The corolla is tubular, with five linear revolute lobes, slig

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

FIG. 6. Flower of *Pinckneya pubens.*

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

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

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

at its best it must be sought in the low river hummock, it favorite habitat, where it reaches the proportion of a tall slende tree with trunk emersed half the year. If seen from a car win dow when slowly passing over a high trestle, a not unusual poin of view, and we look down on the rose-crowned wilderness, sway ing with the breeze just after a refreshing shower, when the sil very underside of the foliage is displayed, and the raindrop catch the glint of the sunshine—a spectacle, never to be for gotten, greets the eye. The setting of this tree is but one o innumerable examples where the landscape gardener has an infal lible guide in nature.

FLORAL NOTES OF FOREIGN LANDS.

By Felix J. Koch.

At Ogulin, in Croatia, one finds at their best the "old-fashione gardens," with the tall pink phlox, the petunia, dahlia and sun flower, as well as mignonette and coriopsis in long beds. Sum mer-houses are set out in these gardens and gay-colored glas balls, such as we hang on our Christmas trees, are hung on th ends of short poles and scattered among the plants.

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

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

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

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

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

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

The giving of a little floral gift is quite the vogue in Bos
On the Buna the old hermit gives the occasional visitor a wl
velvety herb, really used for heart troubles, but presented by
because of its beauty. At Ilidje the porters of the hotels pre
favored lady guests with bouquets. So it goes all over the co
try. There, again, artistic and practical are combined, fo
Mostar the city sand filters are placed in a park that banana pa
and kohlia, the coxcomb and other plants may thrive over
covered reservoirs, and at Ilidje the national fish hatchery like
is in a park with the dahlia and the sun-flower and the morn
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 follo
executive committee: Messrs. Pollard (chairman), Cu
Johnson, Morris and Mrs. Britton.

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

CHARLES LOUIS POLLARD,
Secretary-Treasur

OF INTEREST TO TEACHERS.

EDITED BY DR. C. STUART GAGER.

MEETING OF BIOLOGY TEACHERS OF NEW YORK CITY.— meeting of the department of biology of the High S Teachers' Association, held on February 3, 1906, the topic cussed was "Is it desirable to give more time to the econ 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 standpoi botany. He spoke of the necessity of serving more directl needs of city pupils to whom most of the objects presente laboratory work or those on exhibition in museums and aq are "specimens" only—not in any way connected with the p life. He emphasized the necessity of doing away with the ular misconceptions as to the uselessness of the science an strangeness of the objects studied. The only ground of a to such pupils and their parents would be the economic of the subject. Mr. Eddy presented outlines showing how nomic interpretations were applied in the High School of merce; he emphasized particularly the practical work don bacteria, the study of agricultural processes in connection germination, the observations on marketable roots and st and, finally, showed how the recitations on these topics were ducted.

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 evolutional 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 or
the New York City high schools was returned to the teacher
this comment on the back: "I fail to see how the circulatio
the blood in the tail of the tadpole has anything to do with
formation of character."

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

It is argued that the pupils are not interested in botany. M
if not most pupils, are not interested in algebra. Shall
therefore, teach less quadratic equations, and more mecha
draughting?

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

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

Botany can never hope to reach and maintain the po
which language and mathematics now enjoy in the schem
education if it is willing to acknowledge that its chief valu
in a certain amount of information it can confer abou
economic uses of plants, and that as an educational discipl
has too few claims to entitle it to a position in the course of s

C. S.

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

The Plant World

A Magazine of Popular Botany

MARCH, 1906

TWO MILES UP AND DOWN IN AN ARIZONA DESER

By Wm. A. Cannon,

Desert Botanical Laboratory, Tucson, Arizona.

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

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

Geological record shows the higher portions to be very they constitute an integral part of the Cordilleran uplift, the lower portions of the Territory are more recent and to al the 3,000 foot level were washed by the waves of Tertiary se It is not surprising, therefore, that, with so extensive a va tion in altitude, with a portion of its territory constitutin part of a great plant highway, and with a situation so far so 31.3° to 37°, the plant covering of Arizona should be so div 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 oc in so short a distance as in the northern portion of Arizo From the summit of the San Francisco mountains, an altit of 12,600 feet, to the bottom of the Grand Canyon, which Bright Angel creek is about 2,400 feet above the sea, the dista in a straight line is probably not more than forty miles. T great difference in altitude is accompanied by an equally g variation in temperature. Merriam† assumes the mean temp ture 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 ceder 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 flie vertical one of nearly two miles is crossed during which clim changes and plant zones are encountered which correspond the temperatures and the plant zones of all of North Ame outside of the tropics and the extreme north.

* Privately communicated to the writer by Professor W. P. Blake, U versity of Arizona.

† Results of a Biological Survey of the San Francisco Mountain Reg and the Desert of the Little Colorado, Arizona. U. S. Dept. of Ag Div. of Ornithology and Mammalogy, North American Fauna, No 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 *Cereus giganteus*, in the background.

naissance of the territory traversed was made, so much of interest 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 Mou
tain. Flagstaff was our base of supplies. In Flagstaff eve
thing that is needful for the mountain trip, from bacon to burr
can be purchased, and, if desired, the trip can be made from t
town, but for various reasons we started our burros from B
mont—a way-station nine miles west of "Flag."

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

We left Belmont one Wednesday afternoon late in July a
directed the course of our three burros straight for San Franci
Peak. At first the way lay through a forest of fine pines (*Pi*
ponderosa) and we did not emerge from the pine forest, in fa
until we reached the very base of the mountain and began
ascent. Wednesday night was passed in an abandoned ba
which served better than a tent to keep off the rain, and early
next day we were en route again. By noon we had reached
large meadow which lies so conspicuously on the lower southw
corner of the mountain and which was seen from Belmont. T
meadow was skirted by Douglas spruces and aspens. We c
tinued the ascent and were driven to make camp the latter p
of the day at about 9,000 feet among firs because of the appro
of rains. The rains continued more or less intermittently u
Sunday morning, when, lured by promise of a fair day,
shouldered our rück-sacks and started for the summit.
climbed upward through the forest of spruce and pine (*Pi*
engelmanni and *Pinus aristata*), the trees of which continu
became smaller, until at last we emerged above the timber
and went up on the peculiar debris characteristic of the old
cano. At length the edge of the crater was reached and
stood on a narrow crest with the inside of the crater a few h
dred feet below and to the north, and the plateau through wh
we had come to the south stretching as far as we could see.
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 12,000 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 mad
foot and in a leisurely manner. We left the rim early in
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 rou
and more precipitous trail which lies somewhat north of the
commonly used by tourists. We reached the river's edge by
o'clock and quenched our lively thirst with the brick-red wate

After passing the following day and the succeeding nigh
the Colorado, during which time a crossing was effected,
made the ascent to the rim in a manner quite as leisurely if
as comfortably as when we went down.

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

This remarkable range in the flora at the Grand Canyo

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

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

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

The semiarid region of the Southwest contains a great numbe of historic and prehistoric ruins of cliff dwellings, towers, com munal houses, shrines, and burial mounds, examples of which ar found in the Flagstaff district of the San Francisco Mountain The question of the preservation of this vast treasury of infor mation relative to our prehistoric tribes has come to be a matte of much concern to the American people, and has received specia attention from the Secretary of the Interior. Parts of this regio are sufficiently rich in prehistoric interest and scenic beauty t 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 t
upon desert plants which remain through periods of drough
a leafless condition is a phenomenon which has very often b
remarked. The behavior in this regard is most striking in des
where there is prolonged lack of rain. Although in some reg
the rain penetrates into the ground very rapidly, neverthele
has seemed improbable to many, no doubt, that the absorp

Fig. 8. *Fouquieria splendens*, showing a branch which had been
gated during four days.

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

* This work was done at the Desert Botanical Laboratory, Tu
Arizona, under a grant from the Carnegie Institution, of Washin
during the summer of 1905. Reprinted from *Torreya*, Vol. 5, No
Oct., 1905.

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

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

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

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

On July 11, at 5 P. M., we had the first shower of the ra
season, the amount of precipitation being one and one-tenth inc
within two hours, drenching, of course, all the vegetation.
the following day (the twelfth) at four P. M., it was quite evid
to the eye that the buds had made a start. By July 13, the slen
conical buds along the whole extent of the stems were 7 to 8 m
meters long. On July 14 at five A.M., the rosettes of leaves w
well formed; the length of the largest leaves was 1.5 centimet
their size being, however, quite uniform. On July 15, the ph
graph forming figure 9 was taken. It will be noted that the lea
on the irrigated stem were at that time much larger than
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 m
rapid than after irrigation, notwithstanding that the water
applied artificially from time to time during the period of gro
under observation, while the wetting by rain occurred but o
The fact, however, must not be lost sight of, that following
rain there is a marked rise in the relative humidity, though I
gret that I did not take observations on this point at the posi
of the plant. Then, too, the ground got a good soaking, an
is remarkable how rapidly the soil becomes moist for a consi

able depth. Undoubtedly this fact was contributory to the rapi growth of the post-pluvial foliage. In the experiment detaile above, the total growth in a few days was due wholly to the wate available on the surface of the stem, and the inference is nc strained, I believe, if we conclude that, normally, the first stimulu to growth in the leaves is due to the water taken up, probably, a or near the buds. In view of the very thick coating of waxy bar it seems unlikely that the water would find entrance elsewher though we may be wrong in this, since there are rifts throug which conceivably the water might enter.

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

FLORAL NOTES OF FOREIGN LANDS.

By Felix J. Koch.

(Conclusion.)

At Belgrade, the capital of Servia, the laurel leaf is employe 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 in tervals, 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 the sills between the two sets of windows which the bitter col this region necessitates. Here the " Jew geranium " is popula

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

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

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

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

At Terpscidor, the royal chateau contains a small collectio wax flowers set in queer slanted cases.

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

On stated occasions, in the great Greek Cathedral at Bucha capital of Roumania, the worshippers bow and kneel, and, or ing, are presented with a bouquet by the priest, much as bi palm are presented on Palm Sunday in our own Catholic chur

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

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

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

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

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

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

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

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

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

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

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

In the windows of many of the homes the fuchsia blosso the year around.

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

At funerals, mourners awaiting the cortege at the door the church, one and all carry flowers, and later, still beari these, they follow the body to burial. On the left breast, a across the body alone are flowers placed on the dead, a mourn puttering constantly at their arrangement during service, I elsewhere they are absent. Old floral wreaths are allowec 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 tings in small pots of the ordinary form has observed the fact the first roots developed under these conditions penetrate rap through the soil to the wall or bottom of the pot and then dev against its inner surface, often forming a dense weft of bran in this region before any considerable branch growth has curred within the soil mass itself. It is rarely possible in t pots to obtain such a uniform distribution of the root systen is produced by the same plants in the open soil, where, u normal conditions of moisture, the root branches radiate formly, and by binding the soil grains together, produce familiar ball of earth which clings so tenaciously to small pl lifted from the open ground.

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

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

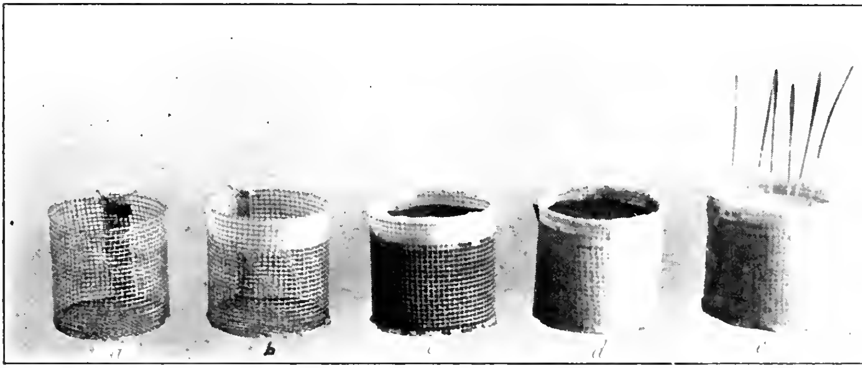


Fig. 10.

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

A new form of pot which completely avoids the difficulties me tioned above and which has other distinct advantages over ordinary clay pot for certain forms of experiment, has rec been devised by the Bureau of Soils of the U. S. Departme Agriculture and bids fair to become widely used for determi by the culture method the manurial and other requirement soils. This pot should prove of great value to anyone wishin perform physiological experiments on the effect of soil condi upon the growth of potted plants, for classroom or other purp and for this reason the present paper has been prepared.

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

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

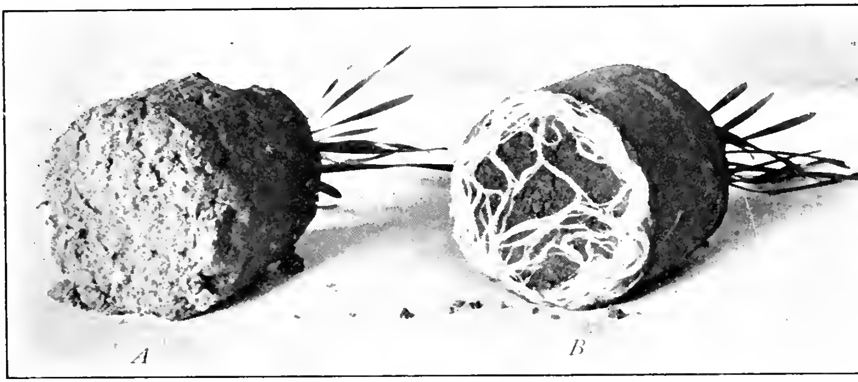


Fig. 11.

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

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

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

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

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

A RARE PALM, THE COCO DE MER.*

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

The home of this rare palm is in the Indian Ocean, severa hundred miles east of Zanzibar, and about 4° south of the equato on a group of islands known as the Seychelles. Here, in 174 this palm was discovered by the French who then occupied th islands. The fruits had been known for many years before, fo they had often been found floating in the sea around the neigh boring Maldive islands, whence they had been carried by th ocean currents. But the tree itself had been a mystery, and the were many tales afloat regarding it. The Malay and Chines sailors insisted that it grew on a tree deep down in the water o the coast of Sumatra, but that the tree instantly disappeare when they dived down to see it. The negro priests declared th it grew near the island of Java, its branches protruding abov the water, in which a monstrous bird had its home, and fro which it made nightly visits to the land, killing tigers, elephan and other large animals. It was further asserted that ships we attracted by the waves which surrounded the tree, and that sailo fell an easy prey to this ravenous bird.

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

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

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

FIG. 12. *Lodoicea maldivica* (Gmel.) Pers., the *coco de mer* or d
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 an pillows; and the nuts are fashioned into various utensils.

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

M. M. B.

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 sugge tions on how to interest children in the practical side of fore growth. He advocates that each country school have a sma nursery, of about one quarter acre or even less, to be planted wit trees and taken care of by the pupils. From two to four hou a week are suggested as being sufficient for the forestry wor which should include the setting out of seedlings, about si inches high, the planting of tree seeds and the care of the nu sery. Pupils should collect the seeds and seedlings from th woods. Correlated with this field work there should be "litt lectures on tree matters" given to the children in the woods.

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

Editor's Note.—The study of trees is surely becoming more and mo a factor in modern botany teaching. The Department of Agriculture leaving no stone unturned to interest the public in the physiographic ar economic importance of trees in general, and the above abstract wou seem to be an indication that this work is bearing fruit. Nearly eve locality, also, contains trees of individual interest, which are quite u known to people of other localities, and we are glad to have been able 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 account of the Georgia Bark or Quinine Tree, in the February issue. W are indebted to Mr. George V. Nash for the facts contained in the accou of a tree of the tropics, the Coco de Mer, a specimen of which is to l seen at the New York Botanical Garden. Next month, Mr. J. C. Blum will tell of an interesting tree of the southwest, the Alligator Junipe We shall be glad to receive other descriptions of trees in different pai of the world.

the nursery area each year. When the trees, at the end of th 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 differ days.

RELATION OF AMIDES TO PLANT GROWTH.—According to *ture* Jules Lefèvre gave an account before the Paris Academy Sciences on November 20, 1905, of experiments showing when green plants are grown in a soil containing amides, t growth is accompanied by a rapid increase in dry weight, altho 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 Ha enden, Herts, England. In 1837 John Bennet Lowes, lord of manor, began experiments in pots with agricultural plants various manures. In 1843 Dr. J. H. Gilbert became associ with him in this work. The duration and extent of their lal is indicated by the following inscription on a granite monum erected in 1893 in front of the Rothamsted laboratory: "To c memorate the completion of fifty years of continuous experim (the first of their kind) in agriculture, conducted at Rotham by Sir John Bennet Lowes and Joseph Henry Gilbert, A. MDCCCXCIII."

As the inscription states, such experiments on such a scal scientific agriculture had never before been conducted. It Sir John Lowes who introduced the manufacture of artif manures, and this alone ranks him as one of the greatest b factors of agriculture.

The present volume gives a summary in seventeen chapter part of the experiments carried out during the fifty years co oration of Mr. Lowes and Dr. Gilbert. The book is of more historic interest to the worker in pure science and of practica value to the agriculturist. C. S. G.

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

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

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

Agriculture Through the Laboratory and School Gardens. Manual and Text-book of Elementary Agriculture for School 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 c high school classes. The teacher of botany will not find it a sul

* New York, A. T. de la Mare Printing and Publishing Company, Lt 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 li
on the inner structure of plants and plant types. Osmosis
insufficiently treated (p. 60), sexual and asexual reproduction
not *clearly* distinguished (p. 271) and a scientist would state
ferently 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 rela
subjects are clearly and fully treated. The city boy would
profited by such a course, but the book seems a direct answer
the needs of our rural schools. J. I

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 E
ing Primrose."

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

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

E. C. Jeffrey and Arthur Hollick: "Affinities of the Cretaceous P
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 invitati

THE PRODUCTION OF OIL OF WINTERGREEN.—While oil
wintergreen was formerly made by distilling an etherial oil fo
in the leaves of the wintergreen (*Gaultheria procumbens*, Lin
the cost of gathering this plant became prohibitive. Now "
of wintergreen" is made by distilling the etherial oil found in
bark of the sweet birch (*Betula lenta*, Linn.). "The whole
chemists refine it and sell it as 'essential oil of wintergreen.' T
is the natural oil. 'Artificial oil' is made by a purely synth
process in the laboratories. Chemically it is exactly the sa
and being produced at less expense sells at a much lower p
—*Forestry and Irrigation.*

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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 formin arch, in such a way as to leave a three-sided opening bet petals and anther; while the third petal stands away from column, the narrow stalk adherent to the calyx, the roughly t gular blade free and pendant from a point within the ma The unmatched petal, the lip or labellum, of orchid flowe usually larger and more highly modified in form and brillia hue than the petals, and is usually so placed as to serve as a ing stage for visiting insects, often with bosses and ridge secure footing, often also with some sac or spur at the bas nectar. The lip of *Masdevallia muscosa* adds still another tinction; for besides being expanded and hollowed and be cushions of deep maroon hairs, its blade is irritable and fu lively motion.

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

The whole surface of the labellum is not sensitive. Tou anywhere except upon a median ridge, or cushion (*cr.* Fig *A*), produce no effect. But the lightest brushing of this 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 transl golden walls, veined with red. When he regains his feet turns about he sees light through a small opening. Climbin 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 fl and is entrapped he may leave the pollen of the first flower the adhesive stigmatic surface of the second, past which su 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 si powers of barberry stamens, which spring together so sud upon having their filaments touched.

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

A side sectional view shows that the movement results fro flexure of the neck (Fig. 14, *h*). In fact, as there are no te and no transmission of power, the motors must be located But the stimulus is received by the crest, which is at a littl tance from the hinge. When the surface cells of the cres pressed by an insect's foot, changes, the nature of which i known, take place in their contents, which cause changes in u lying 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

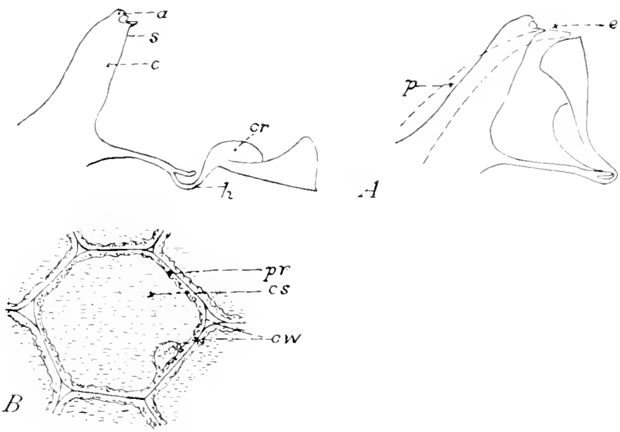


FIG. 14. *Masdevallia muscosa*: *A*. Side sectional veiw of lip and column in open and closed positions. *a*, anther; *s*, stigma; *c*, column; *h*, hinge; *cr*, crest of lip; *p*, petal; *e*, point of insects' exit.—After OLIVER.

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 ext ble—and water, supplied to the general tissue-mass by the of the lip, enters. The entrance of water is the result o expansive tendency, not its cause. As this cell swells, othe so too. The whole upper region of the hinge therefore ex and the hinge gradually straightens, lowering the lip. Whe cell and its mates have reached the full measure of this ex bility and become fully turgid the hinge is at its straightes 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 i cellular spaces or into the ducts of the veins. It seems that r 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 cules of the solubles—hitherto causing distention of the wall pass through with ease. Solubles and water—the sap—pas together, and the cell contracts by its own elasticity. Other act simultaneously, and the tissue on this surface of the shrinks, while that on the opposite side remains turgid. hinge bends and the lip is raised. The great irritability o cells, including those of the crest and the hinge, is seen whe recall the different kinds of stimuli which affect them: t heat, cold, mechanical motion of the parts, and diurnal chan illumination. When the lip is down, the protoplasm of the table parts seems to be in a state of very delicate equilib which may be upset by trifling changes in the physical conditi

* For Fig. 13, which so well represents the plant, I am indebted t 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 r
head moccasin-flowers (*Cypripedium arictinum*) bloom fro
middle until about the twenty-fifth of May. These purple fl
are the smallest of the eastern species of *Cypripedium* and,
pouch-shaped, in certain positions suggest a ram's head.
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
same date along the damp rocky hillsides near the whip-
will's nest. This is the best known of our *Cypripediums*,
conspicuous for its two basal leaves—it being the only two-l
moccasin-flower found in eastern North America. It creeps
the mountain plains where the huckleberry loves to grow
adapts itself, also, to the water-soaked hummocks of the s
lands.

Closely following are its sisters—the two yellow moc
flowers—*Cypripedium hirsutum* and *Cypripedium parvifl*
which bloom so closely associated as to intergrade and co
their individuality. The homes of these two species are in h
woodlands or in the secret solitudes of the swamp and, d
their being such showy and glaring flowers, they are seldon
covered except by the most alert observer.

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

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

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 o

FIG. 15. The Small Purple-fringed Orchis (*Habenaria psycodes*). 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 crow-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 r flower " (*Helleborine Calceolus*).

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

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

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

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

The round-leaved orchis (*Habenaria Hookeriana*) is amon first to bloom, coming just as the pink moccasin-flowers an showy orchis have faded, and choosing much the same ha save that they stand out as sentinels along the higher ri These plants produce round cool-looking leaves, lying fl nearly so upon the ground, between which rises a spike of g ish-yellow flowers, ornamented with fantastic spurs, capes hoods all twisted and tied to the scape. They very much res winged insects, and were likened to a strap by the ancient flowers being placed in a " Certaine 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 *Arethusa*, 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 *Arethusa* 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, lyi the southern slope of the Pinos Altos Mountains of New M This region lies only forty miles north of the Gadsden Pur and seventy-five miles from the Mexican boundary. The bathed peaks of the Mexican plateau are daily seen to ris hazy pyramids out of the desert of Egypt. The tract, last su added to the Gila River Forest Reserve, is tributary to the military hospital at Fort Bayard, and has an altitude of 6,0 7,500 feet. Here the writer spent the latter half of 1905, i interest of the U. S. Forest Service.

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

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

Not so its associate, the alligator juniper, known to botanists a *Juniperus pachyphloca* (see Fig. 16). Though often attainin twice the usual diameter of the one-seed juniper, or over fou

Fig. 16. Alligator Juniper (*Juniperus pachyphloca* Torr.).

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

As one approaches the mountains from the plains 6,000
below, he finds the first tree, cropping up here and there, t
the one-seed juniper. This increases in size, but gradually
its hold as the dominant species and at about 6,500 feet it
appears. The alligator juniper first appears approximately a
line of best development of the one-seed, and becomes domi
where the latter ceases. On the succeeding steep slopes it is i
rupted by horizontal belts of shrubby blue oak, only to re-ap
as occasional lesser belts to the top of the higher slopes at 7
feet, and as extensive orchards on the malpais* mesas. It o
pies a large part of these tablelands at 7,000 feet, to the exclu
of every other noticeable plant except grama and agave. H
however, our desert alligator becomes as picturesquely defor
as its brother species below. Many trees show less than half
girth covered with new wood bark. This gives rise to g
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 meas
one that was five inches in horizontal diameter at the crotch, g
ually widening to eight inches downward, with a vertical dian
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 owin
the absence of the fungi of decay. The living tree undoub
exists to a great age as well. The age of both species is dif
to ascertain. This is due to the formation of two annual r
per year—thus more properly called "semi-annual ring
brought on by two distinct growing seasons. The winter rain
snow give rise to the first growth early in spring, which is che
by the drouth of May and June. The rains of July and Au
diminishing toward October, stimulate the cambium into ren

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

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

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

The globular berries of the alligator juniper run very larg viz., from the size of an ordinary pea to five-eighths of an inc in diameter. One tree was seen that bore fruit as much as thre fourths of an inch in diameter. It contained no good seeds, how ever, and was clearly abnormal. The fibrous flesh is dry a 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 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 son. Several bushels would often hang upon a single tree. light blue mass, distributed about the periphery of the crown, a strikingly unique as well as handsome effect. This is height by myriads of tiny white specks upon the foliage, peculiar to older trees of this species. These are bits of hardened exuded by the single resin duct on the back of each leaf.

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

The bark resembles an alligator skin, and at once distingui it from all other junipers. One seeing it for the first time w not question its identity. This cross-wise checking of the is characteristic even at tender seedling age. Branches less one inch thick usually slough off their cuticles in the form scales, revealing a skin that is perfectly smooth and of a yew red. Where both species make young growth together this se as a secondary distinguishing mark. The primary one natu will be color, which is quite remarkably constant within the spe The one-seeded species is a pretty olive green, while the allig namesake is an exceedingly handsome bright blue. The growing side by side give a color variation not excelled by other conifers, the Colorado blue spruce included. With age, blue spruce often acquires much dark green, approaching the stantly green one-seed. In December, the staminate trees of species become sprinkled with yellow, due to numberless ma flowers, producing pollen despite the snow and frost.

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

The tree shown in the picture is a landmark for many mil around, because of its beauty and extraordinary size. It is a litt over five feet in diameter and between sixty and seventy feet height. The ground on which it stands recently fell into the han of a mining company. A ranchman and ex-cowboy living ne rode by the tree one day. The manager for the company h 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 the way," replied the manager.

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

With this he rode to town, and the manager prudently desist The ex-cowboy spread the manager's intention. For days the after talk of six-shooters was rife amongst the neighbors. T manager abandoned his plan, and the noble tree lives on for t guidance and delight of cowboy children yet unborn.

THE PERILS OF ORCHID HUNTING.

The strange perils and risks that attend the collecting of wi orchids have been graphically described by Mr. William Fit gerald in the Sunday magazine of the New York *Tribune* of Fe ruary 25. The writer tells how, in some of the wildest and m remote regions of the world, in Mexico, Venezuela, Guatema Honduras, Nicaragua, Brazil, Burma, in the interior of Assam a the Himalayas generally, in Borneo, New Guinea, and on t west coast of Africa, a certain orchid dealer in London maintai 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. A man about to collect on the lower Himalayas, for instance, will purchase his outfit and hire his servants in Calcutta. When the 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, from 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 moth dendrobe were growing in and out among the dead bones of the 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 wire and calico soon won them over, and they finally assisted the collector in gathering the new orchid, insisting, however, that he send 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 for thirteen hundred dollars for the purpose of hybridizing. A plan of *Masdevallia Tovarensis* was cut up in the same way and it fragments sold for large sums, until a consignment of forty thou sand plants from Caracas reduced the price to a mere song.

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

The element of gambling begins as soon as the orchid hunte finds his plants. He must bring them to his hut, dry them fo four weeks, and then, when they are entirely free from moisture fasten them to tough twigs and pack them in wooden cases wit a liberal allowance of air. They are then transported by coolie llama, raft or elephant, over land and across the ocean. If the are exposed to sunlight, or are placed too near the boilers o board steamer, they may all be ruined. "Ten thousand plants, writes Mr. Fitz-gerald, "may be collected on some remote Andea peak or Papuan jungle with infinite care, and consigned to Europe the freight alone amounting to thousands of dollars, yet on arriva 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 titl an address, delivered under the auspices of the American I League, in Boston, in December, 1904, by Professor L. T. To send, Emeritus Professor in Boston University.

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

An idea of the author's comprehension of what evolutio and especially of his acquaintance with standard literatur biology may be inferred by his statements that the terms ge plasm and protoplasm (*sic*) have not for five or ten years " employed seriously by any reputable writer on these subje (p. 12); that evolutionists should be able to show a chain wit missing links (p. 15); that species should generally improve primitive forms die out (pp. 16, 17, 19); that evolution m that one species transforms "into another" (pp. 21, 29); evolution demands the existence of "millions of interme forms" (p. 23); that DeVries "appears to have develope mutable species of primrose," but that, on the contrary, noth has been accomplished outside of "an oscillation around a pr tive center" (p. 28); that De Vries is a believer in special c tion (p. 52); that, "There is no evidence whatever of a tend in nature towards the transmutation of species" (p. 28); tha evolution were true, "classification would be out of the questi but "the scientist is not embarrassed by any such perplexing ditions" as a difficulty in classification (p. 29); and, finally, the theory of evolution "is discredited and abandoned by the scholarship of the world." The same writer is the author volume entitled, "Evolution *or* Creation."

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

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

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

"It is well known that if the tip be removed from a growin root a new apex is commonly differentiated, growth in lengt commencing once more when the new tip has been completel formed. The objects of Dr. Nemec's investigation have been t endeavor to throw some light on the nature of the process c regeneration itself, the causes that initiate and determine its occur rence, and the meaning of the physiological events that are as sociated with it. The methods adopted were extremely simpl The tips of growing roots, chiefly of seedlings, were injured i various ways by making incisions into the region about the ape and the reactions that ensued were carefully followed and com pared.

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

"The case is different with the roots of phanerogams, altho in them, also, the conditions of regeneration are more lim than might have been anticipated. In the first place, no un of the halves of longitudinally cut roots took place; the dama apex was either replaced by a new one on either side of the sli else the regeneration was confined to one half.

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

Labelling Paraffin Blocks.—The following may be noth new, nevertheless it is an excellent way to keep a record of material embedded in paraffin blocks. On a small paper write the name and character of preparation, whether staine injected, and lay this in the surface of the still liquid paraffin its embedded material and let it solidify with the block. Or 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 Fairieanum*. "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 Fairieanum* 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 pol yellow skin of a silky texture and very heavy. This is prol one of the best of its class and quite equal to the pear-sh variety. Next comes some excellent fruit from Jamaica, no (that already referred to under the name of Forbidden Fruit."

GERMINATION OF ORCHID SEEDS.—When the seeds of or are sown, especially those of the *Cattleyia* or the *Loelia*, found that the germination, which is quite irregular, is ac panied with the presence at the extremity of the plantule of a ter of filaments due to an endophyte fungus. Recent experin of the French scientist, M. Noel Bernard, have shown tha presence of this fungus is indispensable to the germination o orchid seed. If the seeds are asepticized, they will not germi but if they are put in a pure culture of the fungus, the my filaments of the latter penetrate the embryo; then the germin commences, and is pursued regularly. This observation sho distinct case of normal parasitism, in which an organism ca be developed without the penetration of a parasite.—*Scie American.*

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

The orchid family embraces some 6,000 or 7,000 species, m distributed in tropical regions. In the United States there are about 150 species, representing 44 genera. Nearly all tropica 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
this unique form. His results, thus far, include the develop
and germination of the spines. It appears that the state c
country, Damara land, prevented a full collection of mater
the time of Professor Pearson's visit. We expect that fu
opportunity for collection and study will be afforded.

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

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

ERRATA.

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

* November, 1905.

The Plant World

A Magazine of Popular Botany

MAY, 1906

SOME MONSTROSITIES IN TRILLIUM.*

By F. M. Andrews,

Assistant Professor of Botany, Indiana State University, Bloomington, Indiana.

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 sta and four styles. This change in the size and especially in number of very close successive whorls of the foliar and leaves was also observed in several other species of the g *Trillium*. The plant in this instance was considerably sn than the normal specimens.

Some other specimens of *Trillium sessile* and *T. recurv* showed two sepals and petals partly, or entirely grown toge 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 ap ance by showing a multiplication in the number of parts in whorl, and a reduction in the usual number of parts in ot For example, one specimen (Fig. 17, *C*), had the usual leaves, the three sepals, but five petals, four stamens and styles. In all other respects this plant was normal. Some flo of this species have shown a tendency to unite two or more c parts.

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

It would be an interesting point to determine whether o the plant arising from a rhizome showing such changes as mentioned would appear afterward, or if other and greater v tions would occur. Accordingly, experiments of this natur in progress to ascertain this fact.

A DECEMBER RAMBLE IN TUSCALOOSA COUN ALABAMA.

By Roland M. Harper,
Geological Survey of Alabama.

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

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

Warrior or Tuscaloosa) River crosses the fall-line or i
boundary of the coastal plain. Going up the river (north
ward) from Tuscaloosa one soon enters the terrane of the
Measures (upper Carboniferous strata) at the southwester
tremity of the Alleghanian region, where high sandstone
and deep ravines are characteristic features of the landsca
in many other parts of the country where the same forma
occur. In the other direction from Tuscaloosa the coastal
a region of very different aspect, stretches away to the sho
the Gulf of Mexico. Although by no means a homogeneo
monotonous region, the coastal plain is pretty sharply diff
tiated from other parts of eastern North America by the ab
of high elevations and the scarcity of steep slopes and rock
crops; its Cretaceous and Tertiary strata are almost every
concealed under a blanket of sand and loam of Quaternary o
Tertiary age; and its flora differs constantly and unmista
(but by no means totally) from that of the other regions fa
inland.

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

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

farther up the river this species became more abundant, until a[t] the point where I turned back there was probably more of it i[n] sight than of any other tree.

At the mouth of the first creek I came to, I stopped to examin[e] the flora of the cliffs more minutely, and found there among othe[r] things the lip-fern, *Cheilanthes lanosa*, in abundance; the fern[s] *Woodsia obtusa* and *Asplenium Trichomanes;* stone crop, *Sedu[m] ternatum*, and *S. Nevii;* early saxifrage, *Saxifraga Virginiensis* *Hydrangea quercifolia;* a species of syringa, *Philadelphus* *Neviusia Alabamensis;* golden-rod, *Solidago amplexicaulis*, an[d] *Aster Camptosorus*. The *Neviusia* was discovered somewher[e] near this spot about fifty years ago by Drs. Nevius and Wyman,* and was known nowhere else until Mr. T. G. Harbison found i[t] a few years ago on Sand Mountain in the northern part of th[e] state.† A few specimens of an elm loaded with fruit near th[e] base of the same cliffs could be no other than *Ulmus serotina* 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 th[e] wild state‡ that one can hardly be certain that the specimens see[n] in the woods have not sprung from seeds brought by birds fro[m] cultivated specimens. Its geographical distribution is consequently very imperfectly understood, but it seems to be normall[y] confined to the coastal plain, like many other southern evergreens.

A little farther up the river the fern *Dryopteris marginalis* wa[s] 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.§ Most o[f] these violets, strange to say, were in full bloom, though at thi[s] time the leaves were covered with frost after midday. This particular spot happened to be on a railroad right-of-way, fro[m]

* 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 cle within a few months previously, but whether or not this had thing to do with the appearance of flowers at this unusual se 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 a 1 P. M.). The freezing had evidently commenced in or near cambium layer, and the ice had pushed the bark completely for a distance of several inches in each case, usually in one pi

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

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

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

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

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

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

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

THE PASSAGE OF WATER FROM THE PLANT CEL DURING FREEZING.

By K. M. Wiegand,

Cornell University.

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

* A little later in traveling over the state I was able to recognize this tre from moving trains at many points where if the leaves had all been lyin 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 the "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, the water must be in those spaces before freezing begins; in other words, that the cell actively gives up water at low temperatures, probably as a protection against ice-formation within the cell. Kerner* states the theory thus: "In order that the water may 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 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, is to 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 forthwith 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 Cynareae (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 tha the cells of root tissue possibly act as pumps, forcing water int the vessels, and thus causing root pressure, but whether suc expulsion of water in the roots actually occurs has as yet neve been satisfactorily demonstrated. Droplets appear on the surfac of some mycelial threads when kept in a damp atmosphere, als on many plant hairs and on the rhizomes of Marchantia unde similar conditions. To this list might be added a number o 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 abov 0° C. We have the casual notice of Molisch that in some stame hairs of *Tradescantia* subjected to a temperature of — 5° t — 9° C. for six hours the plasma membrane separated from th wall, but no freezing took place until a temperature of abou — 15° C. was reached. If subjected to a temperature of — 15 to — 20° C. the separation from the wall occurred immediatel In *Tradescantia Virginica*, according to Kühne,* the change before freezing are more marked but take place only when th fall in temperature is abrupt and severe. The separations do n always occur, especially when the cooling is slow, and seem rathe to be accidental contractions due to the cold stimulus, than genera phenomena.

Greeley† has shown that the reduction of temperature to nea zero degrees C. for a few hours will cause the animal *Stentor* t contract and become cyst-like, probably with the expulsion o water. Threads of *Spirogyra* became much plasmolized unde similar treatment, and Livingston‡ has shown that when mounte in oil this plasmolysis is accompanied by an extrusion of droplet of water into the oil. The effect upon both organisms is the sam 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 Wate and the Lowering of Temperature. Amer. Journ. Physiol. 6: 112–12 1901.

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

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

Although from the foregoing it appears that, in special at least, water may be excreted by the protoplasm, and that excretion may, in certain plants at least, be induced by the ap ently stimulating action of temperatures near the freezing still there are some important objections to assuming this 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 this particular temperature stimulates the protoplasm in this ticular way does not warrant us in assuming that all cells are ulated in a similar way at the same temperature. Such a univ phenomenon does not seem probable.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

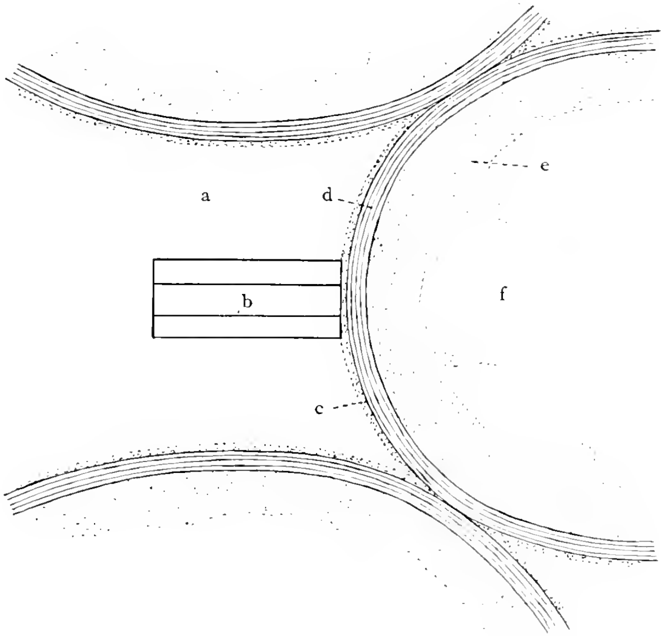


FIG. 18. Diagram illustrating the water-system concerned in the fo
ation of ice crystals in intercellular spaces. a, Intercellular space
prismatic ice crystal; c, superficial water film; d, cell wall; e, protopla
f, vacuole containing cell sap.

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

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

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

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

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

(*a*) The formation of the crystal takes water from the surfac film with considerable force, thus leaving the surface of the wa without its quota of water of imbibition, and that force will the rapidly increase at that point. Following ordinary physical law the water will move through the cell wall until this increas imbibition force is equalized. For this purpose water wi taken from the inner wall layers, thus increasing their powe imbibition. They in turn will be supplied by water from the toplasm, and this in turn by the cell sap. In other words, a r justment of equilibrium will occur throughout the whole sys As crystallization progresses, more and more water will be stracted from this system until finally the force of imbib becomes sufficiently strong to equilibrate the molecular forc crystallization, at which time the growth of the crystal necess ceases. Not all the water passes from the cell on freezing only a part of it, depending upon this equilibration of forces. further freezing will now occur unless the temperature again thus causing an increase in strength of the force of crystalliza More water will then pass to the crystal until equilibrium is a established.

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

(*b*) It may be assumed that the crystal actually draws w toward itself. This it might do in this way. The water throu out, not only the cell, but the whole adjacent tissue may be ceived to be a connected whole possessing an adhesion and rig of molecular structure under certain conditions, as is now ofter 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 surfac we may conceive that the whole structure will be pulled along on molecule nearer the crystal, and so on. This is similar to pullin on the end of a string, thereby moving all the molecules of th string along a similar distance. The greatest objection to thi idea that the crystal pulls the water out lies in the doubt as t whether water of imbibition possesses a rigidity similar to tha of a column of great diameter.

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

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

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

Normal tissue usually contains a large quantity of water an the series of structures concerned in freezing are nearly saturate with water of imbibition. Hence when freezing first begins ver little force is required to abstract the water, but as the proces goes on the imbibition-force regularly but rapidly increases unt it becomes very great, as we have already seen. With the forc of crystallization the increase is not regular. Before freezin begins the force is absent. With the first crystal-formation rises abruptly and becomes very strong; and with the decrea temperature thereafter it continues to rise gradually but much less rapidly than at first. The result is that when t freezes a very large quantity of water is abstracted at the to form the first particles of ice, but with each degree of fa temperature thereafter only a very small quantity is lost by cell. This quantity becomes less and less with each degree, the imbibition force increases at a more rapid rate than the of crystallization.*

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

Botanical Symposium.—The third annual meeting of Botanical Symposium will be held from July 2d to 9th, 190 Mountain Lodge, Little Moose Lake, Old Forge, N. Y. Thro the courtesy of the members of the Adirondack League Club privilege of occupying the club house for one week is exte to the members of the Conference. Tickets should be bo to Fulton Chain Station on the Adirondack Division of the N C. & H. R. R. Single fare from New York City $6.46. Bo $2.50 to $3.00 a day. Stages will meet the party at Fulton C Station. Those expecting to attend are requested to notify Joseph Crawford, Secretary, 2824 Frankford Avenue, Phila phia, Pa.

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

MEETING OF THE SOCIETY FOR THE PROTECTIO OF NATIVE PLANTS.

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

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

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

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

One leaflet, No. 11, a reprint of an article in THE PL WORLD, entitled "A Treasure-Spot of Wild-flowers,"* was is last year. During the spring and summer leaflets and po were sent to hundreds of schools, camps, boarding-houses summer resorts, and in the autumn letters were sent to clergy shopkeepers and persons likely to give large entertainments garding the use of laurel and other evergreen for decora Our literature was also sent to Village Improvement Societies to Women's Clubs in Massachusetts. Publishers have ki sent out many hundreds of slips in their nature books; and po 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 Society will be sent free of charge by applying to Miss Mari Carter, Boston Society of Natural History, Boston, Mass.

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

The following officers were reëlected for the year 1906: orary president, Mrs. Asa Gray; president, Robert T. Jacl

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

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

MARGARET E. ALLEN,
Corresponding Secretary.

SUMMER COURSES IN BOTANY.

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

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

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

Courses: *Investigation:* A. Under supervision—*Morpholog Plant Physiography.* B. Without supervision—information b writing to Dr. George T. Moore, Cosmos Club, Washington, C. *Botanical instruction:* July 5 to August 16. *Thallophyte* Drs. Moore and Wolf; *Plant Life-histories*, Dr. Moore an assistant.

COLD SPRING HARBOR, LONG ISLAND. BIOLOGICAL LABORATOR 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., Columbi University.

* Absent in 1906.

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

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

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

Staff: Professors MacMillan, Tilden, Butters and Rosenda

Courses: *General Algology:* for teachers. *Algology:* for vanced students. *Morphology and Ecology of Kelps, Na Study, Taxonomy of the Coniferae, Taxonomy of the An spermae.*

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

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

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

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

HARVARD UNIVERSITY, CAMBRIDGE, MASS. JULY 5 TO AUGUS

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

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

For further information address Dr. M. A. Chrysler, 61 Ox 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.

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 bec
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 evolutional s
point)—and in the cases where there are interrelations bet
plants and insects. The objection that plants are farther rem
from humanity than animals, and that the zoological side o
subject is thus almost wholly neglected, would be counterbala
by the advantage of a fuller knowledge of the local flora,
the sounder scholarship which would thus be induced.

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

Dr. Denbigh, of the Morris High School, was the last spe
He expressed the opinion that it would be well-nigh impos
to make the first-year biology course too simple. This cour
successful when it secures three objects—the power of scie
thinking, as wide a knowledge as possible of the animal and v
table kingdoms, and the development of a permanent int
which will increase the pupil's power of enjoyment in his
roundings. From this point of view, the insistence upon de
of structure and elaborate drawings is pernicious; precise sch
ship should not be exacted or expected. Dr. Denbigh empha
the fact that field work can be most valuable in arousing inte
and the importance of learning biology is exactly proportion
the difficulty of reaching the plant or animal. This subject
vides a training which the student lacks and therefore needs;

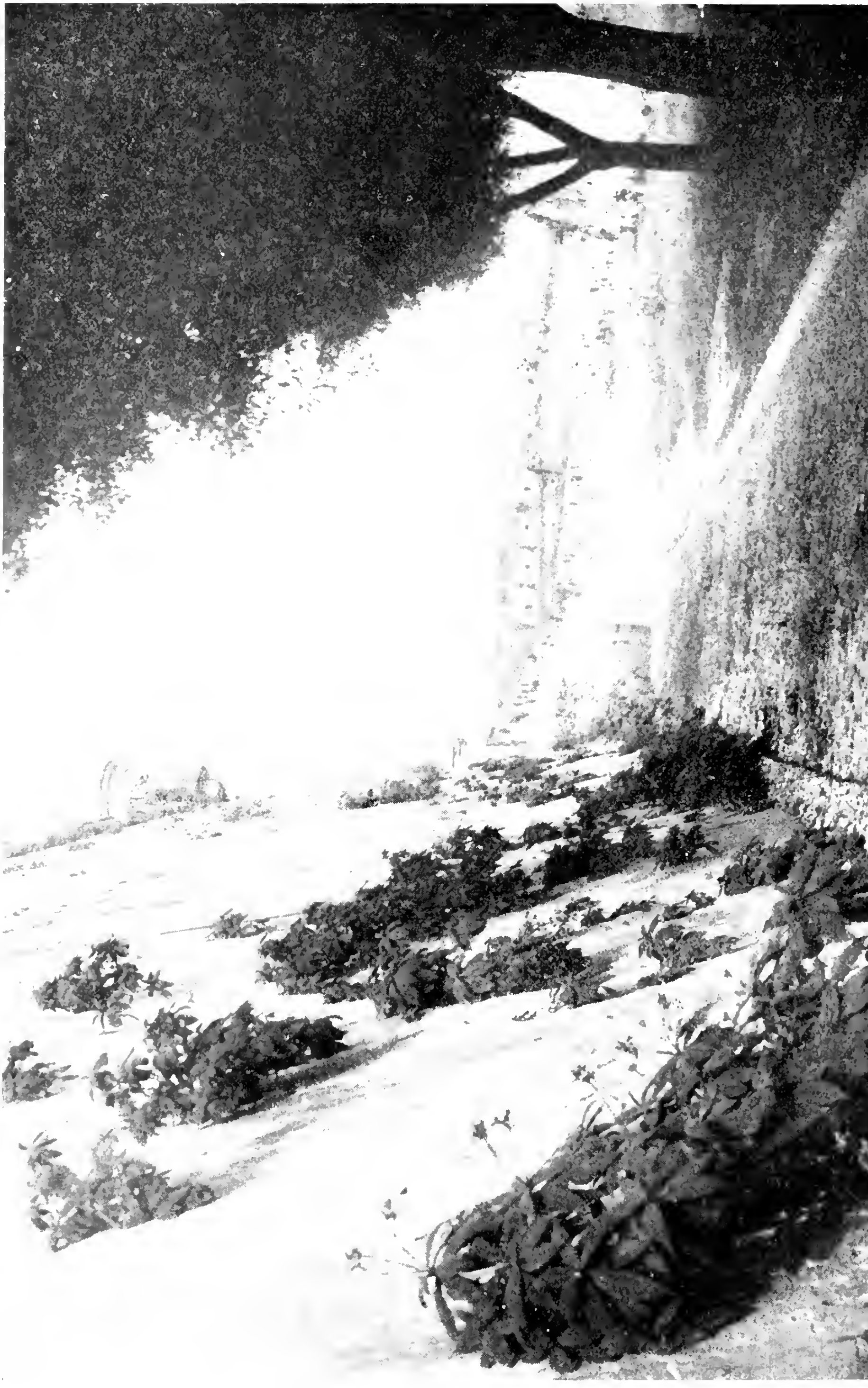
consequently there is no more valuable cultural study than first-year biology. It fulfills Huxley's requirement of knowledge—that of making a man live more happily and usefully.

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.

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 th influences of plants upon their surroundings is voluminous, an yet much more might well be written on this very interestin and important subject. Wherever the conditions will permit plants are continually migrating into new territory, and they ar also continually making their old homes unfit for themselves bu suitable for other species. In this work, in connection wit frost, and water, and animals, they become one of the greates leveling forces of nature. They stop the flow and change th courses of rivers; they fill the lakes, converting them into marshe and then into dry land; they incroach upon the ocean coast lin and gradually push it out farther and farther; they help to leve the hills and to tear down the mountains. Neither are the respecters of the works of man, for they attack and destroy hi greatest and noblest structures. His largest castles, temples, an monuments become vine clad, old, ancient, and then historica memories, in rapid succession.

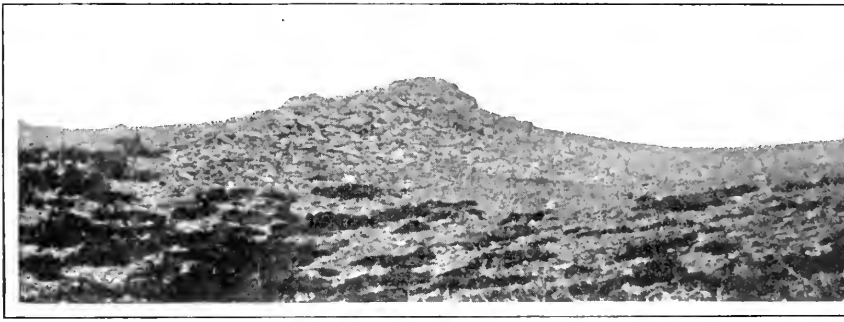
In no part of the western hemisphere is this better illustrate than in the old Spanish fortifications in and around Havana Here, far south of the frost line, plants become the most im portant factor in this slow but sure work of destruction; and unconfused with other disintegrating factors, their work is al the more conspicuous. The most important and best know these fortifications are Morro Castle and Cabanas. Built defence against the "flesh and the devil," Morro only has e rienced one siege, and yet both are being rapidly disintegr through the agencies of nature. Morro is much the older, ing been completed in 1597, while Cabanas was begun in and completed in 1774. And yet Cabanas looks as old or than Morro. For generations these immense piles of mas have stood as military scarecrows to all the rest of the civi world, only to be destroyed by the slow but ever working f of nature.

Crossing the harbor from Havana, the visitor lands at the of a covered road which leads up to the south entranc Cabanas and into "Los Fosos de los Laureles" (the laurel di with its thick walls of masonry forty feet in height. Within moat are a number of very large laurel trees (*Ficus nitida*) at various places through this and other moats are nume plants of many species. Of the trees, the most common are *Delonix regia* (royal poincianas), *Ficus nitida* (laurel) and o sionally some others. Among the smaller plants the follow species are very abundant: *Ricinus* sp., *Solanum verbasifo* and other solanaceous plants, *Ipomœa domengiensis*, *Ha* *patens*, *Momordica charantia*, *Cordia* sp., *Tribulus cisto* *Iresine paniculata*, *Bidens lucantha*, *Vachella farnesiana*, *Sta* *tarpheta jamaicensis*, *Turnera ulmifolia*, *Portulaca* sp., *St* *lobium stans* and a number of Compositæ and Gramineæ.

Many of the above mentioned plants grow in holes and c ices of the walls, but by far the most conspicuous of these plants is *Rhytidophyllum crenulatum* (see Fig. 19) which gr everywhere over the surface of the walls. The plant belong the family Gesneraceæ, and the genus is restricted to the Gre Antilles. This species, though comparatively rare, grows the rocks along the coast. The wonder is how this vigo plant can secure a foothold and nourishment in these walls, yet it seems to take advantage of every opening, however sm and grows in luxuriant abundance. Its work as a disintegra 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.

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 3d 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 a mountain top, if only for the satisfaction of putting it un one's feet. It is an undertaking accomplished and an aspira satisfied. I have always enjoyed reaching the summits of Rocky Mountains, even if these were not the summits of highest peaks. The debris lying at the foot of the chasms the partly thawed lakes look as if some of the old world v yet in the making. The boundless range of vision, and the b amid the alpine summits is a rare experience.

I wish to write here of two little trips—a day each—wher horse-back and alone I rode from Moraine Park to the to the range to collect botanical specimens. The first trip wa a day in July and the second on a day in August of another y The high mountains, like the plains, have a succession of flo ing plants, though the season is short, and I made the chang time to get a greater variety of specimens. Leaving the v I rode leisurely up an old trail made years ago by miners p pecting for gold on the north fork of the Grand river, ascended a hill-side to the crest of a ridge. Far below, waters of the Thompson river coming from the canyon ab wound their way through the valley and meadows and gli and sparkled in the sunlight; and across the valley and be the hills to the southward rose the grand proportions of Lo Peak. Before me was a valley into which the trail desce 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; Tetraneuris 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 bec coarsely granular and hard, and it seems strange that this ticularly tender and fragile buttercup should push its through the hard icy snow. I have always found it blosso close to retreating snow, and have noticed that some other p blossom under like conditions. The dogs-tooth violet is narily an early spring flower, but I have seen it in full blo beside a retreating snow bank on the high mountains in the dle of August. No matter what the time of year, it is spring when the snow melts, and early spring beside a retreating bank.

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

In the middle foreground as I came out on the mountai is a ledge of rock standing ten to fifteen feet above its surr ings, and on the western edge another ledge. Soil has acc lated in the crevices and on the less precipitous places, and it about these ledges that I found the most interesting collec particularly on the eastern side which is sheltered from the west winds. Growing in the crevices was the alum- *Heuchera bracteosa*, which is almost always found in the ices of ledges; *Oreoxis humilis*, a very small umbellifera w blossoms in July and reaches the fruiting stage about the m of August; cinque-foil, *Potentilla nivea;* mountain sorrel, *O. digyna; Macronema pygmæum;* and *Saxifraga cernua.*

About the bases of the ledges, sheltered by large bou which probably hold the moisture, were several larger pl such as *Senecio Fremonti*, first collected by Lieut. Fremont described by Torrey and Gray in their Flora of North Ame columbine, *Aquilegia cærulea*, a beautiful and showy plant whi begins to blossom along the foot-hills in May and reaches t alpine districts in August; *Heuchera parvifolia*, another pla which grows from the foot-hills to alpine heights; *Merten. Parryi*, a species recently described by Dr. Rydberg, and *Rib parviflora*. Growing on the western ledge was the somewh rare cinque-foil, *Potentilla uniflora*. It had been growing he some time, for the decumbent stems were quite long and the bases covered with dead leaves. It trails close to the rocks, a the flowers are large for the size of the plant. Sheltered boulders under which one must look to find it was the colu bine, *Aquilegia saximontana*, and a little farther down amo boulders was *Angelica Grayi*—a plant which for some time w called *Archangelica Gmelini*, then described by Drs. Coulter a Rose with some assurance as *Selinum Grayi*, and again by the transferred to *Angelica*, where it now stands. Growing in t more open were such plants as the thistle, *Carduus scopuloru Polemonium confertum melitum*, the large flowers varying fro deep to light blue; the dwarf alpine form of the whitlow-gra *Draba streptocarpa*; the alpine form of *Chamænerion angus folium*, and *Solidago decumbens*. Here too was *Achillea mil. folium*, the common yarrow, which grows from the sea level the alpine districts.

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

From the mountain on which I was the view extends either hand to still higher mountains, on whose sides and su mits lay banks of snow. To the north-eastward the slope w into Fall river, and south-westward into the Thompson canyo For several hundred feet this precipitous side was strewn wi boulders, rough and sharp because unsmoothed by the action glacier or running water; then to the bottom of the canyon a up the opposite side to timber line was the dark green of spru and pine. Across the canyon rose a massive mountain, whose sides were large banks of snow from which ran strea to the river below. I could trace the creeks and see falls considerable height, but no sound came across the canyon. W was it said something about frozen music?

As the sun declined toward the west, reluctantly I turned horse's head down the mountain side, taking my botanical spe mens, and the memories of a day on the mountain top—a 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 many of the cities of eastern United States, this tree has of late received the attention it once did and which it deserves, for it has quite a few points of comeliness if not beauty. Formerly it was extensively planted as a shade tree the two gigantic trees standing at the entrance to many old co try homes testify to its vanished popularity.

It is now escaped from cultivation and has spread rapidly the suckers from its thick subterranean branches and by the se which are borne prolifically. Some old, well-grown trees h something of that pleasing contour seen in certain large, f topped trees of southern Italy and many tropical countries, giv the landscape a very picturesque appearance. But really pret than the mature trees are the young saplings, with their slen stems and spreading crowns of pinnately compound leaves, fi a yard in length. A clump of these growing among some nat trees gives an ordinary grove that luxuriant tropical appearan obtained by no other tree or shrub of our temperate climate. favorite habitat seems to be fence corners or small groves, in co pany with the locust and the hackberry tree (*Celtis occidentali* which bears the "sugar-berry," so eagerly eaten by the childr of localities in which it grows plentifully. But the *Ailantl* grows almost anywhere, its seedlings coming up along the du roadside as well as in the soil with potted plants. If a tree cut down the suckers appear over an area twenty feet in diamet

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

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

The pistillate trees produce beautiful panicles of one-seed twisted samaras or keys, light green in color, or sometimes sof tinged with pinkish red. The broad tops of the trees, beari many large clusters of these light green, winged fruits, showi brightly against the dark green of the surrounding foliage, ma a very pretty sight in mid-summer. These samaras are strung threads by the children of eastern Pennsylvania, making uniq wreaths, necklaces, or other juvenile adornments. The smoo trunks and branches of the older trees are of a soft gray or whit shade, resembling the trunks of the beech.

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

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

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

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

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

The best specimens are usually found growing in a damp c
soil, thus proving that its natural haunts are wet places. Ho
ever, it also proves its extreme hardiness by developing in w
drained porous soil. Disregarding this natural adaptability
most any situation, the plant inconsistently refuses to develop
our gardens, for more than a season or two. Many experime
have been made to get this native perennial to develop here a
there, but it will only consent to grow in places of its own cho
ing.—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 remark to the Leguminosæ in his Pflanzen-Teratologie, the compoun leaf of this family is subject to many anomalies. Trifoliat leaves are characteristic of whole groups, while in others onl those pinnately divided are to be observed. It is interesting t find that transitions between these types sometimes occur by th division of some of the leaflets and the elongation of the rhachis If the terminal leaflet of an imparipinnate leaf be the one dividec an apparently paripinnate leaf may result. Such have been fre quently observed for *Amorpha*, *Robinia* (locust), *Caraganc Sophora* and *Gleditschia* (honey-locust). The lateral leaflets ar also often divided, as in *Robinia*, *Astragalus*, *Coronilla*, *Gledit schia* and others. Transitions between pinnate and bipinnat leaves are occasionally observed. Simple leaves are sometime seen in species normally with compound leaves. Rarely the ter minal tendril of such forms as *Lathyrus* and *Pisum* is foun transformed into a typical leaflet or into an ascidium. Th development of tendrils in the place of lateral leaflets is also ob served in *Vicia* and *Lathyrus*. Foliar and even stipular ascidi are observed.

During the summer of 1904 I observed on plants of *Cassi Sophera*, cultivated at the Missouri Botanical Garden, a few per fectly formed imparipinnate leaves. As is well known, the lea of *Cassia* is regularly paripinnate. The rhachis, however, pro jects slightly beyond the insertion of the last pair of leaflets i a small subulate or filiform process which might appear to th observer to be homologous with a terminal leaflet.

The first supposition in regard to these terminal leaflets wa naturally that they represent cases of the development of a typi cal leaflet in the place of the terminal scale. In common morpho logical parlance such leaves as these might be spoken of as ata vistic, the terminal leaflet being considered a reversion to a

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

Furthermore, the examination of a large series of specin
showed that the origin of the extra leaflet from the term
process of the rhachis is open to question. Several leaves v
found in which the ultimate segment of the rhachis was m
reduced in length so that the two terminal pairs of leaflets v
inserted together as illustrated in figure 20*B*, while in one exa
one of the leaflets of the ultimate pair was considerably sma
than the other. The terminal process of the rhachis is ra
small in *C. Saphera* and some related species, but it could
made out easily at the end near the dorsal surface in the lea
with two terminal pairs of leaflets approximated, and it co
usually be detected in those in which there was apparentl
terminal leaflet. These facts indicate that the apparently
minal leaf does not originate by the development of a term
primordium, but that it is simply one of the ultimate pair,
one member of which develops, possibly owing to the fact
two pairs occasionally originate together at the end of the rha
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 s
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 gro
among many other forms as a border against the outer wall
the greenhouses. They had in many cases been overtopped
their higher companions so that the leaves had fallen from
shaded, lower portions of the stems which were quite wood
several of the specimens. Many of the leaves still on the pla
had lost some of their leaflets. All of these imperfect lea
were discarded and the remainder, 2,749 in number, coun
Of these, 2,669 were of the normal paripinnate type, while

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

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

Among those with three leaflets the terminal one was in a fe
cases much smaller than the others, but generally it was of abo
the same size. The terminal scale was not always to be seen b
could usually be made out. Occasionally there appeared a sc
or scale indicating the existence of a primordium for anoth
leaf. The origin of the terminal leaflet could in most cases
determined only from the evidence offered by the identity
form and insertion of the petioles in those with three and fo
terminal leaflets, and the presence of the terminal scale. In n
case was satisfactory evidence obtained for the derivation of th
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 1 fifty-two had three terminal leaflets, while only twenty-eight four. It would seem at first that if the form with four minal 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 mordia for both leaflets are formed, but space and nutrition sufficient for the full development of but one, and the ot early disappears.

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

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

In the effort to assist toward uniformity of usage in scient 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. Where 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 indentification 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 can not 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 SECOND. SCHOOLS OF PRUSSIA.

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

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

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

2. *Formally*, instruction in the natural sciences is the nece complement of the abstract subjects. In particular, bi teaches the art, elsewhere so neglected, of observation of crete objects subject to continual change in consequence o processes of life, and, like physics and chemistry, proceed ductively from observation of properties and processes, t logical formation of concepts.

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

3. *As to content*, instruction in natural history has the duty o acquainting the growing youth with the most essential forms o the organic world, to discuss the manifold phenomena of life to present the relations of organisms to inorganic nature, to eacl other and to man, and to give a survey of the most importan 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 genera hygiene, deserve special attention.

4. *Ethically*, biologic instruction awakens respect for the structures of the organic world, an appreciation of the beauty anc 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 necessary part of the general culture which the times demand it is not only useful to the future natural scientist or physiciar 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 ge session of the association at Breslau in 1904, took up the "Report and Debate on the Instruction in Mathematics an Natural Sciences in the Higher Schools." All the questio volved were referred to a commission.

Two of the governing principles which it set up are th lowing:

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

II. The commission recognizes mathematics and the n sciences as of equal culture value with the languages an heres to the principle of specific general culture in the h schools.

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

C. S.

REVIEWS.

Notes on the Life History of British Flowering Plants Lord Avebury (Sir John Lubbock) is a compendious tr bringing together a large number of observations and resu study by the author who has long been known as a stude the natural history of plants by his previously published w such as Flowers, Fruits and Leaves, Buds and Stipules, etc. field of such studies is one which, while it calls for much e 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 a flora of Great Britain is known, Lord Avebury's book sho

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

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

The only general criticism which we may make of Lord Av bury'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 the teleological interpretative method. For example, the auth speaks of the spines on the leaves of the holly as a protectio against the browsing of cattle, and remarks that "it is interestin that the upper ones which are out of reach tend to lose the spines" and quotes from Southey a stanza which embodies t *post hoc* view completely.

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

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

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

* Published by Purdue University, Lafayette, Ind.

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

Hints and Helps for Young Gardeners,* by H. D. Hemenw
is an attractive pamphlet designed "not only for youthful gar
ers, but also for those young in experience," by one whose ex
rience as the Director of the School of Horticulture of Hartf
well equips him for the task. How to plan the garden, soil till
how to test seeds, to plant, to dig and set trees, to make and
for a hotbed, strawberry and asparagus culture and window
dening are the topics treated of in the course of the work.
table of vegetables, showing dates of planting, data of the meth
of culture, and other pertinent matters, including "what its c
vation teaches," is a useful feature, particularly valuable to th
doing school garden work.

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

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

* Published by the author, Hartford, Conn. 59 pp., 8vo. Illustr
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 th commencement of work in the development of the New Yorl Botanical Garden. The meeting was held in the museum build ing of the Garden, and the program consisted of an illustratec lecture by the President of the Club, Dr. Henry H. Rusby, or "The History of Botany in New York City." Dr. Rusby tracec the development of botanical activity in the city of New Yorl from the time of Dr. Torrey, and previously, to the present. Th account of various earlier attempts to establish a botanical garder in the city was especially interesting, as was also the tracing o the growth of the Torrey Club, and the bearing of the Club's worl 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 ir the library, followed by an inspection of the laboratories and th museum exhibits.

Bills have recently been signed by Governor Higgins whicl will save two scenic treasures to the people of New York State— Hook Mountain on the Hudson River, and Watkins Glen, at th 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 blastec away, and had it been destroyed, one of the most beautiful points on the river would have been marred. Now that the future o 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 ar 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 o so easily accessible, nor presents such a variety of phenomen Watkins Glen. Nearer centers of population it would be more famous than now, and would be visited by scores of t sands. Waterfalls and gorges in Europe which cannot be pared in beauty or interest with a score of glens in the F Lake region are far better known to the travelling American Watkins Glen. It seems well, therefore, that it should be t by the state, made better known, and opened freely to the pu

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

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

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

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

John Torrey, 1796–1873.

The Plant World

A Magazine of Popular Botany

JULY, 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.

I. Early Efforts.

Were we to commence with the very earliest botanical histor of our city, we should be carried back to a time when, as a important seaport in a new world, it was made the temporar headquarters of visiting botanists, who accumulated here thei collections, maintaining some of them in a living condition, unti the arrival of a convenient opportunity for dispatching them t the mother countries. Such occurrences as these exerted littl influence in the permanent development of a botanical center Developmental work of the kind that concerns us was active, pre vious to the close of the eighteenth century, at some points farthe south, especially at Philadelphia, and in New England, but no at New York.

The first important event here was the work of Doctor, after ward Governor, Cadwallader Colden and his daughter Jane, who near the middle of the eighteenth century, conducted their studie with the aid of a small botanical garden at their home near New burgh. Perhaps the most important part of this work consiste

* Portion of an address delivered before the Torrey Botanical Club a a special meeting held on May 23, 1906, in commemoration of the tent anniversary of the commencement of work in the development of the Ne York Botanical Garden. Printed in full in Torreya, Vol. 6, Nos. 6–7, Jun 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 1 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 be found in the *Bulletin* of the Torrey Botanical Club, 11 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 Frangula*, 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 designed for such shipment. Nevertheless, so zealous an investigator as 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 arbes 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, and 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 pub-
lication of Pursh's *Flora Americae Septentrionalis* and Bigelow
Florula Bostoniensis, Darlington says " Botanical works now b
gan to multiply in the United States—and the students of 'th
amiable science' found helps in their delightful pursuit, whic
rendered it vastly more easy and satisfactory than it had been
their predecessors."

DAVID HOSACK AND THE ELGIN BOTANICAL GARDEN.

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

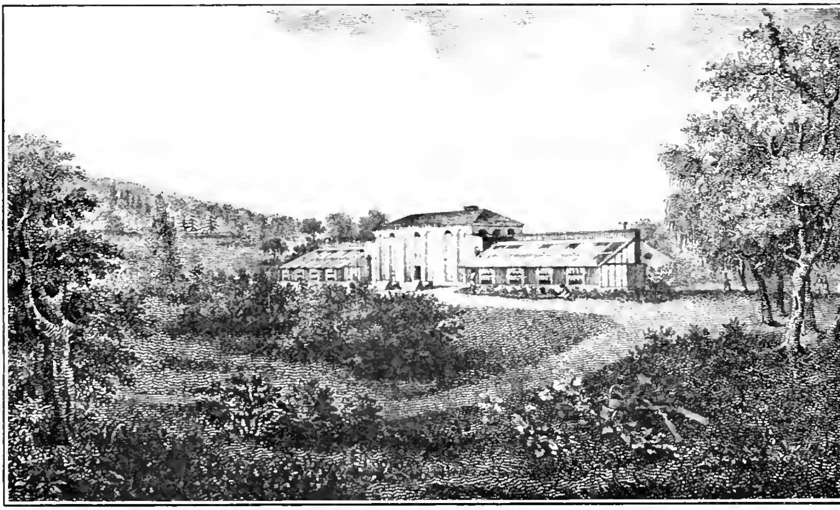


FIG. 21. The Elgin Botanical Garden, including what is now 40th a
50th Streets, and Fifth and Madison Avenues. (Courtesy of the Ne
York Botanical Garden.)

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

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

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

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

enlist state interest, and the legislature was induced to purcha
it in 1810, and to provide the necessary funds by means of
lottery. Hosack subsequently enjoyed the classical distincti
of all successful promoters of great enterprises, in being assai
by the high-class scum of citizenship. By subsequent legislat
action the property was turned over to Columbia College, and
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 withou
brief glance at some of his contemporaries and immediate su
cessors, especially those who exerted local influence. The l
includes the names of some of the most honored of Americ
botanists. Foremost of them all was John Torrey. Followi
Dr. Hosack, he was the third of the five men who, up to t
present, have occupied the chair of botany in Columbia Colle
His characteristics may be expressed in the terms strong perso
character, broad scholarship and great intellectual ability. A
though best known to us as a botanist, yet thirty years of l
life were those of a great teacher and worker in chemistry at t
U. S. Military Academy at West Point, in the College of Phy
sians and Surgeons of this city, in Princeton College, and as
S. Assayer in the New York Office. Had the necessary facilit
then existed in this country, it seems likely that this man, co
bining such a great knowledge of botany and chemistry, mig
here have developed important researches in the chemistry
plants. As a matter of fact, his knowledge of botany was acqui
chiefly as a recreation in the hours of leisure afforded by l
other professional work. Yet Underwood truly writes, "Wh
the annals of American botany are finally written, no name w
have a more conspicuous position than that of John Torrey."

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

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

Except for the published works of Torrey, most of those
this early period which here concern us were of a somewhat ge
eral nature, but naturally including our local interests. Of the
may be mentioned the following: In 1813, Muhlenberg's *Cata-
logue of North American Plants*, and in 1817 his work on No
American grasses and sedges; in 1818, Nuttall's most schola
work on the genera of North American plants; in 1820, Gra
Genera; in 1822, Schweinitz's *Monograph of the Genus Vio*
in 1833, Beck's *Botany of the Northern and Middle States;*
1834, Schweinitz's work on North American Fungi, and in t
same year, Gray's *Monograph of the North American Species*
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 especia
for young students, an elementary work on botany by Barto
Writing of 1824, Darlington says: "About this time some of t
schools in the Northern States began to make a profession
teaching botany, and a demand for suitable books for this pu
pose arose. Accordingly, a number, such as they were, so
appeared. Among the most successful was a *Manual*, compil
by Professor Amos Eaton, of Troy, New York." This sort
botanical teaching entered upon its most active stage with t
appearance of Gray's *Elements of Botany*, in 1836, a work th
is still being sold upon an extensive scale, and this, in yo
speaker's opinion, very greatly to the advantage of botany,
spite of the many books of different character, the use of whi
we so greatly enjoy. The publication, for the use of students,
text-books on structural botany, and later on morphology, in co

nection with manuals on local floras, became very popular, an
of incalculable value in interesting people in the study of plant

GROWTH OF THE BOTANICAL DEPARTMENT OF COLUMBIA COLLEG

We must now pass from this general consideration of loc botanical development to the middle of the last century, and fo low some special influences proceeding from the growth of th botanical department of Columbia College. During the perio when Dr. Torrey was at its head, that department was very a tively engaged in educational work, though this was of a pec liarly restricted sort, characteristic of the times. About the tim of his death in 1873, his herbarium and library, which he ha previously maintained in his home, came into the possession Columbia, together with the herbaria of Crooke, Chapman an Meissner. To these, collections from various parts of the worl and especially from those parts of the United States then bein explored, were rapidly added, and a very large and importa herbarium soon grew up; but no professor of botany was a pointed to succeed Dr. Torrey, and the herbarium was neglecte by the curator in charge. A very large part of it was not cla sified, nor even named, and lay in the form of a small mounta of dusty bundles which were not, and could not be consulte Botanical instruction was most meager, and was merely a pa of the general course in biology. There was not, in fact, a d partment of botany, the subject being treated as a subordinate geology, under Professor John S. Newberry. From 1875 1879, Dr. Britton was a student at the School of Mines, and w strongly attracted, by natural taste and ability, toward the bota ical side of his work. When upon his graduation he was a pointed assistant to Dr. Newberry, he appreciated clearly th great value for a botanical department, of the materials in th possession of the College, and he began a careful and systemat examination of them.

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

this undertaking, an intimate association with the members our Club and an active participation in its work were pri essentials to success, an illustration of the way in which exist forces worked together in carrying forward our natural bot ical development. Another potent influence of a similar nat should be here recorded. At this time considerable botan material from distant parts of this country, and from ot hitherto unexplored regions, was coming to this city for origi study, and this made it imperative that Columbia's botan house should be set in order in the interest of comparat work. With the knowledge and encouragement of Dr. N berry, but with comparatively little on the part of others c cerned in the management of the college, Dr. Britton carried this work in the interim of his official duties, until at lengt great working herbarium existed where before there was ch At the same time the botanical instruction was being exten and, of greater importance, was being modernized. When Doctor was at length prepared to make the situation know Columbia, it was not to submit plans for the organization c botanical department, but to present to it one already made, requiring only to be officially recognized and formally nan New York was now guaranteed as one of the first botanical c ters of the country, and later of the world, with Dr. Britto Columbia's fourth professor in botany.

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

The intercourse and personal and professional associati dependent upon the increasing number of persons in and al New York who became interested in botanical work in Torr 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 w undertaken in 1867, and its incorporation occurred four yea later, under the name New York Botanical Club, changed the f lowing year to that which it now bears. Within three years af its establishment the Club began issuing a monthly publicati the *Bulletin*, since uninterruptedly maintained. Its prefatory n declared its primary object to be "to form a medium of comm nication for all those interested in the Flora of this vicinity, a thus to bring together and fan into a flame the sparks of bot ical enthusiasm, at present too must isolated. . . . We ha chiefly in view the development of a greater botanical inter in our neighborhood, and found our hopes of success as mu upon learners as upon the learned."

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

From this time up to the establishment of the New Yo Botanical Garden the history of our Club is practically that botany in this city, for very little was done that was not direc or indirectly connected with us or, one might say, actually c tered about us. This fact is of the utmost importance in study, since upon it depends the essential character of most 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 c
prairie states than in any other section of the country. Mou
tains, swamps, forests and sphagnum bogs are often the l
strongholds of the wild flowers. Here they linger long, lit
patches of the wilderness beauty untarnished by the hand of ma
But for our prairie wild flowers there are few such places
refuge. Driven by the plow from the sod of their native mea
ows, and from hillside and hollow by grazing herds, they ling
for a time in fence corners and by the dusty roadside, struggli
for their lost footholds, choked and dwarfed beneath the do
nant hordes of introduced weeds.

A few of our native plants, such as the milkweeds and t
compass plant, tend to become weeds and invade the cultivat
fields, but all of our rarer and more beautiful species are quie
withdrawing from their native habitat. The sensitive rose, t
fringed rein-orchis and the lady's tresses are to be found o
where the native sod has been undisturbed. The little white a
purple wind-flowers, first of the prairie blossoms to greet t
spring, have gladdened the heart of many a settler's child. Th
were once so abundant in northern Kansas that whole hillsi
were colored with them, but I have seen scarcely a dozen bl
soms 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 m
still be found but when such places are turned into pasture lan
they almost invariably disappear within a few years.

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

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

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

How may our prairie wild flowers be preserved? Every gr movement is psychological in its origin. If we can only aro in the popular mind an appreciation of the wild flowers and desire to know them more intimately, I have not a doubt but t the method of preservation will be found without much difficu The very fact that they are passing away—if it becomes know will do much to awaken a sense of their value. It is the sa principle to which the director of the New York Zoological P referred when in speaking of the awakening popular interest animal life he said: "As the world's great wild beasts are dri further and further into the dark fields from which there is return, civilized man desires more and more to see them, to to them, and to know them ere they go." Many of our prairie tow are just awakening to a sense of the desirability of parks a other means of beautifying their streets and surroundings. stead of using introduced plants almost exclusively, as at pr ent, these might be planted with native flowers and shrubs, ma of which would be hardier and more decorative than the int duced species. As the people became more interested in wild flowers they would be more often seen in the private flo garden, for they are not so hard to cultivate as is usually s

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

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

SINGED CACTI AS FORAGE.—During the periods of prolong
drouth, to which the southwestern United States is liable, ran
cattle frequently browse upon various species of cacti comm
to the region. At the Arizona Experiment Station, Mr. J.
Thornber has carried on experiments regarding the utility of t
class of forage plants, particularly after the spines have been
moved by burning by means of a prickly-pear burner—that is
gasoline torch similar in principle to that which plumbers u
The spines of about 300 plants of the species of cacti commo
found in the neighborhood of the station, including prickly pea
chollas, etc., were singed, the spines being burned off at interv
for about ten days. The first fifty plants that were singed w
literally devoured by the stock, the prickly pears being eaten nea
to the level of the ground, while only the trunks and woo
branches of the chollas remained. As the work was contin
from day to day, it was evident that the stock (although un
usual circumstances they will eat more or less of the cactus w
the spines) were feeding entirely upon the singed plants, a
that they readily distinguished them from the unsinged ones. T
singeing and close browsing of the cactaceous plants, if continu
would surely result in their final destruction, which would a
more distress to what already exists, so that in general not m
than one-half of the plant should be singed, leaving the remaini
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 dese is most fascinating, and not a small part in the change of colora tion from month to month is taken by the flowers, which develo in great numbers and with remarkable rapidity after the sea sonal rains, which occur in early spring and in the late summe The fact that there are two rainy seasons in our southwester deserts results in what we may very well describe as two spring instead of spring and autumn. It is noteworthy, however, th the plants which develop into flower and fruitage after the sur mer rains are not in general the same as those which develo during the spring.

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

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

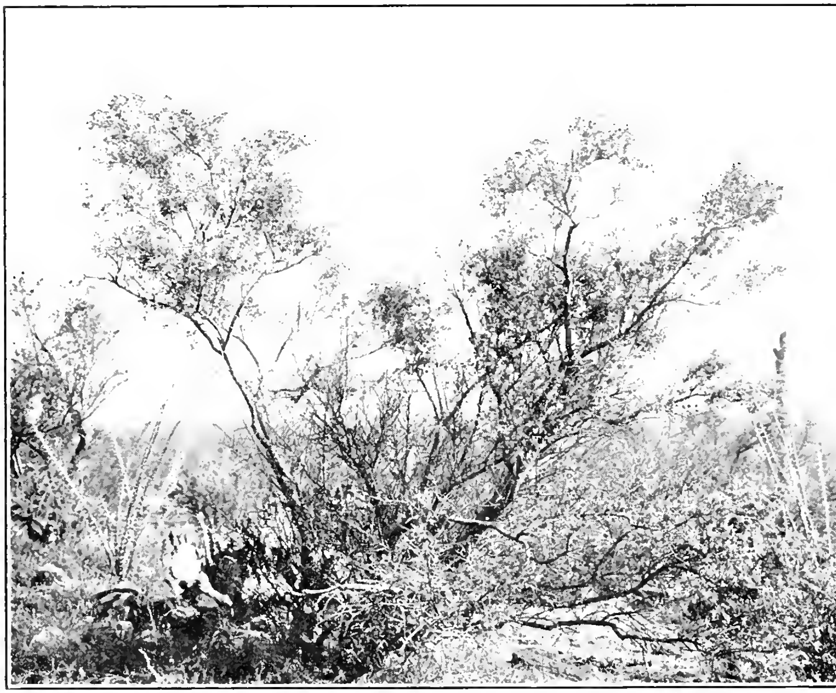


FIG. 23. *Parkinsonia microphylla* in Blossom.

I shall describe first the small leaved palo verde (*Parkinso*
microphylla) (Fig. 23), which is found growing upon the ro
foothills of southern Arizona, California and Sonora, Mex
This plant is as distinctly characteristic of this habitat as are
Giant cactus or Suguaro, the Ocotillo (*Fouquieria splende*
and a considerable number of other plants, which in this c
nection need not be mentioned. It is a small, somewhat irregu
tree, ten or twelve feet high, with more or less twisted and c
torted limbs clothed with a green bark, this feature being comn

* Bulletin No. 17, U. S. Dept. of Agriculture, Division of Forestry, 1

to all the species, and by which the name "palo verde" is ver
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 con
spicuous than usual, has the aspect of a small apple tree, th
whole formation looking rather orchard-like. During the ear

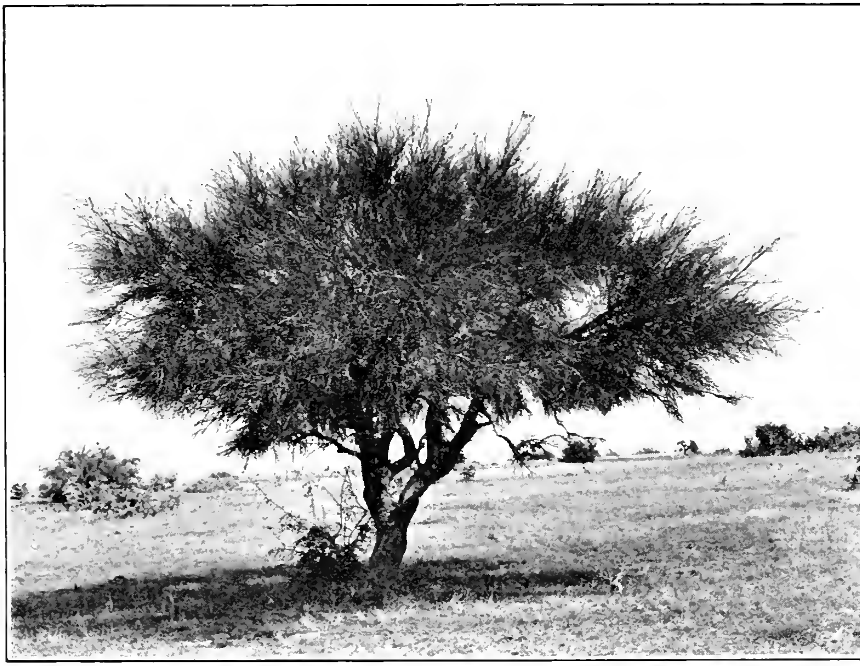


FIG. 24. *Parkinsonia Torreyana*, Sierrita Mountains, Arizona. (After photograph by Prof. V. M. Spalding.)

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

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

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

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

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

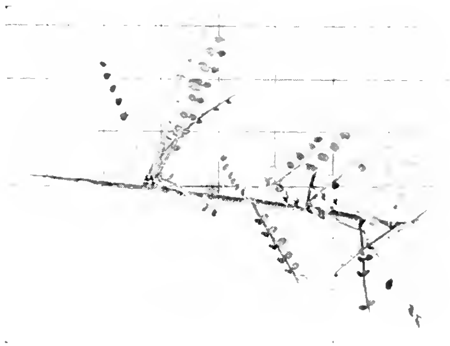


FIG. 25. Twig of Palo Verde. (Courtesy of the Popular Science Monthl

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

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

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

Another matter that is especially worthy of note in this con
tion is the fact that plants of this genus are among the few Le
minosae the seeds of which are provided at maturity with
endosperm, and are therefore described in most systematic wo
as albuminous. This endosperm is reduced, in the ripened se
to two horny, translucent layers lying parallel to the cotyledo

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

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

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

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

herbarium species, prepared either from plants in their na
haunts or from those in collections, are in many instances un
isfactory for study, because they can, at the best, be but f
mentary. Herbarium specimens supplemented by flowers
fruit preserved in formalin, by photographs of the flowering p
and by colored drawings of the flowers, are satisfactory take
connection with the living plant, and if such series of materia
each species can be brought together, it will ultimately lead
far better understanding of this very interesting family.

The preparation of manuscripts for the "North Amer
Flora," now in course of publication by the New York Bota
Garden, through the aid of the David Lydig Fund, beques
by Judge Charles P. Daly, has made it very desirable that a r
accurate knowledge of the cactuses of North America shoul
obtained within the next few years, and the bringing togethe
the material along the lines outlined has been undertaken in c
eration with Dr. J. N. Rose, of the U. S. National Muse
Greenhouses at Washington and at New York have been set a
for the housing of the plants, and exploration of the cactus-y
ing regions of North America, including the West Indies and
continent south to the Isthmus of Panama, is going forward
will be continued as rapidly as means for it become availab
Professor N. L. Britton, in the Journal of the Horticultural
ciety, N. Y., April, 1906.

REVIEWS.

The Principles of Heredity. By G. Archibald Reid. Se
edition. 8vo. Pp. xiii + 379. London: Chapman & Hall

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

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

The sentence, "We may dismiss at once, as obviously in co flict with notorious and indisputable facts, the hypothesis th mutations are stable, and therefore are the materials of evolutic because their transmission is Mendelian" (p. 363), is not entire clear, but there is no doubt of the author's meaning in the follo ing paragraph.

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

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

Lichenology for Beginners. By FREDERICK LEROY SARGEN Pamphlet, illustrated. Pp. 20. The Harvard Coöperative S ciety, Cambridge, Mass. Fifty cents.

This helpful little pamphlet is a reprint from the *Bryologi* Vol. 8, 1905. The first fifteen pages tell the beginner the natu of the lichen, when, how, and where to collect, and how to pr serve and study the specimens, and prepare them for the he barium. A schedule for analysis is given, and also a brief bi liography. The last five pages are occupied with an artificial k to species. This booklet brings the elements of lichenology with easy reach of the beginning student.

C. S. G.

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

The public has awaited with interest the appearance of th long-heralded book, the first supposedly authentic account of t lifework of Luther Burbank. That it has proven a distinct di appointment seems to be due primarily to Mr. Burbank's unfo

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

Mr. Harwood's literary style is that of the average writer
"popular" science for the magazines and newspapers, with so
thing more than a seasoning of yellow journalism. He use
profusion of trite and florid metaphors in the description of
most commonplace natural phenomena; shows a sublime di
gard of the proper meaning, usage, and even spelling of
known biological terms; indulges in fulsome and tedious pa
gyrics upon Mr. Burbank's personality, his achievements, and
infallibility in matters horticultural; and directs shafts of c
cism against men of science who are inclined to ask for the
and wherefore and to demand proofs of categorical statement

As the book deals wholly with Mr. Burbank's work, the revi
of which it has been the subject have naturally centered upon
nature and extent of his achievements, and have thus inevita
taken on more or less of a personal cast. We are glad to obse
that there is for the most part hearty agreement as to the va
of his achievements in improving horticultural standards and
producing some new varieties of undoubted merit. The fact
he has sought neither pecuniary profit nor personal aggrand
ment from his discoveries is also greatly to his credit, and sh
him to be in the truest sense a laborer for the welfare of human
But in justice to the workers who have preceded and are cont
poraneous with Mr. Burbank, we should not permit ourselve
overestimate these services or to be influenced in our judgm
by the fulsome adulation of such writers as Mr. Harw
Blinded by the glamour of Mr. Burbank's truly remark
achievements, the public is apt to overlook the labors of such
as Vilmorin, Crozy, Eckford, Bailey, Webber, and a hos
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 force
to the conclusion that Mr. Harwood is indulging in pure romanc
to call it by the most favorable term, and it is unfortunate that
reputable publishing house should have allowed its imprint to
placed upon a book which disseminates so much misinformati
as we find there. It is, moreover, damaging to Mr. Burbanl
reputation that he does not promptly disavow it. The har
which is done to the cause of science by irresponsible newspap
writers is immense; for the public has neither the time nor inc
nation to seek the proper authority, and knowing how ma
remarkable discoveries have actually been made in recent yea
it accepts these yarns, not for their face value, but as so mu
scientific truth. As the statements are repeated by one pers
to another they descend still further into the realms of fiction,
that we can scarcely be surprised at the amount of existing m
information on recent scientific achievements.

Mr. Harwood's reference to the annual grant of $10,000 giv
to Mr. Burbank by the Carnegie Institution naturally leads to
discussion of Mr. Burbank's methods of work, which are, of cour
extolled in glowing terms by his biographer. The grant w
given with the specific purpose, not of enabling Burbank to secu
new results, but to discover and place on record, if possible, ho
these results might be attained. In the light of the Mendeli
investigations and of de Vries' extensive experiments with m
tating plants it was thought that Burbank's exceptional faciliti
for work would yield results of immense importance. It is ther
fore a distinct disappointment to learn from this book that
keeps no exact records of what he performs, but that in his hybri
izing experiments he neglects the first and paramount essent
for success,—the taking of precautions to insure genuine cr
fertilization and to avoid contamination from foreign sourc
The pollen of the same species is almost invariably prepotent ov
that of another species, no matter how closely related. Yet a
cording to his biographer, Burbank takes no pains to insure t
purity of a cross. "Mr. Burbank . . . says that it is who
unnecessary in ordinary plant-breeding to attempt to cover t
flower with a screen of tissue paper or gauze." He adds, wi

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

C. L. I

In the June number of this magazine, through an oversigh
the reviewer, the author of the *Elementary Botany*, publis
by the University Publishing Company, Lincoln, Neb., was
mentioned, for which we owe him an apology. The autho
Professor Charles E. Bessey, of the University of Nebraska.

Volume 9 Numbe

The Plant World

A Magazine of Popular Botany

AUGUST, 1906

THE GYNÆCOCENTRIC THEORY AND THE SEXES PLANTS.

By Professor Bruce Fink,

Iowa College.

Almost as soon as issued from the press in 1903, a copy Lester F. Ward's "Pure Sociology" fell into the hands of writer and was eagerly read. Among many things of spec interest, the gynæcocentric theory attracted his attention as ing a departure from generally accepted views regarding development and the social relations of the sexes. It was intention at the time of reading to formulate a protest agai certain views expressed, but other things were absorbing atte tion, and the matter was dropped for the time. On seeing article by Mr. Ward in "The Independent" for March 8, 19 bearing on the same problem, and the replies two weeks later G. Stanley Hall, E. B. Wilson and Clark Wissler, the wh matter was again brought to mind.

That the writer of "Pure Sociology" has made a strong arg ment for his gynæcocentric theory is apparent, and no one doubt, after reading his chapter, that the female sex has, p haps, played the more important role in the evolution of th complicated sociological conditions found among civilized p ples; but in discussing his theory, beginning with protoplas Mr. Ward has made some very obvious errors in the presentati of biological principles, and has failed to elaborate certain fa which, to the mind of a botanist, are well worth stating for benefit of the student of sociology. From the genetic poin view, sexes in plants bear some relation to the prehuman pl of sociology, which in turn has led up to the human society to-day. So it is well worth our while to consider this ma of the sexes from the botanical point of view.

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

Regarding sexes in plants, as given in the " Pure Sociolog we find on page 314 the following: " The simplest type of se ality consists in the normal continuance of the original fem form with the addition of an insignificant and inconspicuous m fertilizer, incapable of any other function." This statemen and others immediately following, would lead one to infer th Mr. Ward regards the sperm cell as the male organism; but this be done, it must be regarded as an organism within a organism, and if so regarded in lower organisms, must be lik wise considered in higher organisms as well. But on readin farther, one finds that the author intends to convey the idea th the degenerate males of many articulates and other lower anima are primitive,—a conclusion that will surely not be accepted l zoologists. Viewed in this way, the theory fails also when ap plied to plants. Here, as in animals, sexuality originates in th conjugation of morphologically like individuals as in *Protococcu* Following this we find the conjugation of motile isogametes o like individuals as in *Pleurococcus*, some species of *Ectocarp* and many other algæ. In other species of *Ectocarpus*, we fin a physiological differentiation of the two conjugating cells, on becoming motionless before conjugation occurs, and being slight larger than the other conjugating cell in some of the specie Here we have a differentiation of the sexual cells in bisexu plants, and this differentiation of the sexual cells can be trace through such forms as *Dictyota* and *Fucus*. With the adve of sperms and eggs in plants came a gradual change from th bisexual to the unisexual condition. Within certain genera o algæ, as *Œdogonium*, we find both bisexual and unisexual sp cies, this condition indicating that the origin of the male is som thing very different from a budding off from the female. It true that we have in some species of *Œdogonium* certain dwa males, which become attached to the female, but these are prob ably to be regarded as degenerate organisms, and surely not a primitive, or as indicating anything regarding the origin of sex in plants.

But it is in his discussion of sex among higher plants that M Ward misses the recent view entirely, and writes of male an female flowers and even of whole sporophytes (roots, stems an leaves) as bisexual, or male and female, not recognizing alter nation and the sporophytic generation (the plant as we ord narily understand it), though he does among Thallophytes, Bry phytes and Pteridophytes. But after admitting "the true sex stage" (gametophytic) in lower plants, and that this is follow by the spore-bearing or sporophytic stage, he concludes t "this peculiarity has no bearing on the theory under discussio We must take issue with this view and insist that in the discuss of sexuality among plants we should hold primarily to the ga tophytic or sexual generation and not follow the obsolete erroneous view which holds that the sporophyte of higher pla is a sexual structure as Ward does in his discussion of fertil tion (?) by insects and in his discussions of staminate and tillate plants of *Cannabis sativa* (hemp), *Ambrosia trifida* (weed) and *Antennaria plantaginifolia* (Indian tobacco). We not doubt that there is a physiological sense in which stamens pistils may be regarded as sexual structures, as W. F. Gan has done (*Science*, April 24, 1903), nor do we doubt that pistil-bearing sporophytes are much stronger than the stam bearing ones in many plants, but it is the distortion of the fa of plant morphology and physiology that is objected to, adm ting that the real female sexual plant is parasitic on the pis bearing sporophyte and that the real male sexual plant is l wise first integrated with the stamen-bearing sporophyte afterward a parasite on the stigma of the pistil-bearing spo phyte.

Whether or not it is true of man, as Havelock Ellis says in "Man and Woman," that the female, being "the mother of new generation," is of more importance "from Nature's poin view" than the male, this may be truly said of the plant wo where cephalization has not wrought wonders and where rep duction and maintenance of the individual and the race seen be prime functions. Suppose we begin with *Spirogyra*, a ge in which there is no well-marked differentiation of sexes where there is no alternation of generations, unless we incl in our idea of alternation rejuvenescence without segmentat In *Spirogyra* we find the conjugation of non-motile isogame and the cell or filament from which the more active gamete pa to the less active through the conjugating tube may be regar as male. Here we are near the basis of sexual differentiatio plants, and some observers claim to have found that the recepti cells are of slightly larger size, or in other words, that the incipie female is better developed than the male. Whether such diffe ences in size of male and female plants have been observed higher unisexual, filamentous algæ, where heterogamy prevai as in *Œdogonium*, the writer is not prepared to state, but dou not that here the female plant is likewise the better developed.

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

In the Pteridophytes unisexual gametophytes are more co mon than among the Bryophytes, and wherever the sexes are d tinct, the female is better developed than the male, wheth among the homosporous members or among the heterosporou In our common ferns, the homosporous leptosporangiates, t sex may be governed to some extent in the laboratory, as t writer has done in *Asplenium*, by sowing some spores on cl and others from the same plant on black soil; those on the cl gave rise to small males and those on the black soil to simil males (where crowded) and, where not so much crowded,

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

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

sexual) tissues for food. So it comes about that, in plants, tl
care for offspring is, finally, largely transferred from the fema
gametophyte to the diœcious or to the monœcious asexual (spor
phytic) plant. And with this transfer of labor, the difference
degree of development in the two sexes in our highest plan
seems to be disappearing. Thus, with the progress of plant ev
lution, sexes have been first differentiated; then the female se
has become better developed; and finally the tendency amo
highest plants is toward equality of the sexes, as Mr. Ward thin
is also the case in higher animals. But in plants equality is a
proached through reduction, the female remaining plainly tl
dominant sex, at least until the sexes are reduced, as in Angi
sperms, to little more than reproductive cells.

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

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

AN HISTORICAL SKETCH OF THE DEVELOPME 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 Tor Botanical Club to observe how plants lived, that many of th able to own gardens ignored vegetables and flowers, and ma tained little botanical gardens at their homes. As succeed decades of extending settlement destroyed the localities wl had been so greatly prized, the demand for a botanical gar arose independently in the mind of every botanist, professi and amateur. So early as 1874 the club appointed a commi to act with the New York Pharmaceutical Association in questing 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 rection, and continued until at length it was satisfied. The g value to Harvard and its work of the well-managed plot tha utilized in this way was appreciated and often discussed at little meetings which gathered around the old pot stove in I fessor Newberry's room during his presidency of the Club.

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

* Portion of an address delivered before the Torrey Botanical Clu a special meeting held on May 23, 1906, in commemoration of the tenth a versary of the commencement of work in the development of the 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 prolon
period, directed our attention to these articles and proposed t
he write an official letter to the *Herald* endorsing them. Suc
letter was authorized, and it appeared on December 2 followi
A committee was appointed consisting of Dr. Hollick, Mr. E.
Sterns, and Professor Newberry, to deliberate and report to
club whether it were advisable for us to take any action

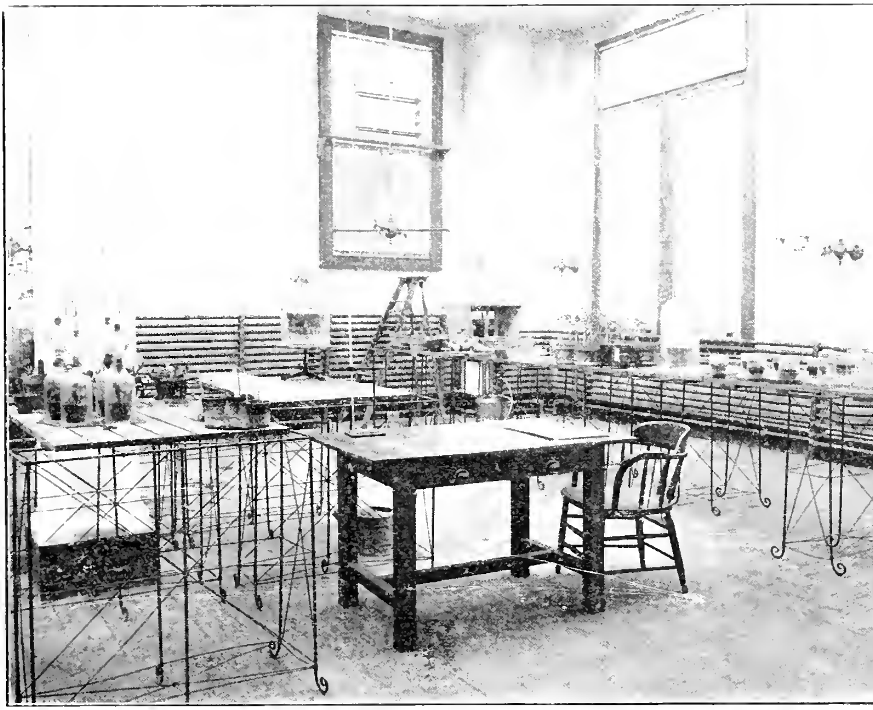


Fig. 27. Physiological Laboratory, New York Botanical Garden.
(Courtesy of the Garden.)

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

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

One element in the success of the garden that has already sho itself to possess a value beyond price, and which is certain to so with increasing clearness in the future, is the protective in ence of its charter. Born of the learning, long and wide expe ence and ripe judgment of Judges Brown and Daly, and occu ing their attention for considerably more than a year before th were willing to regard it as satisfactory, it seems to provide every important contingency that it was possible to foresee, and promises a safety, permanence and stability that are too of wanting in similar organizations. To enter upon a discuss of the personal credit due in the membership, the boards of m agers and of scientific directors, and in the garden staff, wo be an agreeable pleasure, but I must confine myself to the v earnestly made remark that the great success of the garden been due to the love of the institution and its work which animated all concerned in it. It is this which has lent faithfuln earnestness and energy and has incited to many acts of great s rifice. If it could ever be said of any similar institution, we 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 dev opment, and it has been so often and so recently recorded tha 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 mal 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 lustrated 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 herbariu 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 *B 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 made also for the publication of colored plates of Amer plants.

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

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

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

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

EDITOR'S NOTE.—It will be of interest here to speak of t relation of the New York Botanical Garden to public educatio Public museums are generally regarded as part of the education forces of a city, and teachers of natural science frequently av themselves of the opportunities offered by visiting the collectio with their classes. It is not uncommon to have a special exhi for children. Courses of spring and fall lectures on botan subjects for adults, open to the public without charge, have b a feature of the work of the New York Botanical Garden fr the beginning.

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

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

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

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

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

There has been in bloom at the New York Botanical Gar a remarkable plant known as Queen Victoria's Agave, the st of which is out of all proportion to the body of the plant. T latter is fifteen inches high. Above this, the stem extends ten feet, making a total of eleven feet three inches, the up 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 especially fascinating to mankind. In our earliest childho their mysterious depths have concealed the goblins and fairies, and the love for the first wild flowers of spring have us on and on until mystery after mystery was explored, but fascination not lessened.

The early settlers of America clung tenaciously to the fore Where the soil would produce trees it would produce the desi crops, and so the forests were sacrificed and the prairies left touched for many years until chance demonstrated their i portance. Now we lament the wanton destruction of the fore carried on by our forefathers in their fierce struggle with natu Now we are beginning to appreciate their importance, not o for their commercial value but also for their general influen upon the surrounding country, and for their great beauty. T forests give special character to the country. The pine f ests of the north and south, the redwood forests of the Pac coast, the oak, maple, beech and hickory of the central stat and the live oak forests of the gulf and Pacific states ea give specific characters to their respective localities. W has not admired the little spring beauties, dutchman's breech and other delicate plants that are sheltered in the northern f ests, the trailing arbutus of the New England states, the p fusion of liliaceous plants of the Pacific coast or the moss of southern states?

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

In Cuba, the oldest and the newest of the new world, we m with these very interesting forests. A careful study of th has never been made, and they will present problems to scientists for many generations to come. To the casual server, the most striking features of these forests are the phytes which festoon the trees everywhere. The predominat plants among these epiphytes belong to the families Bomeliac

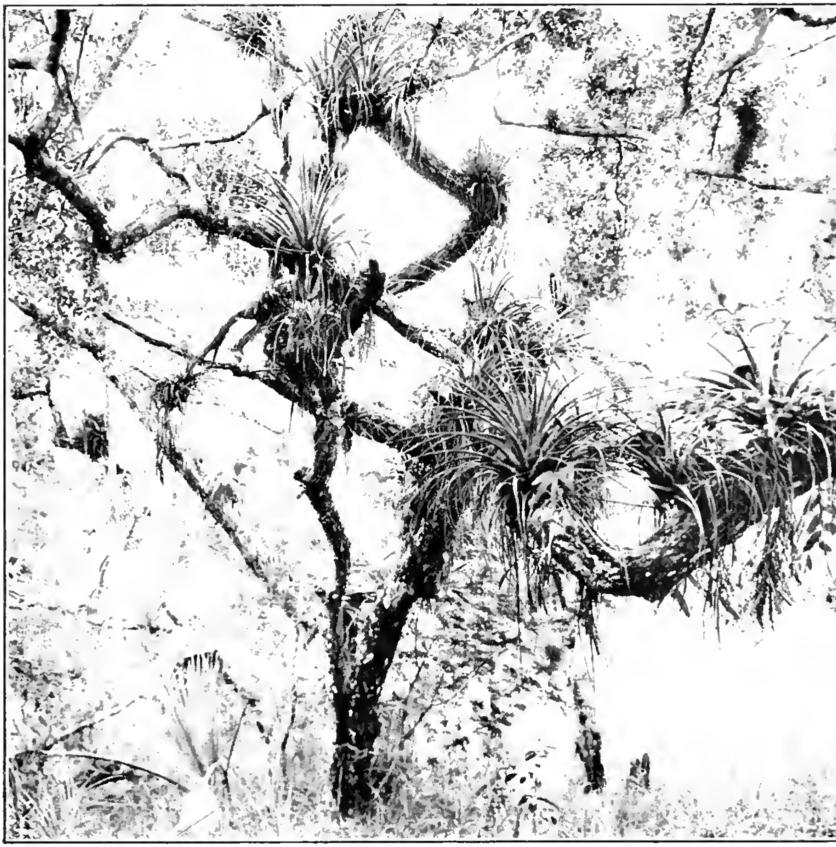


Fig. 28. "Wild Pines" and other Epiphytes.

and Orchidaceae. To the family Bromeliaceae belong the called Florida moss, *Tillandsia usneoides*, and also that lusci fruit of the tropics, the pineapple. Many of these tropical phytes resemble miniature pineapple plants perched upon branches of the trees. The Orchidaceæ is one of the most in esting families of plants, since it includes some of the most in esting and beautiful of our flowering plants. It is not restric to the tropics, but reaches its greatest perfection there. *Bl* *nerecunda* is said to have been sent from the West Indies to E land as early as 1731 and since then, from time to time, vari species of orchids have been sent by officers and missionaries northern countries where they have been grown in glass hous Their value as ornamental plants was early recognized and n were tempted by the high prices to take great risks of health a life in exploration in search of them. One of the most interest lines of study has been the special devices of these plants for sect pollination. Aside from their ornamental value the only of commercial importance is the *Vanilla planifolia* or the van plant of Mexico which is now cultivated more or less in tropi America.

MICROSCOPIC AQUATIC PLANTS AND THEIR PLACE IN NATURE.*

Every piece of water, besides containing large plants and a mals which are readily visible to the naked eye, harbours a m or less considerable number of minute forms, which pervade the layers of the water in varying amount, and collectively c stitute the plankton or pelagic life. The most important diff ence between the plankton and the remaining flora and fauna our waters lies in the fact that all the organisms which comp it are free-floating during the greater part of their life. Pr tically all the pelagic plants belong to the group of the alg and their minute size, of course, suits them well to a float existence. A certain number of them are motile (*e. g.*, *Volv* *Gonium*, *Pandorina*, etc.), and these are able actively to ma tain themselves in their position in the water; but the large m jority are non-motile, and all these forms are slightly heav than water, and consequently tend to sink; they develop dive mechanisms, by means of which their power of flotation is creased. The most important of these are: assumption of a plate-like shape (*Pediastrum*, *Merismopedia*, many desmids development of numerous delicate processes from the body of

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

plant (*Stephanodiscus*, *Richteriella*); arrangement of the in-
viduals of a colony in a more or less stellate manner (*Asterionc*
some *Tabellarias*); assumption of a delicate acicular sha
(*Syncdra*); formation of fat in the cell (many Diatoms and C
nophyceae), and so on.

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

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

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

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

THE JARDIN DES PLANTES BEFORE AND DURIN THE REVOLUTION.*

In the *Edinburgh Review* for April, 1906, an anonymous writ 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 wi inconsiderable trees, it rises imperceptibly from the left bank of the Sei 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 Cant bury), planted with a labyrinth of cedars and evergreen trees, some of th old and fine. Everyone knows the Jardin des Plantes and has felt superannuated charm, composed of mouldy retirement and popular light. That part of it which butts on the Latin Quarter, with its cedar mount and bronze temple, and a certain homely grace in its eighteen century buildings (of which not a few remain), is pleasant with its pl of wild flowers and clumps of peonies among the grass. From this e right in front of the handsome modern buildings which house the natu history collections, an avenue of lime-trees sweeps across the flat to river, dividing on either hand the world of beasts and the world of plant

The Jardin des Plantes was founded by Richelieu. It was th a garden for the study of medicinal herbs—for botany was th regarded merely as a branch of medicine—under the direction the king's physician, Guy de la Brosse. He was succeeded by line of court doctors with no peculiar turn for science, and t garden "dwindled to a desert of dust and disorder." The gener tion of Louis XIV paid scant attention to the herb garden. Th sought Nature rather in the relation between star and star, f lowing the lead of Descartes and Rousseau in France and Hobl in England.

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

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

From 1739 until his death in 1788, Georges Leclerc de Buff reigned supreme as "Intendant du Jardin et du Cabinet du Ro During those fifty years the garden remained, as it had been

garden of plants. When Buffon entered upon his duties the
he found only an old sixteenth century country-house with t
wings; a few greenhouses and sheds; the grounds of no gr
extent, and hedged in and limited by a monastery. The Ro
Cabinet of Natural History consisted of two rooms, one for t
herbarium and one for the storage of medicinal plants. Buff
at once suppressed the private apartments of the court physici
who had a sort of country-house in the garden, and afterwa
he evicted himself as well. He arranged in order the collecti
of natural objects, which year by year increased in intere
rarity and beauty; he entered into communication with naturali
and travelers all over the earth, and created an order of cor
spondents of the garden. There were thus introduced into t
garden the first hydrangea from China; the dahlia, the swe
acorned oak, the first plane-trees in France, and a quantity
shrubs and flowers.

Later, the greenhouses were remodeled, and the garden w
expanded through Buffon's negotiations with the Abbot of t
neighboring monastery. And all the time that Buffon was
tending to every detail of administration in the garden he w
writing his great work, the "Histoire Naturelle."

Buffon's successor at the Garden of Plants was the Marq
de la Billarderie, a courtier who took an interest in nature a
science—after the fasion of the age. The new intendant a
parently regarded his post as a sinecure, resided at the Tuileri
and scarcely occupied himself with the administration of t
garden, which was left in the care of André Thouin, the he
gardener, while the scientific management of the cabinets a
lectures was in the hands of Doctor Daubenton, who had be
the friend and co-worker of Buffon. While the Marquis de
Billarderie was doing nothing, the doctor was laying plans for t
reorganization of the garden and cabinets as a museum
natural history, and André Thouin was laying out the grounds
beautiful mazes and gardens, making of the place the popu
resort it has ever since continued to be. "On the fine summ
nights of 1790 the Parisians used to stream across the bridg
quitting Paris on the brink of revolution for this green paradis

Meanwhile the Marquis, being an incapable administrator, w getting deeper and deeper into debt. By way of economy suggested that the chair of mineralogy, occupied by Faujas de Fond, might be suppressed; the Chevalier de Lamarck also, thought, "peut-être utile, mais pas absolument nécessaire." T garden was proud of Faujas, the great geologist, and of L marck, "who had enriched the cabinet, though he was poor, gifts of specimens, engravings, rare plants, seeds, and miner from Holland and Germany." The officials of the garden rose revolt and recommended to the king that the useless and expensi intendant be the one dispensed with. In the summer of 17 the Marquis sent in his resignation.

The next incumbent of this office was Bernardin de St. Pier who proved to be a diligent, economical and exact administrat It was he who suggested a menagerie for the Jardin des Plant and he thus became the founder of the French Zoölogical Ga dens. About this time the garden officials were elaborating scheme for the conversion of the royal garden and cabinets in a natural history museum, and in 1793 the scheme was adopte a plan in which the post of intendant found no place, and Be nardin de St. Pierre was retired on a small indemnity.

The new system provided for twelve professors, directed by principal annually reëlected; all the lectures free and open to t public. The chair of mineralogy was occupied by Daubento botany, A. de Jussieu; horticulture, Thouin; natural histor Geoffroy St. Hailaire; geology, Faujas de St. Fond. Chairs we also established in anatomy, comparative physiology and zoölog The chair of botany being occupied, a chair of insect zoölog was created for Lamarck, who was also commissioned to found library of natural history.

"Meanwhile the museum inaugurated a new career of laborious a fruitful activity. But the people of Paris continued (and continue sti to call it the Jardin des Plantes, and to love it chiefly for the beasts a birds which Bernardin added to its charms, and for the Swiss valley, whi André Thouin laid out on the land acquired by Buffon with so mu difficulty."

M. M. B.

NOTES ON CURRENT BOTANICAL LITERATURE

Shigeo Yamanouchi contributes to the *Botanical Gazette* June a paper on "The Life History of *Polysiphonia Violac* in which he shows that there is an alteration of generatio 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 p lar article of botanical interest entitled "Plant Kinships." author writes of the relationship between the skunk cabbage the jack-in-the-pulpit of the bogs and woods, and the *Anthur* and calla lily of the florist's window. He describes the tro pitcher plant *Nepenthes*, of the same family as the Amer pitcher plant *Sarracenia purpurea;* and compares the gorg *Medinilla magnifica* of the Philippines with its diminutive rela deer-grass, *Rhexia virginica*.

In the August *Garden Magazine* Wilhelm Miller has writte "The Cultivation of Hardy Orchids." He says: "No one r knows how to grow hardy orchids. There are sixty species i northeastern United States and not one of them will ever bec a common garden plant. Most of them are too small, and al quire special conditions. Hundreds of people can make them for a year or two. A few people have colonies of a dozen p that have flowered regularly for five or six years. No one s to have naturalized them on a large scale. Unless we can su those special conditions it is worse than folly to transplant or from the woods. It is vandalism." Among the nine best h orchids are mentioned the showy lady's slipper, *Cypripe spectabile;* large lady's slipper, *C. pubescens;* rattlesnake plan *Goodyera pubescens;* and the small lady's slipper, *C. parvifol*

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THE HOPE BOTANICAL GARDENS.

By Forrest Shreve, PhD.

The Woman's College of Baltimore.

No country twenty times its size can boast as many botanic gardens as does the island of Jamaica. Of the six which are be found within its narrow borders, one—that at Bath—is nc neglected although not uninteresting, and two,—the Parade Ga den and the King's House grounds,—are primarily show garde and parks. The other three combine the uses of ornament, scie tific interest and practical helpfulness. Hope Gardens are sit ated near Kingston in the dry Liguanea Plain; Castleton Garde are at a low elevation in the moist hills of the north side; and t Hill Garden at Cinchona is at a temperate altitude in the Bl Mountains. The happy choice of these locations renders possil the growing of plants from almost every region of the tropics warm temperate zones, and the visiting botanist is treated to t sight of the palms and screw-pines of the East Indies, the eucaly and grevilleas of Australia, the water-lilies of the Amazon, t rhododendrons of the Himalayas and the cacti of America.

As early as 1775 the Jamaican government began to lend a to a private garden at Gordontown, near Hope, and ever sin that date there has been a more or less intimate association of t ideals of botanical science and agricultural practice in the dev opment of the public gardens of the island, which has been in 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, o 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 br to Kingston and turned over for the new garden, where they set out with the original tags, on which were not names but bers. Among the lot were many trees of economic impor which had never before been grown in Jamaica, notabl mango, the jack-fruit and the cinnamon. "Tree No. 11" p to be a very delicious variety of mango which is known t day in Jamaica as the Number Eleven.

In 1863 the desire of Governor Sir John Peter Grant t what might be made out of the cultivation of Peruvian bark cinchona or quinine tree of the Andes), at higher elevatio the Blue Mountains, led to the establishment of the Hill dens, which for many years continued to be the headquarte

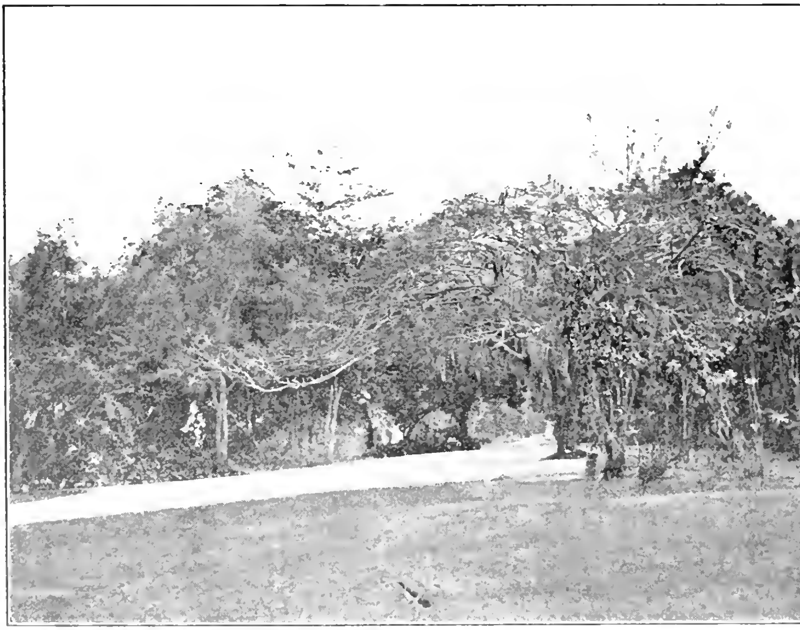

FIG. 29. At the centre of the Garden. The spreading tree is the Poinciana.

the Department of Public Gardens and Plantations. East India competition eventually made the growing of Peruvian bark u profitable, and shifting economic conditions rendered it mo important that the department give its attention to the develo ment of lowland growths. The old Hope sugar plantation ha 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 liberally used.

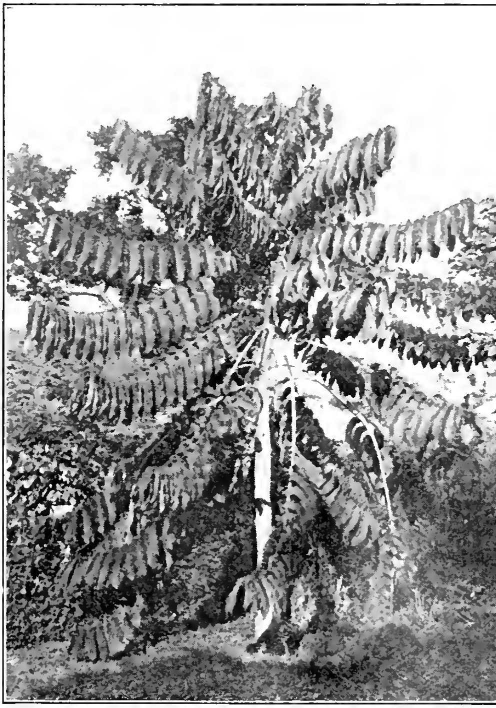

FIG. 30. A Castilloa Rubber Tree in t experimental grounds.

Although the garden at Castleton is more tropical in aspe than Hope, none of the island gardens are more beautiful. forty-minute trolley ride from Kingston brings us to the ma entrance of the Hope gardens, where we traverse a long aven of *Cassia Siamea* to reach the proper entrance to the ground From this spot where the garden first bursts upon the eye it seen at its best, and there are few visitors who do not pause the in surprise and admiration. Stretching away toward the cent

of the grounds is a broad expanse of well-kept sod traversed
a driveway bordered with palms. The lawn is set about the e
with beds of showy-flowered plants or masses of shrubbery
annuals, displaying a pleasing variety of foliage. Above
borders are seen the tops of the trees in the further parts of
garden, strange in form or gay with bloom, and above th
in turn rise the grass-clad hills which quite encircle the gard
and over the further summits of which fleecy clouds are o
rolling down to vanish in the dry air of the plains. The pass
of the seasons works but little change in the appearance of
gardens; in winter the Poincettias are at the height of bloom
little later the papilionaceous tree *Erythrina umbrosa* is a c
spicuous object with its gigantic clusters of scarlet flowers,
it is closely followed by its rival in showy beauty, the Royal P
ciana or "Flamboyante" of Madagascar. Both the purple
the brick-red varieties of the Bougainvillea are grown, and
be counted on for a display of color throughout the greater
of the year. With them, as with the Poincettia, the flowers th

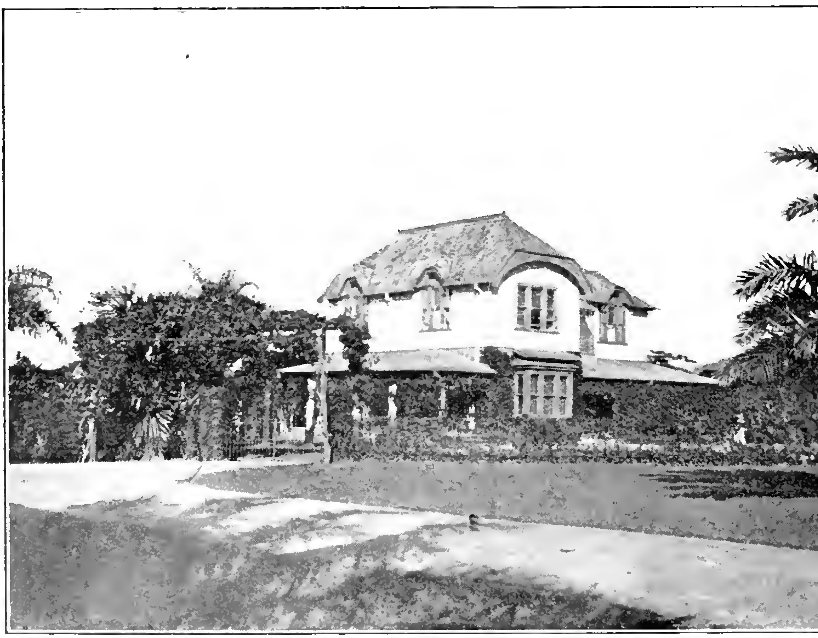

FIG. 31. Residence of the Director of Public Gardens and Plantati

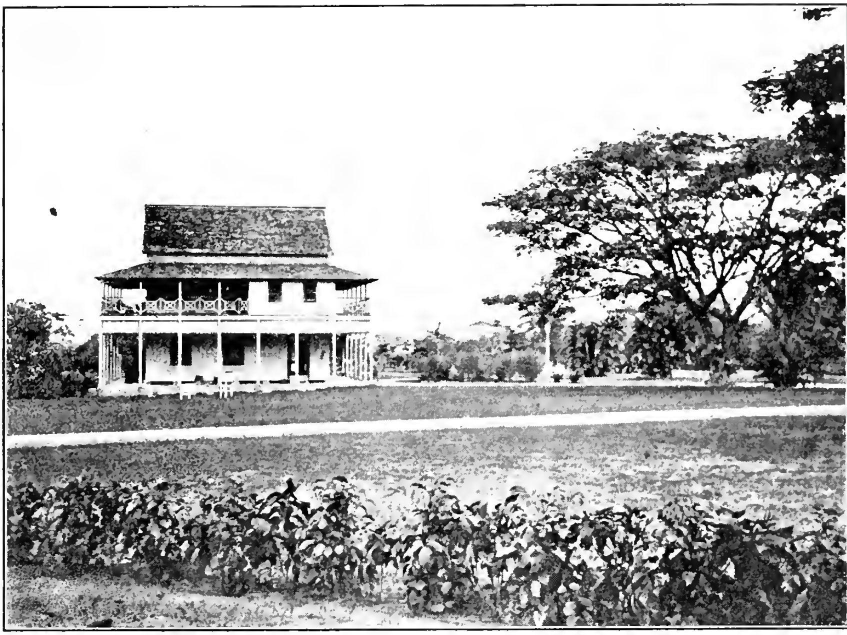

Fig. 32. Administration Building. The tree at the right is a Guango.

selves are small and inconspicuous and the showiness is due t colored leaves or bracts.

Let us now make an orderly round of the grounds beginnin with the collection of cacti, which is sure to catch the eye fro the main entrance. Here are gathered examples of the "dildoe (*Opuntia Swartzii*) which is extremely common on the sout side of the island; the spiny opuntia (*O. spinosissima*); the climb ing cereus (*C. triangularis*) which is frequent as an epiphyte; an other species of cereus, Melocactus, Mamillaria, Agave, Euphor bia, Gasteria and other succulents. Near the cacti is a show and interesting plant, *Norantea Guianensis*, a native of Trinida and Demerara. With foliage somewhat like that of the man grove, this plant has long racemes of flowers which are them selves very inconspicuous but are subtended by long honey-sac of a bright orange-red hue, constituting in color and content very efficient organs of attraction for insects. Here are som native trees of interest,—notably the lace-bark (*Lagetta lintearia*) endemic to Jamaica, the inner bark of which is capable of bein

shredded out into a beautiful and strong lace-like fabric, f
which many things are made to attract the tourists' shillii
The guango tree (*Pithecolobium Saman*), which is commoi
and about the gardens, is a splendid example of the spreac
flat-topped type of tree characteristic of dry savanna regions
world over. Similar to it in appearance is the Albizzia,
"woman's-tongue," another mimosaceous tree the ripe pods
which, filled with loose seeds, have suggested to the imagina
black man his name for the tree. Here, too, are the "umbı
tree" (*Cecropia umbellata*), used in parts of Jamaica as a sł
tree for coffee, and remarkable for its hollow stems, whicl
some of its South American congeners have an opening in
internode, inducing the cohabitation of ants; the "sand-box tr
(*Hura crepitans*), with a very spiny trunk; and the "anch
pear" (*Grias cauliflora*), which is notable for its unbranc
trunk directly out of which grow flowers and fruit. Beau
indeed on a breezy day is the "star-apple" tree (*Chrysophyl*
Cainito), for its leaves are dark green and glossy above, w
beneath they are silken and rusty brown. If you should bel
deceitfully to a native he will tell you: "Yo' two-face' like a s
apple."

Passing toward the centre of the garden we find a collectio
trees which are mostly exotic,—a row of date-palms, a grou
olive trees, ravenalas, myroxylons, *Casuarina equisetifolia*,
a double row of *Caesalpinea coriaria*, the "divi-divi" or "n
key's-ear-ring tree" of Africa. In the shaded walk between
divi-divi trees is arranged the collection of orchids, which 1
be one of the finest in America, as it has been built up by y
of exchange with all parts of the world, and embraces many
and magnificent species. Such is the interest which the pu
takes in the orchids that a list of the species in bloom is publis
every morning in the Kingston papers. Most interesting to
morphologist are those forms in which the shoots have underg
transformation into absorbing organs, losing their foliage le
and most of the chlorophyll, and developing a velamen, but 1
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 guinea-grass (*Panicum maximum*), the chief forage crop Jamaica; cassava (*Manihot utilissima*), one of the most valua sources of starch; and the ippi-appa palm (*Carludovica gracili* from which hats similar to panamas are made. Some notion the diversity in tropical agriculture may be had from the la variety of economic plants grown here, all of which are to greater or less extent planted in various parts of Jamaica, number including sugar-cane, coffee, bananas, pimento (allspic oranges, limes, grape-fruits, shaddocks, tobacco, chocolate, vani kola, mangoes, pine-apples, sisal-hemp, rubber and ginger.

Much of the work of the Public Gardens consists in supplyi planters with young plants of coffee, chocolate, nutmeg, etc., a price which is merely nominal, and since there are no nurseries the island, this is a very important service. The plants are roo in bamboo pots, which are made by cutting stems of *Bamb vulgaris* of about three inches diameter into sections about sev inches long, in such a manner that the partitions at the nodes the stem form the bottoms of the pots. In these cheap receptac the plants are readily handled and shipped.

In the centre of the garden stands the administration buildi in which is the office of the Director and the library of the Depa ment. The library is quite complete in works on tropical ag culture and systematic botany; is well filled with all the texts a general works in the various fields of botany; and has a go representation of the leading journals. On the lower floor i small museum and the herbarium of the department. The h barium cases are all made of different native woods and are interesting exhibit in themselves. The sheets which they cont bear a very complete collection of Jamaican flowering plar ferns, mosses and hepatics, including types or co-types of all more recently described species of higher plants native to island, together with a representation of the flora of the neig boring islands.

OUTLINE STUDY OF SEEDS AND SEEDLINGS

By Dr. C. Stuart Gager,

New York Botanical Garden.

The following paragraphs were written for the use of grade teachers in a city where school gardens had been int duced, and the work here outlined was correlated with the c of-door work in the garden. The studies are only a suggest as to the kind of work essential to secure the most desirable sults from the work in the garden.

It is a great pity that so much school botany formerly con ered the plant apart from the soil and air in which it grew. were as great a pity to cultivate plants in the school garden w out studying the elementary facts of physiology and ecol which are necessary to their intelligent care.

To make a successful garden one must know that the pla need to be a certain distance apart. But if the object of school garden work is something more than merely to train g deners, if it is to have sufficient educational value to justify time it takes, then it becomes vitally important for the pupi know why the plants must be a certain distance apart—to un stand the fundamental needs and nature of the plant that m necessary all that he does in his garden.

While nature study is not a science, and while a course in ture study is non-scientific, it should never be unscientific in ei 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 nature. Both objects should be attained if the subject is to tify its place in the course of study.

The surest foundation for the teacher, so far as plants are c cerned, lies in a clear understanding of the principles of bota The best preparation for teaching nature study is, not to h "taken" nature study one's self, but to have had thorough in ductory laboratory courses in botany and zoology.

The outlines suggest a way to take up with grade pup the topics indicated. The questions may either be asked of t class vocally, or each pupil may be supplied with a specim and a mimeographed copy of the questions. Or the questic may be written on the blackboard. The main point is th the pupil shall proceed as independently as possible in his c serving and thinking. The "Notes," of course, are for t teacher only.

About a week may profitably be spent on the structure of see At the beginning of the study, seeds of the bean, pea, corn, squa and castor-oil should be planted in boxes of soil after bei soaked in water over night.

About three days before needed, seeds of the same kinds shou be soaked over night and placed to germinate in moist sawdu 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 see Are they all practically the same shape? How many times as lo as broad? How many times as broad as thick? Make drawin four times as large as the seed to show the shape as seen from (the side, (*b*) the edge, (*c*) the end. Describe the color of the se Do you find any differences in color? If so, describe them. O serve a seed that has been soaked over night. Does it differ any way from the dry seeds. If so, how? Do you find a parts or marks (besides differences in color) on the surface? so, tell all you can about where they are, and their size and shap Make another drawing, enlarged four times, to show the pa you have observed. Write a paragraph telling clearly and acc rately all you have learned about the structure of the bean see

Note.—This is not a memory exercise and the pupil should n be given any technical names of the structures observed. T aim is to teach the pupil to see the natural object *as it is*, and describe it as seen in as clear and accurate a manner as possib In the process the pupil acquires a knowledge of the seed stru ture, but this is of secondary importance. Nothing shoulc told by the teacher that can be found out by the child himsel observing the specimen.

He should have observed the *scar* (hilum), or place where seed was fastened in the pod; the little hole, micropyle, at side of the scar, and on the opposite side a small knob (s phiole), 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 bec they are hard (hilum is as easy as scar), but because they do add at all to the clearness of the child's idea. Young pupils apt to confuse ideas with their terms, and to think that they k a thing when they know only its name. The knowledge of sc tific terms is an absolute hindrance to the child in an endea to describe.

Inside Parts.

Material.—Provide for each pupil, one soaked seed with cotyledons carefully separated, the seed coat still adhering the halves, and the hypocotyl and plumule still intact. Cut skin so as not to injure any of the structures on the hilum e

Observation.—Observe the half of the seed to which the is not attached. Is the bean covered with a skin or *seed-c* Is this coat tough or very delicate? Is the coloring of the *on* the coat or *under* it? Is the inner surface of this half fla cup-like? Is the surface of the other half the same? Can think of any reason why the cup shape is a better one for seed than a flat surface would be? Was this half attached to other in any way? If it was, describe where. On the other do the knob, scar, and little hole belong to the seed-coat, o the parts under the seed-coat? Is the peg straight or curv What part of the seed-coat is over the *tip* of the peg? Is the same in all bean seeds? What is on the opposite end of peg from the pointed end? Is it composed of parts? If so, many? What is their color? Are they in a straight line the peg, or do they make a curve with it? Is the peg attac to this half of the bean? Can you see any signs of its hav been attached to the other half? Make drawings (X4) show

(1) the halves of the seeds as they were placed at first, onl with the seed-coat removed; (2) only the peg with the leav attached. Write a paragraph describing all you have learne concerning the inner parts of the bean seed.

Note.—This exercise teaches the importance of little things an the need of care and accuracy. The pupil should be made to fe that the bean seed must not be handled carelessly or picked pieces merely because it is a common object. The children mu not be permitted to poke the specimen with pencils, knives pins.

Insist that the drawings be enlarged by the amounts indicate Allow no shading. Every line in the drawing must represe some structure of the seed.

The pupil should have observed:

1. The relatively tough character of the seed-coat. 2. T fact that all the external features belong to the seed-coat. The more or less *concave* inner surfaces of the two halves of t seed, giving room for the *peg and especially for the tender leav at its end.* 4. The position of the tip of the peg *always direct under the little opening or hole.* 5. The peg curved and t leaves at the end making a little arch with the peg. The attac ment of the peg to both halves of the seed. 6. The leaves, tw in number, and folded one within the other.

Each half of the bean seed being roughly cup-shaped is term a *cotyledon* (little cup). The leaves at the end of the peg for the *plumule.*

THE STRUCTURE OF THE PEA SEED.

With this exercise the teacher will doubtless meet such que tions as: "What ought I to find?" "Ought there to be a litt knob on the pea seed?" etc. The treatment of such questio in observational work marks the difference between the wise a the foolish teacher. In observation it is not a question "ought," but a question of fact. Not "ought" there to be little knob, but *is* there one.

This point is dwelt on because there is none more important observational science than this. From the standpoint of *educ*

tion it means acquiring the habit of independent thought a
work, or else a blind, unintelligent following of authority. Fr
the standpoint of *science*, it means valuing facts as they are, ab
preconceived notions of things as we imagine they are or ou
to be. From the standpoint of *knowledge*, it means clear
ideas obtained at first hand, instead of vague indefinite noti
secured at second hand.

From this study of the outside of the pea seed, the pupil
learn its globular shape, the absence of the little knob (strophiol
and the possession, in common with the bean seed, of the scar
little opening. Usually some indication of the peg shows throu
the seed coat. If so, pupils should determine for themsel
whether the little hole is directly over the tip of the peg.

A study of the inside of the pea seed, made as directed ab
for the bean seed, will show the tough seed-coat, the peg, fat
than in the bean seed, not as long, and not curved so much.

The pupil will observe the much swollen plumule here, a
not in a straight line with the peg, but making an arch with
latter. Are the cotyledons cup-shaped?

Drawings (X4) should be made of one view of the outsi
showing the scar, little opening, and peg (if it shows throu
the coat); of the inside, similar to the one made of the bean se

In what ways are the bean seed and the pea seed alike?
what ways do they differ?

Write a paragraph telling all you have learned about the
seed, and another paragraph telling all the ways in which the t
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 b
seed. Here it is much larger and fleshier, and it is directly o
the little opening which may be seen extending down through
The scar is not prominent, but is close up under one side of
knob.

Make drawings (X4), one showing the seed as seen fr
the side, another to show the end view with the knob (here cal
the *caruncle*). Do not give the pupils the term.

The study of the internal structure of the seed is very diffic
for young pupils. The teacher should have several well-soak
seeds dissected to show the pupils, and plain drawings on t
board. Call attention to the hard brittle seed-coat.

Notice the short, straight peg. The fleshy halves of the se
are not cotyledons, but food for the young plant. This may
very carefully removed, showing the white, leaf-like, delic
cotyledons. The plumule is too small to be easily seen.

Germination.

Material.—In boxes of convenient size, containing garden s
or, preferably, clean sand, plant six or eight seeds of the comm
white bean, the pea, corn, squash, having first soaked the see
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
allowing seeds to germinate behind glass. For this purpose, l
a Wellsbach chimney with a tube of blotting paper, setting
end of the chimney in sand or soil in a flower pot or box, a
fill the chimney with moist saw-dust to keep the blotter close
the glass. (If this device is not convenient, an ordinary tumb
may be used. The shallowness of the tumbler, however, does
permit of very extensive root development.)

Have the children place five or six seeds of each kind me
tioned above in water to soak over night. On the following
the pupils will observe that all the seeds have swollen. *This
the first step in germination* and the point should be made at t
time.

Now place these seeds between the blotters and the glass
that they may be seen, and placed so that the tip of the peg
some of the seeds points vertically downward, of others upwa
and of still others horizontally. Be sure that the corn grain
placed with the embryo side next the glass. Keep the seeds mo
but not immersed in water, and, if possible, put in a dark place
develop. Lead the children to see that this would be best
questioning them concerning the light conditions under which
seed germinates naturally in soil.

Observation.—What part of the seed first breaks through th seed-coat? Is this the same for all the seeds? Is it better f the root to grow first? Would it not be just as well if the ste and leaves came out before the root grew? Why?

Do you see any special growth on the peg of the squash see that helps the young squash plant get out of the seed-coat?

Does more than one root come through at first? Is this th same in all the seeds? In what direction does the first root (o roots) grow? Does the root grow downward in the seeds whe the peg was placed horizontally or pointing vertically upwards Would it not be just as well if the roots grew vertically upwar or sideways? Why?

Would the gardener's or farmer's work be any different if roo did not always grow downward in germination? Explain ho

After a time does the root begin to branch? If so, in wh direction do these side roots grow? Would it not be better they grew directly downward just as the first root grow Why?

Can you see any fine white hairs (root-hairs) growing on th surface of the root? If so, do they cover all the root? Do the grow up to the very tip? What do you think they are for?

What part of the seed first appears above ground? Does th 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 pla in action. It is doing something. The value, as in the study o seeds, consists in practice in observation, expression, and inte pretation. That the first root grows vertically downward is a fa worth knowing. It is of infinitely more value to have reason out, even in the most elementary manner, the meaning and sig nificance of this. Here, also, is emphasized the fact that obse vation is something more than merely looking at an objec It implies an active attitude on the part of the pupil in whic *definite questions are put and their answers sought in the objec studied.*

Besides the educational discipline secured, the pupil will lear the following facts:

In the germination of a seed, the first part to begin growth
the root. The squash plant is helped out of the seed-coat b
means of a little knob. One root only always appears first, an
no matter in what position the seed lies, the root will tak
a course vertically downward. After the appearance of the mai
(or tap) root, the stem begins to grow. Branch roots do no
grow downward like the main root, but more nearly horizonta
The root is covered in a definite region with numerous root hair
which never extend quite to the tip of the root.

By careful questioning on the part of the teacher, the pup
should be taught that the greatest need of the plant is water, tha
the most abundant supply is in the soil, and that the plant need
to be held fast where it can get water. Therefore, the best goo
of the plant makes it necessary for the root to grow downwar
first to hold the plant fast, second to absorb water for the plan
If the root did not grow downward (curving when necessary
no matter in what position the seed is placed, then gardene
and farmers would have laboriously to plant every seed ro
downward or else many would perish on germination.

By growing laterally, the branch (secondary) roots hold th
plant more firmly in the soil, and at the same time enable the plan
to secure water from a wider area.

The fine white root-hairs are parts of the root by which
absorbs the water from the soil. If they grew at the very tip o
the root, they would be liable to injury, as the root pushed i
way through the soil during growth.

How the Stem Lifts Itself into the Air.

Watch carefully for the first signs of the planted seeds break
ing the surface of the soil. How does the bean seedling brea
the ground? Does the *tip* of the stem appear first? Do all th
different seeds planted break through the soil in the same way
Describe. Do all the seeds of the same kind break the ground
the same manner?

Rule a horizontal line across a sheet of pad paper to represen
the surface of the soil, and at the left make a drawing to sho
how the bean seedling breaks through the ground. Save th

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 st becomes erect in the air, and represent them, as observed, i row from left to right along the soil line as directed above. R resent five stages in each plant. Are the halves of the seed rai into the air in any of the plants? Written description as abo

Note.—It is best not to try to explain *why* some plants br through the soil in the form of an arch, while others do not, why some lift the halves of the seed, while others do not. I doubtful if the true significance of the fact is known, and a cl is too young to discuss theories.

The Parts of the Plant.

Material.—Young seedlings of the common white bean, inches high. (Any other variety will do.) The plant will cleaner to handle if grown in moist sawdust instead of s Carefully remove the plants and clean the roots in water. It be desirable also to have a plant or two grown in soil or sand the purpose of showing how closely the soil clings to the roots

Observation.—Can you easily distinguish the underground p tion, *the root*, from above-ground portion, *the shoot?* How you tell them apart? What part of the embryo has grown i the shoot? Can you recognize the plumule in the seedli Have any of the parts changed color since leaving the seed-co If so, what parts and how have they changed?

The Root.—Is there a main *tap root?* Is the root branch Which is longer, the root or the shoot? Which is the m branched? Do you think this is an advantage to the pla How? What might be the result if the young shoot sho branch more than the root? Does the soil cling very closely the roots? What advantages result to the plant from the bran ing of the root?

The Shoot.—Observe that the shoot is composed of the st and the leaves. Does the stem have branches? If so, descri Are the leaves opposite each other on the stem? If not, desc how they occur. What do you find at the tip of the shoot?

the cotyledons are raised above the soil, describe any changes y
can see in their appearance. Are they opposite each other?
the stem any bigger below the cotyledons than above them? A
there any leaves below the cotyledons? Do the cotyledons beg
to shrivel up? What do you think makes them do so?

The Leaves.—Observe the first leaves above the cotyledons.
there is a distinct *leaf stalk* and a broad, thin, flat *blade?* Do y
find any *swelling* at any place on the leaf stalk? If so, wher
If possible examine plants that have grown in a window. Ha
the leaves turned toward the light? If so, where did the bendi
take place? The tip of the blade is the *apex*, the place where t
blade joins the leaf stalk is the *base* of the blade? Can you fi
two little wing-like parts on the leaf stalk at the base of the blad
Are there any where the leaf joins the stem? Is there a *jo*
in the leaf stalk at this place?

Does the stalk extend up through the blade toward the ape
forming a *midrib?* Does the midrib branch into *veins?* C
you see an unbroken line of vein extending around the blade pa
allel to its edge? Of what advantage is this to the leaf? H
can you tell the upper from the under side of the blade? Wh
purposes do you think the veins serve? Are the two oppos
first leaves alike? Make labeled drawings.

The other leaves above the first pair are *compound* leav
How many blades has each? Each of these blades is a *leafl*
Has each leaflet a stalk? Is there a joint where each leaflet joi
the leaf stalk? Does each leaflet have a pair of little leaf-li
bodies near the base of its blade? Is there a pair also where t
stalk joins the stem? Is there a joint in the stalk at this plac
Are the stalks of the lower leaves longer or shorter than those
the upper ones? If the lower stalks were shorter could the low
blades get the sunlight as well? If the upper blades were n
divided into three leaflets, would they shade the lower leaves mo
than now? Make labeled drawings and write descriptions.

The cotyledons have shrivelled because the food that made th
thick has gone to nourish and feed the growing seedling. T
first leaf of the bean is not a true simple leaf. It is what is kno
as *a unifoliate compound* leaf, that is, a compound leaf with o

one leaflet. This is shown in part by the joint at the base of t blade, and by the wing-like outgrowths (*stiples*). These ou growths are seen at the base of the blade of each leaflet in t other leaves. The similar outgrowths at the base of the stalk a *stipules*. Elongation of the lower leaf stalks carries the blade o from under the upper leaves so that it gets better sunlight th it otherwise would. To observe this fact and reason out t meaning is more important than to learn the name of the sta (*petiole*). The leaves above the first pair are *trifoliate compou leaves*. This branching of the blade permits more sunlight penetrate to the lower leaves. To recognize this fact is more i portant than to learn that the leaves are *pinnately compound*.

This work gives a basis for the study of any other plant in t garden. It shows the *kind of facts* to look for and question abo All other plants in the school garden will be seen to be modifi tions, more or less profound, of the bean type.

OUR IMPORTATION OF VEGETABLE FIBERS.

In 1905 the United States imported $48,000,000 worth vegetable fibers. Of this amount cotton makes up $9,000,0 Of the 61,000,000 pounds imported 52,000,000 was consign from Egypt. The reason for this large import of cotton fr Egypt is its use in the making of the finer grades of cotton clo The two fibers which excel cotton in the value of the imports a manila and sisal grass. In 1905 the value of the former w $12,000,000 and the latter $15,000,000. In 1905 the Philippi Islands furnished 56,511 tons of the total 61,562 tons of t manila imported and Mexico 97,698 tons of the total 100,301 sisal grass. The only other fiber imported in large quantities jute and jute butts, of which India consigned 93,843 of the tot 98,215 tons imported in 1905.—Report of the U. S. Dept. 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 slen bladder-fern seem to us as exquisite as possible in the way fern structure, but nothing in our northern latitude can comp in delicacy with the filmy ferns which are represented by species in the southeastern part of the United States and numerous species in the tropics and sub-tropics.

In size they vary from *Trichomanes pusillum*, which is l than half an inch long and bears but one sorus, to *Trichoma scandens*, which is about eighteen inches long. They are o one layer of cells in thickness, except at the veins, which gi them their peculiar filmy character. Whether they have the li green color of *Hymenophyllum asplenoides*, or the dark green *Trichomanes rigidum*, or the rusty bronze of *Hymenophyll lanosum*, they form an exquisite drapery upon the trunks of tr or the banks of humus, where their short, wiry stems are buri There are a hundred upon the trees to one upon the ground, some of the more hardy may be found upon limestone rocks.

The life-history of the members of the filmy fern family rese bles that of the common brake (*Pteridium*) of our roadsides, b varies in certain details. Along the margins of the fronds at t ends of the veins the receptacles or *so* within which the spo are borne. These s are flattened in t genus *Hymenophyll* (fig. 34, *A*) and ha the form of a tv valved capsule. In genus *Trichomanes* sporangia are attach to the protruding v and the sorus has vase-like form (fig. *B*). This elongation the veins beyond margin gives this ge *Trichomanes* its na (Greek, *thrix*, ha

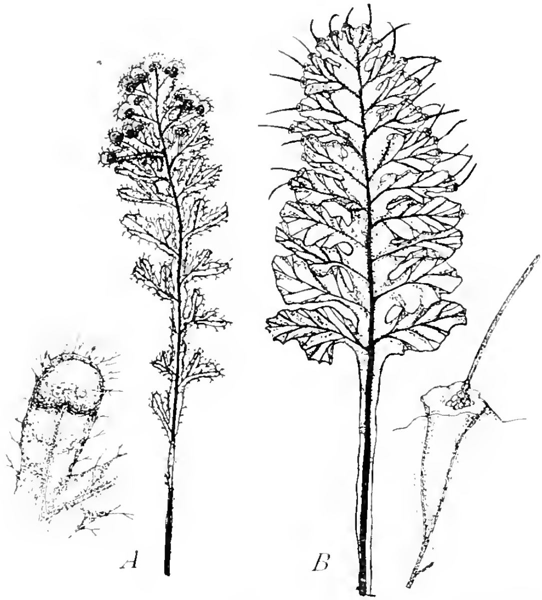

FIG. 34. Filmy Ferns. *A*, *Hymenophylla asplenoides*; *B*, *Trichomanes rigidum*.

The spore-cases are encircled horizontally by a ring or *annu* (fig. 35, *a*) of thick-walled cells, and burst vertically downwa The spores are green, and are spherical or triangular in shape 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 m or *antheridia* (fig. 36, *a*), and the female, or *archegonia* (

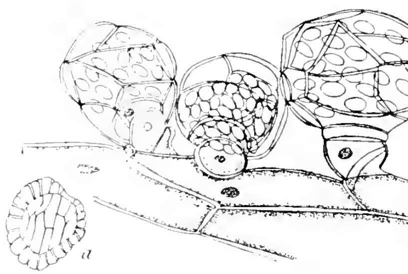

FIG. 35. Sporangia and Spores.

Fertilization takes place in the usual way; an antheroxoid escap from the enclosing antheridium and swims to the neck of th archegonium by means of the small amount of water which

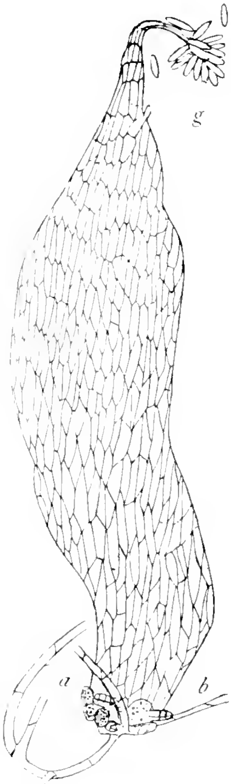

FIG. 36. Prothallus. (*a*) antheridia. (*b*) archegonia. (*g*) gemmae.

always present in the soil where they gro It makes its way down the canal of the archegonium (*fig.* 37, *c*) and unites with the eg cell at its base and from this union a youn fern plant arises. Occasionally in the gen *Trichomanes* the sexual organs appear upon filamentous prothallus, instead of upon t strap-shaped form.

Various forms of asexual reproduction o cur. Figure 36, *g*, shows a cluster of broo bodies or *gemmæ* which have formed at t apex of the prothallus. One of these bodie enlarged, would show the nuclei and chlor phyll granules within its cells.

About 160 species of the Hymenophyllac have been described. They are the arist

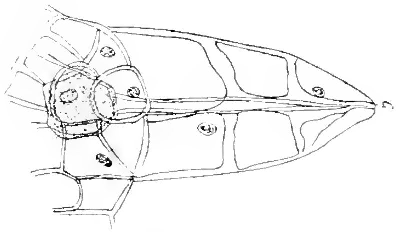

FIG. 37. Archegonium. (*c*) canal; egg-cell at its base.

crats of the fern world. Unable to accommodate themselves variations in heat and humidity, their favorite habitats are t warm, moist forests of the tropics, but in these restricted localiti they produce forms of such rare beauty as to make any fern lov feel that he has been well repaid for the pains of a pilgrimage 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 illustrati Oxford: The Clarendon Press, 1906. 21 shillings.

Every student of botany knows so well the character usefulness of Pfeffer's *magnum opus* that criticism would quite beside the mark. The translation has been long expec and is at last welcomed. To the translator belongs no s amount of praise and congratulation—praise for the excell of the labor, and congratulation on its completion. But for universal acknowledgment accorded the author and his work brief a notice would ill fit the great value of the book.

Mosses with Hand-lens and Microscope. A non-techn Handbook of the more common Mosses of the Northeas 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 the mosses of this country for the work of which the third is now to hand. It contains, besides many other very clear useful illustrations, about twenty full page plates reprodu from the *Bryologia Europæa* and Sullivant's *Icones*, thus this useful extent bringing original literature to the use of person interested in these plants, but who is removed from privileges of the large library. Dr. Grout's treatment is ge ally stimulating, and the book will certainly further greatly wide study of the mosses. The earnest elementary student get from it a very great deal of the help that he needs. typography is excellent.

Species and Varieties, Their Origin by Mutation. Being Lectures Delivered at the University of California. By HU deVRIES, Professor of Botany in the University of Amsterda Edited by Daniel Trembly MacDougal, Director Departme of Botanical Research, Desert Botanical Laboratory, Carneg Institution of Washington. Second edition, corrected a revised. Cloth, 8vo, pp. 18 + 847. With a Portrait of t Author. Chicago: The Open Court Publishing Co. Pric $3.00. 1906.

This most important work of Professor deVries in the Engli presented a no inconsiderable task to the editor, to whom, ne to the illustrious author, are thanks due for bringing this wo to the Western continent. In the previous volume of this mag zine, *Species and Varieties,* on its first appearance, scarcely year ago, received a lengthy review which served to indicate ve fully to our readers the scope and treatment. These rema unchanged, but there are so very many corrections and emend tions that the second edition will needs be in the hand of eve student of evolution in its contemporary form. The portra which was taken by Dr. W. A. Cannon and the reviewer duri Professor deVries' visit at the Desert Botanical Laboratory, we venture to say, a valuable addition from the human point view, and will be highly appreciated by the admirers of t author. It is informal in its treatment, but the more shows t man's kindly soul in the spontaneity of the expression.

L.

How Ferns Grow. By MARGARET SLOSSON. With forty-s plates by the author. New York: Henry Holt & Co., 190

As several good books on ferns have appeared within the la few years, one naturally looks for something unusual in M Slosson's book, *How Ferns Grow.* The author has treated h subject entirely from the standpoint of the development of t fern leaf, showing by detailed description and illustration t successive aspects, in respect to form and venation, taken on the sporophyte from the youngest stage through to the matu 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 int
ductory chapter on the development of the fern leaf. The tre
ment of the subject is both original and scientific. The illust
tions are of the kind that "really illustrate," and are an attr
tive feature of the book. M. M. B

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THE PAIRED SEEDS OF COCKLEBUR.

BY PROFESSOR J. C. ARTHUR,

Purdue University.

The cocklebur (*Xanthium*) is a common native weed throug out the central and eastern United States, especially along sand river bottoms and in corn fields. The seeds are enclosed in hard, spiny covering, two in each bur. The spines undoubtedl assist in the distribution of the seeds by clinging to the roug coats of animals. Unlike many other seed pods, they do not ope to discharge the seeds, either at maturity or by subsequen changes of moisture or temperature. Not only is the bur inde hiscent, but it does not readily disintegrate, and after a numbe of years in the soil may appear little changed. From this har unyielding bur the young plantlet frees itself at the time germination by first pushing out the radicle and then pulling o the seed leaves, while the bur retains its usual appearance.

There is quite a common belief among farmers that one of t seeds in a cocklebur germinates the first year after maturity, an the other seed not until the year following, thus accounting for t persistency of the weed in cultivated fields. The truth in th theory was not tested, I believe, until a few years ago, when t writer took up the matter and made some preliminary trials whic led to a study of the subject extending through seven years, an which established the essential correctness of the farmers' opinio

First there were planted 75 cockleburs in a garden bed in M
and by the middle of June 64 seedling plants had made t
appearance, and in only one instance did two seedlings come f
the same bur. I was able to identify 14 of the burs which
sent out one seedling each and upon opening them found that
contained only the remains of decayed seeds, and the other tw
had a good seed in each bur. Eleven of the husked seeds,
having been destroyed in removing it, were placed in a ge
nating pan in the laboratory, with the result that two of
seeds grew in two days, one in three days, one in nine days,
in twenty days, one in twenty-three days, one in forty-two d
and one in fifty-six days, while the two remaining seeds
the plump fresh appearance for nearly three years, when
accident the germinator was allowed to become dry and the s
were killed. The other 61 burs of the experiment, which
mained in the garden bed over winter, produced 20 seedlings
following spring, but whether from burs that had already gr
one seed, was not ascertained.

This preliminary trial gave considerable coloring to the farm
theory, which, however, was somewhat neutralized by the ra
prompt germination in the laboratory of eighty per cent. of
seeds that failed to start in the ground. Nevertheless, the
facts remained that out of 75 burs only one gave a pair of s
lings the first year, while twenty produced single seedlings
second year.

In May of the second year of the study a quantity of burs
placed in germinating pans and out of these 100 were sele
from which a seedling each had emerged. These burs that
known to contain no more than one seed each were planted
garden bed. No further germinations were observed that
son. The next year the bed was not very carefully watched,
but five seedlings were noted; the year following there were e
teen 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 gro
for more than two years in a growing condition.

Trials on a larger scale were made to ascertain the frequen with which both seeds of a bur germinate at the same time. 137 burs placed in the germinating pans at one time, only c gave twin seedlings. Another year, 1787 burs produced twin seedlings, the largest percentage obtained in any trial.

It is unnecessary to give in detail the numerous observati which finally led to the confirmation of the popular belief. Fr the data obtained it is possible even to extend the statement. round numbers, one may assume that out of every hundred parently good cockleburs, one-fourth will not grow, owing various causes, especially the depredation of insect larvæ a failure to properly mature. Of the remaining three-fourths, ab five burs will produce two seedlings each, and about seve one seedling each. In the year following about thirty seedli will appear, in the third year about five, and two or three in sub

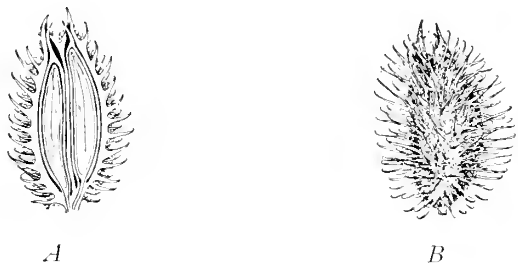


FIG. 39. Cocklebur. *A*. Vertical section showing one seed a little hig than the other. *B*. One side a little more convex than the other.

quent years. Thus it seems that the farmer is amply justified his dislike to these pestiferous weeds with their adaptation a prolonged occupancy of the soil.

Following upon the establishment of the fact that the t seeds in a bur behave differently under like conditions for g mination, came a still more difficult task—the discovery of reason for it. Although the two seeds appear to be exact count parts of each other, some difference must really exist either the seeds or in the protecting bur. A careful microscopic exa nation of the seeds brought out no differences. The comparat weight of the twin seeds was then obtained. Thirty-five perf burs were opened and the seeds accurately weighed on an a lytical balance. The thirty-five heavier seeds of each pair gave average weight of 65 milligrams, while the thirty-five ligh seeds gave an average weight of 46 milligrams, a difference 19 milligrams. This promising result appeared to be of significance, however, when the seeds were placed in the gern nating pan, for the two lots showed no difference in rate germination.

As study of the paired seeds revealed no recognizable featu to account for the difference of behavior, attention was turned the enclosing bur. It was thought that perhaps one side of bur was not pervious to water until partly decayed. To t this, burs were placed in chemical solutions and colored liqui But on cutting them open, however short the immersion, b cavities of the bur were found equally and abundantly affect A little further examination showed that the opening in the ap of each half of the bur, through which the style once protrud was still in the ripe fruit an opening large enough to admi needle, and that, furthermore, a considerable channel existed the base of each half, closed only with loose fibrous mater This structure permits liquids to penetrate through both ends the bur without hindrance, and to pass into both seed cavities w equal readiness.

At the beginning of the sixth year of the study an import discovery was made. In dissecting the cockleburs it was necess to make longitudinal sections, and in this way attention was tracted to a difference in position of the two seeds; one seed placed a little higher in the bur than the other, see fig. 1. T slight but significant difference seems to have escaped the ill trators, for a considerable search through standard and miscella ous botanical books has failed to bring to light any cuts showi the seeds otherwise than exactly side by side. Further examinat made it possible to tell without dissection on which side of bur the higher or the lower seed lay. The unsymmetrical po tion of the seeds causes a slight curvature of the bur, see fig. and the lower seed lies on the inner or less convex side, while higher seed lies on the more convex side. Here was the key the situation. It was now possible without injury to the burs

detect and compare corresponding seeds in each, and further stu
of the subject was taken up with renewed interest.

With this new information at hand a lot of cockleburs we
placed in wet sand to germinate. Out of 223 from which o
seedling appeared, it was the lower seed which grew, except
fifteen burs. Upon cutting open the fifteen exceptions, elev
were found to contain no viable lower seed, and should cons
quently be excluded. This trial, therefore, gave ninety-eight p
cent. germination for the lower seed against two per cent. for t
upper. The result was in general confirmed by further observ
tions of the same nature.

Comparison of the weights of the upper and lower seeds w
now undertaken; when the lower seed exceeded fifty milligra
the upper proved to be lighter, but when the lower seed fell bel
fifty milligrams the upper was heavier. It is clear that when t
burs are well developed, the lower seed will be larger and strong
than the other, and is the one that will grow quicker. This w
found to be true even when the seeds were removed from the b
and placed in a germinating pan. A number of weighed see
were thus tested, and after three to four months twenty per ce
of the lower and also heavier seeds remained in viable conditi
and over ninety-two per cent. of the upper and lighter seeds.
number of trials of this sort were made with fairly unifo
results.

Comparing the various observations, both those where accur
data were recorded and others less complete and exact, the gene
statement appears to be warranted, that as a rule the lower se
in a cocklebur is better developed, sensibly heavier, and will gr
sooner than the upper one. If burs are planted in the soil, t
lower seed usually grows the first year after maturity, and t
upper seed grows the second or some subsequent year. Wh
removed from the bur and placed under conditions for germi
tion, both upper and lower seeds grow more readily than when
the bur, but still differ considerably, the lower growing soo
than the upper.

This rule appears to hold good for all species of *Xanthiu*
The one most employed in the above experiments was *X. Penns*

vanicum, 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 l
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 read
separating, and thus bear some superficial resemblance to
cocklebur. In a trial in which sandburs were placed in a ger
nating 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 *Xanthi*
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 ha
fallen, we are apt to see still clinging to the trees some of t
foliaceous seed-vessels—called samaras, or key-fruits—of cert
maples and ash-trees. These trees are not closely allied, but t
external structure of the fruit, *i. e.*, the wing, is much the same
the one case as in the other, indicating that the function thereof
identical in both. The wing is present for the purpose of serv
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
one samara, while that of the maple consists of two, and these
ultimately separable.

There are about one hundred species of maples (*Acer*) a
forty species of ash (*Fraxinus*). All have winged fruits.
may be certain that this peculiar form of fruit was not develop
independently in each of these numerous species. In order so
believe we should have to expect too much of chance. In the ca
of the maples it was inherited from some ancient aceriform p
genitor, which, through natural selection, had taken to the p
duction of winged fruits; and an old-time fraxinoid tree, a
bearing this sort of fruit, was the ancestor of our present-
ash-trees.

The direct action of the environment can have done nothi
towards the development of the foliaceous fruits of the trees un
consideration. It would be hard to conceive of any other fac
than natural selection as having wrought to produce them. N
ural selection, we know, can operate only where there prevail
fierce and keen struggle for existence. So, in some great strug
of the past, we may conclude that the production of winged se
vessels, by insuring the wider territorial distribution of the tr
that bore them, saved the ancestors of the maples, and those
the ash, from extinction.

That this is true, it may at first be somewhat difficult to app
hend. The ashes and maples, it may be said, grow peacefully, a
in their tranquil shade there is nothing that smacks of strugg
And when contemplating one of our ash-trees, red maples,
box-elders upon the fertile soil of one of our central states, alo
the roadside or in the meadow, where any spot, almost, where
a seed might chance to fall, would furnish the proper conditio
for germination and growth, it is hard to believe that in the p
the ancestors of these trees were subjected to severe hardshi
owing to overcrowding upon small tracts, and through natu
selection, were driven to produce the winged fruits by means
which the species might become broadly dispersed over w
regions, and thus escape extinction. It may be held that even
gentle breeze can waft an actually wingless fruit to a suita
spot. But he who argues thus is thinking of present and lo
conditions only.

Now let us look at one of these trees under another and a diff
ent environment. Upon the great Pine Ridge Indian reservat
in South Dakota, for example, are numerous streams and "draw
or coulees (which are nothing more or less than ravines or gull
free of water except in time of flood and rain) which, as a ru
are far below the general surface of the adjacent country, a
often miles from one another. Upon the flood-plains of su
streams, and in the "draws" grow ash-trees and box-elders
company with trees of a few other species. Nowhere on
high, dry hills do they or any other trees, except pines, gro
although I have often found their wind-tossed samaras there; a
if germination takes place, the seedlings are doomed to peri
Along the draws and other water-courses all the various kinds
trees that grow in such places are crowded together in dense a
tangled masses; wherefore it is to the advantage of a given s
cies that its seeds shall be carried to a "draw" or creek-pl
where the chances of life are more favorable. Now let us supp
the ancestor of our box-elder and maples, on the one hand, or t
of our ash-trees on the other, growing in an isolated "draw" an
vast hills barren of deciduous trees and unfavorable to th
growth. Its fruits as yet are wingless, but often vary towa

producing a minute winglike appendage on the end or margin, is in reality the case with the fruits of many plants. Viol winds, such as sweep perennially over such regions, carry a f of the nascent key-fruits out of the ravine where the parent-t grows, and perhaps, after being borne through the air for a co siderable distance, a few fall upon the fertile and unexhaus soil of another draw, or flood-plain, which is as yet unpeopled trees. The unappendaged seed-vessels, unable to fly far with winds, perish in the tree-crowded coulee or upon the barren hi Plants that spring from the seeds of such fruits, by virtue of laws of inheritance, will themselves have a tendency to b fruits lacking the incipient wing, and growing as they do in i poverished soil, will stand but an unfavorable chance in life, will their descendants also. Likewise, the trees that spring fr the seeds of appendaged fruits by heredity will tend to produ this kind of seed-vessels themselves. Thus year in, year out, selection and elimination goes on, and it can easily be underst how, in time, first a samaroid and later a fully-winged fruit be evolved. Sometimes among hundreds of perfect ones we f a maple key-fruit the wing of which is very short and round that is, has been arrested in its growth. Such partly-develop samaras illustrate an early stage attained ages ago in the evo tion of the typical specimens.

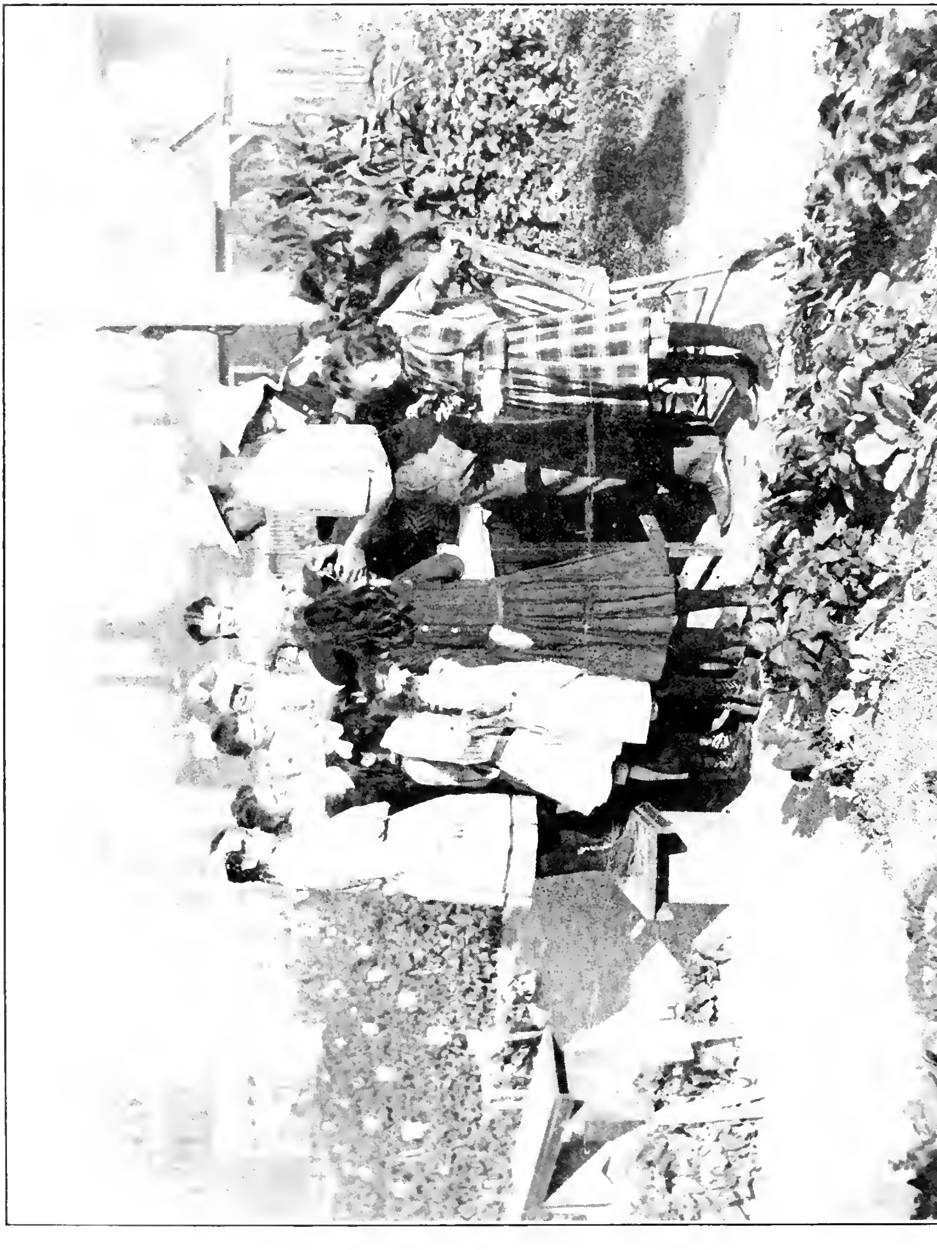
Without a wing of some sort, countless thousands of fruits would annually be stranded amid the unproductive hi and even as it is I have often found samaras of ash-trees a box-elders inextricably entangled in dense mats of buffalo-gra

To support the idea that the ancestral trees may have be driven to develop this peculiar form of seed-vessel in order t seeds might be carried from one productive spot, in an arid semi-arid country to another, I may adduce the fact that pla indigenous to desert regions often have special means of insuri the transportation of their seeds across the barren wastes, to mo and fertile tracts. Says Lubbock, "The *Anastatica hierochun* or 'Rose of Jericho,' a small annual with rounded pods, wh frequents sandy places in Egypt, Syria and Arabia, when dry c 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 o
and sow the seeds." In this plant the contrivance through wh
dispersal is effected differs from that of the maples, but the
to be attained is identical in both.

Easy conditions of life cannot have impelled the ashes
maples to develop key-fruits. Great difficulties have in the
been encountered, and the trees that were enabled to estab
means of dissemination survived in the struggle for existe
But the barriers to be passed over may not have been in all
even most, cases hills. Sir John Lubbock finds that the only t
that bear winged fruits are forest-trees, which fact would s
to indicate that such fruits in many instances have been evol
in order to be carried over vast tracts of dense woodland.
the theory here set forth remains unshaken, and is really thus s
ported, for the principle is the same, namely, that there w
areas so conditioned that germination and growth thereon
impossible or unusual, and these unproductive tracts must be
versed so that at length the seeds might find a resting-plac
propitious and fertile soil.

To sum up: It is certain that key-fruits were developed i
country where they became of far greater service to the t
which bore them than they appear to be to the ash-trees
maples in many regions of our eastern United States and e
where. But I do not wish to insist that the barriers to be s
mounted were necessarily hills. They may have been broad
plains, or forest-growths of other kinds of trees, or even bo
of water—it all depends upon the nature of the region where
changing form first grew.



CHILDREN'S GARDENS AND THEIR VALUE T 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 scho gardens is, in a measure, due to the fact that wherever the wo has been taken up, some side of it finds lively appreciation in t mind of every beholder. It is eminently practical, because wh is learned is of immediate use in the child's daily life, at home a in the school room. Teachers quickly see how the garden wo can be made to vitalize some of the at present "dry" subjec Properly administered, a school garden can be made a source inspiration to the whole curriculum, and the time is coming wh such gardens will be connected with our schools wherever possib

In a subject like botany the lessons often become mere grou of troublesome words, soon forgotten; but for the child to lea of the plants in his own little garden, plants whose very existen he feels sure are largely due to his care and labor, is a progre sive pleasure. The child, having a garden of his own, is inspir with a strong personal interest in the plants, which takes fro the teacher's shoulders a large share of the burden of instructio but this interest of the pupil will be made as nothing unless t teacher is endowed with that sympathetic wisdom which mak him understand that the child wants to know about his ov plants. In any study, let the teacher create in the class a persor interest in the work and then there will be no need of pushi the pupils; instead they will have to be restrained to enable t teacher to keep up with them.

If the child prepares the soil, plants the seeds, cultivates, wate and weeds, and for the time owns the plot of ground and all contains, no matter how small it is, this sense of ownership, con bined with the labor he has put upon it, creates the strongest ki of personal interest. The child that has worked with his har in the earth making the seed bed, planting the seeds and coveri them with fine soil, removing stones and breaking lumps, pre ing the surface here or loosening it there for different results, l a real and definite knowledge which can never be effaced; a when the teacher of botany calls upon such a child to sugg reasons why a fine seed bed is desirable for small seeds his answ is made after calling upon his five senses and several centers information of his body. His feet remember the difference tween the spaded and unspaded plot; his hands remind him plots where one could run the fingers deep into soil like flour, a of others where one's whole strength could make no impress on the hard cracked surface. His eyes remind him of how diff ent were the final results in growth on these two kinds of sc And so, as the questions are asked by the teacher, the ch answers from a memory stored with experiences which are cl cut, well defined, usable.

A plot of ground a foot square can be made to furnish mate for a dozen sciences, geography, composition, arithmetic; alm every subject can be taught with the garden as a text. T earthworm in the ground; the butterfly hovering over the pla the caterpillar eating the leaves; the aphis sucking the sap; lady-bug eating the aphis; the beans "backing up" from soil; the onions coming up doubled as though they were to threaded through a darning needle; the flies "going to roost" night; the spiders catching the flies; everything is of the utm interest to the small gardeners.

To the teacher of botany the pupil's garden plot will be very great help, and an introduction to a wider range of study easily arranged through the weeds that come in. In one gar a specimen of each different weed found was relegated to weed plot, and soon there were several wild cousins of the ta 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 us in medicine, most of which are very common, and this knowled adds must interest in becoming acquainted with them. T hardiness of weeds, their manner of bearing seeds, their pr lificacy, and means of distribution are all more interesting wh we come into the closer relationship which the garden wo gives. Even here we find that a weed or strange plant comi up in the child's own plot will receive close attention and he w want to know about it, when the same plant growing elsewhe he does not care about. And it is this stimulated interest whi comes through the child's garden which makes the garden valuable to the teacher.

Another item of great importance to the teacher: the garden c be made to save many weary trips afield in search of material f the class-room. Many earnest teachers to-day rob themselves hard-earned hours of freedom while collecting material for bota or nature-study lessons, and then, perhaps, give their class plants or insects to study which the pupils in their daily life w seldom come in contact with. Would it not be wise, and wou not material be more accessible, if our common vegetables we used more in the class-room, and would not the resulting know edge of more lasting benefit to the pupils?

In the children's garden the whole life history of plants a insects can be presented objectively, and this fixes the knowled as no other means can.

Mr. Howard H. M. Bowman, in the June number of the PLA WORLD, speaks of the specific name of the tree of heaven as r ferring to the glands of the bark, which, he says, exudes wh injured a very sticky, resinous gum. Professor William Trelea in answer to a question addressed to him from the editor, write

"I have not the original description of *Ailanthus glandulos* but extracts from it, published in Usteri's Annalen, immediate after its appearance, show that the *leaf glands* are repeatedly r ferred to, sometimes by way of contrast with glandless thing and I do not think there is any question as to what character t specific name was intended to refer."

WILD FRUITS AND SHRUBS OF THE PRIEST RIV VALLEY.

By J. C. Blumer.

The extreme northwestern part of Idaho consists of a val some fifty miles in length and eighteen miles in width. In center lies Lake Kaniksu, or Priest Lake, extending across th townships in its length, and across one at its greatest width. feeds and is fed by the Priest River, which drains the basin in southward course and empties into the Peud O'Reille. Cabinet Mountains, attaining a height of 8,000 feet in places forming the eastern boundary, extend from this river northw to the Canadian boundary, where they unite with the P O'Reille Hills, which form the western boundary and attai height of 5,000 feet. There are perhaps two townships of c paratively level country, consisting of white, yellow, and bl pine forest and swampy meadows, while the remainder of the b is filled with high slopes and spurs, where the western bals red fir, and yellow pine flourish. The valley is well watered well forested, except about the lake, where the fire-fiend has wi out both the forest and the possibility of a young growth for m decades to come.

This interesting region contains a number of wild fruits, s of which are of horticultural as well as botanical interest. following notes were gathered while spending here the seaso 1901 in the interests of the United States Forest Service.

The Oregon grape (*Berberis repens*) is not a grape but a berry. It is a low bush 6–10 inches high, quite common on ridges. The leaves are 1½–2 inches long, oval, thick and g rous, with spiny margins. The blue, globular fruit, ⅜ incl diameter, is borne in small, grape-like clusters, and presents typical bloom of the grape. It is extremely acid, but it o served to loosen the parched tongue and quicken the slug limbs when climbing a long slope.

The service-berry or June-berry (*Amelanchier alnifolia*) occu somewhat commonly in some localities on open slopes. It is shrub 3–5 feet high, with small, alder-like leaves, as the nan implies. The calyx is persistent on the fruit, which is of tl same size as the Oregon grape, and borne in racemes. It is blu black in color and sweetish, sub-acid in taste. When hung on the way to camp, we often regaled ourselves with this excelle fruit. It yields itself readily to cultivation and improvemer

The wild strawberry (*Fragaria* sp.*) is a smaller plant tha our *F. Virginiana* and *F. Illinoensis* of the east and middle wes It grows nearly everywhere on open ground, to the top of tl highest hills. Its fruit is elliptical, 3/8–1/2 inch in length, wi conical achenes or seeds, not borne in pits as our eastern wi berry, but on the surface, as in *Fragaria vesca*, the Europea strawberry. It is both juicy and aromatic. Color and taste ne no description, for the strawberry is known and welcomed wi delight wherever found.

The thimble-berry or salmon-berry (*Rubus nutkanus*) fr quently forms a dense ground-cover of the slightly open forest semi-moist slopes and hills. It is 2–3 feet in height, with the le of the raspberry, but six inches in diameter. Its flowers are t size of our wild rose, and a dense thimble-berry patch in Ju often presents a beautiful appearance. The flattened fruit about 3/4 inch across, and when ripe, it can easily be shaken fro the broad, flat receptacle. It is bright crimson, pleasant sub-ac but somewhat insipid.

The red raspberry (*Rubus strigosus*) is not common. It lik to spring up in burnt areas on hillsides, where it occasiona forms dense patches that make excellent picking. It resemb our cultivated raspberry very much, both in plant and fruit. eat out of hand it is equal to or superior to the best cultivat raspberry of the middle west.

The black-cap raspberry is another fine fruit, but somewh rare. It is probably a western form of the variable *Rubus oc dentalis.* It seems to find congenial foothold about the log cabi

* 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 cultiva varieties. Under selection and cultivation something fine mi be made out of several of these fruits.

The wild plum (*Prunus subcordata*) is quite rare. The wr only saw it six or seven times in a four months' sojourn in valley. It is a small, slender tree not over 6 or 7 feet in heig with few spines and small oval fruit, otherwise resembling typ *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 ½ inch in diameter, bright red, sweet, astringe with a globular pit.

The hawthorn, probably allied to *Cratægus rivularis* or *Dougla* is a small tree 8–12 feet high, with smooth white bark and u sharp spines ¾ of an inch in length. More than once they ceremoniously detained us and subjected us to a painful pau 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 *V cinium uliginosum*, the fruit occasionally reaches ½ 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 *cæspitosum*, the berry is ¼ 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 patch upon what the forester calls fresh slopes. These are moist, sha usually north slopes with a heavy stand of forest. It was 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 throug them. After lunch was eaten, we would supplement it with sever times its bulk of this most luscious of wild fruits, nor woul supply give out, or desire grow less.

The bearberry (*Arctostaphylos uva-ursi*), growing from inches to one foot in height, is the most common shrub in th valley. It often completely carpets the more open hills and slope with a thick mat of its recumbent stems, rich, green leaflets, an a profusion of its round, purplish-red berries. The leaves are ½ to one inch in length, oval, glabrous and fleshy, with smoot margin. They form the tobacco of the red man. He construc a small stone kiln, places over it a piece of matting made fro willow and alder sticks, woven together with osier or buckski after the fashion of a slat fence. Upon this he puts the gathere leaves of the kinnikennik, by which cognomen the bearberry universally styled in that country. When dry to a certain degre he sacks it up, and smokes it. The flavor is very mild in con parison to our commercial weed, yet the smoking members of ou party would often prolong their waning supply by drying an mixing kinnikennik with their Bull Durham, Duke's Mixture, cetera. The fruit is ⅜–½ inch in diameter. The rind remin one of the crab-apple in taste. The flesh is mealy, acid-acrid, sou to bitter, but not unpleasant. It contains from 4–6 seeds, of si and shape of those of the rose. It has a persistent, 5-parted caly at the base.

Pachystima myrsinites is a very abundant and characterist shrub of the woods of medium density. Having no comm name of its own, it is probably included with the bearberry. It a tains a height of 6 inches to 2 feet. Its sessile, evergreen leafle greatly resemble those of the bearberry, except that they a sharply toothed, serrate around the upper two-thirds.

The buffalo-berry (*Lepargyrea canadensis*) is a fine shrub about 3 feet height, one that would be an ornament to any law It is somewhat rare. Its foliage is not unlike that of some wi lows, and presents a silvery appearance. The fruit is from ¼– inch in diameter, of bright, crimson color, thin, shining skin a juicy pulp. The first taste is pleasant acid, the after-taste bitt acrid. The twigs bear peculiar, 3–5 fold buds closely clust below the leaves.

The wild rose presents two or more species. The first is s lar to our eastern woodland rose (*Rosa blanda*), both in leaf blossom. It is not common, and grows only in the more c places, upon the moister soil. It commonly grows to a heigh 2–3 feet. The writer found one specimen, however, in a cops the banks of the majestic Peud O'Reille River, that measured f 8 feet in height. This may have been *R. californica* or an a species.

The small form grows only in the shade of the forest, b visited but now and then by a speck of sunshine. It grows f 6 inches to 3 feet high. Its blossoms are ¾–1 inch in diame and its hips are correspondingly small and oval. It is probably *R. gymnocarpa.* Its leaves are small and, like thos most forest plants, are very thin and delicate. One may obs that the whole scanty flora of the dense forest shades extend foliage horizontally, in order to catch every precious bit of light. This is in marked contrast to the greater or less per dicularity of the prairie foliage, which thus avoids the bur summer sun.

The meadow-sweet (*Holodiscus discolor*). This is the b tiful shrub that lends to the many hilltops of the Priest R Valley their exquisite, park-like attraction. The ponde crowns of the bull pine wave in the breeze above, on every h are copses of young red fir, of fresh and lively green, amo which the trail of the deer leads us over grass-covered plots here and there in nature's inimitable way with this hands richly-scented shrub. It grows from 4–10 feet high. Its li green, triangular leaves are 3-lobed and toothed, and pos prominent veins. The small, creamy-white, 5-petaled flo are borne in dense, compound panicles, or grape-like clus The 3–5 sub-panicles extend at right angles to the main a which attains a length of 5–10, or sometimes 12 inches. shrub, where hardy, is worthy of extensive planting on lawns parks.

Its cousin (*Spiræa betulifolia*, var. *rosea*) is a shrub local
known as the hardback. It is somewhat smaller, growing from 2-
feet high. Unlike its relative, it inhabits and dominates t
smaller swamps, and forms almost impenetrable thickets alo
the borders of the larger ones. Consequently we never loved
like its cousin, the fair maiden of the hills. Its pretty, rose-color
blossoms are borne in a thyrse, or dense oblong cluster, abo
half as large as the looser panicles of *H. discolor*. Occasional
a thyrse presents a partly upright sub-cluster. The small leav
are ovate-lanceolate to lance-shaped, with the upper half serra

The alder (*Alnus incana* var. *virescens*) is found in considera
numbers as a shrub and small tree to 20 feet high, following broo
and edges of swamps. The leaves are 2 by 3 inches in si
smooth, oval, doubly toothed and feather-veined, which is prom
nent beneath. The catkins are ¾–1 inch in length and ½ in
thick.

The only species of maple occurring in the basin is the *Ac*
glabrum. It is a shrub and small, straggling tree occasiona
reaching the maximum height of the alder. Its diameter is nev
more than 5 inches. Its leaves are either 3- or 5-lobed, circul
in outline, thin, and horizontally placed. The twigs and lea
stalks are of pink or reddish tinge. It inhabits somewhat sparing
moist spots and "draws" on the higher slopes.

The elder (*Sambucus racemosa*) occurs sparingly in mo
spots at altitudes of 4–5,000 feet, in company with the maple.
compound leaves and bright compound cymes of scarlet fruit a
ornamental wherever seen.

The buckthorn (*Rhamnus Purshiana*) is a shrub and small tr
to 15 feet in height, and somewhat scarce, occurring in low plac
Leaves 2 by 3 inches, oval, acuminate and serrate. The inedib
black fruit is ½ inch in diameter, and of unpleasant bitterne

The snowberry is probably either *Symphoricarpos racemosus*
S. oreophilus. It is a small shrub to 2 feet tall, quite abunda
in a few places. The leaves are ¾–1 inch in length, thin, smoo
oval, and borne on whitish stems. It bears white, watery, inedi
fruit of huckleberry size, placed in the axils.

Buckbrush is the largest constituent of the brush of the va
There are at least two species, of which *Ceanothus velutinus* is
most attractive. It possesses thick, oval to circular leaves.
foliage is so refulgent that it gives at all times of day the app
ance of being covered with a heavy dew upon which the
shines. The fruit, borne in a corymb, resembles a buckwheat
in shape and size. It attains a height of 2–5 feet, and rea
takes possession of "burns," often to the exclusion of ev
thing else.

Ceanothus sanguineus differs from its relative in smaller
age, that lacks altogether the remarkable reflective power of
latter. It more often takes possession of the steeper burnt slo
It has a habit of reclining down hill, and its exceedingly d
growth forms a barrier, to surmount which tries the stre
and fortitude of the forester to the utmost. Is it a wonder
the tender seedlings of a fire-killed forest perhaps never a
gain a foothold?

The nine-bark (*Opulaster monogynus*) is perhaps even n
prevalent than the foregoing, growing everywhere except
swamps and the densest shade. But by reason of its smaller
it is less obtrusive. Its leaves resemble those of the goosebe
Its inconspicuous flowers are borne in small flat clusters
corymbs.

THE GERMINATION OF THE MORNING GLOR

By Mary Ellen Tayler.

An article in the *Botanical Gazette* for August, 1905, by
fessor Beale, suggests certain germination experiments w
were undertaken by the writer upon the seeds of our com
morning glory, *Ipomoea purpurea* (L.) Roth, in connection
the study of the development and morphology of that species.
the unripe seed the embryo is bright green, but as the seeds ri
the embryo becomes yellowish or whitish. Characteristic
structures, such as palisade parenchyma and stomata, are pre
in the cotyledons before germination. Large spherical cav

filled with latex are found in the parenchyma, as has been reporte for *Convolvulus major* by Turnbull. Whether the chlorophyllou cotyledons with their leaf-like structure and the storage of late are ready for germination without further maturation and a perio of rest is a question which can be answered only by experimen tation. To obtain some light upon the subject, seeds of the morn ing glory, varying in age and maturity, were planted in garde soil and observations were recorded upon their germination. Th table below sums up these experiments.

Condition of the Seeds.	Number Planted.	Number Germinated.	Days in Germination.	Per Cent. Germinatin
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 gree seeds blossomed earlier, had shorter stems and produced fewe seed-pods by about one-half than did those raised under the san conditions from seeds having no chlorophyll in the embry When the plants so grown from immature green seeds had cease to blossom, those raised from mature colorless seeds were thrif and still forming buds and maturing flowers and fruit. Bot kinds of seeds were planted at the same time.

From the facts demonstrated above, certain conclusions ma be drawn. (1) Giving a resting period to the fully ripe see shortens the time required for germination. (2) Drying gree seeds shortens their period of germination. (3) Dry, matu seeds having no chlorophyll germinate more quickly than fres green seeds. (4) Fully matured and rested seeds germinate eight days or less, whether the period of rest be eight months, year, or ten years. (5) Twenty-five per cent. of matured seed retained their vitality for ten years. (6) The highest per cen of germination occurs in seeds one year old. (7) Seeds rip earlier upon plants grown from unripe seeds, but the vegetati parts are more scanty and the amount of fruit less than upo plants grown from matured seeds.

REVIEW.

Entomology, with special reference to its biological and econo aspects. By JUSTUS WATSON FOLSOM, instructor in entomolo at the University of Illinois. 8vo, pp. 7 + 485. Five pla (one colored and 300 figures). Philadelphia: P. Blakisto Son & Co., 1906. $3.00.

This is a book which does not belong to the how-to-know cl but which, nevertheless, may be suspected to be of value to learner in entomology, and will lead him, if real knowledge sought, to more than the superficial view of insects, such as so may have in spite of many years of diligent "pinning." treatment is biological, and as so much has been learned ab insects in the last few years which has not got into the books, author has had a rich harvest to draw upon. The reviewer not an entomologist, but is enough interested to feel that the b has a real value for him and infers this to be true for many oth at least as far as the large body of information is concerned. treatment of the speculative aspects of the science which, course, are those which it shares with the other, particularly n ural, sciences, is hardly as lucid as it might be, and these may have been sacrificed to a fuller and more satisfying discussion other matters. It is to be feared that the usefulness of book, good as it is, has been curtailed by the desire for compl ness. The world from the entomological point of view is too a subject for one work. A large and presumably fairly, if entirely exhaustive, bibliography covers nearly sixty pages, this will be of permanent usefulness to the student. The taxono of the subject is left to the other well-known works. Of the t of Packard's "Insects," but brought down to the present, it serve in the place of this well-known work.

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Fig. 40. Grove of *Cryptomeria* in the Botanical Garden at Tokyo. T
trees are handsome conifers resembling our cedars and redwoods. Fr
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 mu often travel a thousand miles or more to find one, we do n appreciate how much they mean for the advancement of botani knowledge. Our universities might well copy from Europe t plan of having such gardens, even if they can not be large. botanical garden not only serves as a place of instruction whe young men may study, but it may also become a place of histo interest.

The botanical garden at Tokyo is one which every botan should be glad to visit. In it may be seen plants very differe from those cultivated in Europe and America—the native plan of Japan and the far East, with, of course, a sprinkling of Eur pean and American species. Whoever sees the great Ginkg tree, now historic through the work of Hirasé, carries with h 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, esp cially in large parks and in the vicinity of temples. The tre

* Material from this tree was used by Hirasé in his researches fertilization in this species. Through his work the botanical world fi learned of motile spermatozoids in gymnosperms. Later Ikeno fou similar structures in *Cycas*, and, in our country, Webber's studies broug the knowledge of fertilization in *Zamia*.

grow to a great age and around some of them are clustered m
ories of episodes important in Japanese history. At the Ten
of Hachiman, in Kamakura, is a fine specimen with trunk ei
feet in diameter. Behind this in the year 1218 it is said the
sassin of the Shogun Sanetomo lay in wait for his victim.
fact the Ginkgo, or "icho" as the Japanese call it, takes
place of oaks and elms in English and American history.
foliage of the Ginkgo reminds the observer of the leaf segm
of the maiden-hair fern and Europeans sometimes call it "mai
hair tree." In autumn the leaves become a brilliant golden yel
and add not a little to the beauty of many a Japanese scene.

A few years ago the present botanical garden belonged to
of the Japanese aristocracy. With the downfall of the fe
system in 1868 came the relinquishment to the state of many v
able private estates, and in this way botanical garden and insti
became possible. The present botanical garden with its
equipped laboratories and many students is about twenty-five y
old. It is under the jurisdiction of the Imperial University.

The garden is located about a mile from the University cam
in the northern part of the city of Tokyo. Its position is offic
described in the University calendar as "Hakusan, Gotenma
Koishikawa, Tokyo." In size the garden is not large, there be
about forty acres, but most of this area is in a high state of c
vation. There are about three thousand species of living pla
In the main part of the garden the arrangement is by fami
according to the system of Engler and Prantl. Besides this
there is a group of medicinal plants and also an ecological se
of plants which grow in shady situations. A green-house
European construction is provided for the tropical species.
side this a number of plant-houses and arbors in native s
offer opportunity for the display of the well-known Japa
taste in floral arrangement.

Although the garden is attractive, it is by no means a n
show-place. Students in botany, entomology and pharmacy
required to spend certain hours in study there and those in s
lines gain a great amount of practical experience in this w
The high degree of specialization in the courses of the univer

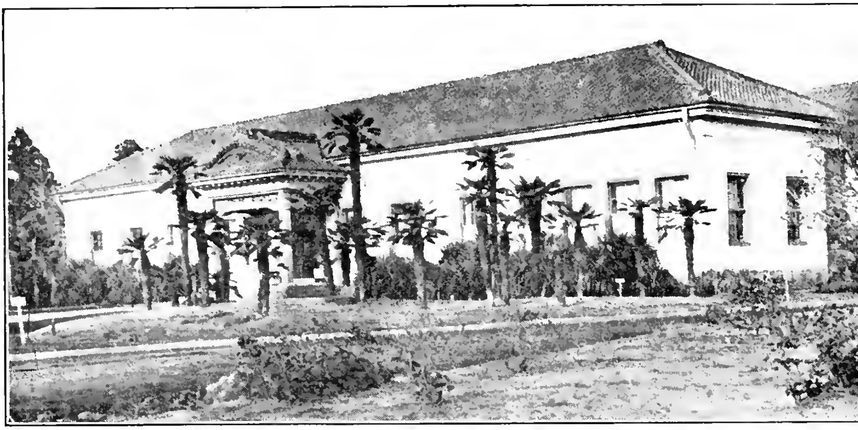

FIG. 41. The Botanical Institute Building, Tokyo Botanical Garden. Fr
a photograph by the author.

requires that students give most of their time to the major subje
and those who specialize in botany come to look upon the botani
garden as almost home to them.

The botanical garden, as an organization, is a part of t
"Botanical Institute of the College of Science." The director
the garden is the head of the department of botany, Professor
Matsumura.* Students of botany go into the garden every ti
they go to the laboratory, for the institute building is well with
the garden. Even the narrow specialist who spends his time loo
ing down a microscope tube must see something of the gard
and thus gain a larger view of botany in general.

If the reader should imagine that the laboratory building
strictly modern with hardwood floors, steam heat, high ceilin
and fine equipment generally, he would be much mistaken. Wh
a Japanese from one of the smaller cities is asked to name the be
building in his town he says "the school building." So, I dou
not, the average Japanese would think the botanical institu
building a very fine one, but it does not compare favorably wi
ordinary college and university buildings in America. It
warmed by stoves—I had almost said heated, but that would

* The writer is under great obligation to Professor Matsumura for
formation about the garden and for a number of the photographs repr
duced as illustrations in this article.

untrue—and such furniture as is there is very cheap in its c
struction.

But if the building and furniture are not of the best, ther
a good equipment in instruments and chemicals. The men of
faculty and the advanced students are indefatigable workers
offer an example of industry to the young men studying in
department. True, the students need much encouragement
cause theirs is a hard path to travel. In America and Europe
student finds it hard enough to become acquainted with a sub
so bound up in terminology and nomenclature, but it is much m
difficult for a native of Japan.

To the Japanese boy all difficulties are increased on accoun
the foreign tongue and foreign alphabet employed by botan
Gray's "Lessons in Botany" is much used by beginners, altho
the more modern works are now gaining recognition. Ne
all the species mentioned in the text-books are unknown to
Japanese student. Usually he has almost no knowledge of L
or Greek. So the technical terms, partly self-explained to
classical student, must be learned separately. Instruction is g
through the medium of the Japanese language, yet the lectu
make continual use of English words, especially in describ
physiological processes. While the student takes his notes
Japanese he must very often put down a word or phrase in
other language written with different characters and havin
totally foreign appearance.

Some very good morphological and physiological work
been done in Tokyo, but it seems to be along taxonomic lines
most energy is directed at present. An attempt is being mad
gain a good knowledge of the native plants of the empire,
extensive herbarium collections have been made in recent ye
The marine algae have received most painstaking attention f
Mr. K. Yendo* and others. The seed plants have been stu
by Professor Matsumura and his associates. Although the J
anese have not spent much time in hair-splitting discussions

* The writer wishes to acknowledge his indebtedness to Mr. Yendo
information on many points of interest concerning the botanical ga
and also many other things Japanese.

nomenclature they have really done very close and careful work the description of species. Some of the publications of th Botanical Institute are very handsomely printed and illustrate

Japanese botanists have an interesting flora with which work. The very moist climate permits the northward extensio of many southern forms. To the botanist Japan is a land of co trasts. At one glance he may see bamboos and camphor tre and fields of rice, all reminding him of the tropics, while with turn of the head he may have brought to his mind his America or European home with the sight of barley and wheat fields groups of pines and maples. Japan has been well characterize as a "kingdom of magnolias, camelias and aralias." These gene and their allies are well represented in the botanical garden. On of the most striking features noted by the present writer on th occasion of his first winter-day visit to the garden was a large be of *Fatsia japonica*, one of the Araliaceae, in full leaf. At th same time a few of the *Camelia* flowers, a little more hardy tha the rest, were open to view. The *Magnolia* buds also, though was early January, had swelled enough to show their crean colored petals.

The people of Japan are fond of "gardens" and so the botanic institute must needs have a Japanese garden for show purpose While the principal part of the botanical garden is given up beds of herbs and shrubs in European style—or rather lack style—there is this charming little plot of ground arranged wit the most exquisite native taste. Here are no geometric walk no ill arranged flower masses, no array of stiff sign-boards. In stead there are winding walks, stepping stones through gliste ing pools, rustic bridges, dwarfed trees of symmetrical form an handsome dark-green shrubs trimmed in rounded masses.

A true Japanese garden is something to delight the eye in i daintiness and good taste. The foreign botanist enjoys this ex hibition of horticultural art so unknown to him, and he admire the skill of the gardener who makes his trees and shrubs gro just as he wants them to grow. He admires, too, the curious an unfamiliar trees and shrubs which are there. Flowers there ar none. To most people a garden without flowers suggests Haml

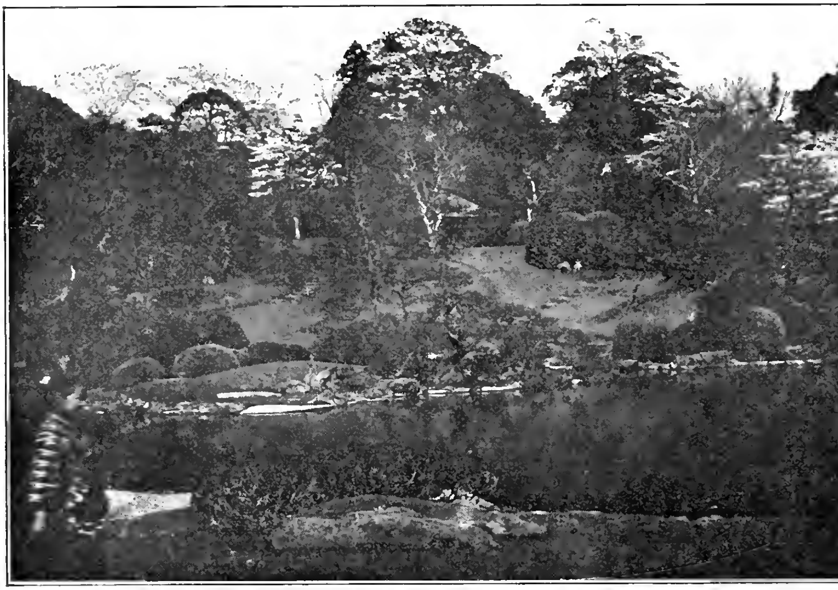

FIG. 42. Landscape garden in pure Japanese style. From a photog
furnished by Professor J. Matsumura.

with Hamlet left out. Nevertheless there is no sense of inc pleteness in looking at a Japanese garden. Such a garden whole landscape in miniature, and it is intended by its arrangem to give an idea of largeness which it does not possess.*

The particular garden which we are considering is not m over two acres in extent. The ground is rolling, and there deep basin with a small pond. In this " landscape garden " visitor sees nothing of the outside world, which is adroitly hid by the massing of trees and shrubs along the higher ground. is this landscape garden which makes the Tokyo botanical gar different at all seasons from all other gardens in the world. course the cherry blossoms and other special features are n conspicuous at certain seasons, but the landscape garden is be tiful at all times.

While the Japanese delight in gardens without flowers, yet t enjoy flowers too. Everyone knows about Japanese " ch

* The writer wishes to acknowledge his indebtedness to Mr. Cham lain's " Things Japanese " from which he has taken certain points use this paragraph.

blossoms," but few people have any idea of their beauty or of t
number of trees planted in the cities of Japan. These blosso
are pink and some are doubled to a great extent. Of course th
do not bear edible fruit.* In the botanical garden at Tokyo the
are great rows of these trees flanking the open spaces. Durin
blossom-time thousands of visitors come to the gardens w
would not think of coming at other times. Doubtless some m
see only the cherry blossoms, but some may become interest
in other things as well. In Japan, as in the western worl
science can be made popular by using appropriate means.

In such an account as this it would not do to omit mention
the Cryptomeria grove in the garden. These trees are handso
conifers resembling somewhat our cedars and growing very t
and straight. Visitors to the sacred city of Nikko in northe
Japan are always impressed with the "cedars," but the trees
Tokyo are quite as handsome although smaller. The writ
of this article holds no more pleasant memories than of stro

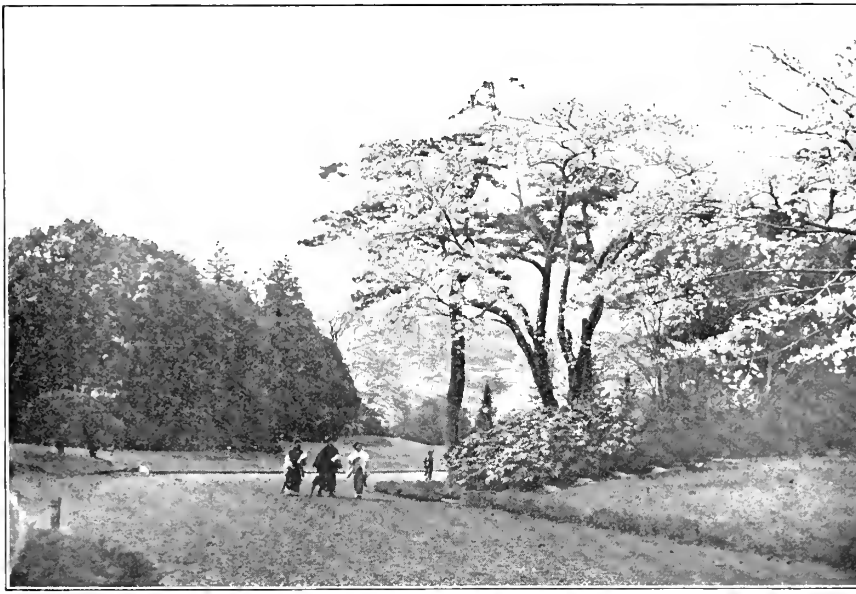

FIG. 43. Cherry blossoms (*Prunus yedoensis*) in the Tokyo Botanic
Garden. From a photograph furnished by Professor J. Matsumura.

* Two or more species of *Prunus* are cultivated by the Japanese f
ornament.

through this little grove. Each day in the garden one can w beneath the Cryptomerias and find new pleasure and satisfact

On the whole the botanical garden at Tokyo is not a g institution, but it is one of which any university might well proud. It answers the purposes of study very well. It is so ranged that the most satisfactory results are obtained with c paratively little money outlay. For native students of botan is of the greatest importance since it enables them to bec acquainted most readily with their own flora.

Every student of botany should be a traveler. Every trav who would appreciate the country which he sees should k something about plants. The easiest way to gain an introduc to Japanese botany is by study in the botanical garden at To American botanists especially should know something of "land of the rising sun" whose plant life can here be so ea studied.

LICHENS: THEIR ECONOMIC ROLE.

By Professor Bruce Fink,

Miami University.

Far back in the very distant past some fungi took to a met of life very different from that of the great majority of clo related species. That peculiar digression was an intimate ass ation with certain algae, green or blue-green. The symbi relationship entered into was doubtless at first accidental, bu proved beneficial to fungus or alga or both, and has been perp ated. When the first such association of algae and fungi t place will never be known, but some undoubted fossils of lich have been found as far back as Tertiary times,—perhaps 2,000. years ago. Since the time of first association of alga and fun in a symbiotic relationship, that relationship of the chlorophyl plants and fungi entering into the symbiotic partnership has come more and more intimate as age after age has passed, u now some investigators regard lichens as autonomies or morp

logical units rather than symbiotic colonies of algae and fun
growing together.

But it were folly for us to enter at length into a controver
that has filled volumes. Whether the lichen may be regarded a
plant in any true sense or not, we may speak of the " lichen plan
in order to avoid unnecessary circumlocution. Also, certa
mycologists consider witches' brooms, burls, swellings, due
fungus infection, etc., as individuals, at least in a physiologi
sense, and if this view is well founded, lichens have surely add
to definite function constancy of morphological characters a
may as reasonably be considered autonomies, both physiologi
and morphological.

While we may not regard as settled the question of the natu
of lichens, there are many questions regarding the morpholo
and physiology of these, at least so-called plants, that are of ve
great interest to the biologist, and it is worth while to recall
relation of lichens to other things in nature from the point of vi
of utility or detrimental effect. In giving this popular stateme
the present writer can do no more than bring together once mo
some of the facts that have repeatedly appeared in print.

Lichens, like the higher chlorophyll-bearing plants, take lar
amounts of CO_2 from the air in the processes of nutrition; th
build up lichenin, a carbon compound very similar to starch, a
return to the atmosphere as free oxygen the portion not need
in the production of the lichenin. It is estimated that the hig
plants take half of their food thus from the air and the other h
from the earth through the roots. It was formerly supposed t
lichens took a very small proportion, if any, of their food fr
the substrata; but that view is certainly incorrect, at least rega
ing many lichens. However, it is quite likely that most lich
take a smaller proportion of their food from the substratum, an
larger proportion from the air than do the higher chloroph
bearing plants. The algal cells of the lichen-partnership do
work of building up lichenin, while the fungal portion of
lichen furnishes protection to these algae and also takes more
less of crude or elaborated food materials from the substratu
Thus the lichens, in the ordinary processes of nutrition, pur

the air by extracting CO_2, the oxygen of which will not answ the purposes of respiration so long as it remains in compositi with the carbon, and give back to the air a portion of the oxyg in the free condition. Therefore there is some ground for t old notion that the air is especially pure where lichens are abu dant. Even travelers in wild regions have sought such places camps and resting places over night, and certain it is that lichens are very sensitive to conditions of the atmosphere. Th tend to disappear in places where man congregates in large nu bers, and are becoming scarce near our cities and larger tow This is due partly to the disturbance of substrata, but it is also tr that the dust and impurities of the air about cities are in so way unfavorable to the lichens. Doubtless the dust fills the po of the thallus and interferes with the passage of gases, wh some impurities interfere with nutrition or breathing or both. is not the intention to give the impression that lichens are great conservators of atmospheric purity, but rather that th contribute their share of work toward this end and that it wou be to our advantage if they could be induced to grow mo abundantly in and about cities.

It is also well known that certain crustose lichens are the fi plants to attack rocks, and that they aid greatly in the reducti of rocks to soil. It would seem from superficial observation th some lichens might begin to grow on perfectly firm rock, an gaining a foothold, reach their full size and produce fruit while t rock is still in a firm and wholly undisintegrated condition. F instance, on the very hard Sioux quartzite in northwestern Io and in southwestern Minnesota, the writer has found liche growing on perfectly smooth surfaces supposed to have been p ished by wind before, or shortly after, the close of glacial tim Yet this rock shows to the eye or lens no evidence of disinteg tion and is, macroscopically, in exactly the same condition und the lichens as elsewhere. But in spite of this, it is not genera supposed that the rhizoids of the lichens ever penetrate perfec firm rock, but rather that the lichen gains a point of attachme perhaps in microscopic openings, and then begins to secrete acid which slowly disintegrates the rock, the rhizoids penetrati

deeper and deeper as the work of the acid makes a way for th
In many other regions where the rocks have not yet been
turbed may be found crustose lichens growing on rock that
not yet fallen to fragments, though so rotten for several inc
below the surface that it can easily be ground to fine parti
under foot. Thus the work of rock disintegration is aided in
early stages by the lichens and especially by the crustose for
Here again we do not intend to convey the impression that th
lichens are the only agents of rock decay, but merely that they
the first visible organic agency and really play an important p
in the process. Atmospheric agencies as rain, winds, changes
temperature, etc., are certainly not to be disregarded. As the
integration goes on and the rock at the surface is gradually
duced to small fragments and soil, the lichens decay and add th
quota of humus. Then on this bit of prepared earth, in so
crevice or flat surface of rock, the foliose and fruticose lich
and certain mosses begin to appear and carry on the work beg
by the crustose species. Then in turn, appear some ferns, her
ceous seed-plants and finally shrubs and trees, first in the crev
and finally spreading until the whole surface is covered and
lichens are largely replaced by larger vegetation. All this m
be most beautifully seen in many places in Minnesota, Wiscon
Michigan, New England and in other parts of America.

Let us consider the uses of lichens as food. It is doubt
whether even the wild animals eat lichens to any considera
extent so far south as the pineries of northern United States,
the reason that there is too much of other available plant fo
But it would not be surprising if some careful observations
winter would show that the moose, caribou and deer of th
regions eat the "reindeer moss," *Cladonia rangiferina* and ot
large *Cladonias* to some extent; for these plants are common a
luxuriant. But farther northward the reindeer moss and so
other lichens are surely important as food for both man a
lower animals. *Cladonia rangiferina* and two or three clos
related species really form the principal food of the Laplande
reindeer and become there as important as some of the grasses
our prairies. This happens for the reason that larger plants

not drive out the lichens so effectually at the north, so that t "reindeer moss" and some other lichens literally cover lar areas as do the grasses in other places. Some suggestion of th wonderful lichen growth may be seen in northern Minneso Michigan and Wisconsin, where patches of such lichens may found covering an acre or more of ground, and in more northe regions, both in America and Europe, the reindeer and other wi and domestic animals depend more or less upon these lichens f their food supply.

Lecanora esculenta grows loosely attached to the rocks in hig places in northern Africa, is carried long distances by the win and falling in areas where food is scarce, is eaten by the inhab tants, both man and lower animals. This species is supposed have been the manna of the children of Israel. Nor is this t only lichen commonly eaten by man, for *Cetraria islandica,* plant found in northern United States, forms an important pa of the food of the people of Iceland, and is eaten also by the domestic animals. This plant is especially rich in the peculi starch-like compound so commonly built up in lichen tissues. Al some of our *Gyrophoras* and other common lichens as *Ramali calicaris, Parmelia physodes, Peltigera canina,* and *Evernia pr nastri* have been used for food by man. From some of the and certain other lichens may be extracted a substance very li gum-arabic. The nutritive qualities of the lichens is due main to the lichenin or starch-like material already mentioned as bein built up in the processes of nutrition. But there is a bitter su stance also found in lichen tissues, which often gives an unpleasa taste and is irritating to the digestive tract. This may be remov by thorough washing in water or some alkali, when the plan may usually be eaten with impunity. Arctic explorers, northe hunters and trappers, the inhabitants of such countries as La land, Labrador, Greenland, Iceland, Norway, Sweden and Fi land, as well as travelers in the deserts of Africa, are very gl to have such food for themselves and their domestic anima When grains or potatoes are at hand, the lichens may be pow dered and mixed with these articles of food, and a very palatab bread may thus be made; or the bitter principle may be remov

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 purpo
but few of the supposed medicinal qualities have been abl
stand the test of modern medical examination. Thus the "
lichen," our common *Peltigera canina,* was formerly suppose
be a curative of hydrophobia, hence the specific name. Like
our *Sticta pulmonaria* was supposed to cure pulmonary disea
while the well-known *Usnea barbata* was supposed to pro
the growth of hair and to be a sort of cure-all. And as the n
canina came from the Latin for dog, so we have in *Evernia*
pina a specific name derived from *vulpes,* the Latin for fox, tho
the plant is said to have been used mixed with other substa
to poison wolves rather than foxes. Lindsay, in his "Pop
History of British Lichens," states that *Cetraria islandica*
nished preparations which were to be found in the drug store
England at the date of publication of his volume, 1865, as c
tives for dyspepsia, and we still find *Cetraria* given as a remed
our latest dispensatories. It is the bitter principle of the lic
that is supposed to give the medicinal value, and it has been
in fevers as a tonic and as a purgative as well as in the other
mentioned above. Also alcohol has been frequently made f
lichenin by fermentation.

But turning from the use of lichens in medicine, it may be
that their use as dyes is more worthy of our attention. Dye
various colors have been extracted from lichens and are
being used in various ways. These colors are usually reds,
ples, or blues, and they are used for coloring cloth, wood, pa
etc. In Europe these dyes have been quite largely used
coloring homespun cloth and yarn, our common *Parmelia s*
tilis being commonly used and producing various colors acc
ing to the method employed in making the dye. In *Evernia*
pina the yellow coloring matter is ready-formed in the tha
and the same may be said of the beautiful yellows and orange
our *Theloschistes* and *Placodiums.* Brown colors are also re
formed in many lichen thalli, are easily extracted and have
used for home consumption. But most of these are not to be

in sufficient quantity to manufacture the dyes in large quantiti for the markets. However, *Roccella tinctoria*, a lichen found o our Pacific coast and on various coasts of the old world, produc a pigment which has been known, by one name and another, sin earliest historic times. Orseille is one of the names applied to th dye, and litmus is another name for it. This is no doubt th "blue and purple" of the Old Testament, and in more rece times the same dye was extensively used in France for colori silk. At the present time paper is colored with a neutral solutio of the dye and used commonly in chemical laboratories as litm paper. This paper forms a delicate test for acids and alkalis, th acids coloring it red and the alkalis restoring the blue colo Litmus is also found in the market as a carmine powder and as a indigo-blue. In obtaining these lichen dyes, the thallus is pu verized, and then some alkali is applied to extract the dye. Litm is made chiefly in Holland.

In closing, something should be said regarding the relatio of lichens to trees. In France and other countries of Europ foresters have supposed that lichens are injurious to the tree and have to a limited extent practiced scraping the larger one from the bark, along with certain large fungi. However, will be seen readily enough that it would be difficult to accom plish much in this way in large forests, even were it known tha the lichens were very injurious to the trees. In our own countr M. B. Waite, while experimenting with fungicides on fruit tree noted also that the Bordeaux mixture killed the lichens ver effectually. He was not at all certain that the lichens were in jurious to the trees, but thought that they might at least interfer with the functions of the bark. It is true that the more conspicu ous foliose and fruticose lichens are more common on unhealth trees than on thrifty ones, but the question still remains as t whether the lichens have worked injury to the trees, or wheth the unhealthy trees are more easily penetrated by the rhizoid of the lichens. Also it may be that the unhealthy trees furn ish for the lichens some food material not present in the health trees, or not so easily obtained as from the unhealthy one In short, it probably is not worth while to take the time to r 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 evid enough that these plants are of some economic importance. A from direct interest in economic problems, it is hoped that brief presentation may add somewhat to the more important pects of lichenology, viz., taxonomic, morphological, ecolog and physiological. An excellent statement regarding the use lichens may be found in Lindsay's "Popular History of Bri Lichens," and the briefer statement in Schneider's "Guide to Study of Lichens" is also very interesting and instructive.

THE VEGETATION OF BALD KNOB, ELMORE COUNTY, ALABAMA.

By Roland M. Harper,

Geological Survey of Alabama.

Wetumpka, the county-seat of Elmore County, Alabama situated on both sides of the Coosa River, just at the fall- (inland boundary of the coastal plain), and about 200 feet ab sea-level. The river crosses the fall-line at such a small an 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 crystalline or metamorphic region, while the newer part ac the river is in the coastal plain, the demarcation between two physiographic provinces being very sharp at this po For several miles west of Wetumpka the country is quite as in many other parts of the coastal plain, but immedia east of the town a steep hill of quartzite and gneiss, kno as Bald Knob, rises rather abruptly to a height of some feet above the river.* The highest summits of this hill thickly strewn with angular fragments of quartz, with the

* These topographic features are plainly shown on the U. S. Geolog Survey's topographic map of the Wetumpka (erroneously spelled tumka) quadrangle, published in 1903.

turned edges of almost vertical strata of rotten gneiss expos in places. The slopes are similar but are covered with more less soil and humus, and are furrowed with numerous ravin

A stay of two or three hours on Bald Knob on December 1905, revealed some interesting examples of succession of veg tation, with almost all gradations between the most xerophy and the most mesophytic types. The vegetation of the wh hill, except a portion of the lower slopes close to the town, practically in a state of nature, and therefore in excellent co dition for study.

Although the flora of the dry summits passes by imperceptil gradations into that of the rich ravines, the whole can be group into three fairly definite habitat elements, namely, the veget tion of summits, dry slopes or radial ridges, and ravines. each of the three following habitat lists the component speci are separated into trees, shrubs and herbs, and the members each of these three structural classes are arranged in order abundance, as nearly as could be determined with such a bri examination.

On the highest summits the following species were noticed: Trees *Pinus palustris* Mill., *Quercus Catesbaei* Mx., *Q. Marylandica* Muenc *Q. brevifolia* (Lam.), Sarg.; Shrubs—*Vaccinium nitidum* Andr., *Sy plocos tinctoria* (L.) L'Her., *Gaylussacia dumosa* (Andr.) T. & *Ceanothus Americanus* L.; Herbs—*Pteridium aquilinum* (L.) Kuh *Afzelia cassioides* (Walt.) Gmel., *Cracca Virginiana* L., *Chrysopsis gran nifolia* (Mx.) Nutt., *Andropogon argyraeus* Schult., *Gerardia* sp., *Lesp deza hirta* (L.) Ell., *Smilax pumila* Walt., *Sericocarpus linifolius* (L BSP., *Polygala Curtissii* Gray ?, *Coreopsis major Oemleri* (Ell.) Britt

Of these *Pinus palustris* greatly exceeded in bulk all the rest of t vegetation combined, but itself made a very open stand, so some idea the sparseness of the floral covering (from which the hill doubtless tak its name) can be had. (See Fig. 44.)

On the dry slopes, or ridges between the ravines, the following speci prevailed: Trees—*Pinus echinata* Mill., *Quercus Marylandica* Muenc *Q. prinus* L., *Q. velutina* Lam., *Q. minor* (Marsh.) Sarg., *Hicoria* s Shrubs—*Batodendron arboreum* (Marsh.) Nutt., *Ascyrum hypericoid* L. ?, *Gelsemium sempervirens* (L.) Ait. f., *Callicarpa Americana* L Herbs—*Chrysopsis graminifolia* (Mx.) Nutt., *Andropogon scoparius* *Solidago odora* L., *Aster patens* Ait., *Meibomia* sp., *Chamaecrista* s *Aristida purpurascens* Poir., *Koellia incana* (L.) Kuntze, *Elephantop tomentosus* L., *Eupatorium aromaticum* L., *Mitchella repens* L., *Antenna plantaginifolia* (L.) Richards., *Solidago petiolaris* Ait. ?, *Panicum Port*

rianum Nash ?, *Sericocarpus asteroides* (L.) BSP., *Sporobolus junc*
(Mx.) Kunth.

This vegetation is much denser and somewhat richer in species t
that of the summits.

In the shady ravines, where humus was naturally abundant, the veg
tion was chiefly of the familiar type which can be seen in rich woods
on bluffs almost anywhere in the Eastern United States. The follow
species were observed: TREES—*Quercus alba* L., *Fagus Americana* Sw

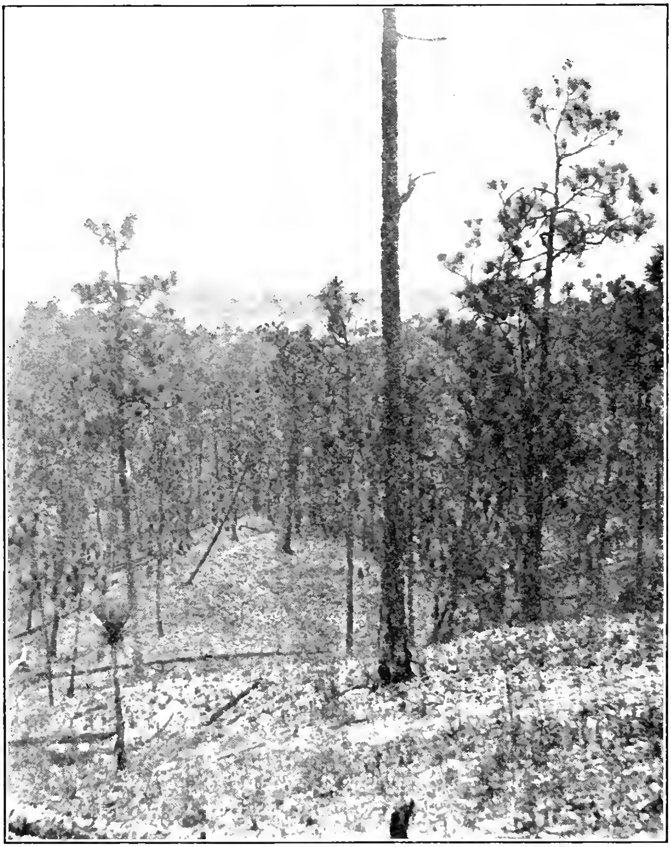

FIG. 44. Scene near highest summit of Bald Knob, showing sparcity
vegetation. Trees nearly all *Pinus palustris.*

Liriodendron Tulipifera L., *Quercus Prinus* L., *Ilex opaca* Ait., *Cor*
florida L., *Oxydendrum arboreum* (L.) DC., *Tilia* sp., *Liquidam*
Styraciflua L., *Acer leucoderme* Small; SHRUBS—*Hydrangea quercif*
Bartr., *H. arborescens* L., *Philadelphus* sp., *Kalmia latifolia* L., *Bign*
crucigera L., *Hamamelis Virginiana* L., *Smilax lanceolata* L., *Berche*
scandens (Hill) Trel., *Callicarpa Americana* L.; HERBS—*Polystich*
acrostichoides (Mx.) Schott., *Adiantum pedatum* L., *Asarum arifolium*

Mitchella repens L., *Aster Camptosorus* Small, *Smilax pumila* Wa *Tipularia discolor* Nutt., *Solidago caesia* L., *Epiphegus Virginiana* (I 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 outcro and of stream-beds, but these were so small that their flora not worth mentioning here.

If now we examine the characteristics of the three habit groups above defined and of their components we shall fi some interesting relations between them.

Taking first the total ranges of all the species in each grou we find that nearly all of those growing on the summ are common inhabitants of the pine-barrens and other pa of the coastal plain; and a few of them are so nearly confi to the coastal plain that I had never seen them outside of it b fore. The plants on the dry slopes can also nearly all be fou in some part of the coastal plain, either in dry pine-barrens in dry woods in the Eocene region farther inland, but the m jority of them are likewise common throughout the Piedmo region of the southeastern states (at the extreme southweste edge of which Bald Knob is situated) as well as on the southe slopes of the Blue Ridge. Few of the species growing in vines are pine-barren plants, though nearly all of them occ locally in hammocks or on bluffs in some parts of the coas plain. With few exceptions they have a pretty wide distributi in the Alleghanies and Piedmont region, and several of th range as far north as Canada.

Looking at the vegetation of Bald Knob from the standpo of historical development, it is pretty evident that as the l is gradually lowered by erosion, and at the same time hum accumulates on the slopes, the summit flora must be gradua giving place to that now inhabiting the dry slopes, and the lat to that of the ravines, thus furnishing an excellent example natural succession. The same reasoning, in connection w the discussion of ranges above, strengthens the evidence alrea gathered from other sources that the vegetation of the pi barrens represents a pioneer or transient type, while that

the much older metamorphic region approaches the "mes
phytic climax" condition described by Dr. H. C. Cowles * a
subsequent writers. While the xerophytic extreme (for Ea
ern North America) is pretty well exemplified on the sumn
of Bald Knob, the ravines still lack considerable of reachi
the mesophytic climax condition, as is shown by the consid
able number of evergreens (about one-third of the list), wh
can hardly be considered typical of the climax forest. All t
perhaps indicates that Bald Knob has been submerged or oth
wise cleared of vegetation at a considerably later period th
most of the Piedmont region, which possesses one of the m
ancient floras in existence.†

Similar examples of succession can be found on many otl
hills in various parts of Georgia and Alabama, both in the mou
tains and in the coastal plain,‡ as well as at intermediate poin
though I have come across no other which exhibits such a xe
phytic extreme as Bald Knob. This tends to support Dr. Co
les's contention that the character of the vegetation of any
cality is to a considerable extent independent of the geologi
formations; a hypothesis which however is still subject to ma
limitations, which it is not necessary to discuss here.

RICCARTON BUSH.

Riccarton Bush is especially noteworthy as being the sole
maining portion of that vast forest which, at one time, must ha
occupied much of the country near the coast of Canterbury, N
Zealand. Notwithstanding its small size, the bush is still in
remarkably good state of preservation, and shows admirably ma
of the peculiar characteristics of a New Zealand forest. T
dominant tree is the kahikatea; but while this gives the stamp

* Bot. Gaz. 31: 78–82, 178–180. 1901.

† See Torreya 5: 207–210. 1905. The lists of plants observed on B
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 Torreya 5: 56. 1905.

the physiognomy of the forest, other large trees are not wanti
Such are the totara, the matai, the hinau, and the pokaka. Th
are plenty of other smaller trees and shrubs. The tarata, with
beautiful glossy leaves, the curious lancewood, the elegant i
tree, the milk-tree, which exudes a white fluid from beneath
bark, the true matipou with its red twigs, the pepper-tree with
blotched leaves, the lovely white-flowered kaikomako, the char
ing lacebark—to mention some of the commoner plants—are
there. Climbing plants, which give such a tropical aspect t
New Zealand forest, are in profusion, the various classes, such
twiners, tendril-climbers, scramblers and root-climbers, be
represented.

Many of the plants exhibit the remarkable phenomenon of pa
ing through two distinct forms in the course of their developme
juvenile and adult plants looking like distinct species. The pok
illustrates this admirably, and in the bush the distinct juvenile
adult forms are much in evidence, while one very old tree has p
duced from its naked trunk a large growth of the juvenile sta
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
present vitality, seedlings are abundant in many places, and i
especially pleasant to record that those of the kahikatea are parti
larly numerous.

Finally, it may be pointed out that no other city in New Zeal
possesses so near its center a piece of pine forest, primeval so fa
its large trees are concerned; and not merely this, but the last pi
of primeval forest of its kind upon the face of the earth!

A timely movement has been started in New Zealand to prese
the Riccarton Bush. A committee has been appointed to furt
the proposal to acquire the forest as a Public Reserve, and
government of New Zealand has voted £1500 toward its
quisition.

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 Cali fornia has been enriched by nearly 125,000 specimens of the flo on the Pacific coast, and by a library of over a thousand volume As a result of this munificent gift the facilities for research wo at the university are practically doubled, and it now possesses th most complete representation extant of the flora of this regio

Mr. and Mrs. Brandegee have for years given their time to th scientific study of the plants of western America. During th time their herbarium has steadily grown in size and importanc specimens having been obtained by means of collecting trips, b purchase, and by exchange. Nearly all of the more importa sets of plants from the southwestern United States and fro Mexico have been acquired, among which may be mentioned mo of the types and duplicate types from the Orcutt and Clevelan collections; a set of Bebb's willows; nearly all of the Mexica plants distributed by Lemholtz, by Palmer, by Pringle, Parry "Manzanitas and Chorizanthes," and many others no long obtainable. Another marked feature of the collection is its ric ness in sole remaining duplicate types, the originals of whic were lost in the recent San Francisco disaster.

The botanical library comprises, besides five hundred sets "Zoe," a biological magazine published by Mr. Brandegee, ma rare volumes—Lindley's "Botanical Register," in thirty-three vo umes of colored plates, Hooke's "Icones Plantarium," a comple series of "Linnaea," and many books on Mexican botany.

REVIEW.

Handbook of Flower Pollination, based upon Hermann Mueller work, "The Fertillization of Flowers by Insects." By Dr. PAU KNUTH, translated by J. R. AINSWORTH DAVIS. Vol. I., Intro duction and Literature. Pp. 19 + 382. Large 8vo. Illu trated. Oxford: The Clarendon Press, 1906.

This book, which is gracefully dedicated to the memory of th

founders of this aspect of plant biology, Christian Konrad Spr
gel and Hermann Mueller, is a rich treasure to the student, p
fessional and amateur alike, and should give a new impulse to
study of the subject with which it treats and, what is still m
to be valued, should direct the student into a far more crit
attitude than is, regretfully, usually characteristic of the aver
observer of the interactions of flowers and insects. The chap
on methods of research is, therefore, especially welcome in s
a volume, because it not only shows how it is to be done, b
that it may be done, and that with little special technique
training. It is a field in which, with this book for referen
the earnest amateur may find himself at home. The introd
tion, which follows an historical review of the subject, is
analysis of the facts at present understood, both from the
tanical and zoological point of view. A most stupendous b
liography occupies 161 pages, and it must be confessed that
relevancy of the works cited is not equally obvious. "Bett
however, "the excess than the defect."

I

Volume 9 Number

The Plant World

A Magazine of Popular Botany

DECEMBER, 1906

THE TOUMEY CACTUS GARDEN.*

By Professor J. J. Thornber,

University of Arizona.

The Toumey Cactus Garden is one of the most unique featur
to be found on the grounds of the university at Tucson, Arizon
However tame and insignificant it may appear to the native wh
is acquainted with boundless areas of like plants, the garde
represents to the botanist a group of most interesting specie
growing under essentially the same natural conditions that hav
contributed for ages to their present highly specialized adaptation
It is not too much to state that outside of the southwest the mai
tainance of so representative a collection of xerophytes is im
possible in our country, except at enormous expense.

Planting in this garden was begun during the years 1894–189
by Professor James W. Toumey, then botanist of the Arizon
Experiment Station. Its location on the university ground
is nearly central, being immediately in front of the main un
versity building and adjacent to the principal approach from th
west. In general outline it is heart-shaped, and in area some
what less than an acre. In addition to the rather prominent loca
tion which it enjoys, it is rendered more striking by the contras
which obtains between its spiny, and for the most part, leafles
desert forms and the refreshing green lawns, shrubs and tree

* Illustrations, by courtesy of the *Popular Science Monthly*, from a
article by Professor F. E. Lloyd, entitled "A Botanical Laboratory in th
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, the
dividing the ground into many small areas a few to twenty

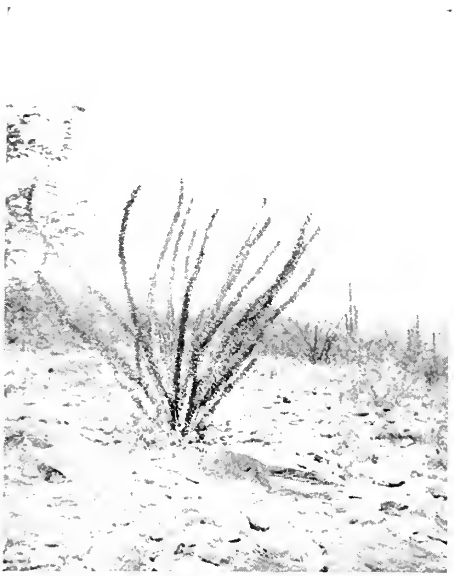

Fig. 45. Ocotillo.

in extent. It will be in
esting to note here that
soil for this purpose was
essarily hauled in, the
cover in the garden ave
ing but twelve inches in de
below which there is a m
or less impervious calcar
deposit several feet d
known locally as "calic
By virtue of the small ri
already noted, the excess
water from the torrential s
mer showers and the less
quent winter rains is
vented from running
Thus all the annual rain
which averages about tw
inches for Tucson, and which is usually sufficient for the
mal growth of these plants, becomes available for them.
garden is, however, irrigated occasionally, *i. e.*, during per
of lessened precipitation or of prolonged drought, the inten
being always to supplement rather than supplant the scant r
fall. As a matter of fact it has never been found needfu
water the garden oftener than once or twice a year, notwithsta
ing that periods of six months will pass with a precipitatio
two inches or less.

About six hundred numbers have been planted, represen
one hundred and fifty species from Arizona, California, Te
and a few from Mexico and South America. Most of these pl
from the two latter countries, and some from higher elevat
have died out, owing, perhaps, to unfavorable conditions.
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 or
inal size. In addition to the cactaceæ there are in the gar
other equally interesting xerophytes—the agaves, yuccas,
sotol, ocotillo, creosote bush, and palo verde.*

The saguaro or giant cactus (*Cereus giganteus*) is easily
most striking plant, and is, perhaps, the best known to the visi
so far as it is possible for one to become acquainted with pla
through literature. The larger of the specimens in the gar
are about fifteen feet high and as yet unbranched, though in
foothills about Tucson mature candelabrate branched ones th
feet or more in height are very common.

The rather large cream-white flowers of the saguaro are p
duced in abundance toward the tips of the spiny, fluted, colu

FIG. 46. Saguaro flower and fruit cut longitudinally.

like trunks during portions of May and June. The fruit, wh
is ovate and about the size of a hen's egg, begins to mature ea
in July, the ripe ones dehiscing from above, thus exposing to
birds' delight their juicy, crimson though somewhat inciped c
tents, studded with many small black seeds. At this stage
fruit with its split, reflexed pericarp, the inner wall of which
also bright red, suggests to one a showy pomegranate flow
In passing it will be interesting to note that the saguaro flo
was adopted as the territorial flower by a recent Arizonian le
lature.

The ocotillo, candle flower, or coach-whip cactus (*Fouqu*
splendens) is another equally interesting and distinctively sou
western species. It is abundant enough in most of the foot

* For a description of the palo verde see PLANT WORLD, vol. 9,
7, July, 1906, p. 165.

country of southern Arizona to give decided character to th landscape. Its scarlet flower, produced during the spring montl in terminal contracted panicles six to nine inches long, sugge many burning candles. Its numerous, spiny unbranched sten diverge at quite uniform angles from a common base, thus givin to the plant the characteristic, sharply outlined, obconical forr During the flowering period it appears at some little distance as green, inverted cone with a bright red base. With a reasonab

FIG. 47. The biznaga, or barrel cactus contains a good deal of water times.

rainfall its stems become clothed with many delicate green leave which turn yellow and fall off at the approach of another dı period. The first young leaves have been noted on the plants i the garden forty-eight hours after watering.* The classificatic of *Fouquiera* has given taxonomists no little concern. The re cent authorities, Engler and Prantl, regard it as a member of th

* F. E. Lloyd, "Artificial Induction of Leaf Formation in the Ocatillo *Torreya*, Vol. 5, No. 10, October, 1905. Reprinted in The PLANT WORL vol. 9, no. 3, March, 1906, p. 56.

tamarisk family; others have classed it with the phlox fam the purslane family, the orpine family, and with the Frankeniac

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 hou and close shortly after sunrise.

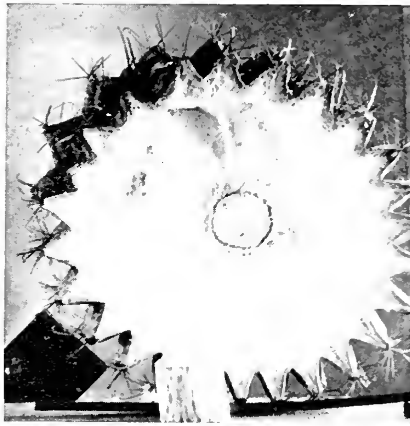

FIG. 48. Biznaga, or barrel cact cut across to show the thick, wh water-bearing tissue. The sn center is the wood and pith.

Other plants of special interest are the chollas or cylindr puntias and the biznagas or fish-hook cacti, the barrel-shap bodies of which almost without exception lean southward. The plants are virtual reservoirs scattered here and there over t arid mesas, from which the thirsting traveller may obtain wat in times of need. From the large fleshy interiors of these plan is made the delicious cactus candy, the "cubierto" of the loc markets.

PREPARATION OF SPECIMENS OF OPUNTIA

By David Griffiths, Ph.D.,
U. S. Department of Agriculture.

We fancy that difficulty of preparation accounts in the larg measure for the dearth of specimens of the genus *Opuntia* in of our large herbaria. That the preparation of specimens difficult there can be no question, but it is not true that good o can not be prepared; indeed the different species lend themsel to the collector's art much more readily than do the succule in general. The impression should not be given that no coll tors have made specimens of these plants, for some have p pared beautiful ones, but poor material or none at all is the ru Our large herbaria are beautifully supplied with other easily p pared plants with which these grow, but the dearth of mater in this and allied groups is appalling. Some botanists have co tented themselves with forwarding cuttings to some garden conservatory,—an admirable plan so far as it goes—but this fo of record is not a permanent one. From these specimens, so times supplemented by a few meager notes by the collector, scriptions have been drawn which in many cases do not descri The cuttings have failed to grow, or growing for a time, ha lost their identity and have had their labels shuffled in the pr esses incident to all cultural work, or they have "gone the w of all living," so that in any case there is no type specimen which botanists may refer questions of doubt. As an illustrat of this point we might mention the case of *Opuntia treleasii* pu lished in 1896. Even with the care exercised in such an adm ably conducted institution as the Missouri Botanical Garden, type of this species has disappeared. It is true that we kn the type locality, and the collector remembers much about characteristics of the plant, but the species is very variable in immediate type locality so that it is difficult even now to det mine the exact form which was originally described. De specimens should, therefore, back up descriptions of new spec

in this group of plants as in all others. The difficulty of prepa-
tion is no excuse for not having them. They are always of m
permanent and certain value than living material.

The most important collection of the genus *Opuntia*, and do
less of other cacti in this country, is that in the Engelmann H
barium in the Missouri Botanical Garden, but, aside from
collection, the garden, like other repositories, contains but l
material. The Engelmann specimens came to him larg
through some of the western surveys and in many cases c
sisted of one or more joints dried in the open air without p

FIG. 49. An arborescent prickly pear, *Opuntia Engelmannii.*

sure. These are stored in boxes, but pressed specimens mou
upon sheets in the ordinary fashion are also numerous.

There are several ways in which these plants may be prese
and each way has some advantages over the others. On
whole, a specimen of *Opuntia* properly prepared and pressed
tween blotters is the most satisfactory. There are some c
acters which can not be perfectly preserved by this metho
is true, but no herbarium specimen shows living characters
fectly. In all cases it is an approximation only.

In many succulent plants boiling before being put in pre
advocated but this it 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 when 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 sides. 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 or 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 litte 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 n
by choosing his method of grasping the joint, but it is very
cult to keep away from the spicules if the joints are touche
all. A few thicknesses of paper or one thickness of pasteb
doubled in the left hand will enable one to handle almost
species with impunity.

Both young and fully matured joints should be put up w
possible. The young joints in the growing season will show
leaves beautifully and these should always be preserved.
young joints for several weeks after growth begins are
tough and leathery, making it a very difficult task to split t
neatly. Experience and a long knife blade to enable one to
away from spines and spicules which are very easily separ
at this time, are the only requisites to success. No scrapin
necessary with these for they usually dry without scraping
quickly as the older joints do after being scraped.

When possible, it is a good plan to leave the prepared jo
to dry in the sun for several hours before being put in p
They can then be subjected to heavy pressure for about tw
hours. When the driers are first changed the cut surfaces
firmly attached to the papers. This prevents rapid evapora
of moisture. The joints should, therefore, be loosened from
sheets each time the driers are changed until the cut sur
becomes dried so that it will not stick. After being under he
pressure until well shaped, the specimens may then be placed
a time between driers without pressure, but when they begi
buckle and curl the pressure should be restored again. I o
find it convenient, especially when in a hotel or other roon
night, to take my *Opuntia* specimens out of the press enti
and spread them over the floor to dry, as they will at ni
placing them under a heavy pressure again in the morning.

But all this relates to joints alone. Flowers and fruit n
also be preserved if they are to be found. The flowers of *Opu*
may be made into specimens as successfully as almost any of
large and showy flowers. The only difficulties involved con
in determining how best to prepare them so as to show the ma
mum of characters upon a flat surface. Very successful fl

specimens can be made by cutting off the top of the ovary ju below the outer petals or, better still, in many cases just belo the upper leaves on the ovary. The flower is then put in pres face down. Of course, this cuts off many of the stamens an the style is severed in every instance, but the relation of th style to the ovary is best shown in longitudinal sections, whic should also be made. If the flower is not too deep, simpl pressing back the petals little is all the preparatio that the flower needs afte being removed from th ovary. When the species one with a deep flower th specimens will not stay pu but will buckle in the cente when pressure is remove and when it is restored agai the petals will be wrinkle and doubled. In this cas it will be advantageous to cut the flower from the center ou ward at a single point, giving it a chance to spread outwar into a segment of a circle. A few extra pistils should always b put up, for they are likely to be severely mashed by the heav pressure given the other parts. Unless the material is abundan flowers should always be mounted upon the herbarium sheets i envelopes so that both sides can be readily examined. Contrar to what was said about the joints, it will be found better not t examine or disturb the sheets between which the flowers ar placed until they are fairly well dried, because when wilted th petals do not lend themselves well to handling and if once out o position it is very difficult to restore them again to their prope shape. Neither do they require as much pressure as the joint Care should be taken never to allow one flower to overlap anothe in press, for when dried they can not be properly separate When dried, the flowers, unlike the joints, are not difficult t remove from the papers, for there is a minimum of cut surfac

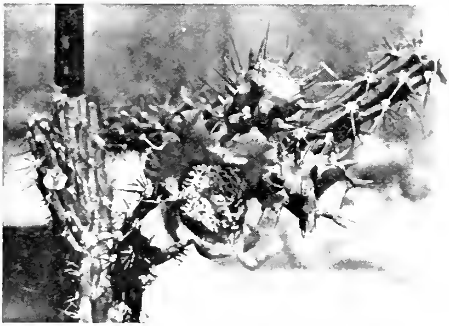

FIG. 50. *O. versicolor*, with yellow, brown or majenta flowers.

The fruit is best put up in longitudinal sections one fourth inc thick. Outer sections can then easily be pressed down or edges and the soft rind cut out with a knife, leaving little the dished epidermis, which when flattened out shows muc the tubercular and areolar arrangement. The sections fron center show the relation of the pulp and rind rather imperf it is true, but still they give characters of value.

Tracings of the fruit should always be made when they put in press. The fruit is cut through the middle length It has been my plan to lay this cut surface on the page o note book and trace its outine with a pencil and then, wit specimen before me, draw in a line representing the outer m of the seedy pulp. Often a section is cut out of the cente stead of simply taking half of the fruit for the tracing. pencil point can then be punched through the edge of the at three or four points so as to guide one in outlining the center. This tracing, easily made, shows graphically an curately the outline of the fruit, the shape of the apex, the rel thickness of the rind and the exact color, which is transferr the paper as the tracing is made. With a little additional the stain on the sheet can often be made to show the rel density of color of rind and pulp, all of which are of taxon importance.

All of this relates to specimens intended for the herba sheet. Of course, fruits can be preserved for a time and species indefinitely in fluid, but the colored parts lose all of color, the liquid must be changed occasionally, and it is a con source of annoyance and inconvenience.

A large part of the old survey material consists of joints in the open air without pressure. This is a very slow pro and while satisfactory so far as showing the spine arrange is concerned, the specimens must be kept in boxes, flowers be separated from their joints in the herbarium, and the co scarcely so well preserved as in pressed specimens.

Of course, the more field notes one can take the better. W ever time permits, it is my practise to write quite as full scription as the condition of the plants will warrant. notes are always much more satisfactory than any drawn 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, c can imagine my surprise at being told "I should expect *Opun fulgida* to assume that appearance under these climatic con tions." Specimens of perfectly familiar species in Mr. Orcu own collections subject to accidental abnormal conditions absolutely unrecognizable.

OF INTEREST TO TEACHERS.

Edited by Dr. C. Stuart Gager.

At a meeting of the Biology Section of the New York Hi School Teachers Association at the High School of Commer on November 3, 1906, Dr. A. J. Grout, of the Boys High Scho Brooklyn, read a paper on "A Possible Way of Obtaini Ideal Conditions for High School Biology in Large Citie

The tendency of population to concentrate in cities both moves the people from the opportunity to become acquainted w living animals and plants at first hand, and also makes them of sympathy with agricultural pursuits and interests. There grave social danger in these conditions, and a general knowled of plant and animal life would go far to remedy the conditio At the same time no satisfactory teaching of Nature Study a Biology is possible when the material is limited to dissecti table specimens. The ideal conditions for teaching these su jects are right on the soil. A plan that will combine the use out-door methods with our New York City school organizati is the following: the city should own a large tract of land witl one hour of the high school by the most rapid means of tra portation; the pupils should be carried out to the park in specia constructed trains, in charge of teachers, that the travelling ti may be used as regular school time; the biology work should done on the plots assigned to the pupils, and in a building fitt up with museum, laboratories, breeding rooms, etc. Some su arrangement Mr. Grout believes feasible, and one that will of ideal conditions for teaching biology to city pupils.

B. C. Gruenberg,

Secretary

A meeting of the New York Association of Biology Teache was held at the High School of Commerce, on Friday evenin December 14, 1906.

The subject of the evening's discussion was, "How C TEACHERS OF BIOLOGY IN SECONDARY SCHOOLS MAINTAIN SPIRIT OF INVESTIGATION WHILE ENGAGED IN TEACHING?"

The speakers of the evening were Dr. C. Stuart Gager, Direct of the Laboratories of the New York Botanical Garden, and I M. A. Bigelow, Head of the Department of Biology at Teache College.

Dr. Gager distinguished between *research* and a *spirit* *research*. Every high school teacher should have a spirit curiosity directed toward high ideals, but he will not necessar be a better teacher because he has added some fact to the su of human knowledge. The world needs teachers more than needs new facts. There is a vast field of research for t teacher, practically as yet untouched, in the pedagogical proble connected with his subject. "While the pupil studies the subj the teacher should study the pupil." Research and publicati are not synonymous, and much good research work is nev heard from. Research should never be a thing apart from teacher's work, but should grow out of his work. A man m gain much from the study of problems already known, provid he gets his information at first hand, and such study may pr a great source of inspiration and rest from drudgery.

Dr. Bigelow started with the asumption that a teacher has t spirit of research when he enters upon his work of teaching a considered the question, "*how can a busy teacher keep up interest in problems which shall add new facts to the sum knowledge—facts which shall be worthy of publication.*" Pra tically, a man must decide to what he will devote his energies to teaching or to research work—for if he gives his energy teaching he will not have time or strength for successful resea work. We are coming to realize that research in the line biological education is as valuable as the solving of stric biological problems. The teacher should keep in touch w periodicals and books relating to his subject, and with the vari

scientific meetings. In these ways a man may keep in the sp
of research while doing little because of lack of time.

A discussion followed in which the following points w
emphasized:

Research problems should be of such a nature that they sti
late to abstract thinking, and they ought to have some defi
relation to human life.

Important problems are those connecting the subject and
pupil as, "What parts of the subject are best to give the pupi
"In what order can they best be given?" "How can the sub
be made most impressive."

As much will be done in the next fifty years in study
methods of teaching biology as has been done in the last f
years on strictly biological problems.

MYRA S. CHATTERTON,
Secretar

OBSERVATIONS ON THE VEGETATION OF TH WALLULA GORGE.*

BY A. S. FOSTER.

The vast zone between the Rocky Mountains on the east
the Sierra Nevada and Cascade ranges on the west, and exte
ing from the Arctic Ocean to the plateaux of Mexico, is an
region, the different parts of which have received various na
That part to which this paper more particularly refers is kn
as the *Columbia Plateau*. The Columbia River winds thro
this region, and after breaking its way across range after ra
and flowing through a succession of basins, it finally turns w
ward in latitude 46° north, longitude 119° west, until it is fin
lost in the "fountain of all waters." At an altitude of 327 f
the Walla Walla River empties into the Columbia just a
enters an immense gorge known as the Wallula Gorge.

This particular gorge—for there are many—is about eigh

* Abridged from a paper read before the *Oregon State Academ*
Sciences, June 16, 1906.

miles long, one and one half miles wide, 1800 feet deep on th
Washington side, and 2500 feet deep on the Oregon side. Th
mesa, or table-land, is composed largely of loess, a decompose
lava dust; the contour of rolling hills and dales is formed b
this wind-drift carried by and in the direction of the prevailin
winds. This drift is from 90 to 150 feet thick where attemp
have been made to reach water by digging. After the surfac
moisture has been penetrated, none other is found. In a fe
basins temporary ponds are formed after a winter rain. Th
soil has an alkaline impregnation, as is indicated by *Chenopodiu
album,* which grows in these depressions. The winds, in givin
a roundness to the contour, often dig out "sand-blows," whic
are the analogue of "pot-holes"; in other places "dunes" ma
travel over a ridge to disappear on the lee side, all of whic
seems to have a marked effect on the character of much of th
life of the region.

The annual rainfall varies from seven to eleven inches; on
third of this is in the form of snow, while a small portion come
from the rime and frost which accumulates on every availab
object during the prevalence of a severe northeasterly wind ac
companied by its usually attendant fog which, freezing, form
acicular points of hoar-frost even to two or three inch crystal
These "Walla Walla winds" are cold and penetrating, in winte
bringing dust storm, snow storm or blizzard. During man
days this gorge is filled with fog, while the mesa is clear an
sunny. The current of this river of fog is determined by th
wind. This body of dense fog hovering over the body of wate
keeps up the general temperature of the gorge, and this may i
part account for the variety of rock-loving lichens therein.

The plant-life of this region occurs in three distinct vertica
zones: (*a*) The mesa and "breaks," (*b*) face of cliffs and talu
(*c*) the margin of the rise, or littoral. There are no bottom o
alluvial lands. The following observations thereon extend ove
a period of nearly six months, from October 17, 1905, to Apr
10, 1906.

On several basaltic reefs extending well out into the rive
and but six or eight feet above water at low stage, was foun

Scouleria aquatica in abundance but not fruiting. This n
is always found on the "up-river" side of rocks where curre
strike strongest. On the upper surface an aquatic lichen, *En
carpon miniatum*, was found in quantity; also a few strands
Scleropodium obtusifolium, a moss usually associated with
Scoulerias.

The shore line seems to be the habitat of most of the im
grants transported hither by this all-water route. Mullein
found, also purslain, *Portulaca oleracea;* cockle bur, *Xanthi
spinosum;* Russian thistle, Shepherd's purse, and one or
mustards of very hardy habit in bloom on December 10
again February 15. Well down the banks, below the flood l
was *Marsilia vestixa* with tomentose rhizocarps, fruiting fr
among the shifting sands. Where some bold wall reached do
to the moist sands a few plants of Scouring Rush, *Equiset
hyemale,* are likely to be found.

Among the woody plants of this narrow margin is the De
Juniper, *Juniperus scopulorum,* having migrated apparen
down the gorge of Juniper Cañon from the flanks of the B
Mountains. Of the willows, a cluster of three *Salix amyg
loides* and a patch of *S. exigua* were found along the expo
bars. The chief tree or shrub is *Crataegus columbianum*
Howell, rooted in the shifting sands, crowded with pecu
"galls" and often encrusted with a lichen, *Theloschistes ly
neus.* A few shrubs of wild cherry, *Cerasus emarginata,*
always associated with *Rosa nutkana*, and the Golden Curra
Ribus aureum, said to be the same as the cultivated currant
Missouri.

Among umbelliferous plants, *Oregenia fusiformis* is the earli
to flower, its white blossoms contrasting later with the yell
ones of *Pucedanum grayi*, both in abundance along the flo
line, with an occasional *Allium douglassii* (sp.?). *Nicot
attenuata*, or a similar tobacco, found here, is said to have be
cultivated by the Indians.

Artemisia ludoviciana, with its densely white leaves, a
another sage brush, *Artemisia dracunculoides,* some fifteen f
tall, grow on the talus. The latter is the host of its paras
Orobranche ludoviciana.

The boulders are covered with a blackish moss, *Grimmia*, i dense cushions, while *Orthotrichum laevigatum* prefers th combined shade of boulder and brush. *Montia rubra* is foun along the water line, and *M. Siberica* higher up. The Greas wood, *Cercocarpus intricatus*, called Mountain Mahogany, a intricate much-branched low shrub, with sparse, small, gree leaves, is found straggling along the bank. Still further accen tuating the arid appearance of the vegetation is the cactu *Opuntia polyacantha*.

Along the ledges of the gulches *Audibertia nicana* seems t thrive best. Upon distillation these leaves yield a volatile o pleasant and penetrating, with a lasting aromatic odor. Th *Audibertia* is related to the "honey sage" or "white sage," s called, of the mesas of Southern California. Along the terrac with a northeastern exposure may be found a few colonies o the delicate fern, *Woodsia oregana*, the only fern of the regio In the upper gulches *Lithophragma tenella*, with its peculia glandular pubescence and laciniate petals, grows in compan with *Montia siberica*, the Indian lettuce. Here also are *He chera* and *Tiarella*, their old stems filling up their niches. the upper stretches, clambering over the coarse talus, sever vines of *Clematis ligusticifolia* (sp.?) were seen at the foot a 500-foot bluff. In a gulch with some appearance of seepa there was one lone specimen of *Rhus diversiloba*, perhaps ne its northern limit east of the Cascades. Nearby was that bea tiful moss, *Anacolia Menziesii*, not fruiting, but always abunda in its preferred habitat. The floor of this gorge was patch with *Grimmia montana*, growing in closely mottled green cus ions, turning a reddish brown as the season closes.

Here the lichens, some twelve species, give color and distin tion to the different buttresses,—*Lecanora chlorophane*, painti walls with a rich chrome-yellow, to be distinguished for two three miles when contrasted with the red of *Placodium elegan* shading off into another *Placodium ferruginea;* then re-touch in another section with the bluish-gray of *Lecidea caerulescen* which in turn is brightened by *Lecanora rubina*.

Other thalloid lichens, as *Peltigera canina*, were plentif usually on the surface of rocks, *Parmelia prolixia* occupying better part of a square yard of the upper surface of a bloc lava in the shade of a sage brush. *Parmelia conspersa* an *caperata* were on the ledges, contending with the *Grimmias* a share of moisture. *Umbilicaria phara* generally stuck to r faces, so situated that the disintegrating material could not behind the thallus to pry it from the hold-fast. Of the fruti lichens *Cladonia fimbriata* was the only one seen.

Besides *Grimmia calyptrata*, with long, pointed leaves, found *G. alpestris*, *G. leucophea* and *G. tenerrima* in sca ing cushions; *Tortula ruralis* and *T. aciphylla*, generally l loosely on or in slight niches of the ledges, while along edges, on small lumps of humus, *Encalyptra vulgaris*, the Extinguisher moss, was sparingly scattered. West of the cades the calyptra is fringed, hence *Encalyptra ciliata*. The tulas sometimes grow in the upper stretches on soil of s gulches. On the sands, under sage brush, *Desmatodon thobius* sends up its yellow seta to fruit quickly and die. scarcest, though most interesting moss, is *Pterigoneurum folium*, with its abnormally large capsules and abundant red brown spores.

The higher plateaux are occupied by *Artemisia triden* which gives its peculiar hue to the "Sage Plains." On hills, among this sage brush, *Gila gracilis* is among the firs put forth its tiny blue flowers, although the yellows always dominate. Among the most beautiful and hardiest of the C positae is *Aster amethystinus*, growing along fence rows, flowering continuing into December. Another, not so large, the basal leaves 5–7 lobed and smaller violet rays, seemed t *Aster fremontii*.

On the hills, *Bigelovia graveolens* offers some "brousi." the Nevada plains it is called "Rabbit brush," as it affords a the only covert for the little cotton-tail, *Lepus bardii*.*

* For the determination and verification of the phanerogamia as we the cryptogamia the writer is indebted to his numerous friends who specialists along their several lines. In consultation a free use has made of *A Flora of the Palouse Region*, issued by the Washington cultural College, Portland, Oregon, June 9, 1906.

CERTAIN RELATIONS OF RAINFALL AND TEM-PERATURE TO TREE GROWTH.

Under the above heading Mr. Henry Gannett, in the *Bulleti* of the American Geographical Society for July, 1906, states tha temperature and rainfall are the two factors which determin whether trees can grow, and, if so, what species. Other factors such as seasonal temperatures, seasonal rainfall, atmospheri humidity, wind and slope exposure, angle of slope, and textur and depth of soil, are secondary factors which have a modifyin effect.

The paper " is designed to show how much and what informa tion our present knowledge of the climatic elements develops con cerning tree growth in the western United States." The record are derived from a little over four hundred stations having a rain fall record of more than five years. " The distribution of thes stations is not, however, by any means what could be desired, th great majority of them being situated in towns and cities, an therefore in low and open or non-timbered country; and very fev of them are high up in the mountains, so that in those parts o the West in which the timber is confined to the mountains th timbered regions are not well represented."

The author's results are tabulated. " The table relating t yellow pine shows that the greatest number of stations is foun where the temperature is between 50 and 55 degrees, while th entire range of the species, as indicated by the stations, is fror 40 to 65 degrees."

" Nearly all the stations in the red-fir region are found betwee 50 and 55 degrees. Indeed, outside of this group the stations ar but scattering."

" In the red-wood region all the stations are between 50 an 60 degrees."

From the results of this study and those published in a forme paper on " The Timber Line," in the *Am. Jour. Sci.*, 1882, p. 275 the author concludes that the timber line has a mean annual tem perature of approximately 30 degrees, so that the location of thi isotherm is a simple matter.

In regard to rainfall, the table shows that the average in t open country is 13 inches, with a range of from 7 inches in N vada to 18 inches in northern California. Yellow pine gro under an average rainfall of probably over 34 inches, with a ran of from 19 inches in Wyoming to 44 inches in northern Calif nia. Red fir in Oregon and Washington grows under an avera rainfall of 56 inches, the redwood of 46 inches. Desert spec grow under a range of from 15 inches in Arizona to 30 inches northern California, with an average for the entire West of inches. There are indications that the lower limit of the yell pine is at or just below 20 inches of rainfall. For the red the lower limit is at or about 30 inches of rainfall, with apparen no upper limit, as the species abounds in regions where the ra fall exceeds 100 inches annually. The isohyetal line of 30 inch appears to be the lower limit of the redwood, as only one stati in the redwood strip in California has a rainfall of less than th amount. C. S. G.

REVIEW.

Principles of Botany. By JOSEPH Y. BERGEN and BRADLEY DAVIS. Pp. 8–555. Small 8vo., with many illustrations. Ne York, Ginn and Company.

The present volume is a partially rewritten form of the earl "Foundations of Botany" of the first named author. It is d tinctly modern in its spirit, and presents the whole subject fair and adequate representation. The success of the previo works which have led up to the "Principles," being as it is a mea ure of their adaptibility to the high school student, will be st further justified in the new volume, which deserves a first pla in secondary schools. It is certainly a first class text-book for t elementary student of the subject. Especially pleasing are t etched illustrations which are made after the photographs whi they happily replace. The use of the colored plate (illustrati the structure of the lichens) is an innovation in American tex book making, and one which should be welcomed.

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