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THE CAMERA IN BOTANICAL WORK.

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The many articles which have appeared of late in the magazines on the application of photography to the study of nature show that the camera is doing a good work, for any means that will bring man into a closer relation with the beauties and wonders of nature is a benefit to mankind. The application of the science of photography for recording one's observations during rambles in the woods and fields involves nothing new, as far as the chemistry of photography is concerned; but it brings into play mechanical skill and ingenuity, which are shown in the various appliances and suggestions used to overcome the mechanical difficulties which are encountered in attempting to fix nature on a gelatine plate. The object of this article is to give a practical and fascinating method for using the camera in the study of botany.

In order to photograph wild flowers in all their native beauty and freshness, the work must be done as soon as possible after plucking them; in fact, in many cases the photograph must be made on the spot. Hence the necessity for an appliance for field work; and as specimens can only be obtained by tramps "over the hills and far away," it behooves one to invent, not only the most practical appliance, but the most compact one, for the smaller the load, the oftener and farther will be the rambles afield. The following method, which I have successfully used for the past five years, will, I am sure, lessen the burden and add to the pleasure of the botanist.

For this class of photography any camera will do, provided it has a long bellows; and I might also say any lens will do, although, as in all photographic work, the better the lens the better the result. However I would recommend a 4 by 5 long focus, reversible back, Cycle camera, equipped with the best lens one can afford.

The essential part of the outfit is the flower screen, which is so constructed as to shield the flower from the wind, and admit light sufficient for short exposure, and it is so arranged as to be easily taken apart, and conveniently carried. This screen consists of two light wooden frames connected by a bellows of sheer white muslin which is reinforced on the side facing the sun (see Fig. 1) by a sheet of tissue or oiled paper, just sufficient to prevent any shadow from being cast by the flower, which lies on the background.

The background consists of a card mount tacked to the front of the rear frame. This screen is practically an outdoor studio and can be easily carried with the camera on a bicycle. It reduces to the minimum all trouble in getting a proper light, and furthermore, the exposure being short, anxiety as to the withering of the specimen is eliminated. The accompanying cut and photograph fully explain the manner of construction and use. A Rembrandt card mount was found, after many experiments, to be the most satisfactory background, giving the best contrast, even with white flowers. In arranging the specimens on the background one need not sacrifice artistic taste to scientific exactness, as the two can be easily combined.

In setting up the apparatus, the top or tissue paper side of the screen must face the sun squarely (see Fig. 1), thus preventing parts of the screen from casting shadows on the background. The light, filtered through the tissue paper and muslin, is exceedingly soft, and seems especially suited to bring out all the charms of the flower. After having arranged the specimen on the background satisfactorily, focus with diaphragm F. 16, and select, for sharp focus, a blossom a little to the front of the center of the spray, and make the exposure with diaphragm F. 32. A few experiments will soon give you the correct exposure, especially if you use a Watkin's or a Wynne's exposure meter, and expose the meter in the shadow of the body. As the work is done out of doors in the sunshine and the specimen is only shielded by the thin muslin and tissue paper, the exposure, even with the ray filter, is very short, compared with studio work.

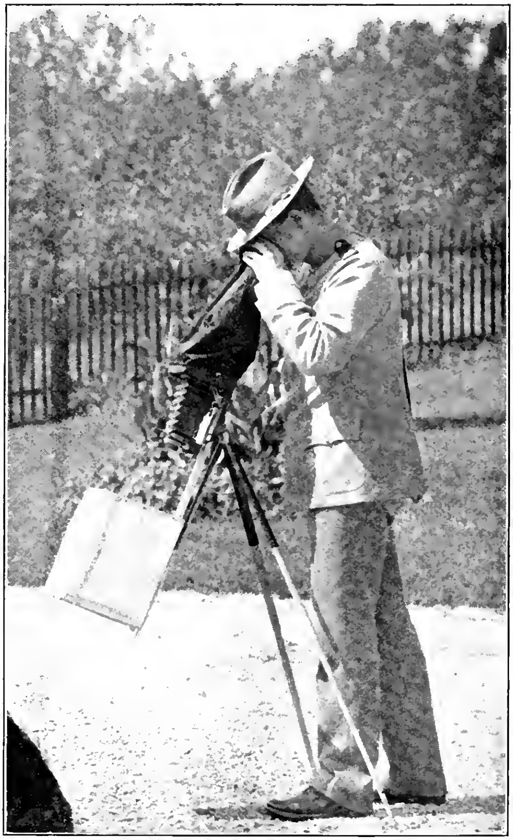

FIG. I. A white muslin screen shields the flower from the wind and softens the light.

Orthochromatic plates or films must be used, and as the prints should be colored, use the ray filter in all cases, except in photographing blue, white and purple flowers.

The color screen gives a lighter print of the leaves and flowers.

Red flowers are difficult to photograph and require an increase in exposure, and with this color the tissue paper should be removed from the front of the screen. Having obtained a satisfactory negative, save the specimen for coloring the finished print. If one can develop successfully a portrait or landscape negative, there should be no trouble in getting a satisfactory flower negative. In printing, while it is important to bring out all detail, do not overprint, as the lighter the print, the more brilliant the colors. The size of the frame and the relative size of the image to the natural size of the flower, is of course arbitrary. I use an 8 x 10 frame and so adjust the camera and screen on the sliding rod as to take in an 8 inch spray on a 4 x 5 negative. This position of camera and screen is marked on the sliding rod, and the same adjustment is used for all work, whether the spray be 8 inches or smaller, thus maintaining the same relative proportions. The 4 x 5 negative is enlarged on $6\frac{1}{2}$ x $8\frac{1}{2}$ bromide or art cyko paper which gives the natural size of the flower. For scientific purposes and for illustration a 4 x 5 print with the image of the flower, one half natural size, will be found very satisfactory.

Having obtained a print of the specimen, by all means color it, for color is the principal beauty, as well as one of the most distinguishing characteristics of a flower, and no black and white photograph, however well done, can convey to the mind the charm and loveliness of the natural blossom. It does not require an artist nor a special course of instruction to do this work, for the camera does the drawing and the shading, and all one has to do is to match colors; in fact it is tinting rather than painting. Bromide paper is more easily tinted with the Acme transparent water colors, but Winsor and Newton's moist water colors can be used by moistening the print with saliva or the juice of a raw potato. Platinum and art cyko papers are the best for painting. A little practice will enable the amateur colorist to produce a photograph that will only lack fragrance to rival the original blossom.

The chief advantages in this method of flower photography are: (1) The screen furnishes a portable studio in which the lighting is excellent and the necessary exposure short. (2) For certain purposes it far surpasses the method of pressing specimens; for the prints, if properly made, are permanent, and "neither moth nor rust doth corrupt." (3) Frequent handling of the flower in arranging it in the screen, developing the negative and print, and painting each petal and stamen, indelibly impresses the characteristics of the specimen upon the mind. My present collection consists of about three hundred 6 x 8 photographs of wild flowers, of natural size and in natural colors. Each print is mounted on a 10 x 12 thin gray card with field notes on the back of each card.

This method of flower photography should be supplemented by photographing interesting groups of growing specimens, and as the relation of insects to flowers is interesting as well as important, the winged visitors, where possible, should be added to the collection. This flower screen and a box of colors also offer

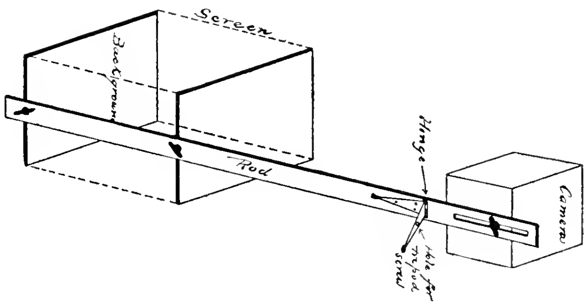

FIG. 2. Diagram of apparatus. The dotted lines are the sides of the muslin screen, the frames of which are held in place by means of wing nuts or tripod screws. The rod is slotted for the adjustment of the camera. The length of the rod varies with the focal length of the lens. (Consult table of enlargements in any Photographic Annual.)

great possibilities to the entomologist. During the long cheerless winters a collection of this nature is especially appreciated, for, as you look through your portfolio and are greeted by the violets, lady slippers, etc., in all their loveliness of form and color, you can recall the glories of spring and almost hear the notes of the wood thrush echoing through the woods, or catch the scarlet flash of the tanager as he darts through the over-hanging boughs.

Fig. 3. La Zacualpa Rubber Plantation and Laboratory, Chiapas, Mexico.

A BOTANICAL STATION IN TROPICAL MEXICO.

By Helen Olsson-Seffer.

Fruitvale, California.

During the last few years it became evident to many of the more up-to-date planters in Mexico that very little progress in rubber culture could be looked for without the aid of scientific investigation—especially with regard to methods of tapping and preparing the latex for commercial purposes. Thus it was that about a year ago one of the largest plantation companies in Mexico engaged the services of Dr. Pehr Olsson-Seffer as Director of a botanical station and rubber laboratory, to be established on La Zacualpa plantation, in the state of Chiapas.

Rubber planting has been, and is, in the experimental stage, but there is no reason to doubt the ultimate financial success of the industry. The hundreds of problems connected with the cultivation of the rubber tree, and the preparation of crude rubber, cannot be satisfactorily solved without a thorough knowledge of the nature of the plant itself, and for this reason the structure of the tissues of the tree and its physiological behavior must be carefully studied. In view of the recent progress in plant breeding it is expected that the qualities peculiar to the rubber tree can be considerably improved under cultivation, and one of the chief objects of the station is to experiment in this direction.

It would be difficult to find a more ideal spot for such a station. The plantation is situated on the lowlands at the foot of the Sierra Madre, about twelve miles from the Pacific ocean and sixty miles from the Guatemala border, in the midst of a magnificent tropical forest. This forest is one of the chief attractions of the station. Great palms and giant forest trees grow here, so twined about and interlaced with lianas and epiphytes as to almost entirely hide the trunks from view—in fact, the trees as such seem to lose their identity, leaves and branches assuming queer and startling shapes. And the beauty of it all is that a five-minutes walk will bring one right into the midst of it. Then, too, it takes but a few hours' travel to pass from the forest to the low, swampy lands, covered with a luxuriant growth of high grass, called by the natives *camalote;* or in the other direction, up wild mountain trails to an elevation of over 7,000 feet. In the dense forest covering of these mountains the daintier terrestrial ferns grow in profusion; rocks and logs are covered with lichens, mosses and ferns; and orchids and bromelias are everywhere. Here, as many as thirty different species of epiphytes have been counted growing on one tree. Among the ferns numbers of species of *Asplenium, Gymnogramme, Polypodium, Blechnum,* and *Pteris* have been seen. Of the climbing plants the most common seem to be different species of *Ipomœa.* These with *Begonias* and bi-lobed *Bauhinias* grow in wild, bewildering profusion. This is a veritable paradise for a collector and it is to be regretted that there is no special assistant connected with the institution for that work. As it is, collecting is done when time can be spared from the more pressing work of the station.

The station building is equipped with all of the varied apparatus necessary for experimental work along many different lines. There is a chemical laboratory, with sloping cement floor, a dark room for photographic work, a plant-physiological room, a library, and a room for one assistant. To the rear of this is another, and smaller, building consisting of two rooms. One of these, used as a tool shop, is supplied with a complete forge and necessary tools for making the more simple apparatus to be used in various experiments. The other is called a "model room" and here the director and assistant are endeavoring to put up a small model of a plantation rubber factory.

In the chemical and plant physiological laboratories there are narrow, crudely made tables, running the entire length of the room and attached to the wall. These are covered with asbestos, zinc or glass. Above, and under the tables are rows upon rows of shelves, which in the chemical laboratory on one side of the room are devoted to reagents, and on the opposite side to glassware. At one end of the laboratory a large hood of glass and zinc is fitted into the corner. Here all work with poisonous gases is done. Under a large window at the other end of the room all apparatus for bacteriological work can be found—incubator, sterilizers, glassware, reagents, also a good microscope, with oil immersion lens and camera lucida, a microtome, and several dissecting microscopes. On specially adapted tables are placed a Ralston still and the necessary chemical balances. In this room as in both the plant physiological laboratory and dark room, is a porcelain-lined sink with running water, piped in from a tank just outside the laboratory building. For heating purposes a gasoline stove is used, and for the smaller work a Primus oil stove.

In the plant physiological room is a klinostat, auxanometer and all of the more common apparatus used in experiments of a phytophysiological nature. At present over a dozen experiments are going on here, principally on the physiology of *Castilloa*, including the influence of light, transpiration, wounding of trunk, effect of gravity on growth, and recording of the rate of growth under different conditions.

Opening from this room is a smaller one, originally planned for a back veranda, but now screened in and used for the potted rubber plants to be experimented on later in the plant physiological room.

Photographic records are taken of all experiments, both in the laboratory and field, and for this reason the dark room is especially well fitted up.

So far, the immediate surroundings of the station building are rather bare. Directly in front of the laboratory is a row of native *Salix* with bunches of mistletoe clinging to the branches. This mistletoe, a species of *Loranthus*, is collected from willows growing along the banks of rivers in the forest and closely resembles the *Phoradendron villosum* of California.

On account of the distinct dry and wet seasons, ground could not be prepared for the station garden until the early part of

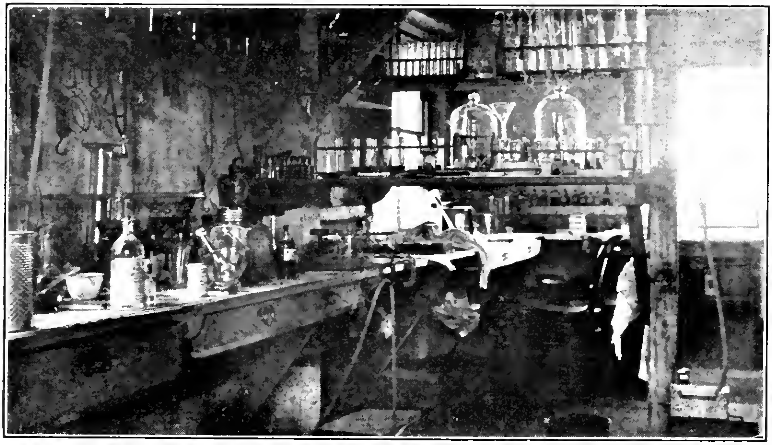

FIG. 4. Interior of Laboratory at La Zacualpa Tropical Station.

May, when the first rains begin to fall, but by the end of that month about two acres had been cleared and planted. The laying out of the garden proved to be very slow work as the native laborers require the constant supervision of the field assistant, but it is expected that at the end of the season about four acres will be planted. The larger part of the garden will be devoted to rubber, the director intending to have here, besides experimental plots of *Castilloa*, a collection of all the rubber-producing plants known. The remainder will be used for the more unusual representatives of Mexican flora and many foreign tropical plants.

In connection with this garden, experiments in hybridizing the coffee tree will be conducted on the Hidalgo coffee *finca,* at an elevation of about 3,000 feet. Many different varieties of coffee will be planted there, the work to be under the immediate supervision of the local manager of the *finca.*

There is a deplorable lack of trained assistants on account of the limited appropriation for that purpose, and for this reason only the most important work can be taken up. Besides the regular laboratory routine there is an immense correspondence to be attended to, an exchange list of both seeds and publications to be kept up to date, and many minor duties that require constant attention if the wheels are to run smoothly. The assistants are up at daybreak, or at the latest five o'clock, and out for a look at their special experiments either in field or laboratory; then off for a ride among the rubber, which on Zacualpa covers thousands of acres. Here notes and photographs are taken of any trees under inspection—these are marked by easily recognized labels—some collecting is done and then the horses are turned homeward. After breakfast, and until noon, the typewriter is kept busy writing up notes of the previous day and attending to the correspondence. Lunch hour comes before the work is half done, and from one until five o'clock all are at work in the laboratory. In the evening the director's private work is taken up, or some reading done for special experiments to be started the following morning. Fortunately we have a fairly good reference library. This has been materially increased by exchange, some institutions being able to send us their entire set of publications.

In connection with the station work complete meteorological observations are made. These are necessary for the ecological work and are also of general interest as no data of the kind have heretofore been collected in this part of the tropics. In the near future two substations for work of this kind will be established on coffee *fincas* at different elevations in the mountains.

As to the climate, it is neither so blistering hot nor so debilitating as many popular books on Mexico would have us believe. In almost any article on the subject one can read of the danger attendant upon those who venture into this southern country, particularly into the state of Chiapas, and many and vivid are the tales of the greatly feared malaria. While to a certain extent this may be true of some of the small native villages, where most filthy and unsanitary conditions prevail, and where nourishing food cannot be procured for love or money, the fever cannot be laid to the effect of the climate. There are occasional hot days when one longs for the cool of the mountains, but even then the temperature does not exceed that of an August day in southern California. For here we are directly in the path of the trade winds, with sea breezes during the day and cool mountain winds at night.

NOTES ON THE VEGETATION OF BOX CAÑON.

By Professor V. M. Spalding,

Desert Botanical Laboratory, Tucson, Arizona.

Box Cañon is one of the numerous cañons of the Sacramento Mountains, a few miles to the eastward of Alamogordo in southern New Mexico. Its name corresponds to its contour, its steep sides which rise almost sheer several hundred feet, hemmed in by surrounding hills, making it seem like a huge box open only to the sky. Throughout its general westerly course of some two miles, its left side has chiefly a northern exposure, while the opposite side is exposed during the greater part of the day to the full glare of the sun. Except for this difference of exposure, it would be difficult to point out any physical feature, aside from differences of vegetation, by which one side of the cañon could be distinguished from the other. The long process of erosion which has resulted in cutting the deep gorge, has left exposed on either side the same strata of cretaceous limestones which form perpendicular cliffs, at the foot of which the talus slopes, though rather steep, offer an excellent foothold for vegetation. With this practical identity of structure, however, there is a most striking difference in the plant covering of the opposite sides of the cañon.

It was my good fortune, in July, 1906, to visit this cañon in company with Mr. A. G. Ruthven of the University of Michigan. We entered it at the upper end, at an altitude of upwards of 6,000 feet, and proceeded downward along the stream which in places leaps with considerable force between the rocks, still contributing its share to the process of erosion, the effects of which are so marked on either hand. A light rain was falling, but the camera was used to good purpose between showers, and the day proved to be more favorable, on the whole, than one of full sunshine.*

At our first halting-place near the entrance to the cañon, it became evident that we were in the midst of a flora widely different from that of the hills over which we had just come. We had there been walking through a low forest of piñon, *Pinus edulis,* one-seeded juniper, *Juniperus monosperma*, and the alligator juniper, *J. pachyphlæa*, all characteristic members of the piñon association, which forms a zone about the mountain approximately 1,500 feet in vertical width at this place. Now, however, in the very midst of this zone, we found in the low ground of the cañon the white oak, wild black cherry, choke cherry, ash, hop-tree, Virginia creeper, poison ivy, grape-vines, and other familiar constituents of an eastern mesophytic forest, and with them a few conifers, the yellow pine, white fir, and Mexican white pine. These latter are more numerously represented and attain a better development 1,500 to 2,500 feet higher up, where, with *Pseudotsuga taxifolia* and *Picea engelmanni*, they form the fine forest which covers the higher parts of the mountain. The place where we stood was their lower limit. As we proceeded below the 6,000 foot level we saw no more of them; they are plainly species that at the present time belong to a considerably higher altitude, but seem, through favoring circumstances, to have crept down the cañon some 2,000 feet below the zone of their best development.

Leaving the case unsettled, we turned our attention to the walls of the cañon. Here was a striking picture. At our feet and around us a mesophytic forest and a group of conifers that

*I am indebted to Mr. Ruthven for the accompanying photographs.

elsewhere cover the mountain some 2,000 feet higher. On the left side was the usual forest of the piñon zone—the two junipers and the nut-pine, just as we had left them half an hour before on the hills above. But the right side, directly opposite, was like a continuation of the desert. Here, on the talus slopes above our heads, were the mesquite, creosote bush, ocotillo, *Dasylirion*, *Yucca*, *Agave* and various cacti; in short, precisely the association of plants that we had been studying the day before at the foot of the mountain 1,500 feet lower down. Within a stone's throw of each other were these well-marked associations of plants, one recalling the woods of Michigan, another a part of the piñon forest of the middle slopes of the New Mexico and Arizona mountains, and the third clothing with characteristic xerophytic forms an arm of the great desert that surrounds their base.

As we proceeded down the cañon the same difference of vegetation on either side was manifested, piñon and juniper on the left, and members of the sotol association on the right; and not until we finally reached its mouth below did we see the plants of the desert gaining the ascendancy on all sides.

These facts, deeply impressed on the memory in the few hours that it took to walk the length of the cañon, are, evidently enough, connected with present-day conditions. The right side of the cañon, as already stated, is fully exposed, through the greater part of its extent, to the direct rays of the sun. The temperature is necessarily higher, the light more intense, the scanty soil more readily dried out, and the diurnal changes of conditions more extreme than on the opposite side. Bearing striking testimony to the effects of these adverse conditions, the scattering individuals of *Pinus edulis* that had gained a foothold there were all dead, killed by the drouth of 1903–'04, and were standing stark and black among the desert plants growing in full vigor around them. On the left bank, although an occasional piñon had died under the stress of "the dry year," it was, on the whole, the best growth that was seen during the day's trip, and the sheltered bottom of the cañon, with abundant water and an accumulation of humus, could hardly be improved upon as a home for the mesophytic forest that was growing there. The fitting of organism and environment, manifested in the correlation of association and habitat, is here perhaps as perfectly realized as one is likely to find it anywhere in this great semi-arid territory, where the perfection of adaptation almost ceases, from constant

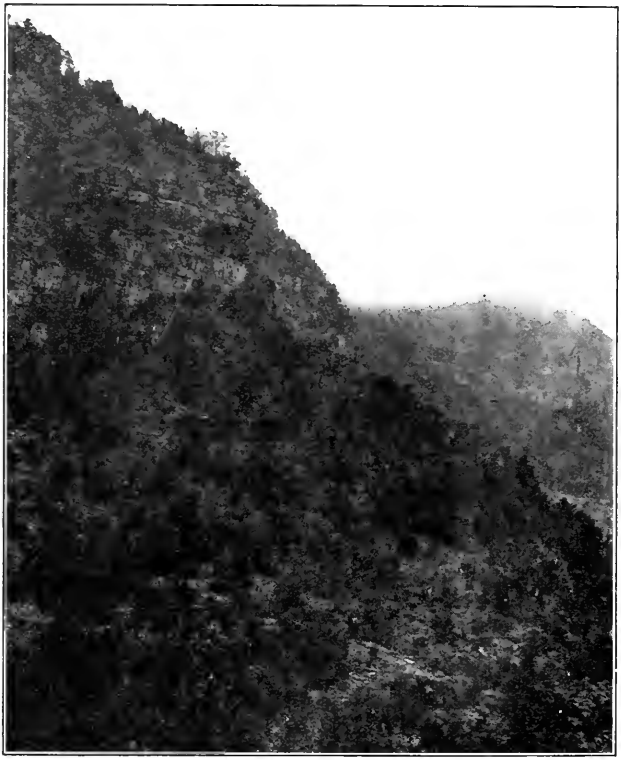

FIG. 5. "On the left was the forest of the piñon zone."

repetition, to be a wonder. One could hardly wish for a more definite *ensemble* of conditions than those that are here so manifestly holding the balance of power and maintaining within a few rods of each other three such widely different plant associations.

But however striking may be the correlation of present environment and vegetation, it is certain that existing conditions, both of the land and its plant covering, are only a phase in a series of changes through which both have long been passing. We are reading to-day only the last page that has yet been written of a long-continued history still in progress. Is it possible by any scientific method to gain some further knowledge of this history? It must be answered frankly that without exact obser-

Fig. 6. "The right side, directly opposite, was like a continuation of the desert."

vations and records extending through a period of years, we are not likely to make the most substantial progress, and it must be added that even the application of such exact methods may fail to bring a complete solution of the problems here presented. Meantime some of the facts here recorded are suggestively open to analysis, and their provisional interpretation, in this stage of our study, is quite as scientific a process and quite as necessary as the collection of further data, indispensable as this may be.

In the first place, then, the desert plants on the right side of the cañon have, without doubt, merely extended their range, in comparatively recent time, with the development of the cañon, and had it not been formed in such a way as to offer exposures favorable for them and generally unfavorable for plants of the piñon zone, they would not have reached the height they have already attained. We may, therefore, speak without hesitation of an upward advance of *Covillea*, *Yucca*, *Dasylirion*, *Fouquieria*, etc., which has been going on step by step with the growth of the cañon, and is apparently still in progress.

In the second place, the dead piñons scattered amongst the agaves and other desert plants mark a lower limit, determined by a minimum water supply, beyond which the continued existence of this species is precarious, and a period of unusual drouth results in its extinction. If, at any point, the slope, exposure, etc., result in lowering the available water supply below this minimum, the lower limit of the species is thereby shifted upward. Thus we have on the right side of the cañon at the present time an upward movement of plants belonging to two different zones, an advance on the part of *Covillea* and its desert allies, and a retreat of the piñon.

It should be remarked in passing that the deportment of individual species belonging to these different associations is highly instructive and suggests a rational basis for the delimitation of "zones" which they occupy. It is significant that while the piñon has locally failed to maintain itself, the two junipers, its characteristic associates, have lived and done well through the drouth to which it has succumbed. It would be quite impossible, therefore, to indicate with exactness the limits of this zone in terms of physical measurements, although it is occupied by as well marked an association of plants as one is likely to meet with anywhere. As far as present evidence goes, water supply is the chief factor determining the lower limit of the piñon zone, while its upper limit is almost certainly determined largely by temperature. With what care, however, such general conclusions should be accepted is illustrated by the fact that the creosote bush deports itself here, at an altitude of some 6,000 feet, precisely as it does in the neighborhood of Tucson, at an altitude of 2,400 feet and upwards, occupying the talus slopes as its special habitat, while *Fouquieria*, *Opuntia*, and others are here, at the higher altitude, with its consequent climatic differences, quite as much at home as there, on the coarser rocks and more rugged exposures, facts that emphasize the necessity of giving due weight to edaphic as well as climatic factors in any attempt to trace the pathway of these plants in their desert wanderings.

How, now, about the third association of plants, that of conifers and deciduous trees and shrubs growing in the bottom of the cañon? Here we need a fact of history. Had they reached the top of the Sacramento Mountain before the cañon was formed? If so, they have advanced down the cañon as it has finally come to offer conditions favorable for their growth, such as do not exist on the bluffs and hills around. Concerning this historical fact, however, there is at present little light. It has been suggested that here, as in the eastern United States, such mesophytes and their associates moved southward with the increasing cold of the glacial epoch, and, here as there, subsequently moved northward, and also took to the mountains, where so many of them are still living. The view has also been put forward, that their presence here is the result of direct migration along the Rocky Mountains and the outlying elevations of the southwest, which, if not continuous, served none the less as good and sufficient stepping-stones for their progress. But more than another day will have to be spent in the patient accumulation of facts. Meantime, it would be hard to find a more fascinating problem.

NEW YORK MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The fifty-seventh meeting of the American Association for the Advancement of Science was held at Columbia University, New York City, December 27, 1906, to January 2, 1907.

The meeting was one of the largest and most interesting in the history of the Association. That fully 1,500 men and women who are devoting their lives to scientific research should have gathered from far and wide for a mutual exchange of ideas and the inspiration that comes from personal intercourse, is one proof more that this is indeed an age of science. The papers that were read and the work that was exhibited during the meeting showed that the results of this research are not only an addition to the sum of human knowledge, but are also an actual contribution to the economic welfare of man.

The evening before the opening meeting of the Association the Torrey Botanical Club tendered a reception to visiting botanists in the botanical laboratories at Schermerhorn Hall. The occasion was marked by a notable gathering of botanists from all parts of the country. Among those present were, Dr. Daniel T. MacDougal, Director of the Department of Botanical Research of the Carnegie Institution; Professor Charles E. Bessey and Professor F. E. Clements, of the University of Nebraska; Professor George F. Atkinson, Professor W. W. Rowlee, and Dr. E. J. Durand, of Cornell University; Dr. Bradley M. Davis, Dr. C. J. Chamberlain, and Dr. John M. Coulter, of Chicago University; Professor William Trelease, Dr. Hermann von Schrenk, and Professor J. Arthur Harris, of the Missouri Botanical Garden; Dr. F. S. Earle, and Dr. Melville T. Cook, late of the Cuba Experiment Station; Professor J. C. Arthur, of Purdue University, Lafayette, Indiana; Dr. B. E. Livingston, of the Desert Botanical Laboratory, Tucson, Arizona; Dr. Duncan S. Johnson, of the Johns Hopkins University; Dr. Forrest Shreve, of the Woman's College, Baltimore; Dr. A. F. Blakeslee, of Harvard University; Dr. Joseph E. Kirkwood, of Syracuse University; Dr. George H. Shull, of the Station for Experimental Evolution at Cold Spring Harbor, Long

Island; Dr. A. S. Hitchcock, of the U. S. Department of Agriculture; Professor W. F. Ganong, of Smith College; Professor E. N. Transeau, of Alma College, Michigan; Professor Herbert M. Richards and Dr. Tracey E. Hazen, of Barnard College, Columbia University; Professor Bruce Fink, of Miami University, Oxford, Ohio; Dr. John W. Harshberger, of the University of Pennsylvania; Dr. N. L. Britton, Director of the New York Botanical Garden; Dr. William A. Murrill, Dr. C. Stuart Gager, Mr. George V. Nash, and Dr. John H. Barnhart, of the New York Botanical Garden; Professor Lucien M. Underwood, and Dr. Carlton C. Curtis, of Columbia University.

Section G—Botany, held three independent sessions for the reading of papers. The members of this section also attended the meetings of the Botanical Society of America, as well as a joint session with Section F, Zoology. The meetings of Section G were presided over by the Vice-President and Chairman, Dr. Daniel T. MacDougal. There was a registered attendance of 139.

The papers read represented some of the best work now being done in botany and included the following:

G. H. Shull, "Elementary Species and Hybrids of *Bursa*."

E. S. Brainerd, "Hybridization in Violets."

D. T. MacDougal, "Origination of Species of Hybrids among Wild Plants."

J. B. Norton, "Mendel's Law as a Tracer of Lost Parents, I.: The American Carnation."

E. N. Transeau, "Hybridization as a Factor in Migration and Competition."

F. E. Lloyd, "The Flowering Period of a Hybrid Opuntia." (By title.)

F. E. Clements, "The Natural System of the Discomycetes."

F. L. Stewart, "The Sub-serial Absorption: A Function of the Ligule and Stipulaceous Tissue of Grasses. An Outbreak of the European Currant Rust."

W. D. Hoyt, "The Periodicity of the Sexual Cells of *Dictyota dichotoma*."

B. E. Livingston, "A Recording Evaporimeter."

E. W. Olive, "Evidences of Sexuality in the Slime Moulds."

Robert Boyd Thomson, "The Araucaricae—a Proto-siphonogamic Method of Fertilization."

W. W. Rowlee, "Localization of Plants in the Finger-lake Region and the Adjacent Ontario Lowlands of Central New York.

S. M. Tracy, "'G' Trees."

E. A. Bessey, "Spore Forms of *Spegazzinia ornata*. Accelerated Blossoming Due to Defoliation by Storm."

M. A. Chrysler, "Tyloses in the Tracheids of Conifers."
E. J. Durand, "The Origin of the Hymenium in some Geoglossaceæ."
C. R. Ball, "The Botanical History, Classification and Uses of Sorghum."
W. A. Orton, "The Plant Disease Survey of the United States."
J. H. White, "Polystely in the Orchidaceæ."

Concurrently with the meetings of Section G, the Botanical Society of America held meetings at which the following papers were presented:

R. A. Harper, Figures Produced by Protoplasmic Streaming in Fungi and Slime Moulds. "The Organization of Certain Coenobic Plants." (Lantern.)
C. R. Barnes and W. J. G. Land, "The Origin of Air-Chambers in Liverworts."
R. R. Gates, "Cytological Studies on *Œnothera lata* de Vries and its Hybrids."
W. J. G. Land, "Fertilization and Embryogeny of *Ephedra trifurca* Torr."
C. J. Chamberlain, "A Field Study of *Dioon* and *Ceratozamia*."
G. T. Moore, "The Genus *Pleurococcus*, Culturally Considered."
T. E. Hazen, "The Early Growth of *Monostroma*."
B. M. Davis, "Spore Formation in *Derbesia*."
A. F. Blakeslee, "Sexuality in the Genus *Mucor*."
J. C. Arthur, "Cultures of Uredineæ in 1906."
G. P. Clinton, "*Peridermium acicolum* the Aecial Stage of *Coleosporium solidaginis*."
G. R. Lyman, "Culture-studies on the Polymorphism of Hymenomycetes." By invitation.
C. L. Shear and Anna K. Wood, "Ascigerous Forms of *Gloeosporium* and *Colletotrichum*."
F. L. Stevens, "A New Chrysanthemum Disease: the Ray-rot."
Bruce Fink, "A Bibliography of North American Lichenology."
Elizabeth G. Britton and Arthur Hollick, "A New Fossil Moss from Florissant, Colorado."
Arthur Hollick and E. C. Jeffrey, "Recent Identifications of Cretaceous Gymnosperms from Kreischerville, N. Y."
H. von Schrenk, "Some Changes in Wood Fiber Immersed in Water."
E. C. Jeffrey, "Some Vestigial Characters in the Cone of Pines."
A. S. Hitchcock, "Classification of the Genus *Panicum*."

One meeting was held at the Museum of the New York Botanical Garden, at Bronx Park, and was followed by a luncheon in the laboratories. The following addresses were given:

C. H. Shaw, "The Teaching of the Subject of Respiration."
B. E. Livingston, "Relative Transpiration in Cacti."
J. W. Harshberger, "The Water-storing Tubers of *Nephrolepis cordifolia*."

F. E. Clements, "The Causes of Dwarfing in Alpine Plants."

F. E. Clements, "The Origin of New Forms by Adaptation."

W. A. Orton, "A study of Disease Resistance in Watermelons."

J. A. Harris, "The Problems of Vegetable Teratology." By invitation.

W. F. Ganong, "A Preliminary Organization of the Investigation of the Ecological-physiological Life History of Plants."

Forrest Shreve, "The Vegetation of the Blue Mountains of Jamaica." By invitation.

At the American Museum of Natural History interesting exercises were held in connection with the unveiling of the busts of ten American men of science, presented to the museum by Mr. Morris K. Jesup. The science of botany was represented by a bust of John Torrey. Dr. Nathaniel L. Britton, Director of the New York Botanical Garden, made the memorial address.

On the evening of the same day there was held at the museum, in conjunction with the New York Academy of Sciences, a reception and exhibit of recent progress in science.

The next regular meeting of the American Association for the Advancement of Science will be held at Chicago in the winter of 1907–'08. M. M. B.

EXHIBIT OF THE NEW YORK ACADEMY OF SCIENCES AT THE AMERICAN MUSEUM OF NATURAL HISTORY, DECEMBER 28 AND 29, 1906.

Botany.

Vice-Chairman, C. Stuart Gager; *Associate Committee*, George Francis Atkinson, John Merle Coulter, Byron David Halsted, Duncan Starr Johnson, William L. Bray, Margaret Clay Ferguson, Edward Charles Jeffrey, Lucien M. Underwood.

1. (*a*) Map of the grounds of the New York Botanical Garden.
   (*b*) Publications of the garden issued during 1906.
   (*c*) Specimens from the Mitten collection of mosses, hepatics and lichens (recently purchased for the garden, through the generosity of members of the board of managers).
   (*d*) New apparatus: Photomicrographic Apparatus: Lieber's

radioactive microscopic slide: Apparatus for growing plants in a radioactive atmosphere.

(*e*) Photomicrographs of cross-sections of American woods (purchased from Mr. James A. Neale, Liverpool, England.

(*f*) The tropical laboratory of the Garden at Cinchona, Jamaica. Views of the laboratory, residence, and wild and cultivated flora.

(*g*) Botanical garden, Castleton, Jamaica. Photos showing additional facilities available to students registered at the tropical laboratory of the Garden.

(*h*) Hope Botanical Garden and vicinity, Jamaica. Photos showing facilities also available to students registered at the tropical laboratory of the garden.

Exhibited by the New York Botanical Garden, Nathaniel L. Britton, Director.

2. Photographs showing effects of radioactivity on plants. Exhibited by C. Stuart Gager.
3. Tuber formation in Solanum Tuberosum in daylight. Exhibited by C. Stuart Gager.
4. Photographs of *Gunnera manicata* in flower. Exhibited by C. Stuart Gager.
5. A new chestnut disease: Drawings and specimens. Exhibited by W. A. Murrill.
6. Regeneration in plants: Specimens and photographs. Exhibited by Elsie Kupfer.
7. The relation of mechanical injury to fasciation in the evening primrose: Specimens and photographs. Exhibited by Alice A. Knox.
8. Magnesium as a stimulant to plant growth. Exhibited by Gertrude S. Burlingham.
9. Botanical features of the mainland keys of Florida: Map, photos and herbarium specimens. Exhibited by John K. Small.
10. New and interesting additions to the moss flora of the West Indies: Specimens and drawings. Exhibited by Elizabeth G. Britton.

11. A spineless cactus (*Opuntia wheeleri* n. sp.) from the island of Culebra, Porto Rico, and its West Indian relatives. Exhibited by N. L. Britton.
12. Illustrations of the flora of the Philippine Islands: (*a*) Herbarium specimens. (*b*) Pandanus fruit. (*c*) Oak; fruiting branch. Exhibited by R. S. Williams and C. B. Robinson.
13. *Scybalium jamaicense* Schott and Endl., from Cuba. Exhibited by Norman Taylor.
14. New American coralline algæ from Porto Rico. Exhibited by Marshall A. Howe.
15. New and noteworthy grasses. Exhibited by G. V. Nash.
16. Recent discoveries and identifications of cretaceous plant remains from Kreischerville, Staten Island, N. Y. Exhibited by Arthur Hollick and Edward C. Jeffrey.
17. Photographs of plant hybrids. Exhibited by Byron D. Halsted.
18. Photographs of grounds and buildings of Syracuse University. Exhibited by Department of Botany, Syracuse Univ.
19. Maps, charts, and photographs showing work and progress of the botanical survey of Maryland. Exhibited by Forrest Shreve.
20. (*a*) Series of drawings illustrating researches.
    (*b*) Papers published from the department.
    (*c*) Series of photographs of tropical vegetation of the Rain Forest, Blue Mountains of Jamaica. Exhibited by Duncan S. Johnson and Forrest Shreve, Botanical Department, Johns Hopkins University.
21. New species of Biotian asters, herbarium specimens. Exhibited by Edward S. Burgess.
22. Studies of insect galls. Exhibited by Mel. T. Cook.
23. Cultures of dairy fungi and bacteria. Exhibited by Charles Thom and W. M. Esten.
24. New species of *Lactarius*. Exhibited by Gertrude S. Burlingham.
25. New and noteworthy Polyporaceæ. Exhibited by W. A. Murrill.
26. Photographs of southern coastal plain vegetation (Georgia and Alabama). Exhibited by Roland M. Harper.

27. Fecundation and triple fusion in the endosperm nucleus of *Lilium Carolinianum*. Exhibited by Carlton C. Curtis.
28. (*a*) Exhibition of laboratory papers in plant physiology.
    (*b*) Contributions from the Botanical Department. Exhibited by Department of Botany, Columbia University.
29. (*a*) Pleistocene plants. Coastal plains of North Carolina.
    (*b*) Leaf variation in *Comptonia peregrina*. (L.) Coulter. Exhibited by E. W. Berry.
30. Photographs of Colorado plants. Exhibited by Francis Ramaley.
31. (*a*) Lieber's radium-coated rods used to expose plants to the rays of radium.
    (*b*) Radioactive microscopic slide devised by C. Stuart Gager and prepared by H. Lieber & Co., New York, for observing the effects of radium rays on cell activities.
    (*c*) Radium preparations used for exposing plants to the rays of radium. Exhibited by C. Stuart Gager, by courtesy of H. Lieber & Co., New York.
32. Publications of the Torrey Botanical Club.
33. Species and illustrations of fungi, by George F. Atkinson. By courtesy of Henry Holt & Co.
34. Principles of botany, by Bergen & Davis. By courtesy of Ginn & Co.
35. The "Flora of Colorado," together with illustrative specimens. Exhibited by Axel Rydberg.
36. Cross-section of *Schlotheimia jamaicense*. E. G. Britton, n. sp. Exhibited by Alexandrina Taylor from specimens belonging to the New York Botanical Garden.
37. Specimen and drawing of *Andreæa Toccoæ*. J. T. Emerson, n. sp. Exhibited by Julia T. Emerson from specimens belonging to the New York Botanical Garden.
38. Photographs, publications and specimens illustrating the work of the Department of Botany, University of Missouri. Exhibited by Benjamin W. Duggar.
39. Photographs of vegetation. Exhibited by Charles E. Bessey.
40. Recent issues of the PLANT WORLD. Exhibited by Editor.

Volume 10 Number 2

THE PLANT WORLD

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FEBRUARY, 1907

HYBRIDS AMONG WILD PLANTS.

By Dr. D. T. MacDougal.

Nearly one per cent. of the seed-plants native to Eastern North America are taken by systematists to be hybrids, or the results of crosses between two species. In most instances conclusions as to the hybrid nature of a plant are drawn from the fact that it appears to be intermediate between the two in form and intimate structure. Oftentimes the two supposed parents constitute the only members of the genus in the region.

This is not an entirely safe method of reasoning, however, since the structure of the leaves, stems, flowers and fruit are not a safe index of a relationship of this kind, and the supposed hybrid may be a sport or mutant coming from one of the supposed parents alone. Whether or not two nearly related species will cross with each other depends on so many delicate conditions that hybridization may not be predicted with safety; the only method on which any reliance can be put consists in actual test.

If we suppose a plant to be a hybrid between two other species we may obtain proof by re-making the cross with some hope of duplicating the hybrid, although this may not always be successful. Then again some hybrids show alternative inheritance, by reason of which the progeny beginning with the second generation include a great number of forms not resembling their parents exactly, but showing the ancestral characters in various combinations. Professor Brainerd, of the Vermont Botanical Club, has recently applied this latter method with eminent success to the violets, in which he finds that hybridizations take place between a large number of pairs. The numerous differing forms which appear in the second generation of the violet hybrids doubtless form the basis of many of the new species that have been described in the last few years, and also has led to erroneous conclusions as to the intergradation between some of the species.

I. II. III. IV. V. VI.

Figure 7. Plantlets grown from acorns of a tree of Bartram's Oak, which bore leaves like Figure 2, III.

Bartram's oak (*Quercus heterophylla*), which was discovered near Philadelphia in 1750, has long been supposed to be a hybrid, and its variations in the nursery has called for much comment at various times during the past twenty-five years. In order to obtain some positive evidence upon its character, a quantity of acorns was procured from a tree on Staten Island in October, 1905. Upon germination these displayed all of the phenomena of alternative inheritance, the seventy-five plantlets obtained including some which bore leaves exactly duplicating the willow oak (*Q. Phellos*) one of the ancestors, while one or two were equally closely similar to the red oak (*Q. rubra*), the other supposed member of the original cross. The remainder of the progeny could be arranged in a series between these two poles, with the ancestral qualities variously displayed.

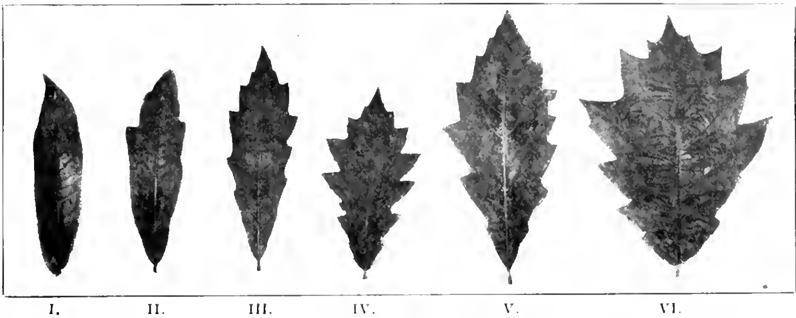


Figure 8. Series of leaves representing individuals grown from acorns from Bartram's Oak.

This signal success may not always be expected, however. Sometimes the cross results in an intermediate stable hybrid in which the first, second and succeeding generations contain only one type which is constant. Cultures of such hybrids reveal nothing as to their origin, and the only method of investigation available in such cases consists in attempting to re-make the hybrid by crossing the supposed parents. The entire number of plants treated as hybrids in the manuals is in need of investigation by the methods indicated above, and the work might be performed by any one within the limits of a dooryard or kitchen garden.

VISITS TO SOME BOTANIC GARDENS ABROAD.

By Dr. Pehr Olsson-Seffer.

In the course of a journey 'round the world for the purpose of studying economic botany, I have visited a number of botanic gardens, many of which are seldom seen by traveling botanists. Others are described over and over again, such as the famous tropical garden at Buitenzorg, the Mecca of every student of botany, which many want to visit, but few are fortunate enough to get the opportunity. I intend in this and following numbers of the *Plant World* to give brief descriptions of these gardens, and to relate some personal impressions of my visits. I regret that it is impossible to publish all the interesting photographs I have secured from these places, as they would give the reader a much better idea of these gardens than any words of mine.

I. HONOLULU.

Who ever heard of a botanic garden in Honolulu? There is no garden with that name, it is true, but so far as that goes, the entire city of Honolulu can be considered a botanic garden, and it will easily stand comparison with many an attempt at a botanical garden, with only the name to entitle it to such a rank.

Figure 9. Residence in Honolulu. Araucarias, Royal Palms and Casuarina in a Honolulu Garden.

The Government nursery at the corner of King and Keaumoku streets is a good nucleus to a botanic garden. A number of trees, indigenous and exotic, are planted here, every tree is labeled, and altogether it is a creditable little arboretum. In one corner of the block is the building of the Territorial Board of Commissioners of Agriculture and Forestry, in which are the offices of the divisions of forestry, entomology and animal industry, as well as an excellent little library of reference books on botany and forestry, with the current periodicals of these sciences.

The grounds are under the direction of Mr. Ralph S. Hosmer, the superintendent of forestry, formerly of U. S. Department of Agriculture.

I visited the grounds almost daily for several weeks, and inspected the nurseries with Mr. Hosmer and his assistant, Mr. David Haughs. There are in the grounds fine specimens of the native screw palm, or "Hala" (*Pandanus odoratissimus*), of *Sabal blackburniana*, a fan palm, of *Calophyllum calaba*, the calaba tree. *Nephelium litchi*, which produces the leechee or lichi fruit, a special favorite with the Chinese, but becoming more and more appreciated by Americans, is represented by a large specimen, and *Cinnamomum cassia*, the "Lignum vitæ" of Southern China, grows equally well.

Figure 10. Screw Palm, Pandanus odoratissimus.

Everywhere in Honolulu the Royal Palm (*Oreodoxa regia*) is used in forming avenues, and gives a distinct character to the place. *Caryota urens*, *Areca rubra*, the Oil Palm (*Elaeis guineensis*), and *Thrinax argenta* are commonly cultivated plants here. The Royal Poinciana (*P. regia*), the *Cassias* (*C. fistula*, *C. grandis*, and *C. nodosa*), *Durantas*, *Caesalpinias*, and the Pride of India (*Melia azedarach*), give color to the tropical green, while introduced *Casuarinas*, *Eucalypts*, and *Grevilleas* intermingle in the parks and on the planted hillsides with the native Ohia Lehua (*Metrosideros polymorpha*), Koa (*Acacia koa*), and sundry other indigenous trees.

Along the seashore and in its immediate neighborhood are numerous groves of cocoanut palms, and in most gardens sundry tropical fruit trees, such as *Carica papaya*, *Mangifera indica*, and *Persea gratissima* are common. The "Night Blooming *Cereus*" covers many stone walls in the city, and when in bloom is a remarkable sight.

Hawaii is an Eldorado for the botanist who has never been in the Tropics. It is within easy reach of the Pacific coast, and there is no place better suited for a pleasant vacation than these islands with their almost tropical flora, where the climate is agreeable, the living comfortable, and traveling easy.

Four weeks spent in the islands in 1902, and four weeks in 1906, made me love "Hawaii nei," "Happy Hawaii," as the natives call their kingdom of the sea, with its fair skies and blue ocean, its bright flowers and its verdant green, its droning palms, and its ragged volcanoes, its drowsy tropical atmosphere, and its brilliant sunsets, surpassed by none in my experience but those of Samoa, the most beautiful islands of the Pacific.

II. Botanic Garden of the Imperial University of Tokyo.

On an early morning in late October, I first saw the "Land of the Rising Sun" from the deck of the steamer laying at anchor in Yokohama harbor. I did not tarry long in Yokohama. Just enough to get a glimpse of Japanese street life, and to pay a visit to the Yokohama Nursery Company's gardens, where hours were spent in examining interesting specimens of Japanese plant life, natural and artificial, mostly the latter. Then off in drizzling rain to the railway station, where the *ricksha* pulled up with a jerk, so suddenly that I was nearly precipitated into the arms of a geisha girl, carrying a graceful bouquet of beautiful *chrysanthemums*. After a short ride through green rice fields, iris gardens and peony farms, we reached Tokyo, the capital of the Mikado. Armed with a—to our eyes—curious letter of introduction written in Japanese, we proceeded to the botanic gardens. Dr. Matsumura, the director, was absent in Europe, so his head gardener took us through the gardens and greenhouses. Afterwards we called on Dr. Miyoshi, and thanks to his courtesy and Mr. Hayato, assistant in botany, I obtained the following data relating to the history of the gardens.

Figure 11. Greenhouse in Tokyo Botanic Garden.

(*To be continued.*)

OBSERVATIONS ON THE FLOWERING PERIODS OF CERTAIN CACTI.

By Professor Francis E. Lloyd.

The following notes on this subject have been gleaned during the flowering season of 1906, and while somewhat scattered, will be of some value as such, there being comparatively little accurate knowledge derived from continual observation of cacti in the field, the great need for which was pointed out by Ganong over ten years ago, and because, also, of the important physiological problems they indicate. No attempt has been made by me to solve any of these experimentally on account of the preoccupation of my time, but to point out the field for work will not be amiss.

The annual flowering period for the cacti in the vicinity of Tucson, Arizona, commences early in April at the close of the winter rains, *Cereus fendleri* being one of the first to put out its marvelously beautiful flowers in abundant numbers. The season closes about the middle of September, when the last of the flowers of the arborescent type of Opuntiae, as e. g., the cholla (*O. fulgida*) are to be seen. The beginning of the annual flowering period of the species taken severally may occur at any time between the inclusive dates given, save, of course, only the last to commence, which will be several weeks before the last flower is to be seen. The summer rains begin here about the middle of July and continue, with abundant interruption, till the last of September. This month, however, is not a wet one by any stretch of the imagination, or at least, it was not this year, though it will be understood the soil water is relatively abundant.

It will then be seen that the flowering period of the cacti of the region to which I refer falls, not at the end of the dry, nor at the close of the rainy season, from which circumstance it is difficult to conclude that the production of flowers is in any way dependent upon the abundance of water in the soil. This may be the case with reference to particular species, but is to be proved. But the fact that the latest species to flower commence to do so before the summer rains set in, early in July, appears to deny this. Their flowering goes on without interruption during the rains, but the maximum of flower production is not a striking one, nor does it seem to be related to a greater abundance of soil water. That the flowers of cacti, then, are not adapted, as are the plants from which they spring, to the dry conditions of the desert, both above and below the surface of the ground, may indeed be true, but remains undemonstrated, and there is nothing in the view that the flowering period of cacti is determined by the advent of the rain.[1]

Perhaps a less dogmatic way to put it is to say that there is as yet a very insufficient basis for such a generalization, and the whole question becomes an open one. The truth of this is further indicated by the fact that in many cacti the flowering commences long before the turgid condition, following the advent of the rain, has been assumed. For instance, I have noted certain of the arborescent opuntias, notably *Opuntia fulgida*, producing flowers in abundance, while the ultimate articles from which they sprang, as indeed the whole plant, were in a woefully shriveled condition.

And from this we might be further led to conclude that the process does not depend on an optimum or even a moderate abundance of water in the plants themselves, a conclusion obviously open, in many cases, to much doubt. Some of the species of *Mamillaria* appear to wait till the rains come. It is clear that the water supply of cactus flowers is derived, in many cases, entirely from the plant. It is a common sight to see a cactus (e. g. *Echinocactus wislezeni*) flowering abundantly after being uprooted for at least six months. It serves nevertheless to direct our attention to the fact that here is a definite problem not yet begun to be settled, and about which it is very unsafe to make generalizations at too great a distance. That the flowers as such are not, at least in a striking way, adapted to withstand the adverse conditions of low relative humidity, appears to be probable, as they are, as a class, ephemeral. The exceptions to this rule are to be found in such species as the saguaro, *Cereus giganteus*, the flower of which is said to open on the second day, a point which I regret not to have settled beyond doubt for myself. I do know, however, that the flowers of a closely related species, *Cereus Thurberi*, the pitalla, in which the anatomical and gross characters of the flower are very closely comparable, if not practically identical, with those of the flower of *Cereus giganteus*,

1. Ganong, W. F. Present problems in the anatomy, morphology and biology of the Cactaceæ. Bot. Gaz. **20:** 129, 1895.

are ephemeral, and in fact open only at night, and not in the day time at all. I observed this while on a visit to the Quiqotoa Mountains, ninety miles west of Tucson, where is to be found a limited and isolated station, but where it grows abundantly and luxuriously on the western slope of the mountains. I found it to be a true night-blooming cereus, opening at sunset, and occupying, in the process, a half to one hour. It is a very singular fact, that of two closely related species, the flowers of which are so much alike in all points of structure, and, if adapted to insect or other visitors at all, to the same kinds, the diurnal flowering period should fall, in one species in the day time, and in the other at night. The same insect visitors may indeed be useful at both times, as is true to my knowledge in the cases of *Opuntia fulgida*, the flowers of which are abundantly visited, in light and dark alike, by the little grey beetle, *Bruchus amicus*, kindly identified for me by Dr. L. O. Howard, of the U. S. Department of Agriculture. So that this point may present no difficulties, since there is no need to assume that night and day flowers are pollinated by different kinds of visitors, although it may be true in particular instances, even when the flowers are as much alike in form as in the two species above referred to. The more difficult part of the problem lies in the practical structural identity of the two flowers of the two species. We have generally supposed the flowers of the night bloomers to be of a delicate nature. Certainly the majority have a more evanescent appearance, an impression which one gets on looking, as I did for the first time last year, on the singularly tender flowers of *Cereus greggii*, which set out its annual array for us this year on the 11th of July.[1] And so also with others which are more familiar to us through cultivation or otherwise. But the flowers of *Cereus thurberi*, are, in appearance, of no such ethereal nature. And yet the sun never looks upon them, while the ghostly petals of *Cereus greggii*

1. The date of flowering in 1903 was June 21. Of this plant Englemann remarked, "They seem to be mostly nocturnal, as Mr. Thurber collected them in the early morning hours, commencing to fade" (Cactaceæ of the U. S. and Mex. Bound. S. *p.* 41). What is more, almost *all* the flowers open in a single night of the year.

frequently wait till the sun is well above the horizon before closing. A photograph was taken with the advantage of shadows cast by him, while one of the flower of *Cereus thurberi* had to be made before the dawn was dispelled. The fact is that the pitalla flowers possess nothing of the evanescent appearance of the night blooming kinds, including also many other plants of widely different families. Yet its thick and stiff petals, like to those of *Cereus giganteus*, are quite as truly evanescent. The explanation must be sought by physiological methods. This brings me to the consideration of another plant, which exemplifies, among the cacti, a third type of diurnal flowering period as yet unrecognized, namely *Opuntia fulgida*. I shall speak now of this alone, though what I say is true in part of several other species more or less closely related to it. The observations on these, however, are set down below. *Opuntia fulgida* differs from both the night blooming and day blooming kinds, in that its diurnal flowering period commences at three, suntime, in the afternoon. So regular and constant is this that one may set his watch by it and be scarcely fifteen minutes away from the true time. This was illustrated on the occasion of a visit to Tucson of Dr. Pehr Olsson-Seffer, to whom I mentioned the fact. Upon this I took out my watch, which read 2:30 p. m. (3:05 sun time), and I suggested that we pass into the adjoining cactus garden, planted by Professor J. W. Toumey, to see if we might verify my statements. Upon doing so, not an open flower was to be seen. I was, however, able to point out what was not very obvious to one who had not given attention to the point, that certain flowers would be out in fifteen minutes, that is, would begin to open. We passed around the garden examining other forms here and there, when we came upon an opening flower, and the watch had advanced fifteen minutes. We immediately returned to examine the first ones we had looked at, and these, too, were beginning to open! In fifteen minutes more a dozen or two flowers could be seen dotting the pendulous branches here and there. Others as well as myself have, during the past summer, scanned large stretches of country, as one may in two long days' drive, and never an open flower of this plant has been seen before 3:00 p. m. by the sun, and our search has included very many thousands of plants.

It must be observed that nearly all these observations were made in bright weather, as there is little of any other kind in this part of Arizona. One observation, communicated to me by Prof. J. J. Thornber, made by him on the mesa a few miles southeast of Tucson on a very cloudy day, indicates that the opening may be induced earlier than normally by continuous reduced illumination. He saw the flowers of *Opuntia fulgida* and *O. mamillata* opening at exactly 2:00 p. m., a half hour earlier than usual. The two species behaved alike. In thirty minutes flowers in open condition were abundant, so that this is probably generally true of these plants on cloudy days. It is well known that changes in illumination induce the opening or closing of certain flowers, and this applies also in many cases to changes of temperature. The immediate cause of opening may be growth or turgor changes, or both. In the case of the plant of which I am speaking, it seems difficult to account for the simultaneous opening of the flowers with such great regularity as a result of any change in the illumination or temperature. Both of these factors are remarkably constant during the hours preceding and following the beginning of the diurnal flowering period; nor are we in a position to state that the change in the quality of illumination is at all marked at this time. Of the very slight changes, insensible to our crude organs, which may well be believed to affect the flowers of plants, we cannot do more than to conjecture. No ordinary means that we have at hand can record them. That the opening of these flowers is a response to such changes or is an after-effect of previous conditions, or how far it is conditioned by factors, such as water content, within the plant itself, are open questions and offer a fertile field for study. Kerner (Natural History or Plants II., P. 219) remarks: "In luxuriant Opuntia plants it is quite common for the flowers on the branches of the sunny side to open a long time before those on the shady side, and this with flowers of the same age." I have failed to observe any such behavior in plants in their natural habitat. The flowers showing no greater inclination to open in the sunshine than in the shade.

The flowers remain open till about 9:00 p. m., when the first signs of closure are to be observed. A somewhat analogous behavior was recorded for "*Cactus grandiflorus*" by Linnaeus in his floral clock, who reported it as opening at 9:00 or 10:00 p. m., and closing at midnight. Closure occupies some hours, this being not a well-marked period. The earlier stages of closure are indicated by the upward position of the inner petals, and the assumption of a rotate position by the remaining members of the corolla which earlier were strongly recurved. Somewhat further inward flexure of the petals is followed by a general wilting of all its members, and these gradually wither and dry up in position, the stamens being most resistant. The formation of a scission layer is very rapid, so that in forty-eight hours the whole floral apparatus readily falls away from the ovary. Indeed, the point suggests itself if the rapid growth of the scission layer may not be the immediate partial, if not the whole, cause of the closing and withering away of these flowers, an idea which is reinforced by the appearance of the petals, which, evanescent as they are, are not at all resistant. On the other hand, there is evidence that the scission layer in such flowers as those of *Cereus Thurberi*, *C. giganteus*, etc., is not formed rapidly, though this may turn out not to be true upon examination. The behavior of the scission layer as related to the period of flowering in the cacti is one which promises a good deal of interest to the student.

The rapidity of closure in the cholla, under the ordinary conditions in the dry portion of the summer, is as just described. There are, however, exceptional conditions under which the flowers behave somewhat differently, that is, the closure is retarded. Rain or a condition of high relative humidity following rain, are favorable to a retention of the open condition, though I have not found that these induce an earlier than normal opening, when they are not accompanied by dense cloudiness. Thus on August 19, 1906, the flowers were still open at 9:00 a. m., the parts having all passed from the reflexed into a rotate position. At 11:00 a. m. the withering had proceeded to an evident extent. August 18th had been a very wet day, and for twenty-four hours thereafter there was a high relative humidity. In spite of this high humidity, however, the new flowers of the 19th opened at 2:30 to 3:00 p. m., no earlier than usual. It happened that it rained at 3:45, and thus the flowers were wet, but no hastening nor delay of the opening was observed. I had occasion during several nights to study the effect of these rains and consequent humidity, and always found this delay in closure and withering. This observation is of interest, as it indicates that the closure may be due in part to active transpiration, and the delay above described to the reduction of transpiration by the rain or humidity. It is recognized as generally true that the rate of transpiration in even delicate flowers is very much less than in the leaves of the plants which bear them, and this can readily be believed to be true of many desert plants, the flowers of which remain in an unwilted condition under the hottest sun, when the leaves are distinctly wilted or even withered. Some flowers, removed from the stem, have been observed to remain turgid a remarkably long time. I have, however, made no exact experiment. It would seem probable that in the case of some, if not all, cactus flowers the rate of transpiration is greater, as compared with many flowers, than might be expected, and not at all low.

Not only is the fading of the flower delayed by high humidity, but, as I have had recently to notice, the quite cool nights which may occur in the early part of September may also produce the same effect, and it would seem, for the same reasons, namely, by suppressing transpiration. Thus, on September 12, at 6:00 a. m., some flowers on one plant which was still active in their production, though the season was drawing to a close, were still open. This was the first time I had observed this since the cessation of the rains. The previous night was exceptionally cool, the mercury going down to 14.5° C. The sun rose at 5:00, and the warmth, or perhaps I should say the heat, soon effected the withering. I may here remark that one may easily be deceived.

except when close examination is resorted to, into believing that the flowers of these cacti open in the morning, as many flowers may be seen in the earlier hours, if the conditions are favorable, which at a distance look fresh. Observation will show, however, that they are the flowers of the previous afternoon.

Of other cacti, there have been noted several that behave similarly to *Opuntia fulgida*. *O. mamillata* has just the same behavior. *O. tesselata* open at about 1:30 sun time, *O. tetracantha* about a half hour earlier. These data are approximate only, as I had no opportunity to do more than determine the fact that they are afternoon bloomers.

Among all the forms I have examined the species of *Echinocactus* are most unwilling to respond to illumination. On cloudy days the flowers, which normally open early, are slow to respond. Aside from such irregularities as I have mentioned, there are therefore three types of cacti, distinguished by their diurnal flowering periods.

1. Those which flower early in the morning, at or a little later than sunrise, *Platopuntiae, Opuntia spinosior. O. versicolor, Mamillariae, Cereus giganteus, C. fendleri,* etc. The large, beautiful flowers of *Cereus pectinatus* open at about 7:00 and are fully expanded in a half or three-quarters of an hour. The more evanescent types, such as this species, commonly close under the hot mid-afternoon sun.

2. Those which flower at night. *Cereus greggii, C. thurberi,* and several others, some of which are well known in cultivation.

3. Those which flower in the earlier half of the afternoon: *Opuntia fulgida, O. mamillata, O. tesselata, O. arbuscula, O. tetracantha, O. biglovii,* and probably some others.

The observation recorded in Kerner's Natural History of Plants are more or less at variance with this classification, but the behavior of the cacti at home accords well with it. It must be remembered that much of our information has been gathered from plants under the special conditions of cultivation.

SUGGESTIONS TO PLANT COLLECTORS.

These hints were written for collectors in Southern Arizona, but have an application in some other quarters.

1. Record the altitude—from a bench-mark if there is one in the neighborhood, if not then by other well-known means. There is nothing more important to a student of distribution.

2. State what the exposure is. Two quite different floras are often growing within a few rods of each other on the opposite sides of a cañon.

3. Note character of soil and rock. If maps of the Bureau of Soils are available for the area in hand, use their nomenclature.

4. Indicate relative abundance. Enclose a few square meters, or such standard area as you may adopt, where the species is at its best, and count the individuals. This will take a few minutes, but will give something definite. It is applicable chiefly to perennials.

5. Collect by habitats as far as possible and enumerate in each at least a few characteristic associates.

A number of other things might be added, but if these suggestions, with such modifications as experience and varying conditions call for, are actually followed for even a score of the most characteristic plants of an area, accompanied by very brief similar notes for the rest, your collection will give an ecologist or a student of distribution, what he specially wants to know, and there will be less "hay" in the herbaria to which your plants are sent.

V. M. SPALDING.

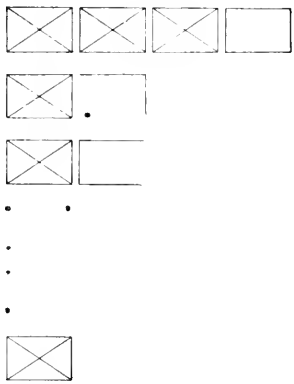
A SIMPLE PLAN FOR COLLECTORS OF ECOLOGICAL SETS OF PLANTS.

In a collection of plants the value of the specimens depends almost directly upon the fullness and accuracy with which data are recorded. Especially is this true at present when growing attention is paid to ecology. The "Texas-04-John Doe" type of label has outlived its usefulness.

The following scheme, which can easily be put upon a page of the collector's notebook, is suggested. It may afterwards be duplicated upon the herbarium label, or so much of it as may be desired. For illustration, an actual record is given:

PLANTS OF NEW MEXICO.

Place: $\frac{1}{2}$ mile north of Fort Bayard, road to Pinos Altos.
Altitude: 6,200 feet.
Aspect: S. W.
Slope: gentle (or moderate, steep, precipitous).
Rock and soil: granite.
Date: July 27, 1906.
Collector:
Frequency of occurrence, and
Associates:



Quercus arizonica	(38)
Juniperus pachyphloea	(16)
Cercocarpus parvifolius	(17)
Schmaltzia sp.	(3)
Juniperus monosperma	(2)
Pinus edulis	(10)

The latter part of the scheme is designed to put before the eye at once the associates and the absolute as well as relative abundance of a given species. It is simply an adaptation of the Forest Service method of estimating timber. In using the scheme, one to four are represented by dots at the corners of the rectangles. When these are joined by lines to make the rectangle, we have eight. The diagonals add two more, making ten. For a vegetation of trees or shrubs, where the latter are not too dense, proceed as follows:

Select a representative area of the type you wish to collect.

Next select a good vantage point looking across this area, pick out an object in the distance as a sight, and pace off, say, 120 paces in the direction of this sight. At the end of the 120 paces turn about and retrace your steps to the starting point. Measure by eye a strip one rod wide on each side as you proceed. One can soon learn to do this by a little pacing to assist the eye when in doubt. Record each species within the limits of the strip as you encounter it, and record each plant by a dot or line, as shown, under the appropriate species. If the starting point should not be visible from the ending point, walk back and go over the strip in the same way as at first, recording the plants.

If your pace is six to the rod, such a sample strip will contain one-fourth of an acre. The length of the sample may be suited to the number and size of the plants present, to the number of the species you wish to collect, to the time available, and to other conditions as they arise; but in order to be readily reducible to a common standard, a suitable unit should be determined upon, and all sample areas taken should be multiples of the unit.

J. C. Blumer.

NOTES AND NEWS.

The Arnold Arboretum has secured funds by the aid of which a horticultural exploration of northwestern China will be undertaken. In the prosecution of this work Mr. A. Henry will proceed to the region in question for two years' work. The cultivated plants of this region are but sufficiently known to promise a large number of interesting and important additions to the horticulture of the western world.

Prof. Chas. E. Bessey, of the University of Nebraska, was elected chairman of the botanical section of the A. A. A. S. at the recent meeting in New York. The next meeting will be held in Chicago during Convocation week, 1907-1908. Prof. Atkinson was chosen as president of the Botanical Society of America, and Prof. D. S. Johnson, secretary.

Dr. B. E. Livingston, of the Desert Botanical Laboratory, is spending the month of February at the Missouri Botanical Garden in carrying on some extensions of his investigations of the relations of xerophytic plants to soil and atmospheric moisture.

At the recent meeting of the A. A. A. S. in New York, a Darwin memorial committee was formed for the purpose of suitably commemorating the fiftieth anniversary of the publication of the Origin of Species. Prof. J. M. Coulter, of the University of Chicago, and Dr. D. T. MacDougal, of the Carnegie Institution of Washington, are the botanical members of this committee, which comprises members from the geological, zoological, anthropological, psychological and botanical sections of the association.

Prof. F. E. Lloyd has brought his investigations of stomatal action at the Desert Laboratory to a close and has now undertaken an investigation of the floral and distributional features of the vegetation of the region contiguous to the Laboratory and inclusive of the international boundary zone.

The botanical department of the University of Michigan is issuing a series of bulletins under the general title of Field Studies in Botany, which are sent free to the secondary schools of the state. There have appeared thus far: Preparation for Field Work, River Studies and Bog Studies, by George P. Burns; Wood-lot Studies, and Field Work in Towns and Cities, by Charles A. Davis, and Gullies and Ravines, by Francis L. Stearns. The clearness of the maps and illustrations, with the brief and explicit directions that are given, are likely to afford welcome and much needed aid to teachers and students who, as experience has shown, are eager to enter upon such work, but need some one to guide them.

W. D. Matthews has recently published as a bulletin of the American Museum of Natural History a series of maps, with notes, indicating the hypothetical outlines of the continents in tertiary times. The continuous land connection of Europe and South America and the connection of the latter with Australia by way of the Antarctic Continent at the close of the Cretaceous; the invasion of the sea resulting in isolation of the six great land masses of the globe in the Eocene, favoring the development of distinct faunas and floras; subsequent emergence with invasion of new forms from Asia into North America and Europe continuing through the Miocene; great elevation during the Pliocene, again permitting exchange of forms in both directions between North and South America; and simultaneous glaciation in both hemispheres in the Pleistocene, with its necessary results, are the salient features of interest to students of distribution.

Guppy's Observations of a Naturalist in the Pacific (Macmillan & Co., 1906) contains some interesting experiments in regard to seed-buoyancy, which go to show that a large percentage of the coast plants of a Pacific island might have been brought to its shores by ocean currents, notwithstanding certain barriers which render this process, in many cases, quite inadequate. The movements of birds as an effective agency is emphasized, and the problem of endemic genera has some light thrown upon it, if the author's views regarding submergence and uplift of various groups of Pacific islands are to be accepted.

It is of interest to note that the author just cited has no faith in acquired adaptations. A plant that is fitted for a certain habitat lives in that habitat if it "gets there," but does not become adapted to it. Similar views are now frequently put forth by others. Thus Piper—Flora of the state of Washington—"Following the retreat of the ice, the areas that then became fitted to support an upper Sonoran flora could have become inhabited either by the northward extension of already adapted plants, or by the gradual modification of species of a colder zone, or by both. The evidence indicates the first method to have been the most potent." It becomes increasingly evident that the origin of adaptations is still a subject for active investigation.

Dr. J. W. Harshberger has recently been made assistant professor of botany of the University of Pennsylvania, a well merited recognition of the service he has rendered that institution during the past few years.

At the recent meeting of the American Association for the Advancement of Science, two grants of a hundred dollars each were made to be expended under the directions of the committee on the relation of plants to climate. Prof. F. E. Clements, of the University of Nebraska, receives $100.00 to be used in carrying on his field work in Colorado, and Dr. J. Arthur Harris, of the Missouri Botanical Garden, $100.00 to be used in carrying on measurements in his study on Influence of Climatic Factors upon Variability of Plants. The committee in question has been in existence since 1900.

Prof. O. W. Caldwell, of the State Normal School at Charleston, Ill., has gone to Cuba to collect embryological material of *Microcycas* which has recently been re-discovered by Prof. C. F. Baker. The existence of this genus has been problematical almost since it was originally described, and the find has awakened much interest since it is probably the only near relative of *Cycas* in America. Dr. Caldwell has made two trips to the island previously in search of material of this plant. It may be expected to furnish much valuable evidence as to the origin and relationships of the interesting group to which it belongs.

The importance of the Panama hat industry to the Republic of Ecuador is apparent from the following figures, extracted from the *Consular Report* for the years 1899-1905, showing the value of the exports for the last six years: 1900, £32,748; 1901, £37,956; 1902, £68,010; 1903, £70,107; 1904, £88,670; 1905, £125,512.

It will be seen that in the period under review the exports have increased enormously in value; the quantity has likewise increased. It is stated that the fashion of wearing Panama hats in Europe has advanced at such gigantic strides as to render the native labor unable to keep pace with the demand.

An interesting account of the manufacture of these hats appeared in the *Agricultural News*, Vol. III, p. 310, published by the British Imperial Government at Barbados.

Panama hats are made from the leaves of a palm-like plant, *Carludovica palmata;* the Jamaica jippi-jappa hats from a closely allied plant, *C. jamaicensis.* Several references have been made in the *Agricultural News* to the great possibilities of the jippi-jappa hat industry in Jamaica.—*The Agricultural News.*

The *Agricultural Gazette*, of New South Wales, for August, 1906, contains an interesting article entitled "A New Potato (*Solanum commersoni*)." The wild plant is native along the wet banks of the Mercedes River, in Uruguay, where it was discovered more than a century ago. After several years of experiments with tubers of a mutated plant, originally from the Mercedes, M. Lobergerie, of Vienna, has obtained many interesting variations, of which several types have been definitely fixed. A violet variety is remarkable in that it produces a much heavier growth of tubers and of tops than the common potato, is entirely immune to potato blight (*Phytophthora infestans*), and the tops are resistant to two degrees C. of frost. The flavor of the tubers is said to be excellent, there being no bitterness even in the green aerial ones, the development of which is quite characteristic of the variety.

Professor Francis E. Lloyd will give a course in botany during July next at the Harvard Summer School.

Dr. W. B. McCallum, of the University of Chicago, entered on his new duties as associate botanist of the Arizona Agricultural Experiment Station January 1, 1907. Dr. McCallum will have charge of the investigations in plant physiology and pathology.

We regret to record the death, on the 18th of last December, of Dr. Jacob Schneck, of Mt. Carmel, Ill. Dr. Schenk was a keen and intelligent observer of plants. He is known to the readers of the *Plant World* through his occasional contributions, the last of which was on "Fasciation in the Cherry."

What may be called the vegetation potential of the desert is by no means a low one. One of the conspicuous features of such regions, as is constantly exemplified in the photographs seen in every magazine, is the isolation of individual plants, and the impression one invariably receives by this means gives one no idea at all of the immense possibilities for plant production.

The first soaking rain of the winter fell in the desert about Tucson, Arizona, early in December. This was the opportunity for the winter annuals to germinate, and this they did in a few days at such rate and such numbers that in many places the ground became a carpet of living green. Taking a rough average, one would say that fully one-third of the ground was covered thickly enough by seedlings to be called fully occupied, and a half of this was distinctly crowded. A count of seedlings, for the greater part of a species of borage, showed that there were 150 plantlets to the square inch. The crowding of seedlings is especially noticeable beneath the shade of shrubs and small trees, a condition due in part to the greater conservation of moisture in the upper layer of soil. This accounts for the observed fact that giant cacti are so often to be found growing in close association with perennials, which afforded to their seedlings the most favorable opportunity for germination. As many as a half dozen giant cacti have been seen to have started in the shade of one palo verde. F. E. Ll.

Scarcely inferior to the common garden nasturtium which has become almost as much of a classic in the botanical as the frog in the zoological laboratory, is the common round-leaved mallow, *Malva rotundifolia*, in point of exact and prompt response to light. In places where this plant is plentiful the seedlings may completely carpet the ground, when the uniformity of leaf position with reference to the impinging light is quite remarkable. The round leaf-blades become placed at right angles to the rays of light as the first light dawns, and follow the sun all the day. The plant is so sensitive that even on cloudy days there is very little lapse from the uniformity of positions noted on bright days. The position of the leaf-blade is attained by the bending of the petiole in a narrow zone, usually colored red, immediately adjoining it. When the bend is a sharp one, the effect of the compression of tissues on the concave side manifest by the wrinkling of the more superficial of these. Seedlings in pots grow readily and show these reactions with the same regularity displayed by plants in the open. It is very hardy, and is readily obtained. It has, to be sure, been used in the botanical laboratory, but is not well known, certainly not as well as it deserves. Clover plantlets are good, but the reactions are more complicated.

Crooke's discovery of a method of obtaining nitrogen from the air has the promise of revolutionizing methods of agriculture if the reports in the public prints may be relied upon.

Elda R. Walker has published her study of the development of the ovary in a number of grasses, and including the Indian corn. Briefly stated, she shows that in all forms studied there are three carpels, two lateral and one dorsal, which bears the ovule. In this the vascular tissue extends above the ovule, often to the top of the ovary. This structure is especially obvious in the Indian corn. The theory is borne out by the fact that three strands of vascular tissue are always present. The dorsal strand has previously been described as marking the line of union between the two lateral carpels. It is now to be looked upon as the median structure of the dorsal (lower) carpel. (University of Nebraska Studies, 1906.)

A gratifying degree of progress in agricultural education in this country is evident from the annual report of the Director of the office of Experiment Stations for 1906. Enlargement of the work along lines of assured usefulness is promised if the necessary funds are forthcoming. Twenty thousand dollars has been asked for.

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THE PLANT WORLD

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A ROUND TRIP BETWEEN IOWA AND PUGET SOUND.

I. Westward Bound.

By Professor Bruce Fink.

Among the sciences which aid one in appreciating nature in rapid survey, Botany certainly holds a high place. Not the dry bones of cytology, for few persons will consider from a car window the nature of apical cells or the origin of organs in the plants about them while covering thirty miles an hour; but rather, a knowledge of plants in a general way, including the names and general characters of the more common species, genera and families of plants, and especially their structural adaptations to ecological conditions. One should know the ecological significance of short, stunted stems, few and small leaves, fleshiness of leaf or stem, the rosette habit, and a few other very elementary facts of Ecology. Besides this he should possess a good knowledge of Physiography and should know something of Geology in order that he may be able, at a glance, to make a diagnosis of the relation of structure to environment. Equipped thus, and on a train that makes longer or shorter stops occasionally, so that some of the plants may be collected and examined, even a rapid ride in a wild country, where plants grow, becomes a holiday vacation full of interest.

Out-of-door Botany is pre-eminently a science of mass phenomena in which one may spend a life time in the study of a very small area without exhausting it; but our purpose now is to consider things in the large, on the fly, so to speak. The region to be covered in the present paper begins at Grinnell, Iowa, and extends westward in Iowa, through portions of Nebraska and Kansas into the mountains from Pueblo westward in Colorado, thence across the deserts of Utah and Idaho to Portland, and from Portland to Seattle.

Starting from Grinnell one morning in June, 1906, we awoke the following morning in western Kansas, after having passed through portions of Iowa and Nebraska. We may well pass the first day and night over with a mere mention of the xerophytic societies of the hilltops, composed of composites with tough stems, small willows, shoe-string, and other similar plants; the very different xerophytic societies of the gravelly road beds, with polygonums, euphorbias, chenopods, spreading grasses, etc.; the higher and the lower prairie societies with their grasses and sedges; the societies of the swamps with their rushes, cat-tails and other plants, some of them too small to recognize from the car window; and the upper strata of the mixed-woods societies, all seen in a whirl as the train passed rapidly along. All these are familiar to nearly everyone, and attention must be directed elsewhere.

After a night of sleep, beginning in Nebraska and ending in western Kansas, the traveler finds himself in a semi-desert region, with the familiar plant societies mentioned above left far behind and the Rocky Mountains and their foothills plainly in view to the westward. If he is a botanist and has not often had the privilege of other knowledge of such a region than can be gained from books and photographs, he will be up at daylight watching the landscape whirl by the car windows, taking every opportunity to get to the ground and will hastily gather a few of the most common plants. The writer had watched thus eagerly for more than an hour, when finally the train stopped at Roswell, a short distance east of Colorado

Springs, and twenty-five miles from the base of Pike's Peak. However often one has been deceived in distances, the impression of nearness is just as vivid on each new presentation of mountain scenery, unless he is constantly in the midst of it, and it looked a half mile to the top of the peak instead of the real distance—thirty-five miles. It seemed that one could traverse the distance from this stopping place to the top of Pike's Peak in a half hour's walk and examine every sort of intervening plant society in a very short time; for the tree-limit and the snow beyond were in perfectly plain view, though we were among the homes of the prairie dogs, thirty-five miles away, where a very slight intervening elevation close at hand would hide the whole peak in a twinkling as we passed along.

At Roswell, the bunch habit was a very apparent characteristic of the vegetation, as it had been for some distance eastward into Kansas, for we were in the semi-desert at an elevation of approximately 5,000 feet. Yuccas, cacti with their special adaptation in fleshiness, characteristic chenopods, legumes with their pubescence and other special adaptations, various grasses with the bunch habit, as *Bouteloua oligostachya*, and the buffalo grass, *Buchloë dactyloides*, with its close dense tufts and spreading stolons, were all noted as well as a number of characteristic composites for most part small and tufted with small amount of leaf expansion. Of the composites, the little *Aster ericaefolius* was collected. The vegetation seemed to cover the surface fairly well as one looked off for some distance, and the bunch habit appeared plainly only when seen close at hand and especially on alighting from the car and walking out a short distance on the prairie.

In passing from Roswell to Colorado Springs, 5,568 above the sea, and only six or seven miles from the base of Pike's Peak, the conditions do not become rapidly more xerophytic, though one is within a ten-hour tramp and climb of the top of the peak. But at Pueblo, less than forty miles south of Colorado Springs, we found grass very scarce, except in moist valleys, and cacti, yuccas, characteristic mallows and sage brush

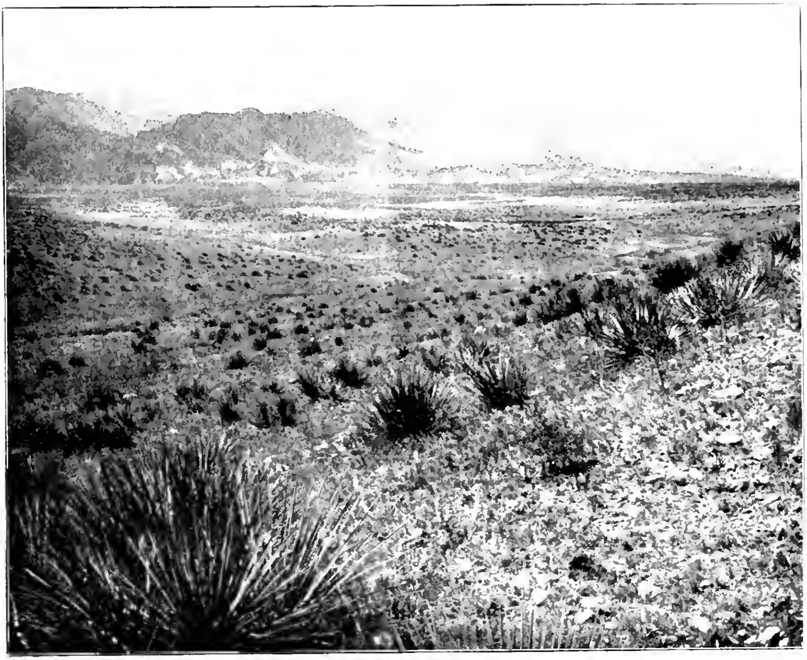

Figure 12. *Bouteloua oligostachya* formation near Colorado Springs. The most prominent plant is *Yucca glauca*. *Artemisia frigida* gives the silvery appearance in the distance.

were growing sparsely. Here we made a stop of nearly an hour, and the writer took a rapid survey of the vegetation, noting the cacti, some of them three or four feet high, and collecting such xerophytes as *Yucca angustifolia*, *Atriplex confertifolia*, *Gaura coccinea*, *Gaura parviflora*, what was taken to be a species of *Tetradymia* and a thistle, probably *Cnicus nelsonii*. The soil was clay for the most part and was colored white in places by alkali, and yet in this desert, as well as westward in Colorado, were seen numerous irrigated orchards and fields of grass, alfalfa, corn and other crops.

Passing westward from Pueblo along the valley of the Arkansas river, one views the same general species forming the plant population, but the country becomes more broken with mesas and mountains visible in every direction. One sees such evergreens as *Pinus murrayana*, *Abies subalpina* and other evergreen shrubs and trees growing along the borders of buttes and mesas, while *Populus tremuloides* is doubtless the tree found most commonly on the flood plains along the streams. These and other trees, together with the cacti, *Yucca angustifolia* and other plants very similar to those found at Pueblo are in constant view as the train speeds on its continuous wind, with the engine in sight first on one side and then on the other in passing around and over mesas innumerable along the river valley, where irrigated land is very productive and held at high price. One is especially interested also in the irrigation canals, gates and smaller ditches so arranged that every part of the irrigated areas may easily be flooded and the whole to support a pure formation of some kind of cultivated plants, showing very different adaptations than those exhibited by the native xerophytes.

Thus one is hurried onward and soon reaches the Royal Gorge of the Arkansas river, where the passengers who are not familiar with stupendous scenery take the observation car. The gorge is about fifteen miles long, fifty feet wide at the bottom and only seventy at the top in narrow places, and reaches in several places a vertical height of considerably more than a half mile. Cacti, cedars, pines, yuccas and other desert plants are seen on the sides of the cañon walls where not too abrupt, and one longs, if a lover of things so insignificant, for a chance at the lichens that grow from the bottom to the top of the walls, and as well on the projecting crags and balanced rocks that often seem to be almost directly overhead and perhaps a half mile above the track. There is probably no more wonderful piece of scenery than this in the Rocky mountains, and we are quite excusable for diluting the botanical narrative with a brief and necessarily futile attempt at giving some conception of the remarkable sublimity of the scene. After leaving the gorge, we traveled for the remainder of the day through very similar scenery, through other smaller gorges and between distant snow-capped mountains, seeing very similar vegetation until night settled upon us after passing that portion of Colorado, in the vicinity of Leadville, where the railroads must attain an elevation of about 10,000 feet.

Again observation gave place to sleep, and morning found us in the alkali desert of eastern Utah, which is no more uninviting to the agriculturalist than it is interesting to the botanist. Its array of such halophytes or xerophytes as the yuccas, cacti, greasewoods, seablights and sage brush is a revelation to the botanist who has hitherto seen these plants only in herbaria. There was no grass visible, at least in rapid passing; and the vegetation was scattered over the dry and wonderfully carved clay and alkali so scantily as to scarcely obscure it at any point, while large areas were apparently bare of vegetation. The plants collected or seen while the train made short stops east of the Wasatch Mountains were an *Atriplex*, probably *A. argentea*, *Lupinus argophyllus*, another *Atriplex* collected in young condition but perhaps *A. volutans*, the greasewood (*Sarcobatus vermiculatus*), spike grass (*Distichlis spicata*) and *Agropyron occidentale*, the first few on the higher grounds and the others on lower ground, usually along the streams, where *Populus angustifolia* also grows more or less successfully. The surface was wonderfully carved, apparently by water, with here a flat surface, then beautiful carvings like *roches moutonnees*, there high buttes and mesas, usually bounded on all sides toward the top by hard rocks. Perhaps the most wonderful scenery of this region is where the Book Cliffs are seen to the north of the Rio Grande Railway and the snow-capped tops of Mounts Wass and Peale thirty or forty miles to the south and rising more than 12,000 feet above sea level.

As one approaches the Wasatch Mountains, the desert conditions become gradually less severe and bunch grasses and scrubby conifers appear quite commonly; while in the valleys are seen luxuriant irrigated fields of trees, especially poplars and willows. Also yuccas are seen for the first time in Utah, and lichens, which were so scarce in the dryer portions of the desert as to escape notice entirely in rapid passage, are seen frequently on the rocks. On getting well up the eastern slope of the Wasatch Mountains, bunch grass and sage brush become quite common, and on passing over to the western slope, where moisture condenses in rising, the conditions are still less xerophytic. Cattle are seen frequently, and there is a considerable amount of good farming land in the valleys. Soon we reached the valley formed by the subsidence of the old lake Bonneville into the present Salt Lake. In this fertile area, surrounded by snow-capped mountains and making a scene of wonderful beauty, one sees an abundance of grasses and sedges of very ordinary appearance, and the first rushes and cat-tails noticed since the first day of travel.

We passed rapidly through this irrigated and wonderfully fertile valley, through Salt Lake City, to Ogden, where an eleven-hour stop gave ample opportunity for collecting some of the characteristic xerophytes of the foothills about the city. Among these the common greasewood, *Sarcobatus vermiculatus,* with its characteristic xerophytic shrubby appearance, often standing several feet high, commanded the attention of the writer, who had previously known it through herbarium specimens and the statements in writings on Ecology. The other plants collected as showing xerophytic adaptations were *Chenopodium album*, *Artemisia ludoviciana*, *Grayia polygaloides*, *Astragalus utahensis*, *Lupinus holosericeus*, *Bigelovia graveolens* and a number of other things lost through lack of proper means of preservation in traveling. Ogden was left in the night, and the morning found us at Pocatello, in southern Idaho, in the great lava-covered area, where thrive the bunch grass (*Agropyron spicatum*?) and much more conspicuously, the sage brush (*Artemisia tridentata*). The sage brush often stands several feet high and has a most peculiar appearance to one not accustomed to it, seeming to cover the ground completely, except near by and often extending as far as the eye can reach, producing the aspect of a stunted forest composed of shrubs so low that one can look over them from the car window. The bunch grass furnishes food for cattle in summer, and the sage

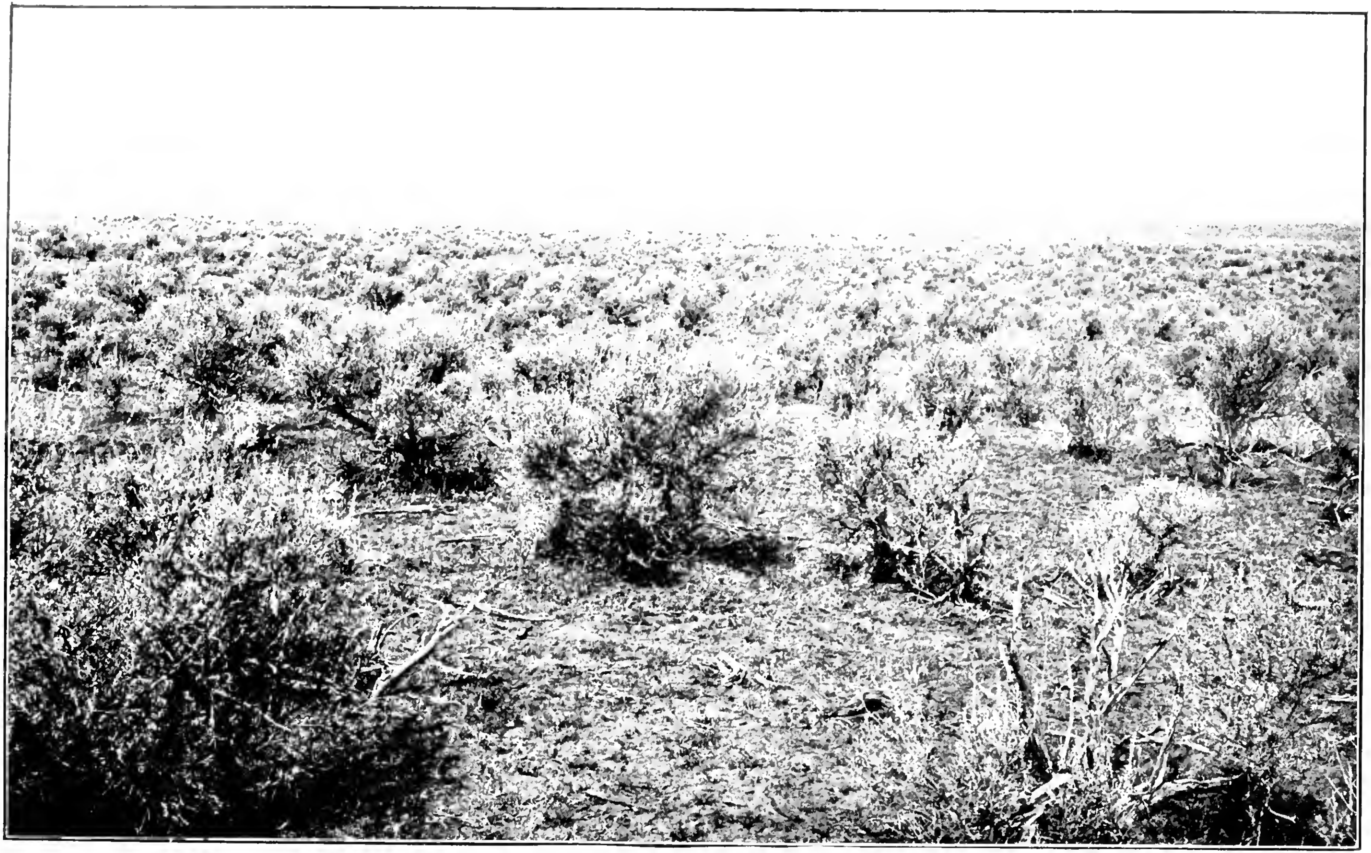

Figure 13. Plains of Sagebrush (*Artemisia tridentata*) such as one often sees in Idaho and eastern Washington, sometimes standing several feet high and extending over large areas.

brush supplies it in winter; but the region is about 4,000 feet high and so situated that it can scarcely be irrigated as is being done on a large scale farther west in Idaho. To the westward the topography presents an aspect quite similar to that of the Utah desert, but less rugged. Finally at Nampa, on Snake River south of Boise, irrigated fields are common along the river valley, supporting excellent growths of hay, alfalfa, fruits and vegetables; here also were seen the great irrigation ditches, in process of construction by the Government and by private corporations, and destined to convert the desert into a land of great fertility. Other interesting plants seen in various environments in passing through Idaho are *Juniperus scopulorum*, *Lupinus sericeus*, *Elymus condensatus*, *Iris missouriensis*, *Amelanchier utahensis*, *Purshia tridentata*, *Balsamorhiza sagittata*, *Wyethia amplexicaulis* and some species of *Bigeloria*, probably the one seen in Utah.

Before dark we began to get into the wooded region of eastern Oregon, and at dawn we were in the valley of the Columbia river, among the beautiful Cascade mountains. We were hurried along rapidly until we reached Portland, and after a short stop, we proceeded on our way to Seattle. During this part of the journey, Mount Hood, Mount St. Helens, Mount Ranier (Tacoma) and Mount Baker were all seen in the distance, rising as white domes of snow, while the Olympic mountains were at times plainly visible to the westward, making a most imposing scene, though seventy-five miles distant. From the Cascades westward and northward from Portland, it was by no means easy to get any sort of notion of the trees growing in the forests. However, it was apparent that the aspect of the forests changed greatly after passing through the mountains. In the Cascades were noticed the western larch, *Larix occidentalis*; *Pinus ponderosa*, which is very rare west of the mountains, *Pinus murrayana*, which seems to be characteristic of the mountains or regions eastward, though only slightly differing from *Pinus contorta* in the lower altitudes west of the mountains; the Engelmann spruce (*Picea engelmanni*), and *Juniperus* *occidentalis*, which sometimes becomes a tree of considerable size in this region. In passing from Portland to Seattle we were in the lower, more humid regions nearer the coast. Here the forests were much more luxuriant, and that most common tree of Washington, the red fir (*Pseudotsuga mucronata*=*P. douglasii*); the giant cedar (*Thuja plicata*); the western hemlock (*Tsuga heterophylla*), which is doubtless better developed at higher altitudes in the Cascades; and a few deciduous trees were noticed. But we are coming very near the scene of the next paper of the series, where there was ample time for more careful study of the higher plants. Consequently, we may well terminate the present paper at this point.

I am under obligations to Dr. H. L. Shantz and the Botanical Gazette for the figure showing the Bouteloua formation, and to Mr. F. V. Coville and the Smithsonian Institute for the one showing the Sagebrush plains.

VISITS TO SOME BOTANIC GARDENS ABROAD.

By Dr. Pehr Olsson-Seffer.

(*Continuation.*)

It appears that some three hundred years ago, or more correctly in the year 15 of Kwansi (1638), the Shogun Yemitsu (Tokugana the Third) established two gardens for medicinal plants, one at Shinagawa on the southern side of Yedo, as Tokyo was called of old, the other at Ushigome in the northern part of the city. The latter was abandoned in the year 3 of Tenwa (1683), during the reign of the Shogun Tsunayoshi (Tokugawa the Fifth), and the southern garden was removed to Hakusan-gotencho, the present site of the botanic garden.

For more than a century and a half this garden was under the protection of the consecutive shoguns, until after the revolution of Meji (1868), when it was taken over by the Meji government. During all this time it gradually improved from a very humble beginning to a garden of some size.

The name of the garden has been changed several times. In the year One of Meji (1868), it was called the Oyakuyen or The Medical Plant Garden, and was then connected with the hospital of the university, and under the immediate control of the Tokyo prefecture. The following year it was taken over by the university and its name was changed to Igakkoyakuyen or The Medical School Garden. In 1871 it became connected with the Educational Department, and again, the next year, the museum and garden were formed into a corporation, which, however, soon was dissolved. In the year 8 of Meji, or 1875, the garden was first called Koishikawa, or Botanic Garden.

In 1876 it was again united to the Tokyo university, being then attached to the College of Science.

On the site where the garden now stands the Shogun Hidetada (Tokugawa the Second) built the Hakusangoten or White Mountain Palace in the beginning of the seventeenth century. During the reign of the next shogun this building was taken away, however, and the grounds were granted to the feudal lords, or knights. The dark grove of *Cryptomeria*, the background of tall firs, and the beautiful evergreen oaks near the entrance to the Botanic Gardens remind one of the former residence of the feudal lords. From the name Hakusangoten of the Shogun's palace there are still remnants in the form of Gotenzaka, the name of the path leading up the slope at the east end of the garden, and the entire neighborhood is still known as Hakusangotencho.

Altogether over three thousand species of plants, native and foreign, are cultivated in the garden. In the main division of the garden the plants are arranged according to Engler and Prantl's classification. In another division there is a collection of medicinal plants; in yet another rare plants kept in pots. One division contains a great number of different garden plants; another is an arboretum of exotic trees. There is an arboretum of evergreens, another consisting of coniferous trees. Here I noticed a giant *Gingko biloba*, said to be 200 years old, and fine specimens of *Sciadopitys verticillata*. Being especially interested in the *Sapiums* I greatly admired a large *S. sebiferum*

Roxb. Of *Prunus pendula* the garden had a very large specimen, and another tree worth mentioning is *Cinnamomum loureirii Nees*, a medicinal plant known as "Nikkei."

A greenhouse built in European style contains many interesting tropical plants, especially from Formosa. There are also several plant houses in Japanese styles, such as the Okamuro, Osakamuro, and Anamuro styles. In the eastern part of the garden is the office building, and close to it stand the buildings of the Botanical Institute.

Attached to the Botanic Garden, which covers some forty acres, is a fine pleasure garden, part of it in Japanese-gardea style. Here is erected a building for social gatherings of the scientific societies of Tokyo. Walking along the hillside one passes a large lotus pond (*Nelumbo nucifera*), and close to it stand trees of *Prunus mume*, the favorite flowering plum of Japan. Several bamboo groves, consisting of different species of *Bambusa*, *Phyllostachys* and *Arundinaria*, border the road on one side, while broad-leaved trees of the cold and temperate regions cover the slope on the other side.

In this garden students of botany, entomology and pharmacy receive their botanical instruction, and the garden is also open to the general public under certain regulations.

In November, 1902, a small Alpine Botanic Garden was established at Hotokeiwa, near Nikko, the most beautiful place in Japan. The Nikko mountains have a rich and varied flora, and the location of this new branch of the Tokyo garden is especially adapted to alpine plants. Representatives of the high mountain flora of Japan, as well as of other countries, will be collected and cultivated. It is expected that measures will be taken to increase the size of this alpine garden, and of the present little laboratory, donated by Dr. Matsumura. Instructors and students of the university are now admitted to study and experiment on alpine plants at this institution.

The Japanese have always been excellent gardeners, and it is a pleasure to see their gardens, private and public. Curious dwarfed trees, hundreds of years old, magnificent *Camellias* and

Azalias, and endless variety of maples, *Hydrangeas*, *Magnolias*, cherry trees, and *Wistaria;* superb lilies and the beautiful *Lycoris*, *Chrysanthemums*, peonies and *Iris*. One is surprised at the variety produced in this seemingly cold climate. Gekka-no-nami or Moonlight on Waves, Kumoma-no-sora, or Sky Between the Clouds, Yomo-no-umi, or Boundless Sea, Shirataki, or White Waterfall, are the names of some favorite cultural varieties of *Iris Kaempferi*. Let these names express the poetry the Japan-

Figure 14. In Hongkong Botanic Garden.

ese associate with their flowers, and let us with this say farewell —sayonara—to the land of chrysanthemums and cherry blossoms.

III. Botanic Gardens, Hongkong.

This garden was laid out some thirty years ago by Charles Ford, who came out to the colony as gardener to the Government House. Under his care for upwards of three decades the garden grew, and is now the pride of the place. For the last twenty-five years the botanic garden has been in care of a special Botanical and Forestry Department. Its first superintendent was

Mr. Ford, who a few years ago was succeeded by Mr. S. T. Dunn, formerly of Kew.

The garden is prettily situated on the slope of the Peak, a mountain rising steeply from the narrow strip of shore, on which the City of Victoria or Hongkong is built. The view from the garden terraces over the harbor is exquisite, and one delights in walking through its interesting collection of mainly Chinese plants. These prevail, but many exotic trees and shrubs are doing well. One of the most interesting trees here is *Libocedrus macrolepis*, a somewhat recent introduction from the interior of China. A very big Banyan tree was noticed. The camphor tree finds a congenial climate here.

In the middle of the garden stands a statue of a former governor of Hongkong, and on the terrace below is a fountain, surrounded by flower beds. A well-kept plant house contains a nice collection of ferns and orchids.

In one part of the garden is the superintendent's house and the herbarium building. The collection of dried plants, which was shown me by Mr. Dunn, is the most complete Chinese herbarium in existence. The superintendent frequently makes expeditions into China and native collectors bring in specimens at intervals.

The severe typhoon of September 22nd, 1906, had worked great havoc in the garden, broken off many fine trees and uprooted others. At the time of my visit, in November, traces of the damage were still noticed. One week's stay in Hongkong made me fairly well acquainted with its interesting little botanic garden, which in natural location probably has no equal in the world, situated as it is on the steep mountain side above the sea.

Winter barley is as yet but little grown in this country. That it should be wherever possible is shown by the result of Government tests which have been made, which show a 50 per cent. increase of yield over that of spring barley.

SPRING FLOWERS OF THE ARIZONA DESERT.

PROFESSOR V. M. SPALDING.

February is the early spring month in Southern Arizona, and flowers begin to bloom in great numbers before the opening days of March. The present year has been favorable, as far as physical conditions are concerned. There was a good deal of rain early in the winter, and for weeks preceding the present date, February 14, 1907, the temperature has been rather high for the time of year. As might be expected, therefore, Tumamoc hill, on which the Desert Botanical Laboratory is situated, has for a week or more presented a great profusion of spring flowers; many of them, it is true, small and inconspicuous, but others, such as the anemone, beard-tongue and California poppy, fully as showy as their congenors elsewhere.

As many as thirty-two different species have been observed in flower here this month, and this number would be considerably increased if a wider area were taken. Some of them, notably certain species of *Cruciferae* and *Boraginaceae* are already forming fruits in the middle of February. Fourteen out of the thirty-two listed are annuals, and are all characterized by the great rapidity with which they push out of the ground in earliest spring, unfold their flowers, and mature their fruits, as if fearful that the least delay might result in their death by drying up before their seeds are sown. Indeed, if winter rains have failed, as sometimes happens, they take no chances, but stay in the ground until another year. Thus the effects of a dry winter are visibly and painfully apparent in February and March in the endless stretches of brown, dry mesa, while winter rains are quite as surely and far more cheerfully attested by the millions of bright green winter annuals that cover the desert like grass.

It is often remarked that these winter annuals are not true children of the desert, that they exhibit no xerophytic structures, and have merely slipped in amongst the perennials which are the genuine xerophytes of the region; but it would be hard to affirm that these latter hold their places and reproduce their generations any more securely or certainly than the humble annuals that have attained by certain habits all the advantages that their more conspicuous neighbors have gained by costly structural adaptations. Rather it would seem that the winter annual might be compared to the light armed soldier who wins the day with only a fraction of the real danger which one with a ponderous coat of mail and long exposure experiences. Certain it is that our winter annuals are a highly successful species.

Discontinuous Variation and the Evolution of Seeds. The first part of the opening address of Professor F. W. Oliver, before the Botany section of the British Association, at the York meeting, 1906, is entitled, "The Seed, a Chapter in Evolution." The recognition of the structural identity of the different parts of the seed and flower is one of the most difficult problems of plant morphology. After giving a detailed discussion of the seed structure in the *Pteridosperms, Gymnosperms* and the *Angiosperms*, Professor Oliver emphasizes the fact that "In glancing back at the early seed structures, one is struck with the complexity of their organization as compared with the relative simplicity of modern seeds. * * * This reduction in complexity may be accounted for on two grounds. In the first place, fertilization by motile sperms has been replaced by fertilization by pollen-tubes. Instead of sperms being discharged into an internal water chamber upon which the archegonia abutted, the male cells are carried through soft tissues to the egg in a plastic tube. * * * Just at what stage the improvisation of the pollen chamber gave place to the newer method we have no knowledge."

"The other cause that must have played a prominent part in the simplification of the seed was the association with it of other structures which relieved it of a part of the original load of duties that fell to its lot." The best example of this is the Angiosperm ovary, but "The steps by which this came about remain hidden, and any discussion of the matter is of course premature." The steps in seed evolution are briefly summarized in the following paragraph:

"The history of the seed, as I read it from the imperfect and fragmentary data that are available, has been a series of advances spread over long geological periods. The possibilities of the seed-habit were realized only bit by bit, and the high efficiency of the modern seed depends in large degree upon the close association of other structures which co-operate in its functions. No doubt the first step, the retention of the megaspore, was the most important of all; though, that this might be effective, some contrivance for the capture of the pollen-grains must have accompanied it. Later steps in the process of seed-evolution would include the adjustment of an intraseminal embryonic stage, and in time the substitution of the pollen-tube for the liberation of sperms."

The great difficulty of conceiving how such a result could be achieved by the process of continuous evolution, and the lack of sufficient data to give such a theory a firm foundation in fact, are clearly recognized, and the speaker continues as follows:

"Now, assuming, as I think we are entitled to assume, that seeds have come into existence along some such lines as those thus crudely blocked out, there is a great difficulty in conceiving the process other than discontinuous. Every one of the stages emphasized involves the conception of something more abrupt than mere gradual variation. And there is, of course, the old difficulty confronting us as to how the organ or mechanism came to be preserved at its inception. All these difficulties vanish when it is recognized that effective variation is of the discontinuous order, and that the successive changes involved may be considerable enough to be designated jumps. Happily such views, based upon experimental results, have been formulated by De Vries in his Mutation Theory. That theory is so well known to botanists in this country that any exposition here is quite superfluous. The least thing that can be said in its support is that it is perfectly tenable. But we may go much further than that. Apart from the Theory of Natural Selection, no modern hypothesis of evolution has been so helpful or so likely to stimulate further work. * * * " C. S. GAGER.

It has been known for many years that the life cycle of the higher plants is divisible into two parts, one of which constitutes the sexual generation, and the other the asexual generation. These two phases in the life cycle are usually not distinct but merge into one another in a manner now familiar to every botanical student. In the ferns, however, the generation bearing the sex cells is independent from the one bearing the asexual reproductive bodies, the spores. In the lower orders of plants there is more difficulty in determining whether this alternation of generations really exists, and we are only now beginning to learn concerning this matter in such forms. Our knowledge of the life history of the plants of the ocean, particularly of the algae, is very limited indeed. For instance, probably not more than three of four of the red algae have been studied at all thoroughly from this point of view. Accordingly, any contribution to our knowledge of the life history of these obscure forms is welcome.

There has lately appeared an extensive study by Shigeo Yamanouchi (Bot. Gaz. Dec. 1906) on *Polysiphonia violaceae*, one of the red algae growing in the vicinity of Woods Holl, Massachusetts. Yamanouchi finds a clearly marked alternation of generations in this alga. The spore bearing plant closely resembles the one which bears the sex cells but is quite distinct from it. Twice as many chromosomes is found in the nuclei of the asexual plants, those bearing the tetraspores, as are in in the nuclei of the opposing generation; the former are, therefore, true sporophytes and the latter true gametophytes. This state of things is homologous to that existing in the ferns and the type of alternation of generations is clearly "antithetic." The red algae are thus the lowest forms of plants in which an asexual phase is interpolated in the life history and in this particular they fore-shadow what we know to be the condition universally obtaining in the so-called higher plants. W. A. C.

Some Effects of a Tropical Storm on Vegetation. During a recent visit to the Gulf coast, I observed some curious effects of the great storm of last October, that I do not remember to have seen noticed elsewhere. At Biloxi, Mississippi, was a magnificent live oak with a main trunk some five or six feet in thickness, standing in an open space a few hundred feet back from the shore. At about six feet from the ground it divided into two enormous branches, in whose wide ramifications the wind played with such force that it had wrenched them apart and split the solid trunk down almost to the ground.

Everywhere along the coast, sometimes extending for more than a quarter of a mile inland, the foliage of the pines and cedars and other plants not belonging to the sea marshes, was browned and scorched as if by fire, on the side next the sea, from the effects of the salt spray that had been blown against them from that direction. E. F. ANDREWS.

A key to the Genera of Woody Plants in Winter. Printed by Weigand and Foxworthy. Ithaca, N. Y., 1906. Pp. 33. 25 cents.

In the August (1905) number of the Plant World we noticed the first edition of A Key to the Genera of Woody Plants in Winter. The demand for it has exhausted the first edition, and in preparing a second edition the authors have thoroughly revised the text and increased the size by six pages. "Two or three more genera have been added, and the portion dealing with the conifers has been considerably expanded by carrying the key to species because such detailed treatment has proved necessary in this case." C. S. GAGER.

The Council of the New York Academy of Sciences has decided to commemorate in fitting manner the two hundredth anniversary of the birth of the great Swedish naturalist Linnæus.

The anniversary falls on Thursday, May 23rd, and will be celebrated by exercises which will begin in the morning at the American Museum of Natural History with addresses and an exhibition of the animals, minerals and rocks known to science in the time of Linnaeus; will continue in the afternoon at the Botanical Garden and Zoological Park in Bronx Park with addresses and suitable exhibits of plants and animals and the dedication of the Linnaeus Bridge, and will be concluded in the evening with simultaneous exercises at the Museum of the Brooklyn Institute and at the New York Aquarium in Battery Park. The scientific societies of the world will be invited to participate in the celebration.

The very pronounced hardness and impenetrability to water of many leguminous seeds is a well known fact. Bergtheil and Day (Ann. Bot. Jan. 1907) find this to be due to the occurrence of a thin outer layer of a cuticle-like substance which upon treatment with sulphuric acid, swells and then allows the entrance of water. The authors question the view of Jarzymowski (Diss. Halle, 1905) who believes that the hardness is due to the size of the lumina of the outer layer of cells of the seed coat. A twenty-minute to half-hour treatment with sulphuric acid, with proper after-washing, insures a ready germination of otherwise refractory seeds.

Studies of the embryology of the flowering plants carried on from the standpoint of physiological interpretation are becoming more numerous. L. S. Gibbs (Ann. Bot. Jan. 1907) has examined *Stellaria* and certain of its allies, with this principle in mind. The earlier suggestion that the suspensor is useful for food absorption is supported, and also that its function in this regard is taken up by the endosperm in the later phases of embryological development, as found to be the case in the *Piperaceae* by Johnson.

Chamberlain (Bot. Gaz., February) announces the discovery of motile spermatozoids in the pollen tubes of *Dioon* and

Ceratozamia. Swimming spermatozoids had previously been found in three other allied gymnospermous genera, *Gingko*, *Cycas* and *Zamia*.

Commencing with number one of volume three, *Muhlenbergia* is to be a monthly journal of botany, devoted chiefly to the phanerogams. It is edited and published by Mr. A. A. Heller, Los Gatos, Cal.

We have received a leaflet by Mr. C. A. Stebbins, of the Chico (Cal.) State Normal School, containing brief but good directions for garden work in nature study. The increase of this sort of nature study is a gratifying sign.

The Mycological Bulletin No. 74 is devoted to a treatment of the stalked puffballs (*Tylostomaceae*) by Dr. C. G. Lloyd, of Cincinnati.

Dodd, Mead & Co. announce for publication in March, "My Garden Record," by Luther S. Livingston. It is hard to remember from one season to another one's garden experiences, and a new season finds one with a more or less hazy recollection of the previous year's successes and failures. The Garden Record will enable one to keep in compact form and in a systematic manner all the data which it is desirable to record.

Dr. George Macloskie, Professor (*emeritus*) of Biology in Princeton, has sailed with Mrs. Macloskie for Ireland, where they will spend some months at their old home.

The New England farmer's woodlot is the source of lumber for the manufacture of the enormous numbers of boxes used for shipping factory products. The value of the wood used in 1905 in 344 box factories was $7,871,500. The supply is gradually diminishing, a condition which promises higher returns from forest planting.

In his recently published work on plant dispersal in certain Pacific islands, Hawaii, Tahiti and Fiji, Guppy accounts for the position attained by species growing by river or ocean solely on their capacity for floating. Further, according to his view, it is not the station which is the determinate factor in the development of the quality of buoyancy but plants already in the possession of buoyant seeds or fruits reach and finally inhabit certain localities because they *can* be carried to them. The local distribution depends on the degree of buoyancy developed. Thus the characteristic of buoyancy determines the station rather than this peculiarity being developed by the station. This is apparently a very modern interpretation of the possible causes affecting and effecting the distribution of riparian and strand plants.

The systematic attempt to destroy portions of the Adirondack forests by flooding for the purposes of private gain under a thin guise of public benefaction will, it is hoped, fail. It is clear that public sentiment is aroused, and a counter attack is being led by the Association for the Protection of the Adirondacks.

A bust of A. Braun, which stands in the Royal Botanical Gardens at Dahlem, near Berlin, is reproduced in half-tone in the *Notizblatt*, Appendix 16. This would be a worthy addition to a collection of portraits of botanists.

The U. S. Forest Service has succeeded in treating lodgepole pine with creosote, rendering an otherwise well-nigh useless stick of wood probably capable of serving a twenty-year term as a fence post. The price of this timber has, in consequence, arisen from 25 to 40 cents.

According to the public press one of the most widely known of the big tree groves of the Sierra Nevadas, the Calaveras Grove, has by Act of Congress been made a reservation.

It is reported that Salton Sea is encroaching on the government date orchard at Mecca, and that to save the orchard from inundation it will be removed to Indio, which is at sea level.

Mr. W. T. Swingle, in charge of Plant Life History Investigation, U. S. Department of Agriculture, who was largely influential in the introduction of the date palm, is distributing about 25,000 stocks of the pistache this year. It is thought that the fertile bottom lands of the Southwest, where such trees as the mesquite grow naturally, will be well adapted to this interesting nut tree from Africa.

We have received the following items from the School of Botany of the University of Texas:

Mr. Harlan H. York, instructor in Botany since September, 1906, has taken up the study of the algal flora of the vicinity of Austin. He is also extending his field knowledge and collections of the mallows, upon a monograph of which he was occupied during his residence at the New York Botanical Garden last year. Mr. York will spend the month of June and part of July in collecting, probably in the Brownville region, going thence to Cold Spring Harbor, to assist Professor Johnson during the regular summer session.

Professor W. L. Bray has recently submitted to the Division of Dendrology of the Forest Service manuscript with full illustrations showing the history of the development of forest formation upon the low flat lands known as the Texas Coast Prairie, east of the Brazos. The most striking phase of the forest here is what is called "thicket," the "Big Thicket" of Hardin county being the best and really very widely known tract. This is the region of the Beaumont, Sour Lake, Batson, and other oil fields and of Bulletin 60 of the Forest Service by Zon on "*The Loblolly Pine in Eastern Texas.*" It is also the main rice belt of the state. Thus forest growth has a very important economic bearing.

The School of Botany of the University of Texas has inaugurated the plan of publishing bulletins and leaflets for distribution especially among the high schools of the state with a view to encouraging the adoption of a thorough full year's course in Botany. These publications will make use of available types of Texas plants for laboratory study and of the Texas vegetation in general to illustrate fundamental botanical questions. The first of these, Bulletin 82 (Scientific series), is now being distributed. It presents *The Distribution and Adaptation of the Vegetation of Texas* somewhat upon the *Plantzengeographie auf Physiologische Grundlage* of Schimper and the well known *Oekologische Pflanzengeographie* of Warming (Knoblauch). A short bulletin will present the biology of the Mistletoe and methods of destroying it. Another will deal with the now becoming destructive *Tillandsia recurvata*. A later series will present certain types of flowers from the local flora, designed to illustrate the course on *Evolution and Adaptation as Exhibited in Floral Structures*, which is now an elective spring term course at the University. It will be recalled that Texas, west of the 97th meridian, lies in the zone of extravagant floral display. In few regions may one find superior facilities for the study of "floral ecology," and accordingly this phase of the subject is to be specially cultivated henceforth.

One of the interesting productions of the Samoan Islanders is a cloth made of bark and called "tapa." In the manufacture of this cloth, single strips of bark from a species of mulberry are prepared by scraping and soaking in water, after which they are beaten out very thin by means of small wooden clubs. These thin sheets, while still wet, are laid one over another and the whole beaten together to form a large sheet of uniform thickness. Such bark cloth is in some respects a kind of paper, but it is serviceable as cloth since it is not easily damaged by water. The finished cloth is often ornamented by printing, or rather rubbing. For this purpose designs in relief are carved on wood or built up of palm-leaf cuttings, upon which the cloth is laid and rubbed with sticks of coloring matter, like crayon. This leaves an impression of the raised portion of the carving similar to that produced when a school-boy rubs the impression of a coin into the fly-leaf of his book.—Science.

Mr. Henry Dautun wishes to purchase or exchange for European material, herbarium specimens of *Pedicularis* and allied genera, *Labiatae*, *Ericaceae*, *Primulaceae*, *Ranunculaceae*, *Cyperaceae* and *Filices*. Address 139 Franklin St., Jersey City, N. J.

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THROUGH BRISTOL SWAMP.

BY GRACE GREYLOCK NILES.

Illustrated by the Author.

The science of botany, as a profession in our country, has not, until recently, offered remuneration sufficient for the livelihood of the student. Few, as yet, fully realize the aim of his work, in spite of the State Agricultural and Botanical Stations, and the numerous popular books discussing plant life. This seems strange considering the attention that our public schools give to Nature Study, and the amount of money appropriated by our Government to encourage observation and publication of plant notes.

The botanist properly equipped for a collecting tour with vasculum or press, is still a curiosity among us. For this reason the real student searching woodland and bog for material and notes is generally hailed by the country children as merely a new species of tramp. But upon the collector's enthusiasm for exploring lonely and dangerous trails depends his success. Practical ability as well as poetical ability is necessary to penetrate nature's solitudes. Suitable dress for the wear and tear of the pathless forests, and unfathomable swamp areas is absolutely necessary, and should include water-proof boots, with hobnailed soles, for climbing rocky slopes, or walking through boulder-strewn streams. The vasculum and press must be made as light and compact as possible. The vasculum should be long enough to take large plants, such as the Queen of the Moccasin-Flowers (*Cypripedium reginae*), and her sister species. Rings should be fastened on the upper side of the can through which a shoulder strap may be buckled, thus comfortably adjusting the extra weight on the homeward journey. A large pocket knife for cutting roots and leaf mould is a valuable accessory; and to him whose bump of locality is small, a compass is indispensable.

Figure 15. The Bog-Trotter of Bristol Swamp in the haunts of Boott's Shield-fern.

The huntsman of rare flowers unconsciously becomes familiar with the soil and environment of plants, and knows when and where to search out the hidden homes of his treasures.

The richest areas for orchids and ferns in New England lie along the Southwestern-Champlain valley of Vermont, between the Green and Taconic mountains, and extend from the Bogs of Etchowog, Pownal, northward through Bennington, Dorset, Middlebury, Brandon, New Haven, Bristol, Monkton, Charlotte, Burlington to Colchester on Lake Champlain. The soil of this vast region is variable, consisting of marble and limerock hills, with deep swampy pockets lying between, filled in with clay, and overlaid with marl, rich humus and peat-moss.

Along the higher, ragged ledges about Mount Mansfield, in Stowe, many rare species of fern have been collected. It is in this region that the pioneer botanists—Michaux and Pursh—explored as early as 1803 and 1814; while later Messrs. Robbins, Carey, Oaks, Torrey and Frost found many rarities which have enriched the herbaria of the whole world. The results of those early researches were published in our first catalogue of plants in 1842.*

About 1873 Cyrus G. Pringle of Charlotte, became especially interested in collecting in this region. At this date little was known of the wonderful flora of the state. Charles C. Frost, the scientist-shoemaker of Brattleboro, was then virtually the one Vermont botanist; and the eastern slopes of the Green mountain state were sufficient to supply him with fresh material for a life time. So the valleys and mountains of western Vermont were left to Mr. Pringle, who has for the past twenty-five years done so much for the flora of Mexico. He was justly styled by Professor Asa Gray, "the prince of collectors." Some interesting papers giving an account of his early rambles in Vermont, and his later excursions through Mexico, led the writer—as doubtlessly they have inspired many others—to explore the luxuriant mountainsides and swamp areas of both the Green and Taconics.

The famous Bristol swamps first claimed my attention, as I was in search of the rare Ram's-Head Cypripedium. These swamps are reached by a beautiful, wild and circuitous route of six miles eastward from New Haven Junction. Here, at the base of Hogsback mountain, the grave of a decadent lake lies in seclusion. It is being slowly packed with sphagnum and dense forests of cedar and tamarack, among which many rare flowers hide. The Bristol swamps extend ten miles northward

* Thompson's "History of Vermont."

to Monkton's marshes, and are from two to four miles wide. In the heart of this region a wild meadow borders a muddy pond, which is a mile and a half long by a half mile wide, and is fed by a sluggish creek and springs. This pond divides the area into two great swamps, the North swamp being the vaster and more dangerous one. The South swamp begins about two miles north of Bristol station, on O'Neil's farm, and extends to the creek flowing through Mud pond. On the outskirts, numerous pines and hemlocks shelter the interior, which is crowded with cedars—the *Arbor vitae* of our lawns and hedges.

Entering the marsh by the woodman's path on the west, May 25th, I observed groups of the Pink Moccasin-Flower (*Cypripedium acaule*), together with the entangled plants of Buckbean and Marsh Marigold. Luxuriant Pitcher Plants and several species of Trillium—especially the Large White Trillium (*Trillium grandiflorum*)—graced the soft couches of sphagnum.

Of the Cypripediums, the five representative species of New England dwell here in close comradeship, the Ram's-Head (*Cypripedium arietinum*), really opening the season for the genus about May 10th. It grows at the feet of *Arbor vitae*, loosely rooted in the sphagnum. One must have sharp eyes indeed who discovers its twilight haunts. The flowers are very inconspicuous, the species being the pigmy of our eastern Cypripediums, and of a dull, mottled purple and white. There is nothing alert or attractive about these flowers, when compared with the gay pink and golden sister Moccasin-Flowers, now nodding in full bud along the roadsides nearby.

After our entrance to the swamp, we turned southward and wandered a mile or more. All along the moss-grown path on either hand the rare Ram's-Head reared their noses. They are not so large or abundant here as in the North swamp, where colonies of fifteen flower-stalks often occur. Here they nod singly, or with but three or four plants associated.

Collectors have formerly reaped a harvest from the stock of rare orchids and ferns in this region; and the well known

Bristol Bog-Trotter has, during his lifetime, raided these marshes and rocky mountainsides in order to supply several florists and dealers of hardy plants. The Ram's-Head Cypripedium bring him three or four cents each, while the larger species yield ten to fifteen cents a plant. Frequently nature is allowed a rest for a season or two, in order to multiply and restore her seedlings in these haunts.

Orchids, as a family, do not reproduce seedlings rapidly. Their seeds are uncertain and slow in germination. Many natural and unnatural causes conspire against their development. It often takes four or five seasons to produce plants robust enough to bloom. Constant gathering of the older plants for a series of seasons would soon bring about their total extinction.

But notwithstanding the raids of the flower dealers, the Bristol swamp area is still a delightful, wild garden for many students, including President Ezra Brainard of Middlebury, and Willard W. Eggleston of Rutland. It was from these solitudes that Cyrus G. Pringle also collected the fresh plants of the Ram's-Head Cypripedium, and *Orchis rotundifolia*, which made happy the heart of Professor Asa Gray. Here, too, the "Bristol Bog-Trotter" has introduced many a wanderer like myself. Indeed it is holy ground over which the early botanists have exulted in newly discovered treasures, and where many more nature students may still make rare finds.

Natural clearings occur in the center of the marsh along O'Neil's sluggish brook—wild meadows indeed, where luxuriant ferns flourish, and where grasses are rare. This is the home of Bootts' Shield-Fern (*Dryopteris Boottii*), the pride of my guide. Slightly east of the stream a woodman's road leads northward under the brow of the mountain to Mud pond. Everywhere along these trails beneath the cedars the Ram's Heads peep, and in its season the Round-Leaved Orchis (*Orchis rotundifolia*), blooms. Beautiful Calypso (*Calypso bulbosa*), was collected here by the early botanists, but it is said to be extinct to-day.

One of the most charming corners of the South swamp occurs near the extreme borders, where many roads lead northward from O'Neil's pastures, beneath the rocky bluffs of Hogsback range. Here the Great White Trillium blooms in profusion, while Violets and Clintonia vie with the Marsh Marigolds; and amid the twilight shades of cedar and hemlock the Large Yellow Moccasin-Flower (*Cypripedium hirsutum*), rears her dainty golden shoes amid the ferns. One must look hard in these glooms in order to behold the dull purple blossoms of the shy Ram's-Head Cypripedium, at the feet of scrubby cedars. Everywhere hummocks of moss, interlaced with Snowberry, pile over decaying stumps and logs, between which dark pools reflect the clinging vines, and twin-blossoms of the delicate rose-purple Linnae. The mosses were fairly spangled with these blossoms of light—a vision worth tramping many weary miles to behold. It is in such twilight solitudes in company with the Snowberry and Linnae that the dainty goddess Calypso chooses to dwell.

The deep solitudes of this spot are charmed, as it were, by utter stillness. The calmness produces a feeling of awe, rather than of peace. I had been warned that the most familiar sons of Bristol had lost themselves almost in hearing of their cow-yards, and waded needless miles through tangled brush heaps and logs. A restless confusion came over me when I was not able to discover the sun. When one becomes interested in some new or unknown plant, and wanders about forgetful of his bearings, he is likely to come out at the place whence he started much mystified.

On the summits one may easily discover his way, but it is a great risk to enter a large cedar swamp without a compass; however, I was nearer the open pasture than I knew. Nature had reared a veritable fortress of hemlock and cedar, and had banked out the light by a dense growth of low, creeping junipers about the edges of her Elysium.

Blindly I penetrated the thicket of barbed junipers, frightening up the Golden-crowned Pheasant. This large, wild fowl has been imported from England by Dr. Seward Webb, and is becoming naturalized successfully in the cedar marshlands of

Vermont. Such haunts offer it a snug winter home. It resembles our native partridge, save that it is much larger and tamer. Questions have arisen among the farmers as to this pheasant taking favorably to domestication.

The *Arbor vitae* swamps of northern Vermont are the homes of many flowers and shrubs rarely observed in southern New England. These marshes are liable to remain undisturbed and undrained for a period unknown. The floor of the region is level and the drainage of the vast area is consequently sluggish.

The lowlands between Hoosac valley and Lake Champlain bear evidence of an ancient glacial sea, which rippled through these now decadent lake beds not so many thousand centuries agone; and moulded the glacial hills everywhere evident to-day. In many of these deep sea-hollows, piles of shells are still crumbling in decay, and forming the deposit known as marl. Peat moss (*Sphagnum*), also carpets the floor of many conifer marshes, and it is due to the vast areas of this soil that the rarer flowers and ferns flourish.

A noticeable shrub in Bristol swamp, as well as in the bogs of Etchowog, in southern Vermont, is the Cranberry-tree (*Viburnum Opulus*), which produces an acid fruit similar to that of the bog cranberry. A species of conifer—wholly unfamiliar to me—in southern Vermont grows abundant in Bristol, creeping over the hillsides and beneath the hemlocks bordering the cedar swamps. It appeared to be a low juniper.

A month later, about June 20th, the Showy Queen of our Moccasin-Flowers (*Cypripedium reginae*), will make these glooms glorious with her alert, dancing slippers. These flowers are among the most gorgeous orchids in the world, and certainly are the most showy of our delicately tinted Moccasin-Flowers in New England. The wax-like texture of the sepals and petals, together with the dainty poise of the whole flower, give the impression of fairies dancing in the twilight, as one beholds them in the dim shades of cedar and hemlock. The foliage is coarse and strongly suggests that of Indian-Poke with which it often grows, frequently attaining a height of three feet. The crest of the slipper is beautifully stained with majenta, and channeled adown the sides, suggestive of a dainty sea shell rather than a flower.

Over the rocky slopes of Hogsback mountains the Round-Leaved Orchises and Rattlesnake Plantain of the Orchid family bloom in their season; and later in their turn Arethusa, Pogonia and Limodorum nod and dance among the sedges about Mud pond. In the open meadows, and bordering elusive streams, the Purple-Fringed Orchises and the Ladies' Tresses (*Gyrostachys Romanzoriana*), flourish; and somewhere nestling in the deeper marsh in June, the Wild Calla Lily blossoms for him who dares to venture through dangerous and muddy waters in a leaky boat.

NUTTALL AND PURSH AND SOME EARLY SPRING FLOWERS OF COLORADO.

By George E. Osterhout.

The early spring flowers may not be the most beautiful ones, but often they are the most attractive, because they are first to greet the eye, first to express the amazing contrast of winter and summer, and are prophetic of the host of beautiful blossoms to follow. In Colorado whoever collects some of the early spring flowers and consults the books to see by whom they were first described and named, finds that many of them were first made known to science by Nuttall and Pursh; or to write their names in full, Thomas Nuttall and Frederick Pursh.

There is *Lupinus pusillus Pursh*, an annual which starts with the warm rays of the April sun and keeps its cotyledons till past flowering. It is one of the plants collected by Meriwether Lewis on that first memorable journey of Lewis and Clark across the continent. Mr. Lewis gave to Mr. Pursh the collection of plants which he made on the return trip from the Pacific to be named, and this was among them. It was on this memorable journey, too, that Mr. Lewis found the plant which Mr. Pursh named in honor of its discoverer, *Lewisia redivira.*

Another of the plants whose head of small white flowers greets us early in the spring is the little umbellifer, which now is *Cymopterus acaule (Pursh) Ryd.* It was first described by Mr. Pursh as *Selinum acaule.* He got it from Mr. Bradbury's collection from "Upper Louisiana." Mr. Nuttall, who also collected it on the same expedition with Mr. Bradbury, says of it: "On the plains of the Missouri, commencing forty miles below the confluence of the White river. Flowering in May and June."

One of the early flowering plants of the plains is a little yellow Violet, (*Viola Nuttalli Pursh*). Mr. Pursh indicates that he had seen it in Mr. Nuttall's herbarium and that it came from the banks of the Missouri. Mr. Nuttall notes that "it is the only species of Viola on the plains of the Missouri from the confluence of the river Platte to Fort Mandan."

A little shrubby plant, quite rare in Colorado, Mr. Pursh named *Amorpha microphylla,* and remarks that he had seen it in "Herb. Lewis." It is therefore one of the plants first collected by Meriwerther Lewis. But Mr. Nuttall had already named and described it in Fraser's Catalogue as *Amorpha nana,* by which name it is still known. Mr. Nuttall says that it is found "On the woodless and grassy hills of the Missouri, from the Platte to the mountains, growing only from six inches to a foot high. Flowers purplish blue and fragrant, coming out in the month of May."

Then there are *Pentstemon angustifolius Pursh*, one of the many beautiful species of this genus; *Gaura cocinea Nutt.* which belongs to the Evening Primrose family; *Rumex venosus Pursh; Troximon glaucum* and *Troximon cuspidatum Pursh*, plants which blossom with the dandelions and resemble them; *Erigeron pumilum Nutt* and *Asragalus Missouriensis Nutt.* And so quite a list of plants which greet the eye in spring-time—as well as many later ones—were first made known to science in the publications of Nuttall and Pursh.

But how came these plants in the possession of Mr. Nuttall and Mr. Pursh? I have already indicated that Mr. Pursh received a few from Meriwerther Lewis. The most of them, however, were gotten in quite a different way, and the answering of the question forms an interesting chapter in the history of the botany of the Rocky Mountain region, a brief sketch of which I wish to recount.

In 1810 a Mr. Hunt, in the service of John Jacob Astor, was making a trip across the continent with a considerable company to Astoria. Mr. John Bradbury, a Scotch naturalist, had been sent out some years earlier by the Linean society of Liverpool to make collections in the New World. The expedition of Mr. Hunt gave to him the opportunity to penetrate a hitherto unexplored region, and he gladly used the opportunity; Mr. Nuttall, then a botanist of Philadelphia, eagerly offered to accompany Mr. Bradbury, and his offer was accepted. Mr. Hunt gave them the protection and facilities of his party, and in this company, in the spring and summer of 1810, they proceeded up the Missouri to the Arickara Indian villages in Dakota; and about the middle of July started on the return trip to St. Louis. Washington Irving, the chronicler of Astoria has told in the book of that name of the activity and eagerness of Mr. Nuttall in collecting plants. "Mr. Nuttall seems to have been exclusively devoted to his scientific pursuits. He was a zealous botanist, and all his enthusiasm was awakened at beholding a new world, as it were, opening upon him in the boundless prairies, clad in the vernal and variegated robe of unknown flowers. Every plant or flower of a rare or unknown species was eagerly seized as a prize." He was "forgetful of everything but his immediate pursuit, and had often to be sought after when the boats were about to resume their course. At such times he would be found far off in the prairies or up the course of some petty stream laden with plants of all kinds."

Mr. Bradbury, too, was busy collecting, and collected much of the same material that Mr. Nuttall did, but he "was less exclusive in his tastes and habits, and combined the hunter and sportsman with the naturalist." Perhaps the two were not altogether congenial; it seems they did not return together, for it is stated in "Astoria" that when Mr. Hunt proceeded on his way from the Arickara village, he left Mr. Nuttall there waiting a party to go down the river, but Mr. Bradbury "had departed some days previously." The return trip was full of dangers and hardships. Mr. Bradbury was captured by the Indians and saved his life by taking to pieces his watch and distributing its parts among them. Mr. Nuttall "overcome by fatigue and hunger in the wilderness, laid himself down to die, but was found by a friendly Indian, who took him in his canoe down the Missouri to the first settlement of white men. In spite of these misadventures, he was able to bring with him on his return, in the beginning of 1811, ample treasures of seeds, plants, minerals, and other natural objects." (Sketch of Thomas Nuttall in Popular Science Monthly, March, 1895.) During the next eight years he remained in Philadelphia, making excursions during the summers, and studying his collections. In 1818, he published his Genera of North American Plants, in which is contained the descriptions of the plants which I have mentioned. Mr. Nuttall thus collected with his own hands the plants of which he so interestingly wrote.

In the preface to Mr. Pursh's Plants of North America, we find what became of Mr. Bradbury's collection. Frederick Pursh, an Englishman, came to the United States to make botanical collections, and for several years worked diligently in collecting and in acquiring collections. In the preface of which I have spoken he says, "In 1811, after an absence of nearly twelve years, I returned to Europe with an ample stock of material towards a Flora of North America." About the same time I suppose Mr. Bradbury found his way to London with his collection, for further on in the preface we read, "I am highly indebted to Mr. William Roscoe, Esq., who very obligingly communicated to me Mr. Bradbury's Plants collected in Upper Louisiana." (Mr. Roscoe, we may presume, was an officer of the Linnæan society, which sent out Mr. Bradbury.) "This valuable collection contains many rare and new species, having been collected in a tract of country never before explored." In 1814, Mr. Pursh published his Plants of North America, which contained the descriptions of such of Mr. Bradbury's plants as he considered new to science. This was four years earlier than Mr. Nuttall published his Genera; but a few of his newly-discovered plants Mr. Nuttall had before this time published in a catalogue issued by the Messrs. Fraser of London, and in this way some of his plants gained precedence in publication. Both were working over some of the same material, and both published some of the same plants, but Mr. Nuttall gives notes of observation and little touches of description which make his Genera still an interesting book to consult.

One feels an admiration for the enthusiasm and perseverance of our early explorers and scientific workers, and learns that many an humble flower suggests a history of patient endurance, of high purpose and courage by men of noble character of whose lives it is a pleasure to know.

VISITS TO SOME BOTANIC GARDENS ABROAD.

By Dr. Pehr Olsson-Seffer.

(*Continuation.*)

IV. 's Lands Plantentuin, Buitenzorg.

This is the official name of the finest botanical garden in the world, founded in the year 1817 by Professor Reinwardt. On the fertile soil of Java, in a salubrious climate, under the sun of the Tropics, Nature has been guided by man's intelligent efforts to produce this unsurpassed collection of more than 10,000 species of living plants. The wise and fostering care of the Government of Netherlands, India, has been freely given this institution, which under the direction of such botanists as Blume, Teysmann, Scheffer and Treub, has gradually increased in size and beauty.

The great feature of this well-appointed botanical establishment is the grouping together of plants of the same natural order, which renders it easy to find a particular plant when necessary. Generally such a systematic arrangement has to be carried through at the expense of the landscape effect, but in Buitenzorg garden the latter has not suffered.

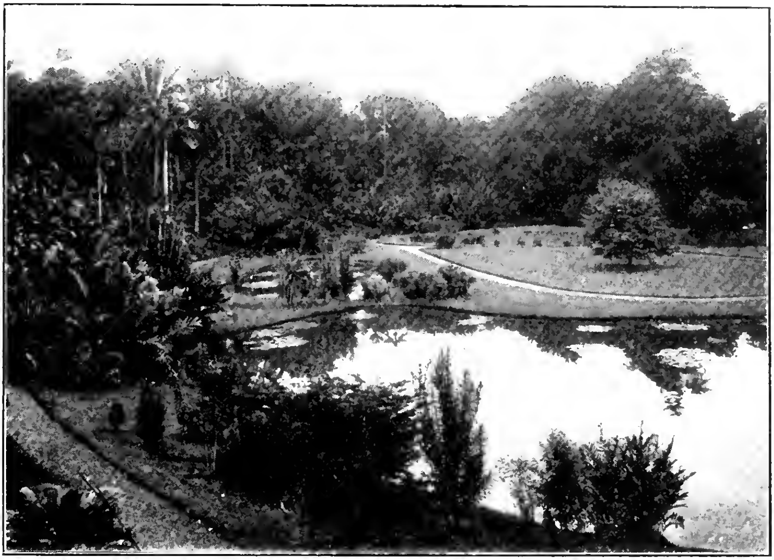

Figure 16. In Buitenzorg Botanic Garden.

Endlicher's system somewhat modified according to Bentham and Hooker is followed. Every species is represented by two specimens, one of which is labeled. At the corners of the different sections labels indicate the families and genera represented in each, and red labels for a plant show that it does not belong to the group comprising the section in which it stands.

Upon entering the garden through the main gate, a long avenue of giant *Canarium commune*, with crowns forming a canopy more than one hundred feet above, stretches before the visitor. Every trunk is covered by climbers, such as *Monstera deliciosa*, *Philodendrons*, *Anthuriums*, and other *Aroideae*, *Loganiaceae* and *Gnetaceae*, and on the branches is a rich flora of epiphytic plants. To the left is the small town formed by the office and laboratory buildings of the institution, of which more below. Further on are the sections planted with *Malvaceae* and *Bignoniaceae*. Among the latter we notice the African *Spathodea campanulata,* the beautiful red and yellow flowers of which are a favored decoration among the Europeans in Java. The Candle tree (*Parmentiera cerifera*) from Panama, stands near the lotus pond, which follows the canary avenue for some distance. In the middle of this miniature lake is a small islet, with a luxuriant vegetation of the red stemmed palm, *Cyrtostachys Rendah, Dracaenas, Yuccas, Crotons,* and *Codiaeums. Thunbergia grandiflora* climbs over the trees, interspersed by *Ipomaeas.*

When we approach the palace of the Governor-General of Netherland's-India we pass another part of the pond with *Victoria regia* and other water lilies. Turning to our left we enter an avenue of Royal Palms, upon which borders a section with sundry other palms and cycads. Close at hand are the *Cannaceae, Musaceae* and *Scitamineae.* The common *Maranta arundinacea,* species of *Elettaria, Alpinia,* and *Kaempferia* are here to be seen, and in the section of bananas we notice *Musa ensete, M. coccinea,* and *M. cliffortiana* among other forms. Passing a bridge over the creek Tjibalok we have dense thickets of bamboos on either side of the road. Through an avenue of *Liristonas,* formed by *L. rotundifolia,* we approach a palm section with some splendid specimens of *Martinezia caryotaefolia,* from Venezuela, and *M. erosa,* from the West Indies.

Close at hand is the rose garden, which naturally shows that even with the best of care the rose in the Tropics becomes at best only a poor hot-house representative in comparison with the beautiful roses of Southern California and Southern France. In the midst of the rose garden is a small monument erected in memory of that eminent horticulturist, Johannes Elias Teysmann, who once was the chief of the Buitenzorg gardens.

Not far from this place we find the Upas tree of Java (*Antiaris toxicaria*), about which there are so many legends and stories. Into its highly poisonous latex the natives dipped their arrows, and the wounds caused by these deadly messengers of hate or war almost invariably proved fatal. Vivid descriptions of animals having been killed by the mere presence of this tree in the neighborhood, or that a drop of latex falling to the ground is enough to destroy all animal or vegetable life within some distance are naturally myths only, but still quite interesting to read about.

Figure 17. Waringin tree *(Ficus benjaminca)* at Buitenzorg.

If we turn to our right from the main avenue we have only a short distance to the block of citrus trees, where most of the species of this group are to be met with. Next we come to the sections of epiphytic orchids and ferns. Large specimens of *Asplenium nidus* and the Staghorn ferns *Platycerium*, are clinging to the branches of the trees, *Lygodiums* climb along the trunks, *Adiantums* cover the soil, and *Polypodiums* seem uncertain whether to grow on the ground or to take refuge in the trees.

Splendid Pandans from the Malayan Archipelago form one section, and then we reach the main palm collection of the garden. Here we notice the *Oncosperma horrida*, covered with

Figure 18. View in the mountain garden Tjibodas, Java.

black spines, *Arenga saccharifera*, from which both palmsugar and palmwine is made in Java, *Zalacca edulis*, producing the sacred Salak fruit, many species of *Phoenix*, *Latania*, *Metroxylon*, *Thrinax*, and *Attalea*. While walking through the gardens with its present eminent director, Professor Treub, my attention was drawn to a very large coco-de-mer (*Lodoicea seychellarum*).

In the section of myrtaceous plants we see the common *Barringtonia*, which often is found among the mangrove vegetation of tropical seashores, consisting of species of *Rhizophora* and other genera. *Caryophyllus aromaticus*, the Clove tree of the Moluccas, *Punica granatum*, the Pomegranate of North Africa, Guavas, Jambos, Para-nuts (*Bertholetia excelsa*), and the Australian Ti-treet (*Melaleuca*), from the leaves of which cajeput oil is distilled, are represented here.

Ripe nutmegs are strewn over the ground of the *Myristica* section, in which numerous different species of this genus occur. In many parts of the garden familiar tropical fruit trees are met with, *Nepheliums*, or Rambutans and Pulasans, Durians (*Durio*), Mangosteen (*Garcinia mangostana*), the "queen of fruits," Duku, Chico, Custard Apple and Soursop (*Anonas*), Mango, Papaya, Langsat, Rambei, Pineapples, etc.

But it is of no use trying to give even a faint idea of the multitude of trees, shrubs and herbs represented in this "*herbarium vivum*." De Burck, Professor Haberlandt, and other botanists have written books about the Buitenzorg garden, and still a visitor finds that they have not been able to give an adequate description of what it is.

It is difficult to say which offers a greater attraction to a botanist visiting Buitenzorg, the large and beautiful garden, or the personality of its official chief and leading spirit for the last quarter of a century, Dr. Treub. Everyone becomes fascinated by both, and with the writer, feels a pang of regret upon leaving, not being able to extend the stay indefinitely.

Through Dr. Treub's persistent endeavors, the Buitenzorg garden has now a most complete series of laboratories for botanical research, the facilities of which are available to scientists, who flock here from all corners of the earth. A very large herbarium is housed in a special building and placed in immediate care of a staff of systematic botanists, a special forest herbarium occupies another building, a botanical library with some 40,000 volumes, and a museum for economic plant products comprise one series of well erected modern structures.

The main group of laboratories consists of one building for agricultural and chemical investigations, another for zoological work, including a museum; there are plant physiological, pathological, bacteriological and geological laboratories. One is devoted to pharmacology, others to tea, coffee, rice, rubber and cinchona investigations. One large building is especially devoted to laboratories for visiting botanists. It is probably well known that certain European countries regularly send a botanist to study at Buitenzorg, while students from other countries arrive at irregular intervals. For everyone there is room, and all necessary supplies and facilities are freely and liberally placed at the visitor's disposal. There is certainly no institution in the world which can offer better opportunities to the student of tropical plant life in its various forms.

Buitenzorg botanical garden is to the botanist what the Zoological Station at Naples is to the zoologist.

The town has an excellent mountain climate, the elevation being 800 feet, and a person unused to tropical conditions finds that he can here work in safety from fevers, as well as accomplish work without the constant enervating effect produced by the Tropics generally.

Professor J. H. Schaffner, of the University of Ohio, has recently described a form of *Verbena stricta* occurring in Clay county, Kansas, which he designates as a mutant of the species. In commenting upon his discovery, he says: "Some have claimed that mutations have been mostly observed among domestic forms. This is true, because there are far more accessible for ordinary observation than wild species. But with proper investigation mutants may turn out to be as abundant in the field as in the garden. One must live in the field and be thoroughly familiar with the plants of the locality before he is likely to notice even the more striking mutations, should he be so fortunate as to pass by their isolated habitat. * * *

Many of the more important processes of evolution can be discovered only through series of pedigree cultures. The notion that species, to be good species, must have their origin in the field, or nature's garden and not in man's, has come down to us from a previous generation. This notion with other modes of thought, formulae, and assumptions has been so thoroughly diffused through scientific thought and literature that it is held by many as a kind of dogma which if logically applied would exclude experimentation entirely as a factor in determining the character of evolution and speciation. * * * And finally, is it not immaterial whether a species to be a good species, cover a square mile or a continent, whether it continue for ten generations with a few thousand individuals or for a geolgoical period with countless millions?"

Commenting upon the article published by Dr. MacDougal in the February number of The Plant World, Dr. R. M. Harper writes us: "In Georgia and Alabama I have seen three presumably hybrid oaks which have probably never been mentioned in print, namely, *Q. geminata X Margaretta*, *Q. alba X Virginiana*, and *Q. minor X Prinus*. There are two or three hybrid ferns which have been discussed a good deal, such as *Asplenium ebenoides* and *Dryopteris cristata X marginalis*. In the volumes of Rhodora, if not elsewhere, you can find references to hybrids in *Rubus* and *Spiranthes* (*Gyrostachys* or *Ibidium*). Hybrids are probably more numerous in proportion to number of species in *Sarracenia* than in any other American genus. I have found *S. flava X minor* and *S. minor X psittacina* in Georgia. (See Bull. Torrey Club, 33:236, Ann. N. Y. Acad. Sci., 17:234), and *S. Drummondii X flava* in Alabama. Natural hybrids of *S. purpurea* with *flava*, *rubra* and perhaps others are also known. In 1900 I found what seemed pretty good evidence that *Laciniaria Boykinii* was a hybrid. (See Bull. Torrey Club, 28:481, 1901). *Habenaria blephariglottis* hybridizes with *H. ciliaris*. (See Bull. Torrey Club, 20:469, Ann. N. Y. Acad. Sci., 17:255), and *Aletris lutea* with *A. obovata*, apparently. (See Bull. Torrey Club, 32:463, Ann. N. Y. Acad. Sci., 17:259).

Postelsia, The Year Book of the Minnesota Seaside Station, 1906. The Pioneer Press, St. Paul, Minn. The writer has the good fortune to be among those who have an intimate acquaintance with the conditions of life upon our Pacific northwest coast, the richness and variety of which challenges the interest of every student of biology, be he botanist or zoologist. It is quite evident that the two volumes of *Postelsia*, the first of which was issued four years ago, are the products of this interest, and the enthusiasm begotten of it, in those who have gone year by year from the University of Minnesota to their far-off seaside station on Vancouver Island, and we are glad to see that the day is not yet past when such interest may be allowed more latitude of expression than that of formal statement in formal journals. The *Postelsia* is a unique publication, but it must be forgiven this fault in view of the evident worth of the matter therein. The larger number of the papers deal with the vegetation of the region, and are either distributional or taxonomic; in one a new kelp, *Renfrewia parvula* Briggs, is described; another is an ecological study of the tide pools; while the last is a geological paper dealing with the feature of the station grounds. One may get from the volume, which is plentifully illustrated with halftones, an excellent general notion of the vegetation of the southern part of Vancouver Island, a locality which is typical of the whole northwest coast.

Dr. C. F. Baker, lately chief of the Botanical Department of the Agricultural Experiment Station of Cuba, has been elected professor of botany in Pomona College, Claremont, California. Professor Baker has already served as an instructor for a year in this institution. It is reported that Dr. Baker's extensive collection of herbarium material passes into the control of the department.

A movement has been started for framing a suitable commemoration of Gregor Mendel with reference to his work on hybrids and heredity. Among the names signed to the preliminary request for support and scientific contributions are to be found those of L. H. Bailey, Bateson, Boveri, Castle, Conklin, Cannon, Correns, Fr. Darwin, Davenport, MacDougal, Engler, Flahault, Goebel, O. Hertwig, Miyoshi, Morgan, Rosenberg, Schwendener, Shull, Strasburger, Tschermak, Vilmorin, Webber, Weissman, Whitman, Wittrock and many others.

An expedition from the Desert Laboratory has recently circumnavigated the Salton Lake in California, which is now found to have an area of about 700 square miles. A basin below sea-level in Mexico sustaining similar relations to the delta of the Rio Colorado was traversed and the more prominent features of the effects of the frequent oscillations of water level on the vegetation noted. This basin was named the Pattee basin in honor of the first American who crossed it in 1827.

The report of the Secretary of the Botanical Society of America, of March 1, 1907, shows that the association now has a total constituency of one hundred and twenty-one. By the recent action of the society, the money in its possession on January 1, 1907, amounting to over three thousand dollars, has been constituted a permanent endowment fund, which with its income is to be preserved until a fund of ten thousand dollars is accumulated. A grant of one hundred dollars was made to Dr. E. A. Bessey, as an aid in his investigation of the flora of the Florida Keys. A grant of fifty dollars was made to Dr. J. C. Arthur to aid in the continuance of his experimental study of the plant rusts.

It has recently been announced that Dr. E. C. Jeffrey, of Harvard University, has been promoted to a professorship of Plant Pathology in that institution.

Professor F. E. Clements, of the University of Nebraska, has just completed a text-book on plant physiology for the use of college students. It will be available for use at the opening of the next academic year.

Professor J. C. Arthur, of Purdue University, gave a lecture in Chicago on March 30th, under the auspices of the Field Columbian Museum. He took for the title of his address, "A Superimposed Vegetation—the Plant Rusts." Professor Arthur is one of the foremost students of this group of plants in the world.

"Lady Hollyhock and Her Friends," a book of nature dolls and others (The Baker and Taylor Co.) may be heartily commended to teachers of children as a useful help to the contrivance of playthings which will help the little ones to that knowledge of things which is the foundation of the wider and deeper experience which makes for an intelligent view of the world.

In May there is to be held at Upsala, Sweden, the two-hundredth anniversary of the birth of Linnæus. Professor Francis Darwin is to represent the University of Cambridge on that occasion.

In a few weeks ground is to be broken for the new Botanical Laboratory and Garden of the Johns Hopkins University, at Homewood, near Baltimore, the future home of that institution of learning.

Wanted To Purchase.—In order to complete a set a premium will be paid for the following numbers of the Botanical Gazette: Nos. 5, 6, 7, 8, 9, 10 and 11, of Volume VII.; No. 5 of Volume VIII.; No. 3 of Volume IX.; No. 11 of Volume X.

Persons having any of these copies for disposal should address Dr. D. T. MacDougal, Tucson, Arizona.

In a recent bulletin of the University of Texas (Scientific Series No. 10), Professor William L. Bray discusses the distribution and adaptation of the vegetation of Texas. Many of the facts set forth have appeared in previous papers of the same author, but their significance and interest are enhanced rather than lessened in this comprehensive review, which he has undertaken with immediate reference to its use in the schools of the State.

Among the noteworthy sections is that on the Edwards plateau type of woodland, the meeting ground of Atlantic, Lower Solonan, and Rocky Mountain species. But many of its plants are to be looked upon as peculiarly Texan, species of Atlantic forest affinity, "modified by climatic conditions into forms constantly different from the Atlantic ones." Thus the live oak on arid hills becomes a dwarfed shrub, called *Quercus fusiformis* by the systematists, and the white oak (*Quercus alba*) becomes a thin oak under the name of *Q. breviloba* on high divides, while the red-bud and hackberry are so nearly identical with those of the East as to suggest genetic relationship.

The rapidity of the invasion of the grass-land of the Rio Grande Plain by chaparral species from the Mexican Plateau is both striking and well attested. Living men remember when hundreds of square miles now covered by mesquite and other brush were open prairie. Thus the geographical origin and the actual paths of migration of important elements of the Texan flora are, to all practical purposes, under direct and continuous observation, and the record preserved in the papers of Professor Bray will make it possible to continue such observations and records to an indefinite future.

The emphasis laid on edaphic factors is timely and indicates a hopeful trend. Eighteen well marked edaphic formations with their characteristic associations are enumerated. In spite of typographical slips, which mar its pages, this bulletin is of unusual value and should be known and read by teachers and students far beyond the limits of the State to which it specially relates.

Professor Walter B. Barrows, in an article on "Fact and Fancy in Bird Migration" (Mich. Acad. Sci., 1906) brings out some cases that have a bearing on the transportation of seeds to long distances. Thus the Golden Plover, reared in Northwestern Arctic America, migrates to the pampas of Argentina, and even to Patagonia, 6,000 or 7,000 miles from their point of departure, going by the way of Labrador and Brazil and returning by quite another route. The Nighthawk, which remains in our Northern States just long enough to rear its young, winters in Central America or Brazil, and in some cases as far north as Paraguay and Patagonia. From these and similar well-attested facts it is plain that agencies now in operation are amply sufficient to account for the occurrence of certain species of plants in regions as remote as Argentina and the Rocky Mountain country.

A remarkable case of foliage orientation occurs in the Mexican greasewood, *Covillea mexicana*, the causes of which are quite obscure. It should be noted that the branches show a distinct dorsiventrality, readily observable, so that a typical branch, leaves and all, lies in a single plane, broadly speaking. In addition to this, however, there is a placing of the branches so that their upper surfaces all face the southeast. It is true that many individual plants, due to disturbing causes, do not display this behavior in a marked degree. On the other hand a careful examination will discover the orientation where at first it does not seem to be present, and the very great majority of plants show it readily. I have not been able to detect that position with respect to the topography affects the matter, and the constancy of the attitude of the branches on large areas of the mesa certainly calls for explanation. F. E. Ll.

The annual session of the Biological Laboratory of the Brooklyn Institute of Arts and Sciences, at Cold Spring Harbor, L. I., will last this summer from July 3 to August 17. The course in Cryptogamic Botany will be conducted by Prof. Duncan S. Johnson, of Johns Hopkins University, aided by Mr. Harlan H. York of the University of Texas. The course in Plant Ecology will be given by Dr. E. N. Transeau, of the Station for Experimental Evolution, assisted by Mr. W. C. Cooper, of Johns Hopkins University. As usual, assistance will be given to all those wishing to do advanced botanical work in either of the lines mentioned. Botanists prepared to take up independent investigation may secure private rooms in the research laboratory by communicating with the Director of the Laboratory, Cold Spring Harbor, L. I., N. Y.

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THE PATAGONIAN FLORA.

By Professor G. Macloskie.

It is improper and misleading to speak of Patagonian plants as Antarctic, for the region lies well within the temperate zone, and its plants are not at all waifs and strays, such as make up the "Arctic" flora. Peraustral America is a better name, suggestive of the two-fold connection on one side, with the rest of America, and on the other side with Australia. This two-fold nexus appears to us to be the key to the distribution, some of the plants coming down along the American rocky axis, and ultimately from Asia and from the highlands of the Old World, whilst there is a cross connection by water with Australia, Tasmania and New Zealand.

As Charles Darwin remarked, there is not much coming and going, of a botanical kind, between Patagonia and the Argentine and Brazilian regions. Very few plants are able to travel directly southwards from Argentina, and the region eastwards of the Andes in Patagonia is chiefly rocky or shingle, a sort of *Patagonia petraea*; all the rivers cross from the mountains to the sea, carrying plants from the mountains to their valleys, and finally to the sea, and also intercepting as colonists such as were being carried transversely. Hence the absence of trees from the eastern part, except such fruit trees as have been introduced. Thus we have a great circular internacial route, along the mountain chains of the old and new worlds; such a genus as *Braya* passing from the European Alps by the Himalayas over Behring Strait and down the Rocky Mountains to Southern Chili, and reappearing in Australia. Hence plants pass over by help of winds, or marine currents, or birds, from Patagonia, to Staaten Islands, the Falklands, Kerguelen, and beyond Australia to the islands of the Antarctic.

My attempt to provide a text-book of the Patagonian flora was the outcome of some small collections of plants made by the late J. B. Hatcher and by O. A. Peterson, as incidental to their geological explorations. The plants did not contain much that had not been previously found and described by others, and as there is no recent general book about them, I was compelled to make a list of the species, and to make notes of their diagnostic marks for my own use. This soon grew far beyond my anticipations, a great work in size, but only very elementary in aim.*

I should also explain that most of the work was done away from my base, in the Gray Herbarium, at Harvard University, at the New York Botanical Garden, and at the Academy of Sciences in Philadephia, and it was consequently impossible to do justice to the subject. I was buoyed up, however, by the hope that it would at least afterwards prove helpful to others, especially when supplemented and amended by specialists. In this direction I am already indebted to Dr. Per Dusén of Stockholm, who has had large opportunities of exploring the Western and Southern parts of Patagonia, and besides contributing to the volume on the general botany, and specially on the Bryophytes, has examined many of the specimens, and criticized my identifications. Dr. Teodore Stuckert of Cordoba, Argentina, has also revised my work on the terminology, and sent me a list of the more useful synonyms.

Of the interesting surprises which occurred during my work, the greatest was as to the large number of species of flowering plants within the Patagonian region. I was so ignorant at the outset as to expect about 800; there turned out to be 2,100, and now Dr. Stuckert sends me the names of about 100 addi-

*Reports of the Princeton University Expeditions to Patagonia, 1896-1899. Botany, by George Macloskie. Princeton, N. J., 1905.

tional species. Next to this is the definite complexion of these plants. Some, indeed, are world-tramps, most so the *Erodium cicutarium;* many more are overflows from Andian and North American vegetation, but very many are characteristic of Peraustral America, and some of these are very well marked, so that their presence in a collection would at once prove its home-land. In most cases the genera are the characteristic groups, in some cases there are peculiar species belonging to cosmopolitan genera; a few of the families are peculiar or nearly so. Thus as a whole we have a well-limited botanical region.

The climate of Western Patagonia and West Fuegia is very moist, with the result of having trees and cryptogamic growth in excess. The eastern part is arid, and with fewer species, and these of xerophil habit. Between these extremes are many gradations, and there are prospects of a future colonization, and cultivation, by human immigration, which is already beginning to be fulfilled in some parts.

Characteristic forms are not confined to any families of Phanerogams, but some families are remarkable for their special products.

Among the Gymnosperms we have some forms connecting with the route up by Chili, and on to Central Asia and Europe: thus *Ephedra* and others connecting with Australia, and New Zealand, as *Araucaria*, and *Dacrydium*. The Tussock-grass (*Poa flabellata* Hook) of the Falkland Islands, the Pampas-grass (*Gynerium*, various species), and the many species of *Stipa* grass, which Spegazzini has described, and the Wheat-grass (*Agropyrum pubiflorum*) give a facies to the plains, whilst species of *Chusquea*, woody grasses, allied to the bamboo, introduce a subtropical element.

Amongst the Cyperaceae, one of the most characteristic is the Patagonian *Carex* (*C. patagonica* Speg.). *Oreobolus* has two-ranked flowers, and *Uncinia* (like *Carex*, but with floral axis terminally hooked), unite with Australia and New Zealand on one side, and with Juan Fernandez on the other.

Of the Juncaginaceae, *Lilaea* is 1-merous, and *Tetroncium* is 4-merous; *Lilaea* confined to the Chilian Andes, and *Tetroncium* uniting Magellan, Fuegia as far as Cape Horn, and the Falkland Isles. *Gaimardia*, of the Centrolepidaceae, forming turf-mosslike masses, has a congener in New Zealand, and this small family unites New Zealand, Tasmania and Peraustral America, *Marsippospermum*, of the Juncaceae, unites with New Zealand, and *Rostkoria* with Campbell's Island.

The frutescent Liliaceae are a surprise to a stranger. Here are monocotylous shrubs with reticulate leaves. One of them, *Callixene marginata Lam.*, unites Magellan, Cape Horn, Staaten Island, Falklands and New Zealand, whilst other species are in South Chili. *Philesia buxifolia* Lam. extends from South Patagonia to Cape Horn, remarkable for its large pink flowers and its leafage like the box-shrub. Of Irids, *Symphyostemon* has rich bell-flowers, and *Tapeinia magellanica* has distichous leaves, like a club-moss. Orchids are represented by many species of *Chloraea*, in Patagonia, Fuegia, and Falklands, and the beautiful *Codonorchis*, like *Arethusa*, but with a whorl of 3-6 leaves midway on its scape.

The apetalous dicots have several singular genera. Thus the species of the Southern beech, *Nothofagus*, forms forests in Western Magellan and Fuegia. These false beeches have about a dozen species distributed over Chili, Patagonia, Australia and New Zealand; they differ from the true beeches by having male flowers few in a cluster and styles short; and the Chilian-Patagonian forms are of two groups, deciduous and evergreen: the deciduous, *N. antarctica*, is remarkable for its small, flabellately folded leaves, and forms dense woods in the Southern Andes and in Fuegia. The evergreen beech, *Nothofagus betuloides* makes forests in Fuegia. On the beeches grow the parasitical shrubs, *Myzodendron*, several species of this "Angel's-beard" being found in Patagonia, Fuegia and Southern Chili, and nowhere else. Whilst Proteaceae are characteristic of Australia and Southern Africa, a few of them, belonging to a particular section, are in Peraustral America.

A curiosity among the Caryophyllaceae is Spegazzi's new

Genus *Philippiella*, which is 4-merous with a 1-seeded utricle, has stipules and the scent of Valerian.

Caltha dioneaefolia is a Ranunculaceous plant with the leaves of the famous Virginia fly-catcher, and *Hamadryas* is a dioecious genus of the same family. The barberries are abundant, and many of them remarkable. *Drimys*, Winter's Bark, is well known as the most characteristic of the West Magellan shrubs, and belongs to a special section of the Magnoliaceae; it has allies in other southern warm, temperate lands—Australia, Papua, Borneo, and in New Zealand—and extends to northern South America and Mexico. *Calandrinia*, of Portulacaceæ, binds western South America to Australia; and *Laurelia* of Monimiaceæ, unites with New Zealand; but it is impossible to cite all the cases of this kind of discontinuity. *Braya*, of the Cruciferæ, however, is most remarkable; its several species follow each other from the European Alps, through the Asian Mountains, China, and Siberia, over to the Rockies of America, and by the Andes to Patagonia; and a species occurs in New Zealand; thus belting the world. A single species of *Saxifraga* (*S. cordillerarum* Presl.) almost equals this, whilst wild species of *Ribes* connect with North America, and with the gooseberries and currant of Eurasia.

The Rosaceæ are represented by the Potentils, Geums and other European forms, often specifically different, and by some remarkable local generic forms. *Tetraglochin* and *Acaena* are most curious, the many species of Acaena having achenes with strong glochidiate spines; one species of this genus reaches California; others are in the Falklands, South Georgia Islands and Australia, but South Chili and Patagonia are the chief centre of its numerous species. Beside them we may cite the Leguminous *Anarthrophyllum*, which has spinelike leaves, reminding of the Furze (Ulex) of Europe. But the greatest of the south Patagonian Leguminosæ is that often called *Adesmia*, now fixed as the genus *Patagonium*, chiefly herbs of the habit of the Astragals, which are less numerous in that region. Its generic name is appropriate, for half of its ninety species are in Patagonia.

In some parts the *Oxalis* species with fleshy, scaly, edible rhizomes, and flowers like in habit to the Campanulas are abundant. One of these in the Hatcher collection is remarkable for its trimorphous stamens and styles.

One of the *Euphorbias* (*E. serpens* H. B. & K.) reaches to North America and seems to be identical with an oriental plant.

The Patagonian *Empetrum* seems identical with the Eurasiatic *E. nigrum*, except its red berries; it abounds in the steppes, forming the chief food of the quails and partridges. Of the Anacardiaceæ, *Schinus* (*Duvaua*) *dependens* Ort. and *S. molle* L., the incense-bush, are chief, yielding an important purgative resin, and having sugary edible drupes. Fragments of the leaf of the *molle* when placed in water move by jerks, from the escape of the volatile oil.

The genus *Ugni* brings up the problem of names. The myrtaceous shrub described by Molina in 1828 was termed *Myrtus ugni*, changed by Hooker & Arnott in 1833 into *Eugenia ugni*; by Turczaninow in 1848 into *Ugni molinae*; and under new rules (not yet authoritative), I have been impelled reluctantly to give it the inelegant name of *Ugni ugni*. If permitted I should greatly prefer to restore the original name in this and all similar cases, only deposing the original generic, and promoting the original specific name; thus giving *Ugni myrtus* as the new name.

The Halorhagaceæ can claim the famous *Gunneras* of Patagonia and Chili. One of them, *G. chilensis* L., is the giant of herbs, like an overgrown rhubarb. The small *G. magellanica* Lam. is unique, a rootstock crowned by two long-stalked reniform leaves and a peduncle crowned by a spike of crimson drupelets (dioecious).

The Umbelliferæ are represented by some of their globe-trotters, and also by some famous specialists. Of these last the *Azorella* (Bolax) is famous, making densely pulvinate clumps of interlacing branches with a veneering of leaves which set off their pretty star-shaped yellow flowers; the mass hard enough to require a hatchet, and old enough to be probably centenarian.

In the *Challenger* reports some of these are figured in Kerguelen, and they abound in Magellania and Staaten Island.

Hurrying along we are stopped by the most extraordinary of shrubs, *Verbena carroo*, like petrified Astrea-corals, but each short branch consisting of four rows of small closely appressed leaves. Next we note the handsomest of shrubs, the *Veronica elliptica* Forst., now familiar to Killarney tourists, as the most beautiful of the vegetable treasures of the lakes. This plant is found in Magellan, Fuegia, Falklands, New Zealand, Auckland Island, Campbell's Island, and is well called the "Southern Hebe."

A peculiar section of *Plantago* (known as *Plantaginella*) has several species characteristic of Australia and Patagonia, having many spikes each few-flowered, often with only a single flower to the spike. A new form of this group was described for me by Prof. E. L. Morris of Washington, D. C., and named *Plantago coelorhiza* (having hollow root-stock). These go with many other groups of species, to prove a direct communication with Australia, by water or wind, or by both, and they seem to be unrepresented in northern parts.

The Calyceraceæ show their affinity to Compositæ by their distribution as well as by their structure, having their headquarters in Peraustral America. One of them, *Boopis scapigera* Remy, appeared to us so little known and so peculiar, that we gave it a special figure (plate xxvi, l. c.). Its radical rosulate leaves send up a crowd of nearly leafless diverging scapes, each of these crowned by a head of flowers, having the habit, but few of the characters, of the Compositæ.

This brings us to the last great family, the Compositæ, which are the lords of the vegetable creation, so far as this region is concerned. We shall give a separate account of these at a future time.

PRINCETON UNIVERSITY, Feb. 21, 1907.

FIELD WORK IN PLANT PATHOLOGY.*

BY PROFESSOR F. D. HEALD.

Field work is of great importance, both in the study of inorganic (non-parasitic) and organic (parasitic) diseases, but laboratory work must still continue to receive its full quota of time. In these days of fads and extremes I fear that the laboratory side of pathology may be neglected; the laboratory must not be deserted for the field, but the student must spend time in both. Sometimes field work must predominate, but at other times the work will be largely confined to the laboratory and greenhouse.

In the study of diseases due to unfavorable climatic, edaphic, or biologic factors, the questions to be treated are largely those of abnormal physiology, and while much can be done in these troubles in the laboratory and greenhouse, many of the problems to be solved can only be worked out under field conditions, using accurate quantitative methods.

The methods to be employed are essentially those of plant physiology, with the incorporation and addition of methods that more properly belonged to meteorology, agronomy, soil investigation, agricultural chemistry, horticulture, and possibly geology also. In short, the student who expects to investigate this class of diseases must use those methods which have been called "ecological methods."

If field work is important in the study of the so-called "inorganic diseases," it is equally important in the investigation of diseases due to parasites. Limiting the remarks to the diseases of fungus or bacterial origin, the following important lines of field work may be mentioned:

1. Observation of diseases, and collection of material.

2. Determination of the extent of injury.

3. Experimental and demonstration work in the prevention and treatment of diseases.

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*Written from the notes of an address given before the Botanical Seminar of the University of Nebraska.

4. Supplemental work on the etiology of diseases.

In the collection of material, essentially the same methods must be employed as the mycologist uses, but the pathologist must go even farther, and collect what the mycologist would pass as worthless. For example, while the sporophores alone of a wood-destroying fungus would suffice for the systematic mycologist, the pathologist must have in addition a sufficient amount of the host to enable him to study the pathological anatomy and to determine the extent of the injury. Or again, while the superficial bark containing the fruit of a "canker"-producing fungus might serve the purpose of the mycologist, the pathological collector must delve deeper and determine the extent to which the host is invaded by the disease-producing organism.

If the host is of importance in mycological collecting, it is doubly so in the collection of pathological material, for the pathologist is even more concerned with the host than he is with the fungus causing the disease. At this point I may take the opportunity to emphasize the importance of a wide knowledge of the species and varieties of cultivated plants, and of the wild forms also; not knowledge culled from books, but actual knowledge of plants in their field garments. While it would be of little value to the mycologist to know whether a given "cedar rust" specimen was from a Wealthy or Ben Davis tree, or some other apple, such facts as this and similar ones are of importance to the pathologist, as it is from the accumulation of such data that resistance and susceptibility of varieties become known.

In pathological collecting, specimens of the host plant should be taken to show as many stages in the progress of the disease as possible, as the pathologist must learn to recognize or diagnose diseases not alone from the fruiting stage of the causal organism, but from specimens taken at various times during the progress of the disease.

One part of pathology has been seriously neglected in much of our field work and in many of our text-books. I refer to accurate observations and statements in regard to the symptoms attending or accompanying a given disease. What a misnomer to characterize one of our well-known text-books as a "Text-book of Plant Diseases Induced by Cryptogamic Parasites," when it is little more than a catalogue of cryptogamic parasites which cause disease! Such important features as symptoms, pathological anatomy, prognosis and extent of injury, and treatment and prophylaxis, often receive only bare mention or are passed over completely. The importance of careful and accurate observation in the field in regard to the symptoms attending the progress of the various diseases cannot be overestimated. Many of the facts which must be incorporated in our future pathologies cannot be obtained from the dry herbarium specimens of the best pathological or mycological collectors, but must be recorded in the field while the patients are still alive, and not after they are dead and stored away in herbarium sepulchers.

In field work in plant pathology it is also highly desirable to make detailed and accurate observations and records in regard to the various factors which might favor or retard the development of the disease, such as amount of clear and cloudy weather, amount of rainfall, character of soil, soil treatment, amount of soil moisture, and other climatic or edaphic factors. Also the condition of the host plant itself should not be overlooked, attention being paid to evidences of deviation from the normal physiological tone due to other factors than the disease under consideration, as by this means much in regard to what may be termed predisposing causes may be learned.

By accurate and painstaking field work, the determination of the extent of injury from the various diseases must be removed from the realm of mere guesswork. Too often our estimates of the amount of damage from a given disease are based on superficial examination and are consequently far from accurate. The injury is generally overestimated, but occasionally the figures fall below the true amount. The camera is a necessary and useful article in field work, but while photographs often show graphically the extent of injury, quantitative methods must be adopted in this line of field work whenever possible.

The value of quantitative methods may be noted, for example, in the determination of the amount of injury from smut in barley. A correspondent, a trained scientific man, estimated the amount of injury in a given case at 15 per cent., but an actual count showed only 10 per cent injury. The methods used in cases of this sort will serve to illustrate the quantitative method and may be presented more in detail. The writer has used three different methods for making the count; the staked quadrat, the hoop method, and the quadrat frame. The observer with full freedom of choice as to location of quadrats is hardly likely to obtain accurate results. The hoop method in its ease of manipulation has some advantages, but my preference is given to the use of the quadrat frame. The quadrat frame is a light wooden frame enclosing a square yard and provided with cross wires which divide it into smaller squares. The observer advances into the smutted field, throws the frame out before him, and then counts the smutted and unsmutted heads in each square. The estimate is made from at least three such counts, with due allowance for the extent to which unsmutted heads of a smut-infected plant have been reduced in size.

In many other cases the extent of the injury cannot be made in this way, but can only be determined with the harvesting of the crop. Sorting and grading the yield give fairly quick and accurate returns for many of our annual crops. Rust injury of wheat or injury of potatoes from early blight may serve as illustrations in this class. Sorting and grading the yield is often the sole method employed in determining injury in the case of perennial plants. We have a good illustration of this in the case of estimates of apple scab injury, where the effect of the disease on the foliage, and consequently upon the general tone and future productiveness of the tree, is almost forgotten. In other cases the yield is not affected in a direct and striking way, and consequently an immediate determination of the extent of injury is impossible, thus making necessary a continued series of observations extending over years.

The next line of field work for the pathologist to which I would call your attention is experimental and demonstration work in the prevention and treatment of diseases. While some of this work can be begun in the laboratory and the greenhouse, it can only be carried to successful completion under field conditions, consequently the pathologist must either be given opportunity to grow plants under field conditions, or must be intimately associated with those who are engaged in that kind of work. As much of the scientific work in the prevention and treatment of diseases is done in connection with our Agricultural Experiment Stations, I must urge the importance of the closest co-operation with the departments of agronomy and horticulture. Due to the fact that in some of our stations the horticulturists have been obliged to serve the double role of horticulturist and botanist, we find some of our horticulturists claiming all spraying work or any treatment of horticultural crops for disease, almost as one of their sacred rights, while the pathologist if he pleased them would remain in his laboratory and diagnose the diseases that were called to his attention. Would it be any more absurd for the animal husbandman to insist that the treatment of blackleg, or mange, was a province of his department, and that the veterinarian should simply be his encyclopaedia of information? Experimental and demonstration work in the field in the treatment of diseases, either animal or plant, can not logically be divorced from the accurate laboratory study without causing the work to suffer, consequently it is to be hoped that the co-operation suggested can be fully realized.

Much has been accomplished in the work of prevention and treatment of diseases by co-operative work with progressive farmers, fruit-growers, truck-gardeners, etc., in different parts of the country, and this must continue to be a fruitful field for work. The co-operative work with farmers must be in many cases only in the nature of demonstrations of the effectiveness of well-known treatments, while frequently intelligent and progressive farmers will interest themselves in the experimental side of the treatment and prevention of plant diseases.

Much of the work on the etiology of diseases must be carried on in the field, and access to plants grown under natural conditions is just as necessary for this work as it is in the determination of the best methods of treatment. The plant pathologist should have at his disposal specimens of various kinds of cultivated plants, or should certainly have the opportunity to grow them as the needs present themselves, not alone in the greenhouse, but also in the field. While much can be done in the laboratory upon the etiology of diseases, the work must be carried further in our plant houses and finally taken to the field.

Inoculations with disease-producing organisms, either in pure cultures or as direct transfers from affected hosts, can in many cases be made equally well in field or greenhouse, but with many of the large perennial plants it is nearly always necessary to go to the field. For example, inoculations of wood-destroying fungi may be made into healthy trees and the trees marked, and visited at a later time to determine the result. It might be necessary to wait years for results in some cases, while others would give much quicker returns.

I have passed in brief review some of the features of field work in plant pathology, and now I wish to call your attention to the plan which has already been inaugurated in several states to have one or more field men spend their time during six months of the growing season investigating pathological problems in the field, or demonstrating the effectiveness of known preventive measures. The value of work of this sort has already been demonstrated in several states, and it only remains for the wisdom of our legislators to extend the work. In so doing they will foster the development of an interesting and important phase of botany, and will benefit the agricultural interests to such an extent that the expense of the work is a mere pittance in comparison.

Agricultural Experiment Station, Lincoln, Neb.

RELATIVE TRANSPIRATION IN CACTI.*

By Dr. Burton Edward Livingston.

It has been the method of physiologists to relate daily variations in the rate of water loss from plants to some physiological activity of the organism, without considering the seemingly obvious fact that the evaporating power of the air varies throughout the day, being relatively large for the hours of light and relatively small for those of darkness. Considering this last fact, it would be expected that, if transpiration were merely a physical process, unmodified by organic activity, the curve of this function would take a form very similar to the one which it is known to exhibit. If a dish of water be allowed to stand in the open and be weighed every two or three hours, the curve of its rate of water loss will be found to conform quite closely to the published curves of transpiration rate. In order to determine whether there is indeed any physiological regulation of the rate of transpiration it is necessary to refer each curve of this function to the corresponding curve of physical evaporation, and to determine how one changes its direction as related to the other. In Publication No. 50 of the Carnegie Institution, attention has been called to the fact that the ratio of the rate of transpiration to that of evaporation, for the same place and for the same short period of time, furnishes us with a true measure of these variations in the transpiration rate which are due to causes other than changes in the evaporating power of the air. This ratio has been termed the rate of relative transpiration, the term rate of absolute transpiration being used to denote rate of transpiration in the old sense, namely the observed rate of water loss from the plant.

Curves or polygons constructed from the rates of relative transpiration and of evaporation, for short periods throughout the day, bring out the fact that for most plants the former rate usually reaches its maximum somewhat earlier in the day than

*The essentials of the present paper were presented before the recent meeting of the Botanical Society of America, at New York.

does the latter. This must mean that while the evaporating power of the air is still increasing the plant in some way begins to exert a retarding influence upon its own rate of water loss. The curve of absolute transpiration may or may not follow that of relative transpiration. In a very general way, as has been pointed out, it is apt to follow the curve of evaporation. The relation of the physiological retardation just mentioned to the acceleration of the increasing evaporating power of the air will determine what form the curve of absolute transpiration will assume. The absolute magnitude of the retardation will, on the other hand, determine the form of the curve of relative transpiration. The latter curve is thus seen to be a curve of the retardation in question. The curve of absolute transpiration may be entirely misleading with regard to the retardation due to the plant as an organism, and this curve is therefore not available at all for a study of such retardation.

The author has studied the curves of relative transpiration for a number of leafy plants and for several forms of cacti, with the interesting result that, while the curves for leafy plants are in good agreement with one another and uniformly show a high period in the day and a low one in the night, the curves for the cacti exhibit the opposite condition of affairs, having a high period in the night and a low one in the day. Of twenty-six tests so far made at the Desert Laboratory, with eight species and three genera of cacti (growing in tin cylinders standing in the open), 84.6 per cent. were in agreement with the above statement, the others showing erratic variations probably due to pathological conditions. The forms studied comprise two flat-jointed and one cylindrical Opuntia, three Mammillarias and two Cereuses.

The method used in obtaining the curves, some samples of which are shown in Figure 1, was as follows: Potted plants, apparently in good growing condition, were sealed so as to prevent water loss excepting through transpiration, and then weighed at intervals of from one to four hours for at least one full day. The evaporation record for the same time periods was taken by

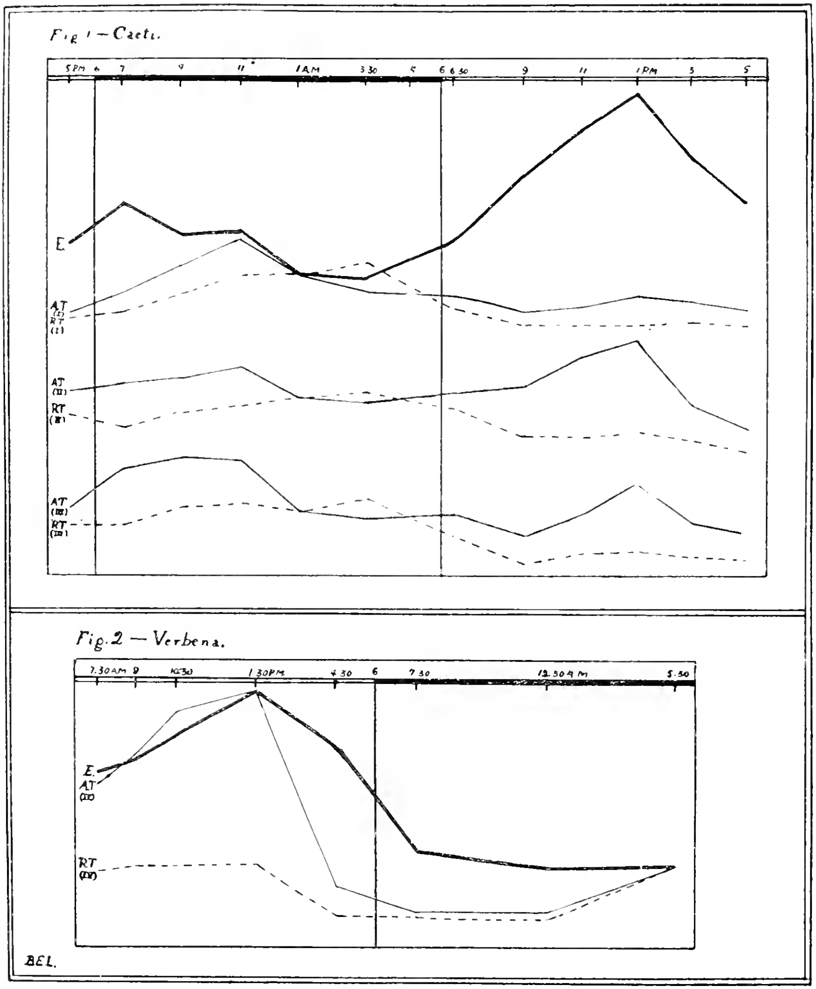
Fig. 1 — Cacti.
5 PM
6
7
9
11
1 AM
3 30
5
6
6 30
9
11
1 PM
3
5
E
AT (I)
RT (I)
AT (II)
RT (II)
AT (III)
RT (III)
Fig. 2 — Verbena.
7.30 AM
9
10.30
1.30 PM
4.30
6
7.30
12.30 AM
5.30
E.
AT (III)
RT (III)
BEL.

Figure 19.

means of the porous cup evaporimeter devised for this work and described in the publication referred to above. Each increment of water loss was divided by the number of hours in the time period, to obtain the hourly rates of evaporation and of absolute transpiration. The rates of relative transpiration were found by dividing the rates of absolute transpiration by the corresponding rates of evaporation. The rate of relative transpiration as thus derived may be simply defined as the quantity which expresses the number of evaporimeters of the form used, which would be required to evaporate as much water per hour during any time interval as is transpired by the plant during the same interval and in the same position. According to the size of the plant in question the average magnitude of this ratio may be less than, equal to, or greater than unity.

In plotting the three curves it is convenient to have them reduced to the same scale. This was accomplished by taking as unity the lowest evaporation rate and dividing each evaporation rate thereby, thus obtaining a new series of rates, one of which is unity and the others greater than unity; and by taking as unity the rates of absolute and of relative transpiration for the time period of least evaporation, and dividing each series by the appropriate unity rate, thus obtaining reduced curves for these two functions. When the three corrected curves are plotted on the same co-ordinates they will all intersect at the lowest point in the curve of evaporation, and can thus be readily compared.

In the figures, the time intervals are plotted as abscissas and the hourly rates as ordinates. The points are placed in the middle of the time periods which they represent. Heavy horizontal lines denote the extent of the night period, from 6 a. m. to 6 p. m. The curve marked E represents evaporation, that marked A. T. represents absolute transpiration, and that marked R. T. represents relative transpiration.

In Figure 1 are presented the curves for three cacti, all derived at the same time, beginning May 2, 1906. The first plant was a small specimen of *Opuntia Engelmannii*, the second one of *O. versicolor*, and the third was a small *Mammillaria*. The curves of relative transpiration are seen to be practically identical, all having a maximum in the night and a minimum in the day, and thus agreeing with the generalization for cacti stated above. The curves of absolute transpiration, on the other hand, do not show any uniformity, and bring out clearly how useless these curves are in a study of the physiological regulation of water loss.

In order to bring out the essential difference between the curves of cacti and those of ordinary leafy plants, the curves from a test of *Verbena ciliata* are presented in Figure 2. Here relative transpiration is seen to be high by day and low by night, the opposite condition from that prevailing in the cacti.

From the observed facts it seems perfectly clear that there exists in the cacti a mechanism for governing the rate of water loss, which is entirely different in its response to external conditions or in its daily periodicity from the corresponding mechanism in leafy plants. Just what the nature of either mechanism may be cannot even be surmised as yet.

Missouri Botanical Garden,
St. Louis, Mo., March 9, 1907.

COMPETITION BETWEEN TWO OAKS.

By Dr. Roland M. Harper.

The campus of the University of Alabama, near Tuscaloosa, is shaded by many fine oaks of a decidedly southern type, i. e., species with narrow entire glossy leaves, such as are never seen in the cooler regions where most of the inhabitants of the Eastern United States live. These oaks are of three species: *Quercus nigra* L., the "water oak," *Q. Phellos* L., the "willow oak," and *Q. laurifolia* Mx., which is variously known to the inhabitants as water oak, willow oak or live oak, though all three of these names belong more properly to other species. The persons who planted these oaks, about the middle of the nineteenth century or a little before, not only contributed to the comfort and enjoyment of future generations, but also laid the foundations for an ecological experiment which it would take many years to perform designedly, as will be explained below.

Quercus nigra is a species of very variable habitat and pretty wide distribution in the southeastern states, and may associate in nature with either of the other two species above mentioned. But *Q. Phellos* and *Q. laurifolia*, while their ranges

Figure 20, (left). *Quercus Phellos* (in center) and *Quercus laurifolia*, on University of Alabama campus, May 5, 1906.

Figure 21, (right). Same as Fig. 20, but taken March 10, 1906. (The negatives of both pictures are the property of the Geological Survey of Alabama.)

are in part co-extensive, have quite different habitats, and never associate with each other naturally. Both seem to thrive equally well in cultivation, however, and they are mixed indiscriminately on the campus, the persons who had the planting in charge perhaps not realizing that they were different species. They are indeed very similar (one was made a variety of the other by Dr. Chapman), their principal difference being that *Quercus laurifolia* is evergreen and *Q. Phellos* deciduous. (This fact, by the way, is not mentioned by Chapman or Small.) In summer, therefore, it is very difficult to distinguish the two species where they are removed from their natural habitats.

Figure 20 shows a group of these trees photographed in May, in which the one nearest the center, and the one next to it on the left, are *Quercus Phellos*, and the others of similar size *Q. laurifolia*. There is nothing remarkable about this picture, but in figure 21, which shows the same group of trees in winter condition, taken as nearly as possible from the same point, the results of the accidentally enforced competition between the two species are brought out in a striking manner. It will be noticed at once that the tree (*Q. laurifolia*) just to the right of the central one (*Q. Phellos*) seems to have lost or failed to develop about half its branches, and the impression is given that the willow oak is crowding the other tree aside. That this phenomenon is not a mere accident is shown by the fact that there are other cases of the same kind in the vicinity; though none of the others happened to be so well situated for photographing as this one. The two trees in question are presumably of the same age, for they are very nearly of the same size, the trunk of *Q. Phellos* being thirty-three inches in diameter breast-high, and that of *Q. laurifolia* thirty-one inches.

It is hardly possible as yet to explain the exact nature of the competition between these trees, but a few correlations can be pointed out. From the standpoint of succession of vegetation the two species are far apart, *Quercus laurifolia* being a sort of pioneer tree, almost confined to the sandy hammocks of the coastal plain, from Virginia to Louisiana,* while *Q. Phellos* is a tree of the climax forests, more common in the fertile valleys and alluvial bottoms of the Palaeozoic region.

In temperate Eastern North America practically all climax species are shade-loving, while the reverse is true of many if not

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*See Bull. Torrey Club 33:529; Ann. N. Y. Acad. Sci., 17:249, 1906.

most pioneer plants. So it seems likely that when the branches of the two trees tended to interlace those of *Q. laurifolia* failed to develop for lack of sufficient light. Other factors may enter into the competition to some extent, but it would take considerable more study to discover them all.

But even if we do not fully understand the ultimate causes of this phenomenon, we may regard it as a graphic illustration of the way in which climax vegetation is everywhere tending to encroach on the territory of pioneer plants, just as in human society the city continually encroaches on the country, and the hunter is succeeded in turn by the lumberman, farmer manufacturer, etc.

College Point, N. Y.

VISITS TO SOME BOTANIC GARDENS ABROAD.

By Dr. Pehr Olsson-Seffer.

(*Continuation.*)

V. Cultuurtuin Tjikeumeuh.

Only a few miles from Buitenzorg, at Tjikeumeuh, is an economic garden, where experiments on cultural plants are conducted. Here we find considerable areas under such plants as coffee, rubber, gutta percha, *Erythroxylon coca*, cassava (Manihot), numerous fiber plants, *Cinchona*, tea, and others.

New varieties of coffee have been developed and they are tried and experimented with in this economic garden. In a large field there were some six hundred and odd forms of rice under cultivation. Of rubber plants *Hevea braziliensis* is here as elsewhere in the Orient the most favored. The Central American rubber tree (*Castilloa elastica*) has been grown for many years, and I saw some very large specimens. *Ficus elastica*, the Rambong or Assam rubber, is largely grown and with its numerous aerial roots assumes very grotesque shapes. Figure 17 showing the related species *Ficus benjaminea* closely resembles the rambong.

The Mexican *Agaves*, *Fourcroya* and *Sanseviera zeylanica* among the fiber plants show a very luxuriant growth in Java, but as fiber producers I think they are inferior to the same plants grown in countries with a somewhat drier climate. Java now has practically the monopoly in cinchona cultivation, and we need therefore not be surprised that they have a number of species and forms of this plant under observation in the economic garden.

Tjikemmeuh, as well as everything else connected with agriculture in Java is under Dr. Treub's able supervision since he recently was appointed Director of Agriculture of Netherland's-India.

VI. BERGTUIN TJIBODAS.

On the slope of the volcano Gedeh, in Java, at an elevation of 4,335 feet, there is still another botanic garden, Tjibodas. Here is also a laboratory for the use of investigators, and with the surrounding virgin jungle on all sides a botanist is never without material for work.

The garden is well laid out on the mountain side. Among its treasures are two good-sized grass trees (*Xantorrhea*)* from Australia. I do not remember having seen larger specimens of this plant within the entire length and breadth of Australia. Different species of *Eucalyptus* grow very well here, and a young stand of *E. saligna* had reached a truly remarkable size in this moist climate, where it rains every day of the year.

Coniferous trees have succeeded well at Tjibodas, and among others I saw an old friend from Queensland, *Araucaria bidwellii*, and another, the Monterey cypress (*Cypressus macrocarpa*), of the middle California coast.

The only palms growing well at this elevation were a *Pritchardia* and a *Phoenix*. In the adjoining jungle I noticed a very large specimen of *Althinjia excelsa*, not less than 180 feet high. Numerous indigenous treeferns give the edges of the jungle an aspect that greatly reminded me of New Zealand.

(*To be continued.*)

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*See PLANT WORLD vol. 9, page 139, for illustrations of this and other plants in Java.

The courses in botany at Woods Holl during the coming summer will be given by Dr. George T. Moore and Professor George R. Lyman.

The fourth annual announcement of the Marine Station of the University of Washington has been received. The building to be used stands on the shores of Puget Sound, at Friday Harbor. Professor Henry C. Cowles, of the University of Chicago, is to give a series of lectures in Elementary Plant Ecology, and Professor T. C. Frye of the University of Washington will give a course on the Classification of Plants. The session extends from June 24 to August 2.

Professor Francis E. Lloyd has been appointed Special Investigator in the Arizona Agricultural Experiment Station, to study certain problems connected with the development of the date fruit.

The Nebraska Legislature has just passed a bill giving $7,500 for the biennium, for the work of investigation and control of fungus diseases and insect pests, the work to be in charge of State Botanist and State Entomologist.

Dr. C. J. Chamberlain and Dr. H. C. Cowles have recently been promoted to the rank of Assistant Professor in the University of Chicago.

The announcement has come to hand that an illustrated journal of scientific news, under the title of "Discovery," has been established, the first number of which will be issued by the Irving Press, 119 E. 31st street, of New York. The new journal will be edited by Mr. John W. Harding, who has resigned from the staff of the *New York Times* to take up his duties in connection with the new project. Mr. Harding is an experienced journalist and has displayed signal ability in the accurate presentation of scientific results in popular language, and the project has the endorsement of Dr. H. C. Bumpus, Director of the American Museum of Natural History, and Dr. R. S. Woodward, President of the Carnegie Institution of Washington, among others.

The recent Arizona Legislature appropriated $40,000 toward the construction of a science building at the University of Arizona at Tucson. This amount will be increased from other sources. The building will be occupied by the Departments of chemistry, physics and biology.

In a recent Arbor Day publication of the Arizona Experiment Station, the cedar of Lebanon, Indian cedar, Chinese arbor-vitae, Monterey and Arizona cypresses, and several species of resistant Eucalypts are among the species recommended for southwestern ornamental planting.

Dr. Tracy E. Hazen, of the Botanical Department of Barnard College, has been advanced to the grade of instructor. Miss Marion Latham, who has been lecturer in the department for two years, has been made tutor. Professor H. M. Richards, of the department, has been elected secretary of the division of Biology of Columbia University.

Dr. W. A. Cannon will carry on some experimental and cytological work at Monterey, California, during the summer, and will also join Dr. Shull in the observations upon Mr. Burbank's plantations at Santa Rosa, California, during the summer.

An international conference on Acclimatization and Hardiness of Plants will be held in New York September 30 to October 2, 1907, under the auspices of the Horticultural Society of New York.

The Seventh International Zoological Congress will be held in Boston, August 19 to 24, 1907. Papers on both plants and animals will be presented before the section on heredity.

News has been received from Dr. E. B. Copeland that after a very brief stay in Morgantown he has decided to leave the position in the University of West Virginia, to which he was recently appointed, and that he is now returning to Manila.

Dr. H. N. Whitford, of the Bureau of Forestry of the Philippine Islands, will spend the summer in America and return to Manila in the fall.

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A MUSHROOM PARASITIC ON ANOTHER MUSHROOM.*

By Professor Geo. F. Atkinson.

In 1902 I described a species of mushroom which was parasitic on another† and named it *Stropharia coprinophila*, since it was parasitic on a species of Coprinus (*C. atramentarius*). The plant was first found in the vicinity of Ithaca, in a piece of woods on the flats near the head of Cayuga lake, by C. O. Smith, then a graduate student in the University. This was on October 9, 1900. Other specimens were found by myself the following year, October 14, 1901, on the Campus of Cornell University, near the street railroad tracks, close to the Armory, and again later in the season on the flats. It has not been observed in the vicinity of Ithaca since that time.

The fungus is doubly interesting because it is parasitic on another member of the gill bearing Basidiomycetes, and is of considerable size, being quite equal to the size of its host. It also often grows in dense clusters, as does *Coprinus atramentarius*. The host is very much deformed and difficult to recognize, but in some of the large deformed specimens gills begin to form and the parts of the deformed pileus deliquesce into a blackish inky fluid. The color of the host is like that of *Coprinus atramentarius*, and it usually grows in dense clusters in localities frequented by this species. These facts point quite clearly then to *Coprinus atramentarius* as the host for the parasitic Stropharia, and were so published in 1902 at the time the parasitic species was described.‡ *Coprinus atramentarius* occurs singly, and also a

*Contribution from the Department of Botany, Cornell University, No. 119.

†Jour. Myc., 8: 118, 1902.

‡Jour. Myc., 8: 118, 1902.

few, two or three or more plants in a cluster, but sometimes a larger number are formed in a tuft. The stems arise quite closely together so that the extreme base in a dense cluster tapers to a rather slender point around which all the specimens of a cluster arise. Much the same relation of individuals in seen when the specimens are parasitized, the cluster of individuals flaring out above ground because of their size and number. But the form of the parasitized plants is quite different from that of the normal condition of the host, and it requires careful observation and comparisons to become assured that the two conditions are individuals of the same species. The deformed hosts are somewhat top-shaped in form, though the contour is often quite irregular. The center is depressed or deeply and broadly umblicate to nearly funnel-shaped. The irregularity may be shown simply by shallow furrows which radiate from the depression out over the broader portion, or in irregularities which resemble excrescences or rudimentary lobes. The context is much softer and more spongy than that of the normal condition of the host, which is quite firm before deliquescence begins.

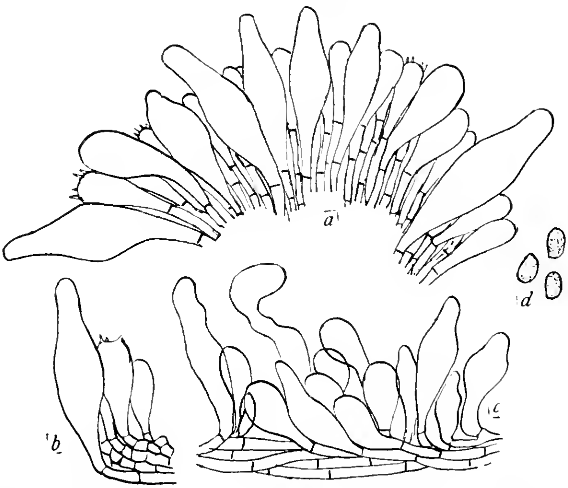

Figure 22. Stropharia epimyces. *a*. Cystidia on edge of gills. *b*. Cystidium on side of gill. *c*. Tuft of sterile cells near apex of stem. *d*. Spores. Camera lucida with Zeiss objective 3 mm. Compensation ocular 6, tube not drawn out. Figures then reduced to three-fourths.

The parasitic Stropharia occurs singly or in clusters of several individuals. The stem is attached at the center in the hollow of the depression of the host Coprinus, and the mycelium courses through the tissue of the host at this point and is interwoven with it. The stems are usually more or less tapering or pointed at the base, where they are crowded by adjacent ones or by the host walls of the depression. The plants are 6-7 cm high. The caps are 2-6 cm broad. The caps are at first rounded, then convex, then expanded and more or less wavy or repand. It is fleshy, quite thick at the center, and thin at the margin. The caps are covered with numerous appressed small scales formed by the tearing up of the surface layer during expansion, as the under layers continue to grow for a longer period than the upper. The edge of the pileus often bears minute portions of the veil as appendages, which only appear, however, during the young stage and they disappear soon after expansion of the pileus. The cap is white, or in age may be pale ochraceous over the center or when quite old, dark brown as the color from the fruiting surfaces probably diffuses through. The gills are plainly joined to the stem (adnate) and slightly notched (or sinuate) or rounded next the stem, as the pileus expands more appearing only to be adnexed. They are 4-6 mm broad. When young they are grayish and then become dark brown, though the edge remains whitish because fringed with numerous sterile cells similar to the cystidia, which are found on the sides of the gills, as shown in figure 22 *b*. These cystidia are subclavate to subventricose, and arise by a narrow stalk from the trama of the gills some distance deeper than the basidia. The basidia are clavate and four-spored. The spores in mass are blackish with a slight purplish tinge, but under the microscope they are of a brownish purple tinge, smooth, oval to short oblong or elliptical, and measure 7-8 x3.5-4.5 micra. The stem separates quite easily from the tissue of the pileus through the gills are attached to it. It is hollow, the flesh soft and fibrous, even or somewhat enlarged toward the base, but usually tapering at the extreme end. The surface is finely floccose and fibrous striate and with a delicate ring near the base

Figure 23. Stropharia epimyces (Peck) Atkinson, on Coprinus atramentarius, showing the top-shaped deformities of the host with the Stropharia parasite growing from the depression, veil on young plants, ring at base of stem and relation of gills.

where the veil was attached. This ring is often formed of coarse floccose tufts, the remnant of the veil. The veil is very evident in the young stage, as shown in the button mushrooms in figures 23 and 24. There is one curious thing in connection with the taste of this Stropharia parasite of the Coprinus. The taste is very similar to that of its host, the *Coprinus atramentarius*, a slight nutty taste as of fresh hickory nuts before they have dried or quite ripened. Mushrooms sometimes have a flavor or odor suggestive of their environment. Dr. Peck says that *Agaricus maritimus* has an odor suggestive of the sea. Several years ago I received specimens of *Volvaria speciosa* from Lansing, Michigan. They were found growing in a potato patch. On decaying the fungi had an odor of rotten potatoes.

While there are many microscopic fungi which are parasitic on mushrooms, comparatively few of the gill bearing fungi are parasitic on other members of their own family or other families of fungi. Two cases may be mentioned here. A species of Volvaria (*V. loveiana*, Berkeley*) is parasitic on *Clitocybe nebularis* in Europe. The host plant is here not so badly deformed, the pileus becoming well expanded and the gills normal. *Nyctalis parasitica* (Bull.) Fr., is a small plant on species of Russula in Europe. One species of Nyctalis is common in this country on dead or decaying specimens of Russula, Lactarius, or other agarics. It is *Nyctalis asterophora* Fr.

The Stropharia parasite of Coprinus has been known for a number of years. Dr. Peck first described it in 1884 as *Agaricus (Panaeolus) epimyces*†, parasitic on fungi, from North Greenbush, N. Y., and collected probably as early as November, 1881, since the report in which it is published was transmitted to the Legislature in January, 1882. Dr. Peck does not mention the name of the host, probably because of the difficulty of determining the abnormal specimens under most circumstances. The first publication of the identification of the host plant was by

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*Engl. Fl., 5, 104. Outlines British Fungology, pl. 7. Fig. 2, 1860. Cooke Illus., 295. Quelet. Champ. France, 2, 386.

†35th Rept. N. Y. State Mus. Nat. Hist., 133, 1884.

Figure 24. Stropharia epimyces (Peck) Atkinson. Sections of host (Coprinus atramentarius) showing point of attachment of Stropharia parasite, veil in young plants, ring near base of stem and relation of gills. Photomicrograph of spores, Zeiss microscope, objective 3 mm. Plate holder 370 mm. from object on slide. *a*, with compensation ocular 6; *b*, with compensation ocular 18.

myself in 1902.* A second publication of the host was in 1905 by Miss Sherman† being an account of studies of the host plants by Mr. McKenna and herself in the vicinity of Madison, Wisconsin. Mr. McKenna recognized *Coprinus atramentarius* as one of the hosts, and Miss Sherman had added from her own observations a second species of Coprinus (*C. comatus*) as host. The plant has also been collected by Mr. O. L. Taylor, of St. Paul, Minnesota, October, 1889, on Maniton Island, White Bear Lake, Minnesota. It is thus of quite wide distribution, though it does not seem to have been very often found. This seems a little singular since its hosts are very common and widely distributed. Its appearance in certain years is curious. It was found at Ithaca, N. Y., in the autumn of 1900 and 1901; the latter year it was rather abundant in two localities. In 1889 it was found by Mr. Taylor on Maniton Island, Minnesota, and in 1900 by McKenna at Madison, Wisconsin, and 1904 at the same place by Miss Sherman.

There seems to have been some difference of opinion as to the genus in which this mushroom parasite of Coprinus should be placed, since Dr. Peck placed it in Panaeolus, and the present writer placed it in Stropharia. The presence of a distinct veil in the young stages which leaves a ring on the base of the stem similar to that of *Coprinus atramentarius*, together with the purple brown color of the spores, led me to place it in Stropharia. This also accounts for the fact that I overlooked the earlier description of the species by Dr. Peck. There are a number of the purple brown spored agarics in which the gills look black, or the spores on paper may look black, but under the microscope they show the purple tinge rather than the black color. This is true of the common mushrooms (*Agaricus campestris*) and other species of the genus Agaricus. The plant generically shows some relationship to the genus Agaricus, but the attached gills would indicate the nearer relationship to other genera. The fact that the margin of the pileus is appendiculate with

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*Jour. Mycol., 8: 118, 1902.

†Host plants of Panaeolus epimyces Peck. Jour. Mycol., 11: 167-169. Pl. 80, 1905.

fragments of the veil suggests Hypholoma, but portions of the veil remain on the stem also which would indicate more clearly Stropharia, since several genera with annulate stems have a number of species in which portions of the veil cling to the margin of the pileus. It is also near the genus Psilocybe, especially to the section in which there is a rudimentary veil in the young plant. But taking all of these things into consideration I believe the species should be located in Stropharia, but with the species name given by Dr. Peck. In this connection a technical description of the species may be given.

Stropharia epimyces (Peck) Atkinson.

Plants clustered, often with the bases of several joined, 3-7 cm high, pileus 2-6 cm broad, stems 6-15 mm in thickness. Pileus convex to expanded and margin often elevated in age, fleshy, 2-3 mm thick, thin at the margin, dingy white and soft, with a finely floccose surface appearing something like a chamois skin and often with numerous appressed scales. Margin appendiculate with fragments of the veil. Gills adnate to adnexed, slightly sinuate or rounded, 4-6 mm broad, grayish then dark brown, edge white. Spores blackish with a slight purplish tinge, brown with purplish tinge under the miscroscope, oval to short oblong or elliptical, smooth, 7-8 x 3.5-4.5 μ. Basidia clavate, 30-35 x 6-8 μ, 4-spored. Cystidia clavate to subventricose, extending above the hymenium and arising from the lower part of the subhymenium, 60-65 x 10-12 μ. Stem fleshy, separating easily from the flesh of the pileus, soft, hollow, even or somewhat enlarged at the base, whitish, fibrous striate, floccose scaly with a delicate annulus near the base where the margin of the cap separates from the stem in young stage. Parasitic on clusters of Coprinus atramentarius, Ithaca Flats, N. Y., October 9, 1900, C. O. Smith, C. U. Herb., No. 5424; lawn near Armory, C. U. campus, October 14, 1901, G. F. A., C. U. Herb., No. 7852; Maniton Island, autumn, 1901, O. L. Taylor; Madison, Wisconsin, 1900, McKenna; North Greenbush, N. Y., 1881, Peck; on Coprinus comatus, Madison, Wisconsin, 1904, Miss Sherman. Edible. Taste when fresh exactly like that of *Coprinus atramentarius*. The host is deformed and prevented from opening fully, but in some specimens the gills and pileus were well enough developed to permit of identification.

There is another interesting feature in connection with this Stropharia parasite on Coprinus. This relates to the struggle for existence of Stropharia epimyces or its ancestors, which at one time undoubtedly grew on dead organic matter in the soil under conditions where it would come in competition with others of the same life habit, as *Coprinus atramentarius*. In the struggle between the two for food in the same substratum the Coprinus would seem to have had the advantage, while the Stropharia being driven from the dead organic substratum, the common possession of both, had adapted itself to grow as a parasite on its former competitor. In this closer and more intimate struggle the Stropharia has overcome the individuals of the Coprinus which it attacks, though its existence is rendered precarious because of its being entirely dependent on the Coprinus host.

This success of the Stropharia in this intimate competition with Coprinus is also interesting in view of the suggestion by Massee in his Monograph of Coprinus* that the genus Coprinus represents a very primitive group of the agarics from which the others have descended, the four groups in the following order: First, the black or purple brown spored agarics (Melanosporæ), second, the ochre or ochre brown spored (Ochrosporæ); third, the pink or salmon spored (Rhodosporæ), and fourth, the white spored agarics (Leucosporae). In the struggle for existence the later appearing groups have had the advantage over the earlier appearing ones because of a more specialized structure, better means for distribution of spores, greater number of species, etc., thus the Melanosporæ succeeded the Coprinæ, the Ochrosporæ, the Melanosporæ, the Rhodosporæ, the Ochrosporæ, and the Leucosporæ the Rhodosporæ. According to Massee wherever members of any two of these groups come into competition, it is the later one in time of evolution which succeeds. If this were so it would be expected then that wherever any member of the agarics other than the Coprinæ come in competition with a member of this group by reason of a similarity of life habit, the Co-

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*Massee, G., A Revision of the Genus Coprinus, Ann. Bot., 10: 123-184, pls. 10, 11, 1896.

prinus would be worsted. In the relation of the parasitic Stropharia and Coprinus, even if the Coprinus did primarily succeed when the competition was limited to a common substratum (though there may have been other reasons for inducing the Stropharia to desert its dead organic food substratum) the Stropharia has won in the finals. If this should appear to give some support to Massee's view, it is otherwise in the case of *Volvaria loveiana*, a pink spored agaric, which is parasitic on *Clitocybe nebularis* (l. c.), a white spored one, though it must be said that the white spored *Clitocybe nebularis* does not suffer the atrophy and destruction from its pink spored parasite, *Volvaria loveiana*, which the Coprinus suffers from the parasitic Stropharia.

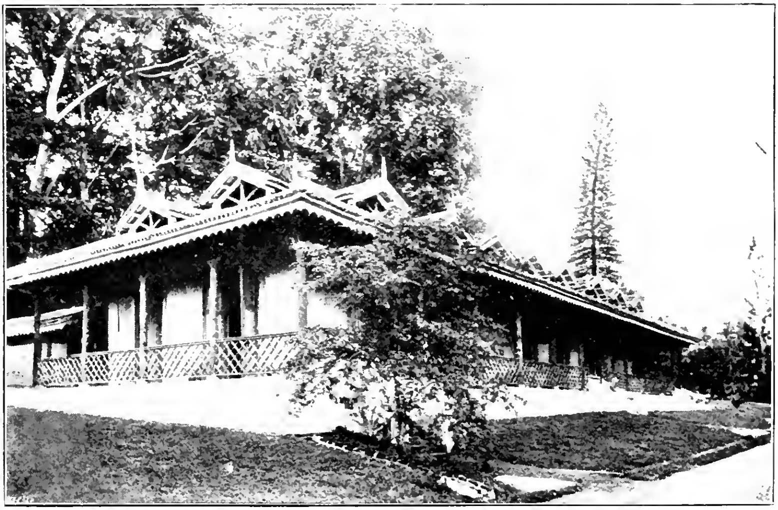

Figure 25. The herbarium of the Botanic Garden, Singapore.

VISITS TO SOME BOTANIC GARDENS ABROAD.

By Dr. Pehr Olsson-Seffer.

(Continuation.)

VII. Botanic Gardens, Singapore.

Jogging along in a gharry (as the local carriages are called) on Orchard Road in Singapore, I thought I would never reach the botanic garden, so long seemed the distance. I began to entertain serious doubts as to whether I had pronounced the Malay words Kabun bunga right in giving my directions to the driver, when he suddenly pulled up his ponies at the gate, and I stumbled out. The first plant I noticed was a large West Indian Raintree (*Inga Saman*), which I consider was very appropriately placed near the gate to remind one of the fact that rain is one of the main features of an existence in Singapore. At least I found it so during my six weeks sojourn in that place.

Like all other botanic gardens in the British colonies, the one in Singapore is a landscape garden, but Mr. H. N. Ridley, the director, has to some extent grouped the plants together according to their natural relationship, and thus succeeded in making a good scientifically arranged collection of plants.

Singapore garden is especially rich in palms, and in number of species of *Aroideae* it stands second to no other place. *Pinangas* from the Philippines, Borneo, Sumatra, Celebes, Java, and the Malay Peninsula, *Dictyospermas* from Mauritius, *Ptychococcus paradoxus* and *Coleospadix oninensis* from New Guinea, *Chrysalidocarpus lutescens* from Madagascar, the Mountain Cabbage Palm (*Euterpe oleracea*) from West Indies, *Ptychoraphis augusta* from the Nicobars, *Prestoea montana* from Grenada, *Malortiea fenestrata*, *Chamaedorea elegantissima*, *martiana* and *Sartorii*, and *Acanthorhiza aculeata* from Mexico, *Stevensonia* and *Verschaffeltia* from Seychelles Islands, *Excorrhiza Wendlandiana* from Fiji, *Geonoma baculifera* from Guiana, *Arenga Engleri* from Formosa, *Phoenix Hanceana*, from China, *P. Roebelini* from Siam, and *P. zeylanica* from Ceylon, show that palms have been collected from many different countries. The Cabbage Palmetto (*Sabal Palmetto*) of Southern United States, forms an avenue near the little lake in the garden, *Neowashingtonia filifera* from California, and *Chamaerops humilis*, the only palm indigenous to Europe, are represented. The Carnauba Palm (*Copernica cerifera*) of Brazil, numerous species of *Cocos*, *Bactris*, and *Raphia* have been included in this interesting collection. Rattans of the genera *Calamus*, *Daemonorops*, *Licula* and *Korthalsia* are making some parts of the original jungle in the garden almost impenetrable.

On the top of the hill above the herbarium building are many conifers, on the slope *Bignoniaceae* have been planted, and along one of the side roads Bromeliads are grouped together. Various succulents such as *Agaves*, *Cacti* and *Stapelias* form one division of the garden.

In the orchid house I noticed among others *Apostasia nuda*, *Calanthe rubens* and *C. Ceciliae*, *Cypripedium ciliolare*, *C. niveum*, *C. Hokerae*, *C. concolor* and *C. purpuratum*, *Cattleyas*, such as *C. Gaskelliana*, and *C. Trianae*, *Dendrobium floridulum*, *tuberiferum* and *Treacherianum*, as well as the *D. Dalhousieanum* from Singapore. *Phalaenopsis grandiflora* was there in quantities, *Eria* species, among them *E. acerrala*, *E. armeniaca*, *E. floribunda* and *E. hyacinthoides*, many *Goodyearas*, *Spathoglottis Wrayi*, and *Rhenanthera histrionica* are some of the other orchids in this house, admired by every tourist who passes through Singapore on his way east or west.

Figure 26. *Cyrtostachys lakka* Becc., in the Singapore Botanic Garden.

Out of doors orchids are growing in many parts of the garden, and among these I noticed various *Arundinas*, *Rhenantheras* and *Anaechlochili*, *Microstylis cuprea*, the Siamese *Hermenaria columbae*, and the new *Dendrobium Foxii* from the Malay Peninsula.

In the latticed plant houses a good show of *Gloxinias*, caladiums and ferns can be seen, and a very interesting rockery had been erected near the orchid house, shaded by *Baccaurea dulcis* and various jungle trees. Here we find *Begonias*, *Calatheas*, *Pellonias* and *Phryniums*.

In the lake splendid Nelumbiums are growing together with the Water Hyacinth, *Eichhornia crassipes*, and many other interesting aquatic plants. Bamboos and palms shade the edges of the pond.

One of the features of Singapore garden is the *Cyrtosachys lakka* or Sealing Wax Palm, as it is sometimes called on account of some imagined resemblance of its red stem to a bar of red sealing wax. This palm is very decorative and highly prized in all private gardens in the colony, where it is also indigenous.

Among the genera of Aroids best represented are *Alocasia* with some seventeen species, *Amorphophallus*, *Aglaonema*, *Dieffenbachia*, *Homalonema*, *Rhaphidophora*, *Philodendron*, *Crytocoryne*, *Schismatoglottis, and Scindapsus.*

A number of myrmecophilous plants such as *Clerodendron myrmecophila*, *Korthalsia* and *Myrmecodia* offer a very interesting study.

The herbarium of the gardens consists of collections from the Malay Peninsula and Archipelago, Assam, India, Australia, Christmas Island, and Polynesia. It is especially rich in Malayan plants, most of which have been collected by Mr. Ridley during his eighteen years of work on the flora of the Peninsula.

Besides the ninety acres comprising the main garden, there is an area of about seventy acres devoted to an economic garden. Here are cultivated most of the economic plants of the Tropics, some only represented by one or a few specimens; others which are or may prove suitable for the Straits settlements are grown in quantities for experimental purposes.

A stand of several hundred old Para rubber trees (*Hevea braziliensis*) are especially interesting. Experiments are periodically made in tapping these for rubber, and the published results have proved to be of the greatest value to the rubber planting industry of the Malay Peninsula.

Varieties of China grass (*Boehmeria*) are grown in a number of plats to ascertain the suitability of this fiber plant for local soil and climate.

Many gutta percha producing plants occur in Malaya, and most of the indigenous plants of this character are grown in the garden. The Getah Sundik (*Payena Leerii*), *Dichopsis* species, such as *D. Calophylla*, and *D. oblongifolia*, *Willoughbeia* and others are included in the garden collection. Quite a number of different bamboos are planted, and all tropical fruit trees occur.

A large arboretum, in which the plants are arranged systematically, has been established, and this is of great interest to the student of economic botany.

It is worth mentioning that the excellent condition of the Singapore Botanic Gardens is entirely due to the untiring efforts of Mr. Ridley, who took over the directorship of the gardens in 1884, only a short time after they had been laid out and begun by his predecessor, Mr. Cantley. With Mr. Ridley as guide I had many an interesting and instructive stroll through the garden, and after seventeen different visits I still felt that I could have spent with benefit considerably more time there.

VIII. Kuala Lumpur Botanic Garden.

It may be necessary to give some geographical details regarding this place, which probably is unknown to most readers. Kuala Lumpur is the capital of Selangor, one of the Federated Malay States. The little town is situated some thirty miles from the coast at the foot of the backbone range of the Peninsula.

The garden is most picturesque and laid out with good taste. Its total area exceeds 170 acres. A great number of native plants are to be seen here, as well as many common tropical and subtropical trees and cultivated plants. The garden is mainly a landscape garden and cannot so far claim much interest as a botanical establishment. The garden has for a number of years been in charge of the Federal Secretary, Mr. A. R. Venning, but it has recently been taken over by Mr. J. B. Carruthers, the Director of Agriculture and Government Botanist, and under his direction it promises to become a true and good botanical garden.

A laboratory building is now being erected, and opportunities will be given visiting botanists to work at this institution.

Figure 27. Botanic Gardens, Kuala Lumpur. The Travellers palm is to be seen on the left.

IX. Waterfall Gardens, Penang.

In a valley near Georgetown on the island of Penang there is a small botanic garden, which for a good many years was under the superintendence of Mr. C. Curtis, who succeeded in making it a very creditable institution. Mr. Ridley, of Singapore, as

Figure 28. Fernery of the Penang Botanic Garden.

the Director of Gardens in the Straits Settlements, is also the chief of the Penang Botanic Garden.

In scenic arrangement and effect the Waterfall Gardens take the lead in Malaya, and with some 3,000 species of local and tropical plants generally, it is very interesting botanically.

In the little orchid house I noticed the fine *Habenaria carnea*, many *Cattleyas* and *Cypripediums*, *Dendrobiums* from Borneo, Java, Philippines and Lower Burma. Many *Calanthe* species, among which *C. Rosea*, *C. veratrifolia*, *C. vestita*, *C. Regneriana*, *C. veitchii*, and the interesting *C. rubens*, were growing here.

A fernery with the usual tropical *Adiantums*, *Aspleniums*, and others, is of particular interest.

Many hybrids of *Canna indica* give color to the garden, and climbers such as the local *Congea tomentosa* cover trunks and buildings.

Of new trees I had never seen before *Crypteronia pubescens* drew my special attention. A large shrub with brown leaves, silver grey underneath, proved to be *Pterospermum Jackiana*, also from the Malay Peninsula.

The largest orchid existing, *Grammatophyllum speciosum*, was represented by good specimens, which, however, could not compare in size with those in the Singapore gardens. The flower spikes are some twelve feet long, covered with numerous flowers. Mr. Ridley told me he had counted 4,000 flowers on one specimen of this magnificent orchid.

While walking up to the waterfall as a series of small cascades are called, I saw a large flock of black monkeys in the jungle which fringes the garden. When I tried to focus my camera upon them they quickly retreated. The Malays claim that, ever and ever so long ago, when all the world was young, man was as the monkeys, only his pride made him talk. Then Fate made him work. Ever since then our simian relations, wiser than we, have maintained a discreet silence. The moral is obvious.

NATURAL HYBRIDS.

At the international conference on Genetics, held under the auspices of the Royal Horticultural Society of London, in August, 1906, Mr. E. G. Camus presented the results of a study of over thirty years upon the spontaneous hybrids of Europe. The complete paper contains the bibliography, synonyms, geographical distribution and herbarium notes, and was much too large to be published in full. In the brief abstract which was read before the Society, Mr. Camus finds only two classes of hybrids; those which are goneoclinic to the pistil parent and the other to the pollen parent, and since he has dealt chiefly with herbarium material, has not gone into the segregation of characters in the second generation. The whole paper is in fact a study of hybrids from the point of view of the systematist rather than of the experimentalist. Mr. Camus believes that hybridization is least common in species in which pollination occurs early in the development of the flower. Among other favorable circumstances, dioecism is one of the conditions which promote it. This paper of course, represents a detailed study of the flora and indicates that the hybrid constituents form a very large proportion of it. When a similarly minute examination is made of American plants, a corresponding accretion to the list of hybrids may be expected.

While this author does not present any analysis of successive generations of hybrids, yet he notices that several intermediate forms result when two willows are hybridized.

At the same conference, Professor MacFarlane of the University of Pennsylvania, presented a paper dealing with the natural hybrids of the sarracenias in which he demonstrates that *S. purpurea*, *S. flava*, *S. minor*, *S. psittacina* and *S. drummondii* hybridize in the wild state when growing in close proximity.

Mr. R. Irwin Lynch, Curator of the Botanic Garden at Cambridge, presented a discussion of certain British and Continental hybrids which goes far to sustain the contention of Kerner as to the importance of such forms in the wild flora.

Mr. E. Malinvaud has made a special study of the hybrid mints as found in France. He concludes that, while these plants hybridize constantly, crosses are found in great numbers, yet these crosses are not capable of perpetuating themselves as new races, and the results of any individual cross survive for only a few generations.

It is to be seen from the above that the time has arrived when the plant breeder may look to natural hybrids as one of the most profitable sources of material from which he may draw, and also it is clearly apparent that in the study of distribution and evolution of native forms, hybridization must be assigned a very important role. It is believed that no more valuable aid to research at the present time could be made than by a well considered digest and descriptive list of forms of natural hybrids.

D. T. MacDougal.

A RECENT WORK ON EVOLUTION.

William Lawrence Tower in his recently published investigation of evolution in Chrysomelid beetles of the genus *Leptinotarsa* (Carnegie Institution of Washington, Publication No. 48) presents much that botanists as well as zoologists will read with interest and profit.

It is shown that the main ecological factors which control the distribution of all the groups of the genus are, first, moisture; second, temperature; third, soil; and fourth, altitude; but in addition to these are considered effects of habits in dispersal, winds, and available food. Needless to say, the viewpoint of the writer is the dynamic. Of the static he says: "The study of animal distribution from this standpoint is a dead and profitless pursuit."

Accordingly the task of the present time is to explain the facts of distribution as we now find them in terms of the relation of organisms to each other and to their environmental complexes. It is found that the groups of species of this genus and the species themselves are confined to particular habitats, which habitats are natural topographic and climatic areas, and that the various groups and species are very closely correlated with the physical conditions of their habitat. This raises questions which, as stated by the author, strike at the very root of matters that are at present rather loosely discussed in current literature.

"Can we account for their present distribution on the hypothesis of direct modification in response to environmental stimuli accompanied by natural selection? Or must we invoke the aid of unknown factors which will operate to produce species * * * adapted to various remote environmental complexes, and then, by chance dissemination, have the newly modified organisms, and the appropriate habitats brought together, with the final result that the entire genus shall present a uniform and perfect correlation and adaptation to its environment? Are the phenomena of distribution to be explained on the basis of variation and natural selection, or on the basis of mutation and segregation in the fittest environment?" From an enormous mass of data, and especially from observed continuity of specific differentiation, the author strongly inclines to the former hypothesis, but frankly admits that it remains unproven, and after such an extended study of the relations of organism and habitat as we are not accustomed to meet in botanical literature, it is refreshing to read "from this we get a general view, a clue here and there," but "at no point are we able to put our finger upon any one fact and say with any certainty that this is the result of that factor in the environment or of any method of evolution." Yet it is safe to say that even the monumental work of De Vries leaves no clearer impression than does this of a definite advance toward a solution of the problem of evolution.

In the work just referred to, the ten criteria for the determination of the center of dispersal of the species of a genus, as given by Adams, are examined by Tower in their applicability to the genus *Leptinotarsa*, and, excluding those that are of doubtful value, he fastens upon four that he considers to cover fully all cases, viz.:

(1) Location of greatest differentiation of a type.

(2) Continuity and convergence of lines of dispersal.

(3) Location of synthetic or closely related forms.

(4) In some cases, location of dominance or great abundance of individuals.

If to these we add:

(5) Location of least dependence upon a restricted habitat, we shall have the criteria most generally useful in determining centers of dispersal of plants. VOLNEY M. SPALDING.

NOTES ON HELIOTROPISM OF SISYMBRIUM CANESCENS.

In the vicinity of Tucson, Ariz., a little cruciferous winter annual, *Sisymbrium canescens* Nutt., was observed blooming and fruiting in large numbers in the middle of February, 1907. It exhibited a marked case of heliotropism. In open places, the rather erect stems leaned uniformly to the south. In shaded places no leaning was noticeable. Where the plants grew on the west side of a shading object, they pointed some degrees west of south, where they grew on the east side of such an object, they indicated a direction a few degrees east of south. In other words, they pointed in the direction of what were probably the strongest rays of the sun that they received. But the stems were not as straight, nor the leaning as uniform, as in case of the plant growing in the open.

Later, large numbers of this species were seen fruiting on a fallow field in the Santa Cruz River bottom, where the same phenomenon occurred. It was noted here that the smaller plants leaned southward most uniformly, and at the greatest angle, while the largest plants showed only an indistinct or no tendency to lean.

On March 29, the plants being then mature, in a place where the leaning was most uniform and decided, the angle of deviation from the vertical was determined for 24 individuals. The average result was 29.4 degrees. The latitude of Tucson is 32° 13′. From the fact that the midday sun at the time of the vernal equinox in the Tropic of Cancer is 23½ degrees south of the zenith, we know that at the place and date first mentioned, it is 30.1 degrees below or south of this point. Thus, in places where this heliotropism appeared most strongly, the plants were pointing practically straight toward the noonday sun.

Of the many winter annuals blooming and fruiting at this place in February and March, a considerable number exhibit more or less heliotropism of this kind, i. e., the kind that produces leaning stems. But none are so strongly affected as *Sisymbrium canescens*. J. C. BLUMER.

Dr. Pehr Olsson-Seffer, who has been spending the past year in a journey around the world for the special study of certain botanical problems, has returned to this country on his way to his home in Mexico. The readers of THE PLANT WORLD have had the pleasure of following in his steps month by month by reading his interesting accounts of the various botanical gardens which he has visited.

Dr. R. H. Pond has been granted a research scholarship for a second term in the New York Botanical Garden, and will continue his work in that institution during the summer.

Dr. F. E. Clements, recently Professor of Plant Physiology in the University of Nebraska, has been elected to the chair of Botany in the University of Minnesota. The incumbent of this chair is also State Botanist and has charge of the botanical work of the Geographical and Natural History Survey of the region.

An International Conference on Plant Hardiness and Acclimatization will be held under the auspices of the Horticultural Society of New York on September 30th, and October 1st and 2d. Delegates from nearly all of the States, Canada, Europe, Africa and elsewhere have signified their intention of attending, and the meeting promises to furnish a fine array of papers and discussions. Twenty-four titles have already been furnished the Secretary. The proceedings will be published as Volume II of the memoirs of the society.

The sum of $1,200,000 has been given to Princeton University for the erection of two buildings, one for physical sciences, and one for biology and geology. The cost of each building is to be $400,000, while $200,000 for each is set aside as endowment. The names of the donors are at present withheld.

A publication entitled "The Physiology of Stomata," by Professor Francis E. Lloyd, has been approved by the Carnegie Institution of Washington, and is now in press.

Professor L. M. Underwood has an article in the Popular Science Monthly for June, 1907, on "The Progress of Our Knowledge of the Flora of North America," from which it is to be seen that nomenclatorial science suffers much from an indulgence in warping prejudices, pointed personalities foreign to the subject, and a general indulgence in more feeling than is consistent with a judicial consideration of the main facts.

A series of records of the evaporation rate at a number of stations, distributed from Maine to Oregon and from Florida to Southern California, is being carried out for the present growing season by the Desert Botanical Laboratory in co-operation with observers at the various stations. It is hoped that new information may be obtained concerning the relation of climatological evaporation to the growth and distribution of plants.

The members of the staff of the Museum of Natural History of Paris have opened an international subscription for the purpose of raising funds to defray the expenses of a statue of Lamarck, in the Jardin des Plantes. Participants who subscribe a sum of not less than twenty francs will receive a heliogravure of an unpublished portrait painted by Thevenin in 1801. Subscribers of two hundred francs will receive a plaster cast of a bust by Fagel.

The New York Botanical Garden has received an appropriation of $100,000 for the erection of additional glasshouses.

The Botanical Department of the University of Chicago is soon to have a new experimental glass house and plant garden, which are to be situated near the Hull Botanical Laboratory.

A bulletin on the relation of unproductive soils to plant growth, by Dr. Burton E. Livingston, is in the press of the U. S. Department of Agriculture.

Professor and Mrs. V. M. Spalding have gone to Witch Creek, California, to carry on some botanical work on distribution during the summer. A portion of the time will be devoted to the observations planned by the Desert Laboratory on the vegetation of the Salton Sea region.

Mr. C. E. Blumer has gone to the Chiricahua Mountains in Arizona to carry forward his work on the flora of that region, begun in 1906.

Bergen and Davis' Laboratory and Field Manual of Botany, just published by Ginn & Co., is destined to accompany the "Principles of Botany," by the same authors, or, for shorter and more elementary courses, Bergen's "Elements," or his "Foundations" of Botany. It is pleasing to come upon a thoroughly scientific manual which approaches botany, as does this one, through the old, but always practical and satisfactory, gate-way of familiar seed-plants, the germination of their seeds and the development of their seedlings. Following sixty-nine pages devoted to the structure and physiology of seed-plants, are eighty-four pages giving the usual morphological series of type studies, from the flagellates to the angiosperms. Then follow twelve pages on Ecology, giving an insight into this branch of the science. Chapters on Microtechnique, Culture Methods, Material, etc., together with a bibliography, a glossary, and a workable index, complete a volume which is by far the best of its kind yet produced in America. B. E. L.

To the Eclectic Series of readings for children, published by the American Book Co., are now added two books of nature study: The Trail to the Woods, by Clarence Hawkes, and Nature Studies on the Farm, by Charles A. Keffer. The former comprises a series of stories of wild animal life, and deals with a number of the beasts, fish and fowl most apt to be already more or less familiar to the average boy or girl. The latter is a treatment for children of some of the more salient facts and principles of agriculture and of the physiology of plants. Both volumes contain numerous illustrations.

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THE RELATION OF INJURY TO FASCIATION IN THE EVENING PRIMROSES.

By Alice Adelaide Knox.

The fact that fasciation can be produced artificially by means of injury has been known for many years, and has become especially familiar through Sachs' *experiments with *Phaseolus multiflorus* and with *Vicia faba*. The method has been summarized by Goebel in his Organography, and both authors devote some space to its discussion. The plants used are seedlings and the injury is made at as early a stage as possible after germination. The mutilation consists in cutting or pinching off the plumule so that the growth of the main axis is arrested. The branches which develop thereafter in the axils of the cotyledons are apt to be flattened, or banded. There may be one or more of these secondary axes, and several of them may have the abnormal cross section. They do not keep their form permanently, but revert to the normal as they grow. Their shape at first, however, the irregular arrangement of the leaves, and the forking, or bifurcation of the axis, mark them as true fasciated stems. Other species than *Vicia* and *Phaseolus* may be used, and among the best of them are *Agrostemma githago* and Nasturtiums.

The same phenomena may appear as the result of mutilation at more advanced stages. Lamarlière† by cutting back *Barkhausia taraxifolia* succeeded in producing fasciated flower heads, and Blaringham‡ produced fasciated panicles in Zea

*Sachs, J. Gesammelte Abhandelungen über Pflanzen-Physiologie, 1:597, 1892.

†Larmarlière, G. de. Sur la production experimentale des tiges et d'inflorescences fasciées. Comptes Rendus, Paris, 128:1601, 1899.

‡Blaringham, L. Anomalies hereditaires provoquées par des traumatismes. Comptes Rendus, Paris, 190:378, 1905.

mais. There are other forms which are "susceptible" and which respond to the traumatic stimulus, but these are the ones to which particular attention has been directed.

Over against these experiments emphasizing the results of mechanical interference lies the series carried on by deVries* on the influence of environment upon fasciation. Rich fertilization, plenty of light, space and air, the time of the year, and care in planting may all be utilized in producing increased numbers of fasciated stems. Hus† controlled the water supply and the nutrition in such a way as to regulate the appearance of fasciation in ten or more species, and numbers of interesting observations have been made as to the apparent effect of rainy seasons and other environmental factors on its prolific occurrence. In this connection, however, it must be remembered that the influence of many co-existent factors has not been eliminated, so that the actual causal relation between these phenomena is undemonstrated.

Aside from the artificial production of fasciation through injury its natural derivation from the same cause might be expected. A nasturtium seedling whose top dies back may fasciate just as if it had been rudely pinched or bruised. The various tearings and breakings to which plants are subject or the destruction of parts through the influence of fungi may also stimulate fasciated development of the latent growing regions. By far the most common source of disturbance, however, is to be found in the insects which are constantly visiting the plants, and which often live parasitically upon them for the greater portion of their existence. The creatures frequently pierce the young parts with their ovipositors, or in the larval stage with their mandibles, while feeding upon the tissues. Wounds of such a character are what produce fasciation in the evening primroses, and the various forms of fasciated stems owe their origin to this stimulus.

Examination of species of Œnothera by cutting or splitting the axes, reveals within many of them comparatively large num-

*deVries, H. Die Mutations-Theorie. Leipzig. 1901.

†Hus, H. Fasciation in *Oxalis crenata* and Experimental Production of Fasciation. Rept. Miss. Bot. Gard. 17:157,1906.

bers of the larvæ of a small moth named Mompha, which subsist on the pith toward the end of summer, and winter in the hollow stem. Some of the larvæ develop in the ovary and emerge in the winged state from the ripened capsule. Still others hatch in the leafy tip of the flowering stalk or in the rosette, and in the latter bind together the leaves to make a protective covering and feed in its heart during the cold months. In each case the eggs are laid in the growing region, so that the initial meristem is subject to injury from the ovipositor. In the last instance large mutilations may be caused by the devastations of the feeding, and such ravages account for the frequent abortion of the main axis among the fasciated plants. On the other hand many plants remain unaffected, for the new leaves furnish sufficient food, the larva does not penetrate the center of the axis, and never reaches the meristem. In still a third case the meristem may be barely touched or irritated, and the injury may be a small one in its effects similar to those caused by the ovipositor. Where the wound is inflicted by the mouth parts of the larva it is ordinarily more easily detected than when made by the ovipositor of the imago, for it frequently interferes with procambial development in such a way that the bundle ring is symmetrical, or there is conspicuous callus formation, or other signs are evident, by which its course may be traced and its origin ascertained. When the tissues are pierced by the ovipositor the injury is so small that it is impossible to find it after any considerable amount of growth has occurred. A comparatively deep incision measures 1.25mm in longitudinal section; it disappears almost immediately upon the consequent enlargement of the surrounding cells, and it is useless to look for traces of it at advanced stages of development. Fasciated tips so young that their flattened character can only be determined microscopically show wounds in the meristems at the apices, but as the banding of the stem becomes conspicuous, all traces of the disturbance are gradually lost.

The young fasciated tips can be recognized externally by their compact appearance due to the abnormal number of leaves; by signs of irregularity in the radial symmetry of the apex; or by apertures suggesting callus or a bifurcating meristem. Reddish color is indicative in some species, and large numbers of these "stung tips" when sectioned reveal fasciation phenomena.

The character of the fasciation induced varies widely, but the forms are found together on the same plant, and the cause is the same for all of them. In the adult plants it is common to find ring fasciations and bifurcations along with the simple flat bandings. (See figure 29.) There are also grooved stems which gradually flatten, and which in the development of the secondary meristems and the reinforcement of the primary bundle ring are to be classed as forms related to the ring fasciations. Certain stems begin to fasciate at a point where a cylindrical protuberance, looking like an aborted branch, projects from the axis. The protuberances are various in character, and may or may not be abortions of the axis. They are sometimes mere distorted projections of the surface, composed of bundle elements covered with callus. They are always associated with callus formation, and are due to the ravages of the insects. Their structure varies greatly, but in its more complicated form is similar to that of the ring type in the occurrence of the secondary meristems. Bifurcations ordinarily accompany them and all of the forkings are often fasciated. Sometimes in these bifurcated stems the forks are not flat, but the stem is then banded below the point of division. The histological condition of the various types cannot be dwelt upon at length here, nor the structural phenomena attendant upon the injuries.

It seems not improbable that the form of the fasciation is dependent upon the localization of the injury. Stems injured in the centre of the apex or irritated there may produce ring fasciations by a spreading of the apical meristem in radial distribution. Those injured on the side may become linear fasciations, and a larger, wider attack of irregular kind produce the protuberances. The time of the attack makes a great difference in the development. If the injury is to the growing region of a biennial plant still in the rosette stage, the plant fasciates during

Figure 29. Œnothera parviflora, fasciated stem.

the rosette period, and the growing region becomes linear before the time of the elongation. The stems are then flat from the base. If the plant is adult at the time of the invasion the injuries are in the upper part of stems which have already completed their first growth. These fasciated stems are round below and flat above. In a given field of plants it will also be noticed that most of the fasciated individuals begin to flatten from the same relative point on the axis. This seems to indicate that the banding is stimulated in all of them at the time of the advent of the new swarm. In an adjoining field, apparently of similar character, the failure of a swarm, or its less penetrating mode of attack, may account for the absence of any degree of fasciation whatever.

The importance of conditions of culture correlates well with the above observations and the character of the environment is significant in the production of the fasciations in two ways: namely, in providing a favorable habitat for the insect, and in promoting vigor in the individual plant, such that it will recover from, and not succumb to, the mutilations. Degrees of moisture, isolation, and light all influence the activities of the insect as well as the development of the plant itself. Healthy plants may be more attractive to the insects; damp, or rainy weather may drive the insects into the flowering heads, or under the young leaves; isolated plants in full sunlight may be better exposed for the hatching of the eggs. An entomological study of the habits of these animals would be of interest in this connection, and would throw light on the exact relation of the insects's life-history to the life-history of the plant. There always remains the further necessity that the plant shall be "susceptible," but we are assured by deVries that the degree of susceptibility of the normal, and flourishing primrose is superior to that of the ailing plant, and that the physiological responses of the two are not alike.

The question of heredity in the Œnotheras is of interest because of deVries' long-continued experiments. He found fasciation to be partially hereditary in several other species, and made some observations on Œnothera. He did not, however, carry special cultures for the purpose of testing this form, but made notes upon it in its wild state near Hilversum, and in the cultures of his collection. At the New York Botanical Garden, the pure seed of unfasciated *Oenotheras* was as prolific in fasciation as the seed of fasciated individuals. Many of the groups of plants also in the large general collection showed it, and it was found in the purest strains of normal heritage. In all these cases its appearance was due to the insects, and the malformation was stimulated through their agency.

The insect is but indirectly the cause of such curious anomalies and their physiology belongs to the category of striking and interesting traumatic phenomena. Malformations involving change of leaf arrangement, increase in the number of parts, and secondary histological differentiation are numerous in the annals of teratology, and the study of the relation of insects to abnormal growths of all kinds may be said as yet to be scarcely begun.

THE COMPOSITÆ OF PERAUSTRAL AMERICA.

BY PROFESSOR GEORGE MACLOSKIE.

George Bentham's Survey of the Compositae (in the *Journal of the Linnaean Society*, 1873) has been our chief help on this subject. He gives his idea of what the Compositae are, having superior, sympetalous flowers, 5-merous, save that the gynecium is primitively 2-merous, and is subsequently reduced to an achene with a single erect seed, devoid of endosperm. A crowd of such flowers are combined into a larger unity, or compound flower head, having a common receptacle, and a common involucre; so that the head of flowers has the appearance of a single more complex flower. This "compounding" has resulted in the reduction of particular parts of the flowers thus aggregated, the anthers coalescing, and the corollas diminished in size, the calyx very much diminished and altered into a pappus, or completely suppressed; the bracts altered into the chaff of the receptacle, or the scales of the involucre. And sometimes there is a sexual dimorphism by the abortion of the ovules or of the anthers in different parts of a flower head, or in different heads of the same plant; and in rare cases this results in dioecism. Somehow or other this compounding must be advantageous in the struggle for existence; else the Compositæ should not be the most abundant family of the flowering plants. Their only competitors for primacy are the Gramineæ and the Cyperaceæ, which possess an analogous system of reducing and crowding their flowers.

Bentham's idea was that in the diversity of the involucre and other parts we may have some key to the comparative antiquity of the different orders of Compositæ. Assuming as probable that the decaying groups are older than the progressing groups of the family; also assuming that decaying groups are recognized by having the subordinate races very distinct in their structure, by their restricted areas, and fewness of numbers, he would place the sunflowers or Helianthoideæ (at least some subtribes of them) in the decaying stage, and probably the most antique. Correlated with this he cites the fact that the great consolidation and uniform structure of the floral organs of Compositæ are least seen in that group; and conversely are most pronounced in the Cichorieæ, which are the most modern, according to his view. The outer bracts of the involucre are leaflike in Helianthoideæ, the receptacular pales more like bracts, and the pappus more calyx-like, than in other tribes; all indicating that they are old-fashioned and less specialized than Asters or Senecios; and perhaps suggesting why they are now retrograding. The Cichorieæ, on the other hand, are most specialized, and for this reason, most puzzling. The uniformity of their organs of reproduction is such that neither pistil nor andrecium, nor corolla affords the slightest structural or sexual character among the numerous species; the pappus is not at all like a calyx-limb; and the pales of the receptacle are not like bracts, and are very frequently mere rudiments or entirely suppressed.

Some groups of Compositæ take a higher order of specialization, having glomerules or heads of which the components are not flowers, but are themselves flower-heads, further reduced in size and provided with an outer wrapper, like an involucre of higher order; they are Composites in duplicate ratio. Such occur among the Mutisieæ.

The outcome of this condition of matters as to the task of classification is embarrassing; somewhat like what a zoologist encounters in classifying the birds. It is very difficult to find distinctive characters; and even when found they are subject to variations of degree, and to numerous exceptions. Shutting off the Cichorieæ, as a separate tribe, or as even a family, limited by their ligulate flowers and milky sap; a dozen tribes remain, two of which (Vernonieæ and Eupatorieæ) have uniformly hermaphrodite, tubular flowers; and the remaining ten have one or more rows of female flowers in the periphery, with exceptions. The styles of the female flowers are very uniform, 2-branched (save in sterile flowers, which have undivided styles); yet the tribes are limited chiefly by differences of the styles, also by differences of the bases and tips of the anthers, and by the differences of the pappus, and the form of the involucre.

Thus we obtain a trial-analysis of the tribes (subject, however, to many exceptions), viz.:

A. *Tubifloral,* and homogamous. All the flowers tubular.
- (1) *Vernonieae.* Anthers basi-sagittate, styles slender.
- (2) *Eupatorieae.* Anthers basi-entire. Styles long, obtuse.
- (3) *Cynaroideae.* Thistles. Anthers tailed. Styles short, obtuse.

B. Heads heterogamous, radiate, or abortively discoid.
- a. Anthers basi-obtuse, apically appendaged.
- b. Receptacle mostly naked.
- c. Involucres imbricated.
- (4) *Astereae.* Style branch flat. Pappus setaceous.
- (5) *Helenioideae.* Style branches truncate or hair-tipped. Pappus palaeceous.
- c2. Involucre scales 1-2-seriate, subequal, scarcely imbricate.
- (6) *Senecioneae.* Pappus setose.
- b2. Receptacle with chaff about the achenes.

(7) *Helianthoideae.* Involucre scales imbricated, leafy.

b3. Receptacle chaffy or naked. Involucral scales dry.

(8) *Anthemideae.* Pappus none, or reduced.

a2. Anthers basi-obtuse entire or sagitate. S. Africa and Australia.

(9) *Arctotideae.*

a3. Anthers basally mucronate. Styles flat-truncate.

(10) *Calenduleae.* Pappus none or woolly.

a4. Anthers tailed. Style branches rounded apically. Pappus often setose.

(11) *Inuleae.* Rayflowers ligulate; often no ray.

(12) *Mutisieae.* Flowers bilabiate, or ligulate in ray, bilabiate inwards at least the inner flowers.

C. Liguliforal, all the flowers ligulate. Plants with milky juice.

(13) *Cichorieae.* Pappus setose. Leaves never opposite.

Of these tribes one is confined to South Africa, with a single species in Australia. Two others are represented in Patagonia, each by a single species, *Vernonia nitidula* Less, in North Patagonia, straggling from Brazil; and *Eriachaenium magellanicum* Sch. Bip., of *Calenduleae*, an extraordinary little denizen of Fuegian shores, having its corollas 4-merous and connate with the achenes, the only species of its genus.

The *Eupatorieae* are represented by nine species of the genus *Eupatorium*, which extend from North America; by a few species of the Brazilian genus *Steria*, and by *Willughbaea* (Mikania) the common climbing hemp of the United States. About half of these plants are shrubby, a character which very frequently meets us in this region; which is correlated with the xerophilous character of the country, rendering it the home of the frutescent Compositæ, as South Africa is of the Arborescent Compositæ. The climbing form, *Willughbaea scandens*, represents a genus of 125 to 150 species, nearly all confined to Brazil, except this one.

The *Astereae* are represented by seventeen genera in Patagonia, some of which are nearly confined to Peraustral America, and most of the species are more or less frutescent. *Grindelia* and *Gutierrezia* resemble the North American Gumplants and Goldenrods. *Gutierrezia cupressiformis* by its leaves resembles a cypress, and such resemblance is still greater with *Lepidophyllum cupressiforme* (Pers.) "Mate-verde" (plate xxvii, A), and *Nardophyllum humile*, A. Gray; extraordinary instances of resemblance, which can scarcely be mimicry. *Chiliophyllum fuegianum O. Hoffm.* resembles a Solidago, save that it is shrubby, and has a chaffy receptacle. *Lagenophora commersonii* Cass., "Tiny", is a gem, like a variation of the British daisy, and the genus extends to Australia and New Zealand. *Aster* itself is represented by about half a dozen species, most of them in North Patagonia, and most of them frutescent. A. *vahlii* H. & A. is common in Fuegia, reaching to Cape Horn. *Erigeron* has 22 species in the region, nearly all herbaceons, and one, *E. alpinus* L. common to Eurasia and North America, and extending to South Patagonia. I saw a specmen of it in the Gray Herbarium, with the label that it was collected in 1767 by Commerson, in the "Bay Boucent.," Patagonia; it was erroneously named *E. myosotis*. (J. D. Hooker unites *E. alpinus* and *E. myosotis*, but Franchet rebels against that). *E. sullivani* Hook, f. is found in the Falklands and South Patagonia. Erigeron has a great many species in the American Cordilleras, where are its headquarters and possibly its birthplace.

Chiliotrichium diffusum (Forst.) is a common bush in the steppes, and the nearest thing to a tree in the Falkland Islands. This is closely allied to the Australian shrubs *Olearia* (85 species) and thus links together two continents.

Chrysicoma is another linking genus, having several species in Africa, and a single species, *C. cuneifolia* Jacq., in Magellan; a shrub with discoid golden heads. *Histerionica jasionoides* W., which is common near Rio Negro, is remarkable for its large sloitary golden head, and its narrow, veinless leaves. *Heterothalmus*, Less, has several species of shrubs with polygamo-dioecious heads; the male and the female heads being alike discoid, save that the male heads have sometimes a ray of fertile flowers.

Sir J. D. Hooker remarked anent such forms as *Chiliotrichium* and *Senecio*, that radiate flower heads often affect a moist climate, whilst dry climates are apt to produce discoid heads.

The Aster tribe ends with the great genus *Baccharis*, whose species are normally dioecious, most frequently frutescent, and often with winged stems. In South America occur 300 species of them, of which 31 are in Patagonia. They are troublesome to botanists from the circumstance that many species are known only from one sex, and usually the specific characters must be fixed chiefly from the leaves alone. *Baccharis juncea* Desf. has a tall, rushlike stem, and few very strict linear leaves, and *B. urvilleana Brongn.* with opposite leaves, was figured, but never described; the figure has been obtained for our *Flora* (plate xxxi) through the courtesy of Professor F. E. Lloyd.

It is strange that dioecious plants should be so flourishing, as if the separation of sexes rendered them more prolific.

The Inuloideæ, or Everlastings, are remarkable for having their anthers both tailed and appendaged, and their styles not appendaged; and for their small heads, often without rays. They are mainly an old world group, and some are interesting for giving evidence in favor of a former land-connection between Australia and Africa. Some sub-tribes or genera are confined to America; thus *Tessaria* is in California and North Patagonia, extending along the Andes. *Cherreulia* (with long achenial beak), is confined to South America (with a species in Falkland Islands, and one in Tristan); and *Facelis*, achenes beakless, is confined to the Andes, and North Patagonia. *Psilocarphus* reaches from California to Patagonia; and *Micropsis*, an Old World genus, has a species *M. nana* DC. in Chili and North Patagonia. *Adenocaulon* is another case of generic discontinuity; one species being in Asia and North America, and *A. chilense* Less. being in Chile-Patagonia.

(*To be continued.*)

SOME ECOLOGICAL OBSERVATIONS ON THE NAPLES FLORA.

By Joseph Y. Bergen.

Author of *Principles of Botany*, etc.

The writer was for about four years resident on the south Italian coast in and near Naples. During this time he was able to make studies of the vegetation of the region from several points of view and wrote some brief papers based on these studies.* The following notes are in part abridged from those papers and in part consist of new matter.

As the winter of the coastwise part of the Province of Naples is a very mild one, with only a few freezing nights, vegetation of some sort flourishes during every month of the year. Indeed, the hillsides, where they are not wooded, are greener in January than during the droughts of July and August. There are two principal seasons for the flowering of seed plants. The greater one is April and early May, the lesser, October and November.

The curious fact was noted that some annuals which produce a summer-flowering and a winter-flowering crop are dwarfed in winter by the comparatively low temperature. Thus on January 11, specimens of *Erigeron canadense* were found flowering at a height of 15-40 cm. and apparently with their growth completed. Other specimens which had developed between October and December had reached a height of 70-100 cm.

January 11th full grown plants of *Datura Stramonium* were found to measure only 15-20 cm., while those in bloom August 1st reached a maximum height of 70 cm., and were much stouter than the specimens which matured in January.

To one acquainted only with the flora of the Middle or Eastern United States, the plants of the Neapolitan region offer much that is novel. Of course new genera abound and the familiar genera are represented by more or fewer species. The lily family is much in evidence, especially in the genus *Allium*, of which

*Botanical Gazette, 1903-1905.

there are about a dozen species. Two species of *Narcissus* are rather common in open woods, one of them also on beach sands. Orchids so abound as to form the principal floral attraction of many grassy hillsides from March until May. The most wonderful color displays, however, are due to various yellow-flowered leguminous shrubs, especially various species of broom (*Spartium*, *Genista*, and *Calycotome*) which gild many square miles of mountain side during the spring months. Leguminous plants abound everywhere and it is easy to imagine the difficulties of a botanist little versed in the systematic part of the subject, confronted with some thirteen *Medicagos*, twenty-two clovers and as many vetches. Of the *Compositae* nearly a third of the genera belong to the chicory sub-family, and there is only one aster and one golden rod. It is a noteworthy fact that none of the troublesome weeds in fields and vineyards are familiar to us as important weeds. A few species, such as *Erigeron canadense*, the dandelion, the jimson weed, *Solanum nigrum* and some nettles and pigweeds, which are pests of our farms and gardens, occur to a limited extent in cultivated ground throughout the Neapolitan region. But their most formidable weeds are two species of *Euphorbia*, *Mercurialis*, *Fumaria*, *Convolvulus*, a small heliotrope and several *Compositae* mostly of the chicory sub-family. Two succulent American plants which are often cultivated, also frequently occur spontaneously, namely, *Agave americana* and *Opuntia Ficus-indica*.

The woody plants of the Neapolitan flora are moderately xerophytic, as would be expected from the facts that the soil is much of it volcanic, parting readily with its moisture, and that there is a long and nearly rainless summer. On the island of Capri, during the exceptionally dry summer of the writer's residence there, the total rainfall for four months was only six millimeters, with an average maximum daily temperature of about 26° C., and an average relative humidity at 3 p. m. of 55%. Broad-leaved evergreen trees and shrubs, such as the ilex, the carob tree, the olive, the arbutus, the lentisk, the myrtle, the rosemary, the ivy (*Hedera Helix*), *Rhamnus Alaternus* and

Smilax aspera, are highly characteristic of the woodlands and thickets. Along the cliffsides occur many plants with woolly or silky pubescence, such as *Artemisia, Matthiola and Helichrysum.*

Some of the problems which suggested themselves in connection with the vegetation forms of the Naples region were:

I. The summer rate of transpiration of such sclerophyll species as ilex, olive, lentisk and others.

II. The functional importance of the summer deciduous leaves of switch plants, *Spartium junceum* and other leguminous species.

III. The manner in which the plants inhabiting cliffsides almost waterless in summer support life through the dry months.

IV. The longevity and relative activity at different ages of some coriaceous evergreen leaves.

V. The relative activity of the sun leaves and shade leaves of the same individual.

The rate of transpiration of such highly coriaceous leaves as those of the olive, the lentisk, and the ilex proved to be very considerable.* At 21° C. and a relative humidity of 67 per cent. when supplied with plenty of water they transpired from two-thirds to six-sevenths as much as ordinary mesophytes like the common pea and the European elm. The evergreen buckthorn, *Rhamnus Alaternus*, transpired nearly twice as fast as the elm. These facts indicate that the coriaceous character of the evergreen leaves studied is partly to protect them from injury during such emergencies as periods of excessive drought and partly to withstand the severe whipping of violent winter storms.

The summer deciduous leaves of such switch plants as *Spartium* are said, even by authors of the standing of Grisebach and Kerner, to be unimportant, having little to do with the gaseous exchanges of the plant. No attempt was made to investigate their photosynthetic work; but it was found that on comparing

*Herman Ritter von Guttenberg obtained very high values in similar cases. See his Immergrüne Laubblatt der Mediterranflora, Engler's Bot. Jahrb., **38**, 4 and 5 Heft.

the transpiration of equal areas of leaf surface and cortical surface the former was from 2½ to 3 times as great. In such forms as the Scotch broom, *Cytisus scoparius*, the total transpiration per hour of the leaves during the leafy season is more than three times as great as the total cortical transpiration. It is a significant fact that thrifty plants of *Spartium junceum* which in any given season do not produce leaves, grow hardly at all, though they usually blossom and fruit.

Cliffside plants were found to be in many cases ill provided with means of resisting the extreme conditions to which they are exposed during the summer drought when the total soil moisture may fall as low as 2 per cent. Some of these plants seemed to be occupying almost bare rock surfaces, simply because the competition there was less severe. When found growing in ordinary soil these species were much larger and more vigorous. Important means of protection from dessication are shedding the leaves or even sacrificing a large portion of the younger shoots toward the end of the summer. The value of parting with the leaves as a means of reducing transpiration is well shown by the fact that a very characteristic cliff-side shrub, *Medicago arborescens*, in its leafless and nearly dried condition loses less than 3 per cent. of the water per hour that it lost when fully leaf clad in early spring.

The leaves of evergreen trees and shrubs were found to differ greatly in longevity, their duration ranging from about 15 months in some species to more than 30 months in others. The extreme age limit for those which last more than two years was not ascertained. Those leaves which last more than 15 months were found to transpire much faster when 15 to 18 months old than at 3 or 4 months, when they have just reached their maximum area. The average for six species gave a transpiration twice as rapid for the older leaves.

Sun leaves and shade leaves on the same individual were found to differ much in shape, thickness and area. Sun leaves are narrower in proportion to their length, thicker and smaller than shade leaves. When the transpiration of sun leaves placed in sunshine is compared with that of shade leaves in the shade, the former are found to lose water from three to ten times as fast as the latter. Even with both kinds of leaves placed in the sun or shade the sun leaves lose more water than the shade leaves. Some reasons for the greater vaporizing power of leaves grown in the sun seem to be that they spring from stouter twigs, are fed by stouter petioles, have a more fully developed set of veins and contain more inferior evaporating surface per unit of leaf surfaces.

The extremely incomplete studies which the writer has been able to make of some of the physiologico-ecological relations of this interesting flora lead him to conclude that it would amply repay further investigation.

Cambridge, Mass.

VISITS TO SOME BOTANIC GARDENS ABROAD.

By Dr. Pehr Olsson-Seffer.

(Continuation.)

X. Royal Botanic Gardens, Peradeniya, Ceylon.

While every botanist readily acknowledges the superiority of the Buitenzorg Gardens above any other as a botanical institution, the general tourist of the globe trotter kind is loud in praising the Peradeniya Gardens as "the most beautiful gardens in the world." Even from a purely landscape point of view it is doubtful whether the palm for beauty should be given to Peradeniya. Among the eighty and odd botanical gardens I have visited in various parts of the world I consider several as fully equalling the Peradeniya Gardens. But it cannot be denied that the natural advantages of this place are unusual, and that the gardens have been laid out with much taste and care.

The site of the garden is on the bank of the Mahaweli Ganga, the largest river of Ceylon, on a peninsula formed by the winding river, and sheltered by high mountain ranges. The elevation above sea level is nearly 1,600 feet, and in this mountain valley we have an ideal tropical climate with a mean temperature of about 76° F. To this place the Royal Gardens were transferred in the year 1821 from Kalutara, in the southern part of the island, where they had been for a number of years. The

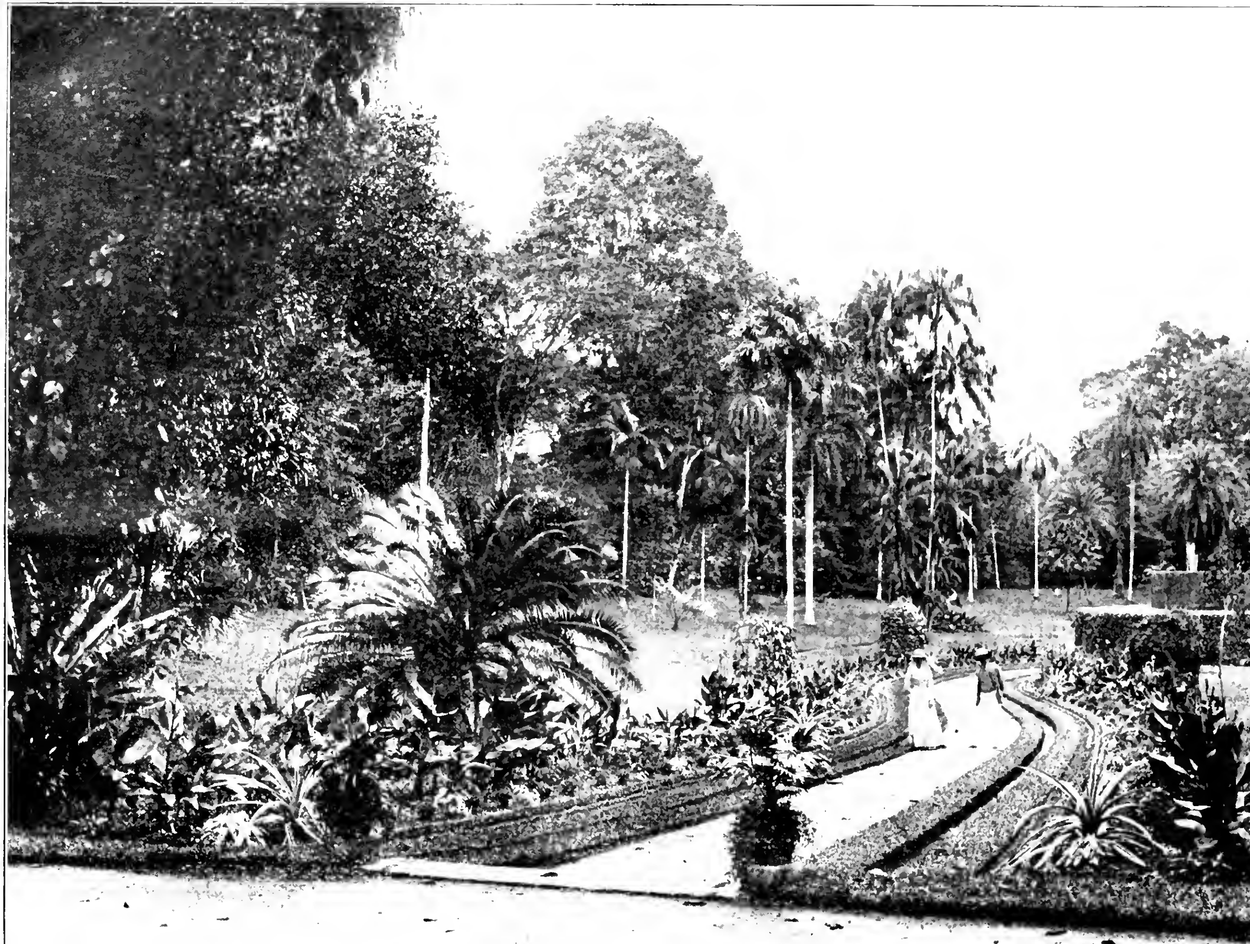

Figure 30. In the Paradeniya Botanic Garden.

then superinteendent, Mr. Alexander Moon, laid out part of the present garden, which has since been enlarged and improved by his successors.

The garden comprises an area of over 140 acres. As in all British Colonial gardens an attempt has been made to combine a scientific collection of living plant specimens with a park arrangement. Broad lawns intersected by irregular roads, and dotted with clumps of trees and shrubs make a fine landscape effect, especially in a tropical climate where the vegetation can luxuriate almost at will, but it does not facilitate the handling of the garden or make it easy to find specimens. This last was made the more difficult by the arrangement introduced by the former director of the garden, who wanted to copy nature as much as possible and therefore planted trees and shrubs promiscuously, giving the general appearance of the primeval jungle, but making it extremely difficult to obtain a general and clear impression of the distribution of plants in the garden. The present director is gradually changing this state of affairs into a more systematic arrangement. The visiting student of tropical botany who wishes to get a general comprehensive view of the flora must spend considerable time at Peradeniya, while in gardens arranged like that at Buitenzorg he can in a very short period see and learn much more about the natural relationship of genera and orders. I found that for my special purpose—economic botany—the Singapore gardens were a more suitable place for study than either Buitenzorg or Peradeniya. Buitenzorg has too many specimens to permit a visitor to see the various economic plants side by side, while at Peradeniya the arrangement referred to makes it difficult to find anything at all.

One great advantage of the Peradeniya gardens is that the roads are wide and built as drive-ways permitting the casual visitor with only an hour or two at his disposal to see all the various parts of the garden. Entering the garden by the main entrance from the road to Kandy, the ancient capital of Ceylon, we notice to the left a number of gigantic specimens of *Ficus elastica*, the Assam rubber, which is quite extensively cultivated in parts of

Burmah, the Malay peninsula and the Sunda Islands. Passing on along the Main Central Drive, we notice a large group of palms containing many different species, among which the Ivory Nut palm (*Phytelephas macrocarpa*), the Panama Hat plant (*Carludorica palmata*), and the Thatch palm (*Sabal umbraculifera*) of Jamaica. A splendid Burmese *Amherstia nobilis*, one of the most beautiful ornamental trees of the tropics, stands close by. Many of the roads are bordered on either side by foliage and flowering plants forming a pleasant foreground to the dark green shrubs and trees rising behind in an impenetrable jungle intertwined with lianas and covered with epiphytes. We pass a number of roads branching from the Main Central Drive, such as Monument Road, Liana Drive, Nutmeg Walk, Palmyra Avenue. Among trees worth noticing we saw *Hura crepitans*, the Sandbox tree of South America, well known for its peculiar explosive fruits. Close to the Nutmeg Walk there is a large collection of the various spices, such as Cardamon (*Elettaria Cardamomum*), Allspice (*Pimenta officinalis*), and Cinnamon

Figure 31. In the conservatory, Paradeniya.

(*Cinnamomun zeylanicum*), the first and the last mentioned being extensively cultivated in Ceylon for commercial purposes.

The conservatory and the fern house contain a large collection of exotic ornamental plants. The orchid house is rich in specimens, some of which can always be found in flower. *Stanhopea, Phalaenopsis, Laelia,* and *Cattleya* are especially well represented. Close by in the flower garden is the *Aristolochia* pergola, formed by a number of climbers of this genus. The Aristolochias are known as Fly-catchers, on account of the peculiar flowers acting as insect traps. A fairly good collection of other insectivorous plants is found in the garden, including species of *Nepenthes* and the *Dischidia rafflesiana,* a small climbing plant from Java, with leaves resembling bladders.

In the center of the flower garden is the so-called Octagon Conservatory, with a number of shade plants. Near this shade house there is quite a display of ornamental plants from *Cannas* and *Caladiums* to palms, such as *Chrysalidocarpus lutescens* from Mauritius, and *Oncospermas.* Farther on along the drive we come to the orchard in which many tropical fruits are grown. We have there the common Avocado pear (*Persea gratissima*) and the Chicle or Sapodilla (*Achras sapota*), of Mexico, the Cashew nut (*Anacardium occidentale*) from South America, the Pomegranate, the Loquat, Mango, and others. Rambutan (*Nephelium lappaceum*), *Averrhoa Carambola, Sandoricum indicum* or Santol, *Chrysobalanus Icaco* or Coca-plum, and Mangosteen grow here and fruit.

Coming to the River Drive we follow the winding stream and in several places notice the giant bamboo (*Dendrocalamus giganteus*), which at Peradeniya reaches a greater height and size than in any other place. One of the curious trees growing here is *Couroupita guianensis* or the Cannon Ball tree shown in one of our illustrations. It derives its name from the large woody fruits borne on the trunk. One of the sights of the garden is the Palmyra Avenue formed by large specimens of *Barassus flabelliformis.* The Palmyra palm is very important to the natives in the dry region of Northern Ceylon, where it is used in

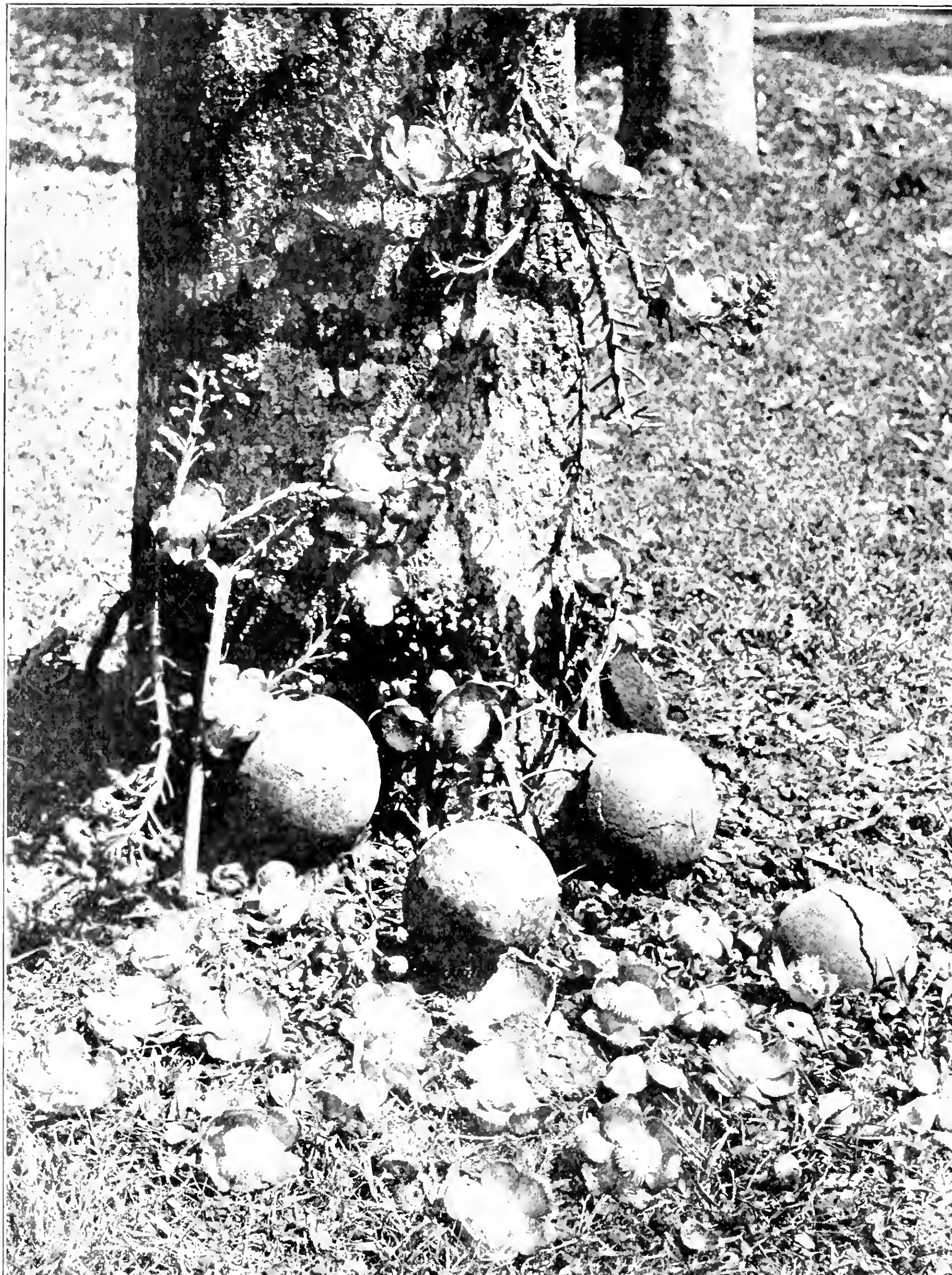

Figure 32. Cannonball tree (*Couroupita guianensis*).

many ways. From the fan-shaped leaves the so-called "ola paper" is prepared. This is extensively used by the natives of Southern India and Northern Ceylon for the transcription of native texts, and many ancient Pali documents of Palmyra and Talipot palm leaves are still preserved in the temples of these countries.

A small experimental plot is used for economic plants, while across the Mahaweli Ganga is the large experiment station of Ceylon, which will be described later on.

One of the noteworthy trees growing near the bank of the river is the paper mulberry (*Broussonetia papyrifera*). From the inner bark of this tree paper is manufactured in Japan and China, and the "tapa cloth" of the South Sea Islands is pounded out from the same material by the natives of that region.

(*To be continued.*)

Mr. Edward F. Bigelow, of Stamford, Conn., one of our most devoted promulgators of the nature study idea, has been unanimously elected President of the Agassiz Association. Mr. Bigelow succeeds Mr. Harlan H. Ballard, who has been President since the organization of the association, in Lenox, Mass., in 1875.

Prof. J. J. Thornber will spend the month of August in Botanical work in Northern Arizona.

Prof. William Trelease, who has held the chair of botany in Washington University since 1885, received the honorary degree of doctor of laws from that university at the commencement commemorating its fiftieth anniversary.

Dr. D. T. MacDougal will be absent from the Desert Laboratory during July and early August, making visits to Chicago, New York, Boston, Woods Hole, and to various places in the field. Mail for him may be addressed in care of the Carnegie Institution of Washington during this period.

Prof. D. H. Campbell, of Stanford University, is visiting Ann Arbor, Detroit, Washington and New York during the summer vacation.

Mr. Charles Louis Pollard, well known to lovers of wild flowers, has been appointed curator of the Staten Island Association of Arts and Sciences, and may be addressed at New Brighton, Staten Island.

The June number of "Discovery" contains an interesting account of a visit to Watlings Island by Drs. Britton and Millspaugh, in which are some interesting notes as to Columbus' first visit to this island. An agave native to the island is figured.

The May number of the same magazine contains an article by Dr. MacDougal, "A Mirage Realized," in which a brief account is given of the recent explorations of the Salton Sea.

The Biological Station of the University of Montana at Big Fork will hold a session from July 11 to Aug. 16. Mr. Thomas A. Bonser of the Spokane High Schools is in charge of the botanical work, and Miss Gertrude E. Norton, of East Helena, of the nature study course.

Prof. F. E. Lloyd, formerly of Teachers' College, Columbia University, and recently of the Desert Botanical Laboratory and the Arizona Experiment Station, has been appointed to take charge of certain agricultural experiments at Hacienda de Cedras, Mazapil, Zacatecas, Mexico, and will take up his new position in a short time.

Dr. Hermann von Schrenk has resigned his position as pathologist in charge of investigations of timber diseases and methods for preventing the same, in the Mississippi Valley Laboratory of the U. S. Department of Agriculture, and has opened a technical laboratory and consulting office for the prosecution of investigations into the uses of timber. Associated with him are Messrs. E. B. Fulks and Alfred L. Kammerer, two competent chemists who have recently been engaged in prosecuting investigations in regard to the preservation of timber for various railway companies. The address of the new firm is: von Schrenk, Fulks and Kammerer, Consulting Timber Engineers, St. Louis, Mo.

Dr. Heinrich Hasselbring, recently assistant in Plant Pathology in the University of Chicago, has been appointed Botanist in the Experiment Station of Cuba, at Santiago de las Vegas, and will immediately take up his new duties.

Volume 10 Number 8

The Plant World

A Magazine of General Botany

AUGUST, 1907

VISITS TO SOME BOTANIC GARDENS ABROAD.

By Dr. Pehr Olssen-Seffer.

(Continuation.)

Numerous are the interesting and curious tropical trees and plants which can be seen in the Peradeniya Garden. One which deserves special mention is the Bo tree (*Ficus religiosa*). This tree is sacred to the Buddhists and is always found growing near the temples. The Buddhist religion forbids the cutting of a branch or uprooting of a seedling of the Bo tree, regardless of position or locality. The oldest historical tree in the world is a Bo tree planted at Anuradhapura, an ancient city of Ceylon. This tree was planted 288 years before Christ, and is therefore now 2,195 years old. The story of this identical tree is a curiously early instance of that much-used modern term—woman's rights. A missionary, Mahindo, had converted the Rajah and people of Anuradhapura to Buddhism, and the effects of his zealous preaching were by no means confined to the male sex. The queen and thousands of her country women became earnest followers of the new cult; they begged to be allowed to take the vows of self-devotion. These vows, however, Mahindo declared himself unable to administer to their sex and he suggested that his sister Sanghamitta, an abbess in India, should be sent for to admit the novices. She responded to the call, and with her the king of Patna sent a branch of the sacred Bo tree under which Gautama sat on the day that he attained Buddha-hood. The story of this tree's life has been handed down in a continuous series of authentic chronicles. It was carefully tended and was spared amid all the different invasions which ruined the great city of Anuradhapura. It is now annually visited and venerated by

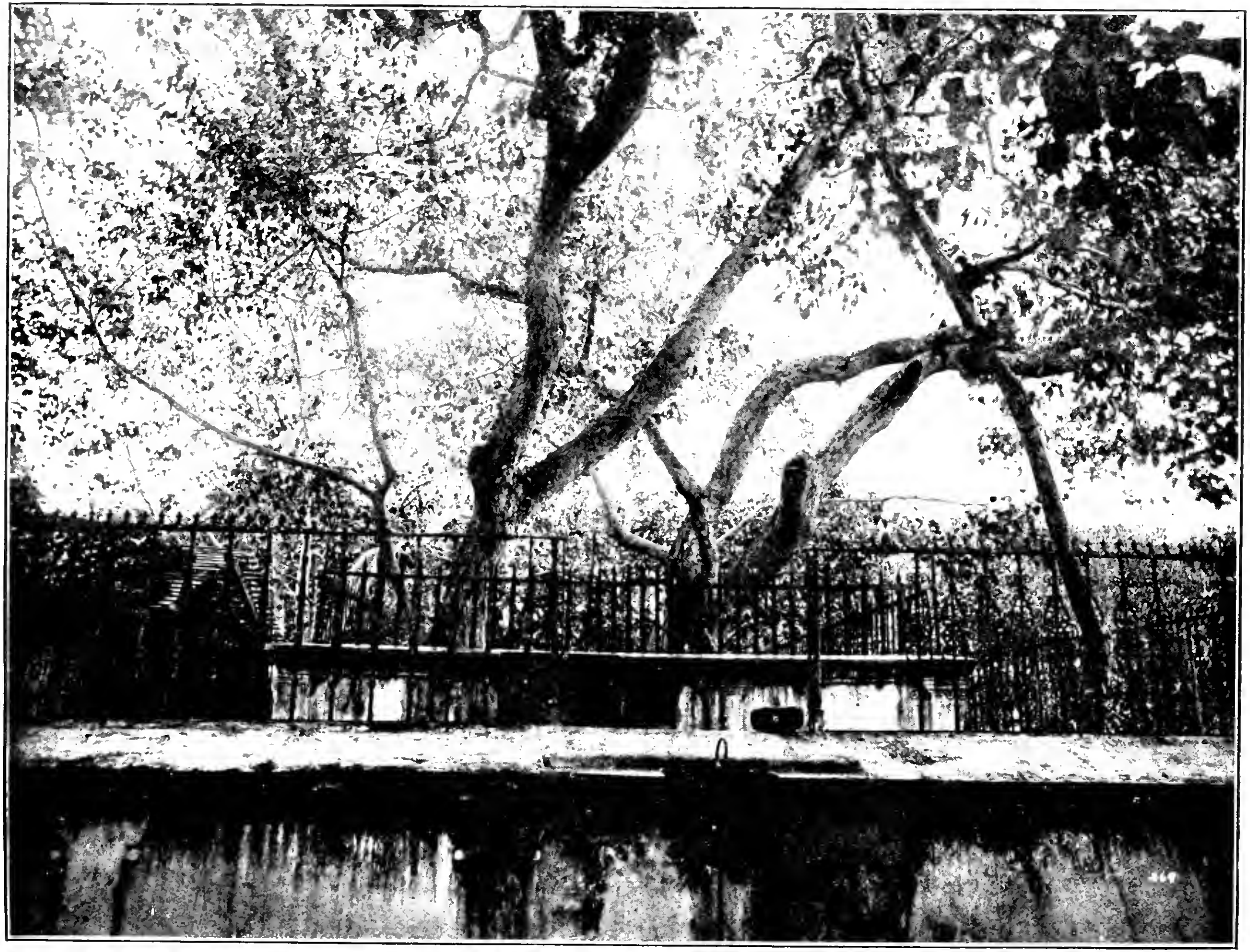

Figure 33. Sacred Bó tree at Anuradhapura, Ceylon.

thousands of pilgrims who come to worship it especially during the full moons of June and July. Figure 33 shows this tree as it appeared when the writer visited it in the beginning of this year.

Of other interesting trees growing here we may mention *Pterocarpus indicus*, a valuable timber tree, *Treculia africana*, the West African bread fruit tree, *Strychinos Nux vomica*, from the seed of which strychnine is obtained, the Baobab tree (*Adansonia digitata*) from tropical Africa, the Chian turpentine tree (*Pistacia terebinthicus*) from the Mediterranean, the Tonquin bean tree (*Dipterix odorata*) which supplies a fragrant oil used in perfumery, the Balsam of Tolu (*Toluifera balsamum*), the Kola nut tree (*Cola acuminata*) from West Africa, the seeds of which are so widely used as a stimulant in aerated beverages. Of ornamental trees, *Lagerstroemia flos reginae* is prominent through its masses of mauve flowers, the satin wood of Ceylon (*Chloroxylon Swietenia*) is as handsome as it is useful on account of its valuable timber, *Jacaranda mimosaefolia*, with its elegant foliage and pretty blue flowers, stands out conspicuously by the side of *Schizolotium excelsum*, with its beautiful yellow flowers borne before the leaves have appeared.

Peradeniya Garden is comparatively poor in coniferous trees, but some big specimens grow here, especially of the Norfolk Island pine (*Araucaria Cookii*), and the Kauri Pine of New Zealand (*Agathis robusta*). Many economic plants besides those already referred to are found throughout the garden. The Shea Butter tree (*Butyrospermum Parkii*), of Western tropical Africa, gives a vegetable fat used by the natives as butter and largely exported from Africa to be used in soap manufacture; *Caesalpinia coriaria* produces the divi-divi pods, containing a large percentage of tannin; *Styrax benzoin*, the Benzoin tree of Sumatra, gives the resinous substance known as benzoin sometimes used in medicine, and throughout the Orient in incense; *Murrya Koenigii*, or the Curry-leaf tree, affords aromatic leaves used for flavoring the different curries of India; *Termin-*

alia belerica furnishes nuts used in tanning, and the flowers of *Cananga odorata* yield the Ylang-ylang perfume of commerce.

The well-known Teak tree (*Tectona grandis*), with its most valuable timber, is represented; as are also the Jamaica ebony (*Brya Ebenus*), the Sandal wood (*Santalum album*), the Ceylon ebony (*Diospyros Ebenum*), the Central American Mahogany (*Swietenia Mahogani*), and many other timber-producing trees.

The Peradeniya Gardens have for a long time been a notable centre for botanical study and research. Many botanists from England and elsewhere have spent longer or shorter periods in the laboratories here, where surrounded by all the facilities of a scientific laboratory, an excellent botanical library, and the ample supply of material afforded by the garden and the forests, they have been able to study tropical botany and pursue research work to the best advantage.

Various persons acted as superintendents of the botanic garden until the year 1857, when Mr. G. H. K. Thwaites was promoted from superintendent to director. He was succeeded in 1880 by Dr. Henry Trimen, who did very useful work on the flora of Ceylon until his death in 1896. The present director, Dr. J. C. Willis, has greatly improved the garden and, assisted by a staff of scientists, is doing valuable work in the service of science and practical agriculture; the result of the work accomplished at Peradeniya is easily noticeable in the flourishing state of the plantation industries of Ceylon.

There is a standing invitation for botanists to visit Peradeniya and to avail themselves of the facilities offered. Dr. Willis has in an article in the Annals of the Royal Botanic Gardens, Peradeniya (June, 1901,) described the institution as a convenient place for study, and in the present year a new building for museum and library purposes is being built, thus giving still better accommodation for visitors, to whom true Ceylon hospitality is offered with open hands.

(*To be continued.*)

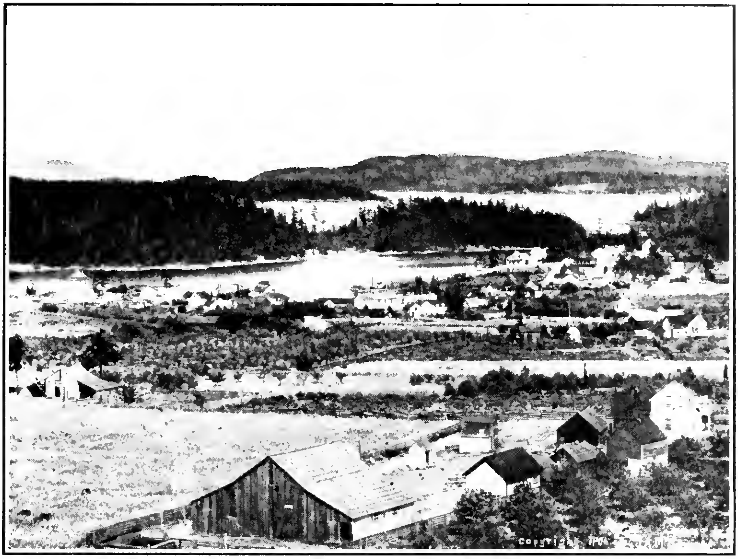

Figure 34. Portions of Puget Sound and islands, from Friday Harbor, Washington. Mount Constitution, on Orcas Island, the highest point explored, shows dimly in the extreme left background.

A ROUND TRIP BETWEEN IOWA AND PUGET SOUND.

II. IN PUGET SOUND.

By Professor Bruce Fink.

As stated in the preceding paper of this series (this magazine for March, 1907), what follows in this presentation is based upon observations made in a more leisurely way. However, this does not make the task of deciding what to write about easier; for after one has studied the flora of a limited area, even for so short a period as six weeks, it is difficult to crowd a general statement into the limits of one short paper. Though another writer would certainly not select all of the plants considered below for a popular discussion, all botanists would agree to include the majority of them, and they will serve to give a glimpse of the vegetation of the San Juan archipelago, in Puget Sound.

It was through the kindness of Dr. T. C. Frye, professor of Botany in the University of Washington, that the writer was invited into this region to spend six weeks of the summer of 1906 at the Marine Biological Station of the University of Washington. The station is located at Friday Harbor, on the Island of San Juan, the largest of the many islands composing the San Juan Archipelago and the County of San Juan, Washington. The region had been sufficiently exploited so that it was known that the opportunity for botanizing was too good to let pass, for here it was that Professor Josephine E. Tilden had stopped years ago, before the Minnesota Seaside Station was established in the Strait of San Juan de Fuca. Also the work of Professor T. C. Kincaid on the marine animals of the archipelago and other portions of the coast was well known, and the opportunity of seeing this expert in the study of marine life at work was an incentive which would have been sufficient to induce any lover of out-of-door study to decide to take the long journey involved. Also, the writer had examined lichens collected by members of the party of the Minnesota Seaside Station all the way from Banff, in the Canadian Rockies, to the Minnesota Station on Van Conver Island, as well as those collected by Dr. Frye and his students in the San Juan Archipelago and other portions of Western Washington, so that the chance of studying this flora at first hand was another strong incentive. Likewise Dr. N. U. Gardner, Professor Josephine E. Tilden and Dr. Frye had worked on the marine algæ sufficiently to enable one not well acquainted with these forms to add considerably to his knowledge of them even in so short a time. Finally, there was the added interest in seeing a seed-plant flora quite different from that east of the Rocky Mountains.

The history of the early exploration and settlement of the San Juan Archipelago is very interesting, involving the narration of the exploits of Peter Puget, George Vancouver and many other persons, but we must pass all this by and confine ourselves mainly to biological considerations. Friday Harbor, the county seat of San Juan County and the seat of the Marine Biological Station of the University of Washington, is a village of about four hundred inhabitants, located on a quiet harbor. The work of the station is carried on in a large building on the wharf, and the books and apparatus needed are easily transported by steamer from the laboratories of the University at Seattle. The surroundings, with the many islands and reefs, the towering Cascades and the Olympics in the distance, the cool fir woods to landward and the broad expanse of water in front are a beautiful and inspiring as could be desired. Looking eastward on a clear day, Mount Baker in the Cascades appears to be but a few miles distant, appearing very distinctly as a great white dome, though some thirty-five miles of Sound and forty of mainland intervene.

A small steamer is kept at the station during the sessions of the summer school and is at the services of students who may wish to accompany the dredging expeditions or to explore some of the many islands of the Archipelago. The work of previous sessions at the Station and the independent explorations of Professors Kincaid and Frye had given a good knowledge of best places in the Sound, both for dredging and for the study of the flora of the islands. The steamer trips range in length from a few hours to two or three days, so that ample opportunity is given for exploring various portions of the county of San Juan. The statement made by the Management of the Station that the fauna and flora are much richer than those of the Atlantic coast is fully warranted by observation of the great numbers and large size of many species of the marine plants and animals. Starfishes, sea-urchins, seacucumbers, jellyfishes and many other marine animals may be picked up in enormous numbers and often of very unusual size, on the piles at the wharves, on various reefs and on every shore at low tide. A great variety of animal life is at hand for those especially interested, ranging all the way from tiny creatures somewhat larger than the bacteria that light the waters with phosphorescence at night to the seals and black whales that are seen occasionally.

Wonderful as is the animal life of the salt waters of the

Sound and noteworthy as are the results already secured by Professor Kincaid in the study of it, we must direct our attention to the plant life of the region. We were fortunate in having with us Dr. F. T. Harper, of Chicago, who possesses a wide knowledge of species of plants, and are especially indebted to him for his aid in the study of the mosses and fungi. Dr. Harper found that fungi are not so numerous on the islands as on the mainland in portions of Western Washington where he had botanized earlier in the season. Whether this is mainly due to lack of moisture on the islands, or is more largely the result of isolation, we are not able to decide. Of the *Basidiomycetes*, the writer saw most commonly *Polystictus hirsutus*, *Polystictus pergamenus*, *Fomes angulatus*, *Polystictus subsericeus*, *Poria subacida*, *Polyporus volvatus*, *Poria ferruginosa* and *Polystictus versicolor*. *Polyporus volvatus*, especially interesting morphologically, is very common on pines, but is, as usual, so badly injured by insects that good botanical specimens are secured with difficulty. Besides the *Basidiomycetes* named above, *Trametes abietis*, *Trametes pini*, *Fomes carneous*, *Polyporus picipes*, *Merulius nivens*, *Clavaria mucida* and *Thelophora proculaformis* were seen more or less frequently. The *Agaricaceae* were absent at the time of year when we were at the station, but are doubtless common enough during the wet season.

Time was so limited that no effort was made to collect any of the seasonal fungi as rusts, smuts, mildews, etc., but a few *Discomycetes* may be mentioned. First of all, the common and pretty little red *Lachnea scutellata* was seen in great profusion on old boards along a stream on Orcas Island. Also we were fortunate enough to find *Chlorosplenium aeruginosum*, which so commonly makes bluish or greenish stains on logs, in fruit. Two or three unknown *Discomycetes* were collected, which are still in the hands of Dr. E. J. Durand for determination. Among these is one found very commonly on the leaves of *Gaultheria shallon* and *Berberis nervosa*.

The tree known as the Douglas spruce or the red fir, *Pseu-*

dotsuga mucronata, was doubtless the most common of the conifers as well as the largest tree of the islands, reaching six to nine feet in diameter. The giant cedar, *Thuja plica*, is much less common, and the western hemlock, *Tsuga heterophylla*, was for the most part confined to the higher elevations, as far up the sides of Mount Constitution, where it was seen very commonly. A balsam fir, *Abies grandis*, was often noticed, and *Pinus contorta* is common at high elevations on some of the islands. Nor should we leave the *Gymnosperms* without adding the Rocky Mountain juniper, *Juniperus scopulorum*, and the yew, *Taxus brevifolia*. Of the deciduous trees, *Alnus oregona* and *Quercus garryana* are at least the ones from which lichens were collected most frequently. Besides these must be mentioned the madrona, *Arbutus menziesii*, which grows along the rocky shores and, with its characteristic reddish-brown bark, is one of the first trees to attract the attention of one not familiar with the flora. The madrona is a tree of limited range and, with its peculiar bark and its evergreen leaves, is surely one of the most interesting plants of the west coast.

Of shrubs and herbs we can only give space to a few of the most interesting. Two pretty little shrubby plants of the woods are the two Oregon grapes, *Berberis nervosa* and *Berberis aquifolium*. Salal, *Gaultheria shallon*, also challenges the attention of the stranger at once. The beautiful twin flower, *Linnea borealis*, is very common in certain places in the coniferous woods, and the Indian pipe, *Monotropa uniflora*, grows in great profusion in places in dark woods. Two especially interesting plants of xerophytic adaptation are *Sedum spathulifolium* and *Gormania oregana*. The former occurs on rocks in rather exposed places at all elevations found on the islands, and the fleshy roots and stems of the specimens collected had not lost all their moisture and succulence after lying five months in the herbarium. The latter is a very similar but smaller plant noticed only at the top of Mount Constitution. The little parasite, *Arceuthobium americanum*, locally called "mistletoe," is a very interesting plant found on *Pinus contorta* at the highest elevations, as on Mount Constitution and Turtle Back Mountain. Before leaving the flowering plants, we must mention *Plantago maritima* and three members of the genus *Rubus*, viz., the thimble berry, *Rubus parviflorus*, the salmon berry, *Rubus spectabilis*, and the dew berry, *Rubus macropetalus*.

The common brake, *Pteris aquilina*, is very common and grows to enormous size. We repeatedly measured specimens more than twelve feet high. Mosses are also unusually abundant and luxuriant. On logs and on the ground in woods several species of *Hylocomium* and *Hypnum* are very common. *Barbula membranifolia* is abundant on the ground in places, while *Polytrichum piliferum* was often seen on the same substratum. *Mnium menziesii* and two or three species of *Neckera* are very common on the trees. The leafy hepatic, *Porella navicularis*, is common on trees, and fruited specimens may be found for study in great abundance.

Of the marine algae, the giant kelp, *Nereocystis luetkeana*, with its long stem, bladder or float and several laminae, is the most noticeable. This plant adjusts itself in length to the depth of the water in which it grows, and specimens were measured more than seventy feet long. Clinging to this are *Ulva lactuca*, *Enteromorpha intestinalis*, *Enteromorpha linza*, and other algae, while the beautiful *Porphyra naiadum*, like dentist rubber, clings in similar fashion to eel grass, *Zostera marina*. Even more interesting than any of these are two coenocytic algae, *Codium mucronatum* and *Bryopsis plumosa*. The former is found on rocks at low tides, and except for its dichotomous branching, looks not unlike certain fresh water sponges. The delicate little *Bryopsis* is eagerly sought by teachers for class use, but is by no means easily found, though doubtless common enough. Besides these, *Fucus evanescens*, *Halosaccion glandiforme*, *Soranthea ulvoides*, *Calpomenia sinuosa*, *Costaria turneri*, *Hedophyllum sessile*, *Corallina officinalis*, *Amphiroa tuberculosa*, *Rhodomela larix*, *Desmarestia aculeata*, *Cystophyllum geminatum*, *Gigartina mamil-*

osa, *Iridea laminarioides*, *Fauchea gardneri*, *Pryonitis lyallii*, *Rhabdonia coulteri*, *Egregia menziesii*, *Alaria cordata* and *Ceramium californicum* are species frequently seen and of more or less special interest. This somewhat laborious list has some value at least in that it represents forms that may be easily found and readily determined with good keys and herbarium specimens, by one pressed for time and not very familiar with marine plants.

Finally, brief mention may be made of the group of plants on which the writer spent most of his time. After studying the lichen flora of the islands until new lichens were picked up very slowly, except in a few favored places, it does not appear that the lichen flora is an especially rich one. The work thus far done on the collection would indicate that the whole number of species collected is not far from two hundred, which is a rather small number for the time spent in collecting. The lichens of the various islands are very similar, except for a few very conspicuous exceptions due to differences in substrata or elevation. For instance, the limestone at Roche Harbor furnished a few lichens characteristic of such substrata, and the sandstones of Waldron Island were found to be exceedingly interesting after the other rocks of the islands had been examined carefully. The soil over the sandstones of Waldron Island was also found to be especially interesting, so that the high areas examined on this island proved most fruitful toward the close of the collecting season when lichens new to the collection were not easily found. The top of Mount Josephine furnished *Cladonia coccifera*, *Cladonia bellidiflora*, *Cladonia gracilescens*, elongated forms of *Cladonia gracilis*, *Thamnolia vermicularis*, *Alectoria sarmentosa* and peculiar forms of *Cetraria glauca*, all of which are very rare or entirely absent at lower elevations on the islands. The collecting here proved that the elevation of 2,409 feet brings undoubted differences in lichen flora. It may be mentioned also that the only place where *Sphaerophorus globiferus* was found in fruit was on the hemlocks near the top of Mount Constitution. *Physcias* and

Parmelias are by no means so common on the islands as they are in the Mississippi Valley and eastward, and our common *Lecanora subfusca* of the eastern United States is replaced almost entirely on these islands by *Lecanora pacifica*, which abounds everywhere on bark, living and dead. *Rhizocarpon geographicum* is very common on dry rocks, and with its bright greenish or yellowish crust, will always attract the attention of students who visit the Archipelago. Closely related to this lichen and as common is *Rhizocarpon petraeum*, which is not so easily seen because of its dull color.

There is an excellent opportunity for the study of lichen formations on these islands, but such work must be done by one who is very familiar with the lichen flora of the region and consequently not during the first summer's study. The most conspicuous lichen near the Station is *Ramalina reticulata*, which covers some of the trees after the manner of some of the longer *Usneas* of the coniferous woods of Michigan, Wisconsin and Minnesota. This *Ramalina* is, with its reticulated structure, a most beautiful plant, which will always attract attention in the region. The *Cladonias* of the islands are very interesting, and there are many most excellent formations of them. With the *Cladonias* on the rocks, often grows *Pilophorus cereolus*, which with its erect habit is easily mistaken for a *Cladonia*. For the student of lichen ecology there are the damp and deeply shaded woods, the more open woods, the common matamorphic rocks in the woods and those along the shores and drier places, the sandstones and limestones in limited areas, deciduous and coniferous trees, various conditions of soil and various altitudes from the sea level to 2,409 feet. Also various sizes of islands may be found, from the smallest reefs, with a few rock-loving lichens growing on the portions of the reef above high tide, to those ten or more miles in length and for the most part more or less densely wooded, except in places where the ground has been cleared and is being used for agricultural purposes.

THE COMPOSITÆ OF PERAUSTRAL AMERICA.

By Professor George Macloskie.

(Continuation.)

The *Helianthoideae*, or Sunflowers, are essentially an American group, and seemingly of ancient origin, having several isolated genera; are chiefly tropical or warm-temperate. Those in Patagonia are chiefly confined to its northern regions, and we miss such North American genera as *Helianthus*, *Coreopsis* and *Rudbeckia;* but the monoecious genera are found, as *Ambrosia* (the American Ragweed, with the habit of the European *Senecio jacobea*). This species, and *Xanthium*, the cosmopolitan Burdock, have lost many of the chief marks of Compositae, as the synanthery, and the ligulate corollas of the female flowers. It is said that *Xanthium spinosum L.* came originally from Chili, though long before the days of Columbus it was spread over Europe, and it has recently reached Australia. *Xanthium italicum* Mor., though first described from Italy, is deemed to have still earlier been in Chili, and still exists there and in North Patagonia. *Parthenium hysterophorus* L. is found from Texas to N. Patagonia; and *Wedelia buphthalmiflora Ltz.* is found in Eurasia, Africa, Australia and North Patagonia. *Spilanthes* is tropically cosmopolitan, mainly American, and its species *S. arnicoides* DC. (a creeper with opposite leaves and long-headed scapes) is the "nim-nim," or chewing-root of the natives. *Thelesperma* has its involucral scales connate half way up. *Madia*, the Tarweed, with 1-seriate, carinate, involucral scales, is cultivated in Chili for the sake of its seeds, which yield oil.

The Helenioids, though chiefly a West-American tribe, are not very largely represented in Peraustral America; but *Flaveria australasica* Hook., an Australian species, is thought to be closely allied to, if not identical with, an undescribed form in Southern Argentina.

The Anthemideæ are eminently an Old-World, non-tropical tribe, and are best known by their dry, often scariously tipped involucral scales, their tailless anthers and truncate styles. Their pappus is wanting or reduced, and their leaves usually dissected.

Achillaea millefolium L., Yarrow, is cosmopolitan, and was found by Dusén at Magellan. *Anthemis cotula* L., once confined to the Old World, is now naturalized in America, and even in Patagonia. (*Chrysanthemum* seems not to be in S. America, nor *Matricaria*, nor *Tanacetum*.) *Artemisia* runs down the Andes, and a species, *A. magellanica* Sch. Bip., is in Patagonia and on the steppes of Fuegia. Two genera, *Cotula* and *Abrotanella* (both with 4-merous flowers), by their different species connect Patagonia with Australia, Tasmania, New Zealand and Chatham Island; the former also with Tristan, and the latter with Auckland Island and Campbell Island.

The Senecioneæ come next to the Astereæ for number of species, and yet few of them are widely distributed, no species being common, apparently, to the Old and New Worlds. They have also varying habits, some being frutescent or arborescent, and even the herbs being usually erect and not, as many Astereæ, with rosetted leaves. Like the Astereæ, they have a setose pappus, and naked receptacle. But the involucral scales are only 2-seriate (3-seriate in *Culcitium*), and subequal, often with a calyculus. The anthers are basiobtuse, and the style branches truncate. Among genera with tailless anthers they are distinguished from Vernonias and Eupatoriums by their yellow disks, and often heterogamous heads, and from the Astereæ by their involucres and non-appendaged styles, and by their hibit.

Senecio, Groundsel, is one of the largest genera, having 1,200 species. It is represented by 88 species in Patagonia, usually with 5-10-ribbed achenes and copious pappus. *Senecio Johnstoni* Oliv., of South Africa, is a tree, while *S. humillimus* Sch. Bip., of the Andes, is a cespitose shrub. The Patagonion species are analysable by the inflorescence (heads solitary or 1-3-corymbed, or few-corymbed, or many-corymbed, others panicled), by the heads (discoid or radiate), by the shape of the leaves (webby or woolly or glabrous) and their margin, and by their herbaceous or fruticose habit. Two new species of Senecio are described and figured in the Flora by Dr. Hoffman, named respectively after Dusén and Hatcher: the first with few, radiate heads, and pinnatifid leaves, the second with single, discoid heads and small linear leaves (plate xxx). Culcitium differs from Senecio chiefly by having a several-seriate involucre, scales smaller externally; two of its species are in Patagonia, one of them with silky leaves.

Calenduleae, the Marigolds, are known by their mucronitailed anthers, flat, truncate styles, 1-2-seriate involucre, and no receptacle-scales nor pappus. The tribe is almost exclusively South-African, Calendula being Mediterranean. *Eriachaenium*, however, belonging to this tribe, is a monotypic Fuegian plant, *E. magellanicum* Sch. Bip., closely related to the African *Oligocarpus*, which also has a species on St. Helena Island. The fertile flowers of *Eriachaenium* are 4-merous and the corolla is adnate to the achene.

The Cynaroideae, or Thistles, the predaceous tribe, are chiefly from the Old World, but they have come to America, and now reach down the Andes as far as Chili, and dominate in parts of Argentina, extending to North Patagonia. Structurally they are defined by their homogamous heads with long-tailed and long-appendaged antlers, their short styles, their many-seriate involucres, and bristly receptacles; and most of all by their coarse habit, and spinescent involucres and herbage.

The true thistles of Europe (*Carduus*, strieté) are not in America; but the Plume-thistles, *Carduus* (*Cnicus* or *Cirsium*), also *Cynara*, Cardoon (having fleshy receptacles and with pappus on a basal ring, and *Silybum*, the Giant-thistles, with filaments half-way connate. *Silybum marianum* Gaertn. and *Cynara cardunculus* form the dense thistle-groves of Argentina. Both occur near the Rio Negro in North Patagonia. *Carthamus*, the Safflower, with oblique scars on its achenes, and with unarmed linear leaves, though its 20 species are oriental, has a species, *C. magellanicus* Lam., in Magellan. *Cirsium lanceolatum* (L.)

Scop. of North America, occurs in La Plata, but is not reported farther south. The Arctotireæ are unknown in America, being nearly confined to South Africa, with outlying species in Abyssinia, the Mediterranean region and Australia. They are like Cynaroideæ, but have radiate heads, and tailless anthers, and their styles are scarcely branched.

The tribe Mutisieæ and its subtribes are in some respects the strangest of the Compositæ, and they have their chief seat in Peraustral America, and in Brazil, just as the Cynaroideæ most closely related to them, reign at the remotest part of the earth from them. Mutisieæ have some representatives in North America and in the Old World. With much diversity of structure their chief characters are prevailing bilabiate flowers (both lips often revolute), tailed anthers, unappendaged styles, mostly setaceous pappus, naked receptacles, many-seriate involucre and frequently fruiticose habit.

Mutisia itself, with 60 species in tropical and subtropical America, often climbs, being aided by its winged stems, and its pinnate, tendril-bearing leaves. It loves the preandine shrubberies. *Tricholine*, of smaller habit, with 1-headed scape, and rosulate leaves, like a yellow daisy, has 27 species in extra-tropical America, and a single species in Australia. *Plazia* is a shrub resembling the Euphorbias *Plazia argentea* O. Ktze., is all silvery, and its stem supplies the Indians of the pampas in Argentina and North Patagonia with a masticatory, like chewing-gum elsewhere. *Lasiorrhiza* (Leuceria) comprises herbs with snowy pinnatifid leaves; some of its species along the Beagle Channel taking the place of the Swiss Edelweiss, but having their purplish heads on tall scapes.

Hoffmann's genus *Dusenia*, recently erected in honor of our distinguished friend, is remarkable for its 10-pale pappus and its graceful habit, with pairs of narrow fleshy leaves. *Chuquiraga* is a contrast to these, bristling with spiny leaves which resemble bundles of polished steel needles, *C. erinacea* D. Don, being called "Herba del perdice" (Rhea-food), attesting that the famous South American Ostrich must have a good stomach.

The species of *Perezia*, with large pink-purplish heads, are vegetable gems, as is our plate xxix, which the lamented van Iterson, and J. Nugent Fitch unitedly prepared to represent the habit and structure of *P. recurvata* (Vahl) Less. Sir J. D. Hooker calls this plant "one of the most interesting of the Falkland Isles, from the sweet smell of its large, pale blue flowers;" and of another, *P. lactucoides* Less., he confesses that "two plants of different size are included in this; except, however, in size, I am unable to distinguish them."

Nassauvia seems to be the climax of Composite structure, having glomerules, or heads of heads, and often the particular involucre of the individual heads is reinforced by a general quasi-involucre for the community. Such will be seen in the new species, *N. dusenii* O. Hoff., described by Professor Hoffmann, dedicated to our Swedish friend, and figured by the courtesy of its author in our plate xxx. Its sessile, revolute, striated leaves, crowded on each other, and surmounted by its glomerulate inflorescence, makes up a graceful column which may serve as the model of a new order of architecture. Most extraordinary is the *N. serpens* d'Urv., because of its underground brittle stems, which make their way for fathoms down through the "streams of stones" of the Falkland Isles till they reach the underlying soil.

The Cichorieæ, or Dandelion tribe, having their headquarters along the Mediterranean, are poorly represented in South America. A few of the widely distributed species are in Patagonia, as the Dandelion itself, and *Hypochoeris*, *Sonchus* and *Hieracium*. Also the American *Agoseris* (also called Troximon, and Macrorhynchus), which haunts the Andes, connecting Patagonia with Mexico and California. *Hieracium pilosella* L. of Europe, as it has come to North America, is also at home in Magellan-land. Another species, *H. triste* W., which differs from its congeners by having neither glands nor stellate hairs, belongs to the Aleutian-Behring district, and was found by Hatcher in the Cordilleras of Patagonia. *Hypochoeris coronopifolia* Sch. Bip. was found by Hatcher in Magellan and also on the Beagle

Channel, and differed in no respect from the specimens in the Gray Herbarium, which came from Golden Gate, California.

Princeton University, March 7, 1907.

TERATOLOGIC NOTES.

By Professor John W. Harshberger.

These notes represent observations made on a number of abnormal forms of plants collected at various times and preserved in alcohol for future dissection and study. They show the range to which a healthy plant can modify its organs, without sacrificing the mophologic identity of the different parts. I am unable in this paper to throw any light upon the genesis of the abnormal structures in question, nor am I able to say whether these teratologic forms could be propagated so as to show that they are hereditarily transmitted. I think they are of sufficient morphologic interest without a discussion of their genesis or character.

Fasciation in Marchantia. I collected in August, 1903, at Pocono Pines, a specimen of this liverwort which showed the fusion of the stalks of two archegoniophores. The fasciation extended nearly to the top, but there the stalks diverged from each other, each fork bearing a one-sided, umbrelloid, upper portion with the usual rows of archegonia.

Forked Frond of Nephrolepis exaltata. Mr. Henry B. Evans presented to me a frond of the sword fern *Nephrolepis exaltata* two feet four inches long, which forked nineteen inches from the leaf base into two exactly equal forks, each bearing the normal kind of two-ranked pinnules with the characteristic rows of sori.

Reduced Iris Flower. One of the most interesting specimens in the above mentioned teratologic collection is an Iris flower from one of the hybrid garden forms with only one sepal, no petals, a single stamen standing opposite to the large petaloid style arm. The stamen is normal in structure and position and

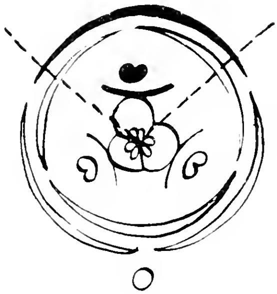
Figure 35.

has an extrorse anther. The petaloid style arm lacks the usual stigmatic flap and the ovarian cavities are entirely obliterated. This flower has been divided in such a way that the two division lines have passed through the flower in the manner indicated in the floral diagram (Figure 35) where the heavily shaded parts represent the organs that are present.

Dimerous Symmetry in Cattleya Flowers. From the orchid greenhouse of the University of Pennsylvania was obtained a flower of Cattleya sp. that showed dimerous instead of trimerous symmetry. The two sepals opposite to each other were exactly of the same size and appearance, standing in a lateral position. The two petals (not hooded) stood in a posterior and an anterior position respectively and were exactly the counterparts of each other.

Abnormal Flowers of Phajus Wallichii. A single raceme of this orchid showed two anomalous flowers. The sixth flower from the bottom of the raceme had only two sepals, the anterior sepal was absent, while two petals were present, one of the anterior lateral petals being suppressed. The seventh flower from the bottom showed two lateral sepals, an anterior petal (secondary labellum) and a posterior petal (true labellum) each petal spurred at the base. Each labellum developed also two winglike projections, which probably represent the two posterior lateral stamens of the outer row, which are considered to be intimately fused with the edges of labellum. From another raceme with nineteen flowers on March 15, 1906, I secured two teratologic flowers, one with two sepals and two labella like the preceding, and one with two sepals and each of the petals modified into a labellum, two of them with spurs.

Proliferated Flowers in Adonis davurica. From Dreer's Nursery I secured on March 20, 1903, two proliferated flowers of the above-named plant. This proliferation was brought about by the modification of the hypogynous stamens into green laciniate leaves similar to the leaves of the plant. All of the stamens were thus modified and the pistil was rudimentary.

Division of Violet Leaves. Miss A. L. Taylor presented to the teratologic collection several leaves of a species of violet

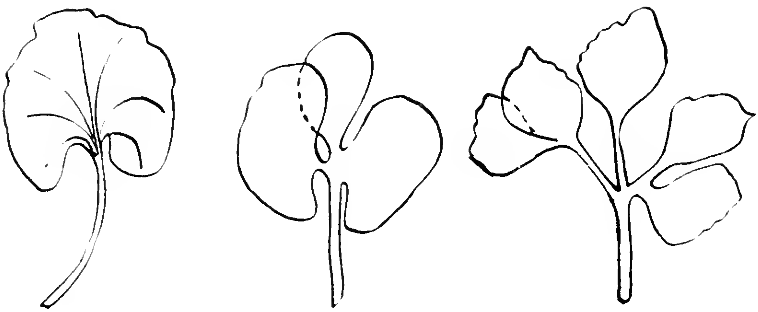

Figure 36.

with normally heart-shaped leaves, obtuse apex and crenate margin. In another specimen, the leaves were tripartite, the two lateral lobes being reniform and the middle one obovate. The petiole of another was divided, so that the leaf became a palmately compound leaf. Each of the two lateral leaflets of this compound leaf are again bipartite with rounded lobes. The shapes of these leaves are shown in Figure 36.

Fusion of Violet Flowers. The violet studied was *Viola canina var. Muhlenbergii*, presented by Miss Frieda Mueller on May 7, 1906. It represents the fusion of two flowers by their receptacles, but by the union, each flower has lost one sepal and one petal. The petal lost in both cases is the anterior or spurred petal, so that with the loss of a stamen tetramerous symmetry becomes the one displayed in each flower. Although the bearded petals are slightly larger than the other two, the flowers become almost regular by the suppression of the spur and the loss of the spurred staminal appendages. The ovary is of the normal character, one-celled with three parietal placentæ.

Fasciated Flower Stalk in Cyclamen macrocephalum. From the Botanic Garden of the University of Pennsylvania on March 26, 1903, I obtained two examples which display united flower-stalks. In one specimen, the peduncles were fasciated to within an inch of the calyx, while in the other the fusion was between the bases of the calyces.

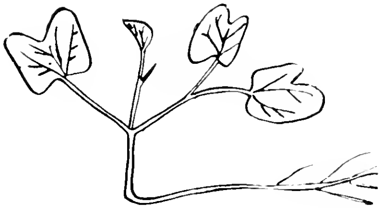

Figure 37.

Split Cotyledons in Ipomoea purpurea. The specimen displaying this condition was obtained in the laboratory among some seedlings raised for class use on July 8, 1904. One cotyledon, as shown in Figure 37, was of the usual form, the other was divided into two cotyledons, each with a distinct petiole.

University of Pennsylvania.

A NOTE ON THE POISONOUS QUALITIES OF THE YELLOW LADIES' SLIPPER.

By Otto E. Jennings.

That the beautiful Yellow Ladies' Slipper, *Cypripedium hirsutum* Miller, is to many people quite poisonous by contact, is apparently not well known among amateur botanists, or even among some of our more strictly technical friends.

In two contributions in Volume I of the Minnesota Botanical Studies (1893-1898), Dr. D. T. MacDougal mentions a number of species of plants of Minnesota which are to many people more or less poisonous to the touch and adds to these the three Ladies' Slippers—*Cypripedium reginae* Walter, *C. hirsutum* Miller, and *C. parviflorum* Salisbury—citing also previous reports from several sources as to the poisonous character of these orchids and himself adding considerable experimental evidence along this line.

Dr. MacDougal's experiments upon both himself and others are interesting as well as convincing. Briefly stated, he found that the poison is contained in the small gland-tipped hairs so abundant on the stem and other parts of the plant. About the same percentage of those subjecting themselves to these experiments were found susceptible to the poison as were also susceptible to ivy poison. The secretion was found to be an acid substance of an oily character soluble in alcohol and increasing, as did also its toxic effects, up to the time of the formation of the seed capsules.

On May 25, 1907, the Botanical Society of Western Pennsylvania held one of its field meetings at Hillside Station, on the slope of Chestnut Ridge, in northern Westmoreland County, Pennsylvania, and during the day several fine colonies of the Large Yellow Ladies' Slipper, *Cypripedium hirsutum* Miller, were found along the crest of the ridge.

Several of the members of the party having expressed surprise, not unmingled with doubt, upon the writer's statements as to the poisonous qualities of the plant, he determined to put the matter to a personal test. While placing a specimen in press the next morning the middle and lower parts of the stem were lightly rubbed across the inner side of the fore-arm midway between the hand and elbow. No effects were to be seen until the third day of the experiment, when the skin began to burn and itch almost exactly as in ivy poisoning, of which the writer is a frequent victim. At the same time the skin became reddened and on the fourth day minute watery vescicles began to appear, increasing in number and in height until about the ninth day. The inflammation was permitted to run its course unhindered and, decreasing after the ninth day, it has at the present writing practically disappeared. The palms of the hands were evidently immune to the poison, as no precautions were taken to protect them while collecting or pressing the specimens and, so far as learned, none of the other members of the party who touched the plants were affected.

The effects of the poison upon the writer were very similar to those of *Rhus vernix* Linnaeus, except that the watery vescicles were smaller and more distinct and were packed more closely together, and that the sensations of itching and burning were less noticeable, although this latter condition may have been more or less the result of the exceptionally cool weather prevailing at that time.

On a later occasion like experiments with the Pink Ladies' Slipper, *Cypripedium acaule* Aiton, produced similar but less pronounced results.

Carnegie Museum, June 8, 1907.

In "Comments on the Experiments of Nilsson and Burbank" (Open Court, Chicago,) Professor de Vries describes the discovery and use of the method of selection of elementary species which in the hands of the Swedish breeder has brought about results of marked value in a comparatively brief period, and also sets forth some of the principal methods used by Burbank in hybridization and consequent selections. A chapter is devoted to the correlations of associated characters and their value in breeding work, in which the operator will find much of practical importance as well as of theoretical interest. The author has not been able to resist the temptation to indulge in some hasty generalizations as to geographical distribution, which he doubtless would repudiate after a more prolonged acquaintance with the vegetation of the desert.

Prof. John H. Schaffner, of the Ohio State University, has been granted a year's leave of absence, and will carry on researches in Zürich.

Prof. G. J. Peirce, of Stanford University, is investigating the effects of smelter fumes on plants, in the interest of the San Mateo Home Improvement Co., and is visiting the leading smelters of the United States and Canada in pursuit of data on this subject.

Prof. W. R. Dudley and Dr. A. A. Lawson are soon to return to Stanford University. Prof. Dudley has spent the last year in Europe and Egypt; Dr. Lawson has been studying in Europe.

Prof. LeRoy Abrams and Dr. H. B. Humphrey have been engaged by the Case Publishing Co., of Minneapolis, as critical experts on their forthcoming extensive and popular publication concerning Luther Burbank and his work.

At the University of Nebraska, Dr. Elda R. Walker has been promoted from the Instructorship to the Adjunct Professorship of Botany. After holding a teaching fellowship in the University for two years, Miss Walker has held the Instructorship for one year. Her doctor's thesis was a report of work determining the tricarpellary nature of the pistils of grasses, and was published in the University of Nebraska Studies, Vol. VI., No. 3, 1906. Mr. Pool is a Bachelor of Arts of the University of Nebraska, and has been for three years Collector for the Department of Botany. He spent last summer in ecological work with Dr. Clements in the region of Pike's Peak. He is now engaged in similar work with Dr. Clements' party in different portions of Colorado.

Dr. Otis W. Caldwell, recently Professor of Botany of the Eastern Illinois State Normal School, has been appointed Associate Professor of Botany in the University of Chicago. He will give certain courses in the University and will have charge of the work in Nature Study in the School of Education.

Dr. Edgar N. Transeau, of the Station for Experimental Evolution at Cold Spring Harbor, Long Island, has accepted the Professorship of Botany in the Eastern Illinois State Normal School, made vacant by the resignation of Dr. Caldwell.

Dr. H. C. Cowles, of the University of Chicago, is spending the first half of the summer with a party of twenty-two students in ecological work in Washington and British Columbia. The same party will spend the remainder of the season in Alaska.

Dr. J. E. Coit, of Cornell University, has been appointed Associate Horticulturist at the Arizona Experiment Station.

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VISITS TO SOME BOTANIC GARDENS ABROAD.

By Dr. Pehr Olsson-Seffer.

(*Conclusion.*)

XI. Ceylon Experiment Station.

Across the Mahaweli Ganga from Peradeniya an experimental garden was established in May, 1902, for the purpose of cultivating on something approaching a commercial scale certain economic plants which are or promise to become of value to the agricultural industry of the island. The grounds compare very favorably with those of Peradeniya gardens, and the climatic and soil conditions are nearly identical in both places.

Extensive experiments with green manures have been conducted during the last few years in connection with cacao, cocoanuts, tea, rubber and rice. These experiments have proved to be of considerable interest. Among the leguminous plants most commonly used for manurial purposes are several species of *Crotalaria*, especially *striata*, *incana* and *laburnifolia*, *Albizzia moluccana*, *Erythrina lithosperma* or Dadap, *Cajanus indicus*, *Tithonia diversifolia* and various species of *Vigna*. In tropical agriculture it has been found advisable to use in certain cases the arborescent forms in preference to smaller herbaceous plants as green manure, because the former also provide shade and assist in keeping down the weeds. Their large roots also make the soil more porous.

Special attention has been paid to cacao cultivation, and the adaptability of numerous different shade trees in cacao culture have been tested. A large part of the experiment grounds are taken up by cocoanuts and the experiments in cultural methods carried on are being followed with great interest by the com-

Figure 38. Cacao trees at Ceylon Experiment Station.

munity as the cocoanut industry is the second largest in the island.

With the advent of the new rubber industry, part of the rubber experiments, which formerly were conducted principally at Henaratgoda, have now been transferred to the experiment garden and several plots have been planted with various rubber-producing trees.

A number of fibre plants are being cultivated for experimental purposes, and on the side of the neighboring hill, some 700 feet higher than the rest of the grounds, plots of Citronella grass (*Andropogon*) are planted. From this grass the Citronella oil of commerce is obtained, and the suitability of this grass as an intermediate crop between rubber is at present much discussed.

In the office building, rooms are equipped for laboratory purposes and considerable research work is being carried on under the direction of Dr. Willis. The plan adopted for this experiment station is somewhat different from that of other experiment stations in the British Empire, in so far as the various crops are cultivated on a scale sufficiently large to permit of judging as to their commercial feasibility. The product of the station is sold in the open market under the native name of the estate, and the results obtained can thus be compared with those from any ordinary plantation, while in case of usual experiment stations the products receive a higher price on account of the name of the institution.

XII. Henaratgoda Botanic Garden, Ceylon.

In the year 1876 the government of India dispatched a man to Brazil for the purpose of obtaining seeds of the Para rubber tree, and when it was found that the climatic conditions of India were unsuitable, the seeds were sent to Ceylon. They were planted in the new experiment garden at Henaratgoda, some 17 miles from Colombo. This garden is at a low elevation, only about 16 feet above sea level, and the climatic conditions are distinctly tropical. The rainfall here is about 100 inches per annum, and well distributed throughout the year. The mean temperature is about 82° F.

Figure 39. Tapping Para Rubber tree (Hevea Braziliensis) at Henaratgoda.

For a number of years experiments on rubber tapping and preparation had been carried on in these gardens, and the entire rubber industry of Ceylon, such as it stands at the present day, is a direct result of the work at Henaratgoda. Valuable observations have been made, new methods of cultivation have been developed, and the industry promises to become of considerable importance to the islands. It can be said that the Henaratgoda experiments, and those of Mr. Ridley in Singapore have increased our knowledge of the rubber producing plants, especially in regard to Hevea, more than the experimental work of any other institutions in the East. It must also be taken into consideration that no one either at Henaratgoda or Singapore has been able to devote more than a fraction of his time to rubber.

Besides rubber many other economic plants are cultivated at Henaratgoda, but the place is of special interest on account of its old rubber trees, from which all the seeds for the Ceylon plantations have been obtained.

A small laboratory is provided for in the gardens and as a center of botanical work in the low country of Ceylon, Henaratgoda has special advantages. It is close to the railroad and in the neighborhood many botanically interesting localities are within easy reach.

This garden, as well as all the other botanic gardens of Ceylon, are under the direction of Dr. J. C. Willis.

During my last visit to Henaratgoda I specially watched along the railroad some Talipot palms (*Corypha umbraculifera*). The Talipot is one of the most beautiful palms, with a tall mast-like trunk, sometimes reaching a height of over 100 feet. The great semi-circular, fan-like leaves are often as much as 15 feet in radius, giving a surface of about 350 square feet. The natives claim that the Talipot can be used for one hundred and one purposes, the principal ones being as a rain coat and a sun shade. Its use in place of paper has already been mentioned. For this purpose the leaves are cut into strips and afterwards boiled and dried. On these strips of "ola" or paper the history and the religious systems of the people have been handed down to modern times.

When a Talipot palm reaches maturity its leaves decrease in size and finally a gigantic bud nearly four feet in height is developed. This bud bursts open with a report, and an immense inflorescence unfolds itself, appearing like a pyramid of cream-colored flowers rising to a height of 20 feet or more above the leafy crown. Innumerable nuts follow in due course and their appearance is a sign that the tree is nearing its end. It gradually begins to droop, the leaves wither and in less than a year it falls dead.

Figure 40. Areca Palms (Areca catechu) in a Ceylon garden.

Another palm frequently seen throughout the eastern tropics and also cultivated near Henaratgoda is the *Areca* nut palm. These graceful trees with a tall slender trunk and a feathery crest are conspicuous objects of beauty in the tropical scenery. The nuts, produced prolifically in clusters beneath the crown, are used to a great extent, as all the natives are addicted to the habit of betel chewing, and the areca nut forms part of the mixture used for this purpose.

XIII. Hakgalla Botanic Garden, Ceylon.

About six miles from the mountain resort, Nuwara Eliya, the Hakgalla Garden is situated on the steep mountain side, at an elevation of 5,600 feet. This garden was founded in 1860 for the reception of the Cinchona plants which had been introduced from Peru by Sir Clements Markham. The area is about 5,550 acres, part of it being in jungle and a considerable area is covered with grass forming the peculiar *patana* formation typical of Ceylon. The climate of Hakgalla is quite temperate, the mean annual temperature being about 61°.

For many years Hakgalla was simply a government Cinchona nursery, from which seeds and plants were distributed to planters, until the Cinchona industry had attained large proportions. In 1882, however, its transformation into a botanic garden was begun. Mr. W. Nock, who then became superintendent, did much to build up this garden.

A great variety of trees and shrubs from temperate countries and from the mountains of the tropics are cultivated. The garden is nicely laid out and the natural situation just below the mighty crag of Hakgalla, towering to a height of 1,600 feet above the garden, contributes towards making the place one of unusual beauty.

One of the principal features of this garden is the tree fern (*Alsophila crenata*), which occurs in great numbers and is of a large size, sometimes reaching nearly thirty feet, with fronds spreading into a crown some twenty feet across.

Different pines, oaks and other plants of temperate regions

Figure 41. Entrance to Hakgalla Gardens.

intermingle with bananas and other trees of a more tropical nature; ferns and epiphytes crowd on the tree trunks; roses flower as profusely as in Southern France, and orchids of various kinds give the garden a tropical appearance.

A small laboratory building with living accommodation is situated in the garden, which offers an excellent opportunity for work on the hill flora.

During my recent trip to Ceylon I did not go to Hakgalla, but I understand the garden has improved greatly since my visit there seven years ago.

For the purpose of botanical investigations the gardens of Ceylon are admirably situated. The variety in elevation, from near the sea level at Henaratgoda to about 1,600 feet at Peradeniya, and 4,000 feet more at Hakgalla, offers good opportunity for comparative studies of the tropical flora and vegetation under different climatic conditions.

SOME OBSERVATIONS ON THE FLOWERS OF ACER SACCHARINUM.

By W. H. Hein.

The object of this study was to ascertain what structural and physiological variations exist in the flowers and inflorescence of the Silver Maple (Acer saccharinum).

Structural Observations.—It was necessary to examine a large enough number of flowers so that results might be relied upon to give a fair average of the conditions as they exist in the locality where the study was made. Flowers were collected from some thirty individual trees scattered about the city of Lincoln. A close examination was made of each separate flower under a dissecting microscope, and in all doubtful cases the compound microscope was brought into use. As this proved to be a very slow means of getting results, it was necessary, in order to prevent the rather short flowering season from putting a sudden end to further study, to preserve in a 75% solution of alcohol, a very liberal supply of both staminate and pistillate flowers. These were used after fresh material was no longer obtainable, and though less easily handled, were quite as valuable for showing the structural variations. In all, 1000 staminate and about 200 pistillate flowers were examined.

The staminate and pistillate flowers occur in separate clusters but on the same tree, the former being much more numerous. A cluster of staminate flowers contains from three to ten fascicles, each of which in turn, contains five staminate flowers always arranged in a definite pattern with one flower in the center. These five flowers are protected by a series of tomentose scales, ten in number, the outer two of which are early deciduous. The color of these scales varies from a dark reddish-brown in case of the outer ones to a pale green within. The calyx is somewhat five-lobed at the top, rather long and narrow in the staminate, short and broad in the pistillate flower.

Sargent gives the number of stamens present from three to seven, but in the 1000 flowers examined, no flower was found having but three stamens, and only four flowers contained as many as seven stamens. Fourteen per cent. contained four stamens, sixty-five per cent. five, and the remaining twenty-one per cent. had six stamens each. An additional 500 flowers examined for number of stamens only, failed to reveal any more with either three or seven.

The rudimentary pistil is most commonly found in staminate flowers of four stamens. This pistil is usually dwarfed and quite commonly misshapen, but sometimes it is perfect and matures into a well-formed, two-seeded fruit. In flowers bearing five stamens, the pistil is merely rudimentary, consisting of a small knob in the center of the base of the flower, and is covered with long white hairs. Occasionally only the hairs are found. In six-stamened flowers little trace of any rudimentary pistil is found, in many cases even the hairs being absent. In the four flowers which contained seven stamens, absolutely no trace of a rudimentary pistil could be found.

Of the five staminate flowers always found in a fascicle, the central one, if any, generally bears the pistil. Not infrequently, several flowers in the same fascicle are pistil-bearing and in a few cases a pistil was found in each of the five flowers. If, however, but one flower bears a pistil it is the central one, and no pistils are found in other flowers of the fascicle unless the central flower is pistil-bearing.

Wherever a rudimentary pistil is found in a staminate flower, the stamens are generally reduced or are backward in their development. In some cases the stamens themselves remain mere dwarfed rudiments showing no filament whatever, and with the anther less than a half millimeter long. Such flowers, on the other hand, show a rather well-developed pistil. Also, the six-stamened flowers bear larger and healthier-looking anthers than do flowers having a smaller number of stamens.

The proportional number of staminate flowers bearing pistils, either rudimentary or functional, varies greatly in different trees. The first 200 staminate flowers examined, taken from one tree, showed no rudimentary pistil whatever. The next tree from which flowers were gathered showed an average of nearly 12% of all staminate flowers to have pistils. Many trees ranged as high as 7% to 10%.

All pistillate flowers were found to contain stamens, the number of such stamens in a flower varying from one to five. Most of these stamens were functionless, but often one, and sometimes two, produced pollen. In some flowers no stamens whatever were visible, but upon dissection one or more small stamens could be found imbedded in the downy hairs at the base of the pistil. The anthers found in pistillate flowers are always less advanced in their development than the anthers of neighboring staminate flowers; the latter being about three days' growth in advance. The very closest observation failed to reveal a single case where an anther of a pistillate flower had been ruptured and pollen grains liberated, until the pistil had grown to a considerable size and probably had been pollinated from some staminate flower.

Physiological Considerations.—Wherever a pistil of any considerable size is found in a staminate flower it appears quite regularly to be accompanied by a dwarfing of the stamens, or at least their growth is retarded to such an extent that they do not scatter their pollen until some time after anthers in adjoining flowers have burst. Such hermaphrodite flowers often mature their anthers from one to three days later. By that time the stigmas have had every opportunity to become covered with pollen from other flowers.

To ascertain whether pistils found in staminate flowers are ever really functional, several such hermaphrodite flowers were marked and left on the trees. Because of the difficulty of finding these minute structures without detaching or injuring the flower, only eight such specimens were located. These were marked so that the flowers might be readily found again. These flowers were then examined every few days, and it was found that five flowers out of the eight produced seeds at the same time as did the pistillate flowers on the same tree. This proved conclusively that some of the pistils found in staminate flowers are still functional.

To determine whether such hermaphrodite flowers are capable of self-fertilization, further observations were made. Small pieces of court-plaster were rolled up into hollow cones, and with these cones or caps several hermaphrodite "staminate" flowers were covered. When a staminate flower was found containing a pistil, the stamens of the other four flowers in that fascicle were taken out without in any way disturbing the flower to be experimented upon. This taking out of other flowers served also to give more room for growth within the fascicle, should the flower fertilize itself and distend its pistil before the removal of the cap a week later. After these amputations, the little cap was placed over the entire fascicle with sufficient care to avoid any possibility of inflicting a mechanical injury to the sole remaining flower. After the cap was adjusted it was securely fastened by passing a narrow band of adhesive tape entirely around the twig, both ends being fastened to the cap. A week later only four caps remained, the others having been pulled off accidentally. These four remaining caps were removed and the flowers taken from the tree. The calyx was literally filled with pollen from the opened anthers, but the pistil remained a mere rudiment, somewhat shrivelled and no larger than before. In each of the four flowers the calyx was uninjured and the taking out of adjoining flowers probably had in no way interfered with the process of self-fertilization, if it had otherwise been possible. From this evidence it seems probable that self-fertilization does not occur.

A further point investigated was as to whether pistillate flowers are ever self-fertilized. It is well known that all pistillate flowers contain a few, more or less rudimentary, stamens. Close examination shows a few of these stamens to produce pollen, but in every case they are so tardy that by the time the anthers are ready to scatter their pollen, the air is already filled with the pollen from staminate flowers, and the ovaries are already quite distended.

An important fact in cross-fertilization was also observed, namely, that all trees produce their staminate flowers several days earlier than their pistillate flowers. As the time of flowering varies with different trees, one tree may often have shed its pollen before its pistillate flowers are ready to be fertilized and hence a neighboring tree must be depended upon. Staminate flowers were found from March 28th to April 15th, and pistillate flowers from April 5th to April 18th.

In passing, an observation in regard to the fruits may be recorded. Sargent (Trees of N. A., page 638) states that the fruit "ripens in April or May *before the appearance of the leaves*." This statement certainly can not be verified in this locality, nor have I ever seen trees farther east that would bear out this statement. The first fruit ripens in from forty to forty-five days after flowering, or about thirty-five days after the leaves begin to appear. The first pistillate flowers were found on April

5th and the first seeds ripened on May 21st, a period of forty-one days. The first leaves appeared on April 10th and these were for the most part, quite full-grown by the time that the first fruits were matured.

SUMMARY.—To summarize briefly; it is found that many staminate flowers contain pistils of which at least some are functional, but apparently require cross-fertilization. As the number of stamens in the flowers increases, the tendency is away from hermaphroditism and polygamy. All pistillate flowers contain stamens, but these stamens are either rudimentary, or in a few cases where functional, are so far retarded in their growth as to be practically useless. Considerable variation in flower structure and in the time of flowering exists among different trees. There is a strong tendency for the flowers of one tree to fertilize those of another tree, since the pistillate flowers of each individual tree appear several days later than its staminate flowers.

The foregoing evidence suggests that *Acer saccharinum* may only recently have become monœcious and that there is a rather marked tendency towards the production of a large number of stamens, since the six-stamened flowers are doing most of the fertilizing, while the four-stamened flowers are retarded in growth by the pistil. There now appears also to be in this species a tendency from lately acquired monœcism toward diœcism as shown by the fact that staminate and pistillate flowers are produced several days apart, thus inviting cross-fertilization between individuals.

The University of Nebraska.

ALFILARIA IN ARIZONA.

Perhaps the most abundant and wide-spread of the introduced species that have become naturalized in the southwest is the interesting plant alfilaria, *Erodium cicutarium*, a near relative of the geraniums of woods and gardens. In common with a number of other annual plants indigenous to the Mediterranean

Figure 42. Patches of Alfilaria growing at 4,000 feet elevation, near Oracle, Arizona.

region, alfilaria enjoys quite a general distribution throughout the warmer parts of both temperate zones. Its introduction in the New World is believed generally to date back to the time of the Spanish explorations.

The introduction and spread of alfilaria in Arizona forms an interesting chapter in the earlier history of our stock ranges. The occurrence of a prolonged drought over southern California, during 1870 to 1871, resulted in numerous herds of sheep being driven into Arizona where boundless hills and plains, as yet little grazed, afforded timely relief from them in addition to an abundance of range for years to come. These animals carried in their fleeces a liberal quantity of alfilaria seed from the mesas of southern California where the plant had been growing plentifully since the memory of the earliest settlers. Two or three years later alfilaria appeared in quantity along certain frontier stage and freight roads over which the sheep had been driven.

From these original scattered patches of the plant, some of which may have been due, also, to the feeding of freighting teams along the way, alfilaria was spread by the ever-increasing herds, at first to the adjacent districts and later to the more remote parts of the territory.

The rapidity with which it has become more or less dominant over considerable areas in Arizona and other southwestern parts, in competition with the less ambitious native annual species, indicates that it is remarkably well adapted to our environment. Its seeds germinate at almost any time during the cooler months of the year, at which period on account of the greatly lessened evaporation, moisture conditions are most nearly uniform. The young plants soon develop into close, many-leaved rosettes at the centers of which flower buds appear as early as January. In virtue of this winter rosette growth alfilaria plants are able to bloom by the time the seeds of many of the slower growing species are beginning to sprout. Thus our mild winter temperature, combined with winter and early spring rainfall, are factors entirely essential to the successful growth of alfilaria. In all the above desirable qualities alfilaria is similar to the indigenous winter annual species for which this flora is noted.

Its larger rosettes, however, develop a deeper and more extensive root system than that of the native plants; also, its hairy seeds, which are provided with curved, sharp pointed bases, are admirably fitted to stick to the coats of such animals as sheep, to whose agency it owes much of its present distribution; and lastly, a good percentage of its seeds literally plant themselves even in such unfavorable situations as worn roadbeds, washes, etc. All these are important characters for a plant growing in this region to possess.

The matter of self-planting is accomplished by the spirally twisted awns of the seeds which are hygroscopic, thus rolling and unrolling with the changes of moisture in the air from day to day. Small objects, as stems of the floral covering or even masses of the seeds themselves, may act as fulcrums against which the moving awns brace, which action by degrees forces the seed into the ground.

In order to observe more fully these hygroscopic movements, the writer camped for several days in the vicinity of large alfilaria patches about Oracle, Arizona. At the close of a dry, hot day the awns were coiled tightly in the usual spiral manner, thus giving a nominal coherence to the abundant seed masses. The next morning at 4:00 o'clock, the formation of dew having been copious, the awns were everywhere observed uncoiled and pliable from the large amount of moisture taken up. With the rising temperature of the morning, the moisture being gradually dissipated, the hygroscopic movements of the awns became apparent, at first slow, later very active so as to give to the seeds curious, twisting or writhing movements. About noon this came by degrees to a close, leaving the seeds in about the same condition as on the previous afternoon. Thus continued, from day to day, the interesting process of seeds actually planting themselves.

J. J. THORNBER.

The University of Arizona.

NOTES ON SPIDER-FLOWERS.

Some years ago when botanizing on the high plains of western Nebraska in a period of very hot, dry weather, when many plants were more or less wilted on account of the lack of moisture in the soil, I noticed the peculiar appearance of plants of the common Spider-flower *(Cleome serrulata)*. The branching stems of this species bear trifoliate leaflets upon petioles of considerable length, the leaflets normally spreading at the summits of the ascending petioles. Now, under the stress of a scanty water supply, these leaflets, instead of falling limply in wilting, actually stood up erect. That is, this plant wilts *up* instead of *down*.

Another species *(C. spinosa)* is remarkable for the great length of its stamens, which are often from four to six or more centimeters long. I have been interested in watching the opening of these curious flowers, and especially the emergence of the long stamens. When the flower bud is about full grown the claws of the tightly wrapped petals elongate, and at the same time the filaments, also, elongate and crowd the anthers against the closed top of the corolla. The result is that the cluster of stamens soon begins to bow out between the petal claws, while the pressure causes the petals to bend over to the opposite side, giving the flower its "lop-sided" appearance. For some reason, not made out, the stamens push out from the *lower* side of the flower bud, so that when open the four petals are above and the six spreading stamens are below. Incidentally it may be recorded here that the stamens in this species are not equidistant upon the receptacle, but when one looks down into the open flower he finds three closely inserted filaments on each side, with a distinctly greater interval between the stamens above and below.

CHARLES E. BESSEY.

The University of Nebraska.

NEW SOIL STUDIES.

It is a curious fact that, while the relation of the plant to the soil in which it grows is one of the most important among the environmental relations of the organism, yet plant physiologists and ecologists have so far paid almost no attention to the details of the nature and behavior of the soil solution. This is perhaps due to the extreme difficulty of the problems involved, but they are seemingly no more difficult than the problems of absorption, photosynthesis, etc., with which botanists have successfully grappled. The work so far accomplished has been done almost entirely by students of agriculture who are not primarily interested in the science of botany but in its applications.

For some years the members of the laboratory staff of the Bureau of Soils of the U. S. Department of Agriculture have been following this line of inquiry in a truly research spirit, and have brought out a number of valuable contributions. In Bulletin No. 41 of that Bureau, Frank K. Cameron and James M. Bell present the results of a study of "The Action of Water and Aqueous Solutions upon Soil Phosphates." The discussion lies mostly in the realm of physical chemistry, as must naturally be the case, but direct application of the facts brought out is made to the theory of fertilizer practice in agriculture. "The phosphates of the soil * * * are of such a nature as to yield a solution containing very small quantities of phosphoric acid. * * * The least soluble phosphates are the ones which will be formed and will control the concentration of the soil moisture. This fact, together with the well known phenomena of absorption, gives a satisfactory explanation of the observation that the concentration of the soil moisture is low and varies but little for different soils and with the total amount of phosphoric acid in the soils. For the same reason, the addition of phosphatic fertilizers can not be expected to influence materially the concentration of phosphoric acid in the soil moisture. The action of phosphatic fertilizers is, therefore, on the soil and not primarily on the plant; for the concentration in plant food constituents of the solution on which the plant feeds is not materially altered by the addition of phosphatic fertilizers in the amounts used in ordinary field practice." B. E. L.

Few scientific theories have stood the test of time and experiment so long and gained such universal acceptance as the Liebig theory of soil fertility. Nevertheless, recent investigations seem to indicate that this conception is likely to undergo considerable modification in the near future, suggesting that the "exhaustion" of many soils may be due, not so much to the withdrawal of mineral constituents as to the accumulation of certain organic toxic substances. This idea is not a new one, for as long ago as 1832 DeCandolle stated that many plants give off in their growth substances which are injurious to themselves and to closely related plants, but harmless to others. This conception, based on insufficient evidence, as it was, did not gain acceptance, but has smouldered along in agricultural science ever since, flickering up occasionally only to be smothered for lack of experimental proof.

During the last few years, however, a great deal of new evidence has been presented in favor of DeCandolle's idea. In 1897, and subsequently, investigations at the Woburn Experimental Fruit Farm, in England, have shown that the presence of grass in the soil about apple trees has a marked deleterious effect upon the growth of the trees. It was shown experimentally that this effect could not be due to removal of nutrient materials nor of water, nor to the exclusion of air, and it was suggested that it must be caused by poisonous bodies emanating from the grass roots. A similar antagonism has been shown to exist between butternut trees and cinquefoil, and between peach trees and several herbaceous plants. In 1904, Livingston published evidence to the effect that bog water exhibits properties of a toxic nature and suggested that the xerophilous character of bog plants may be due to these properties.

For our knowledge of the presence of toxic substances in agricultural soils we are largely indebted to the work of the U. S. Bureau of Soils. In Bulletin 23 of this bureau, it was shown that the unproductiveness of certain soils examined could not be attributed to any lack of available mineral matter, and that the injurious properties of the soil could be transmitted to its aqueous extract, independent of the salt content. In later publications from the same bureau, evidence was presented in favor of the idea that certain poor soils contain toxic substances which act to retard the growth of roots. Further evidence favored the conclusion that wheat roots give off substances toxic to themselves, and that this toxicity, as well as that of the soils mentioned above, can be removed from nutrient solutions or soil extracts by the absorbent action of carbon black, ferric hydrate, and other finely divided inert solids. In Bulletin 28 it was shown that when a nutrient solution becomes "exhausted," so that plants grow but poorly in it, it is greatly improved by treatment with carbon black, etc., the suggested explanation being that the roots first grown in the solution gave off substances injurious to themselves, and that these substances were removed by the absorbing action of the finely divided solids.

Two recent bulletins (Nos. 36 and 40) from the Bureau of Soils have contributed more information on this subject. In Bulletin 36, Livingston and others give more evidence in favor of the existence of toxic bodies in unproductive soils and add certain points as to the nature and origin of such substances. The conclusion is that toxic material is present in certain unproductive soils, either in very minute quantities or in a very slightly soluble form; that this material is volatile in some cases and in others non-volatile; that it is often destroyed by boiling the soil extract in which it occurs; that it is often accompanied by an acid reaction of the extract, but that in such cases the toxicity is not due to the acidity as such; that it is probably organic in its nature; and that it is absorbed by finely divided solids. As to the origin of such material, it is shown that toxic properties appear not only in nutrient solutions in which wheat is growing, but also in pure sand when this is used as a medium for growth. Similar substances appear to diffuse from soaking wheat seeds, and a similar toxicity is exhibited by the washings from the leaves and bark of certain trees.

In Bulletin 40, Schreiner and Reed show that agar-agar, in which the roots of wheat have been allowed to grow, soon becomes injurious to these roots. Agar-agar in which maize roots have grown is injurious to wheat, but not to so marked a degree as that rendered injurious by the growth of wheat itself. In pointing out the logical conclusion that the physiological action of the used agar-agar must be due to excretion from the first crop of roots, the authors call attention to the analogy between this supposed excretion by roots and the well-known excretion of toxic substances by bacteria.

The importance of all this to scientific agriculture is evident, and the changes that these considerations may bring about in the theory of soil fertility may be very profound. The beneficial effects of crop rotation may be explained equally well from the standpoint of the Liebig theory or of this newer one, and this may explain why the phenomena of toxic excretions have so long escaped serious consideration. It appears that the Liebig theory has been pushed rather farther than necessary, but how far it is to be supplemented or replaced by the new conception is at present only a matter of conjecture. There are enthusiasts on both sides of the argument. W. B. McC.

A DISEASE OF SYCAMORE TREES.

Sycamore trees (*Platanus occidentalis*) are suffering from a fungus or a cold spring season in parts of New Jersey and in eastern Pennsylvania. The early leaves are shriveled and dark in color and the trees appear dead excepting for a few green tips. The farmers attribute it to the cold spring. The fruit buds have escaped in many instances. Out of about seven hundred trees observed in the region mentioned, less than fifty have escaped marked injury, the rest having lost at least three-fourths of their leaves. Those which have suffered least are those under thirty feet in height and growing in sheltered locations.

If a fungus is responsible for the appearance of these trees, the question arises, why does not isolation play a more important part? I know of no single tall tree which has escaped almost complete defoliation. Would the action of a fungus account for the fact that in the least injured trees the lower branches (which are most protected from the cold) have all suffered somewhat?

JEAN BROADHURST.

The diseased condition referred to in the above note is due to a fungus, "the active vegetative portion of which lives within the leaves and twigs; the fruiting portion appearing in brown patches on the twigs or veins of leaves that have been killed. The effects of the fungus are usually not lasting except in the case of trees already weakened by disease or starvation." (W. A. Murrill, in Jour. N. Y. Bot. Garden, July, 1907.) The fungus is *Gloeosporium nervisequum Sacc.* according to Murrill.

F. E. L.

Prof. William L. Bray has resigned the professorship of botany in the University of Texas to accept the newly created chair of botany in Syracuse University.

Dr. Harold P. Lyon, of the Botanical Department of the University of Minnesota, has gone to Honolulu to accept a position with the Hawaiian Sugar Planters' Association.

Mr. E. E. Free, of the Arizona Experiment Station, has been appointed to a position on the staff of the Bureau of Soils of the U. S. Department of Agriculture. He will have his headquarters in Washington.

Mr. W. H. Ross, of the Chemical Department of the University of Chicago, who has held a research fellowship of the Royal Society of London for three years, has become Assistant Chemist at the Arizona Experiment Station.

The Mississippi Valley Laboratory of the Bureau of Plant Industry, of the U. S. Department of Agriculture, has been abolished, and the work in forest pathology will now be carried on by the Laboratory of Forest Pathology, of the Bureau of Plant Industry. This new laboratory will be located in Washington, and is under the direction of Dr. Haven Metcalf. Associated with Dr. Metcalf are Drs. George G. Hedgecock and Perley Spaulding, both formerly of the abolished Laboratory. Dr. Spaulding is at present at the New York State Forestry Nursery, Saranac Inn, N. Y., working upon a serious damping-off disease.

Prof. Francis E. Lloyd has taken up the work of his new position as Director of Investigation to the Inter-Continental Rubber Co., of Jersey City, N. J. He will have charge of investigations upon useful plants. He may be addressed at Hacienda de Cedros, Mazapil, Zacatecas, where the Laboratory of the Continental-Mexican Division is to be established.

Prof J. E. Kirkwood has relinquished the chair of Botany in Syracuse University, and has accepted the position of Assistant Botanist to the same company. He may also be addressed at Hacienda de Cedros.

There has just been issued a volume entitled, Lectures on Plant Physiology, by Dr. Ludwig Jost, translated from the German by R. J. Harvey Gibson, M. A., F. L. S. It is a book of 564 pages, in the splendid style of the Clarendon Press, and recalls in its scope and grasp the monumental work of Pfeffer, with which all students of botany are familiar. Every plant physiologist will welcome this important addition to the literature.

Experiments with Plants, by W. J. V. Osterhout, published by the MacMillan Company, is a useful book and worthy of special mention by reason of the facility which it lends itself to experimental work in plant physiology. The most striking feature of the book is the simplicity of the apparatus required and the multiplicity of the experiments outlined.

A second and revised edition of a University Text-Book of Botany, by D. H. Campbell, has lately come from the press of the MacMillan Company.

The next meeting of the American Association for the Advancement of Science will be held during Convocation Week, at the University of Chicago. The sessions of Section G (Botany) will take place in the Hull Botanical Laboratory. Inasmuch as the Secretary of the Section is at too great a distance for quick mail service, it is particularly requested that titles of papers to be read be sent directly to Dr. Henry C. Cowles, University of Chicago, Chicago, so that the Secretary, upon his arrival, may have all business promptly in hand. Affiliated botanical societies are invited to hold their sessions in the Hull Botanical Laboratory.

The Horticultural Society of New York has issued a preliminary program of the International Conference on Plant Hardiness and Acclimatization, to be held in New York City, Oct. 1, 2 and 3. Among the titles listed are to be noted the following of general interest: Factors affecting the seasonal activities of plants, by D. T. MacDougal; Factors that control acclimatization, by M. C. Cowles; Evaporation as a climatic factor influencing vegetation, by Burton E. Livingston; Air drainage as affecting the hardiness of plants, by E. A. Bessey; The real factors in acclimatization, by F. E. Clements; Plant improvements needed in specific cases, by W. M. Hays; Studies on the acclimatization of plants in the prairie regions, by L. H. Pammel; Experiments in plant acclimatization in Alaska, by W. H. Evans. The paper by Dr. MacDougal will be printed with three full page illustrations in the October number of THE PLANT WORLD.

A party from the Desert Laboratory, accompanied by Professor J. P. Goode, of the University of Chicago; Dr. H. N. Whitford, of the Bureau of Forestry of the Philippines, and Dr. W. B. MacCallum, spent two weeks in September in operations at the elevated mountain plantations connected with the Desert Laboratory in the Santa Catalina Mountains. A great number of acclimatization exchanges have been effected and a few species are now growing over a vertical range of a mile.

Professor and Mrs. V. M. Spalding are in Washingotn for the purpose of consulting the collections of the U. S. National Museum.

Dr. D. T. MacDougal lectured at the Brooklyn Institute on the evening of October 4, and at the New York Botanical Garden on the afternoon of the 5th on the Salton Sea and the changes in the vegetation of the enclosing basin.

Dr. J. Arthur Harris, of the Missouri Botanical Garden, has accepted a position on the staff of the Station for Experimental Evolution at Cold Spring Harbor, in place of Dr. E. N. Transeau.

Professor James W. Toumey, of the Yale School of Forestry, and formerly botanist of the University of Arizona, spent a portion of his summer vacation in Southern Arizona.

Dr. David Griffiths of the Bureau of Plant Industry, Washington, D. C., spent several days in September at Tucson to continue range investigations in the Santa Rita Mountains.

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FACTORS AFFECTING THE SEASONAL ACTIVITIES OF PLANTS.

By Dr. D. T. MacDougal.

DISTRIBUTION AND ACCLIMATIZATION.

Every species inhabits the areas which it has been able to reach and occupy from the starting point of its place of origin. Neither its birthplace or any of the places within its range may offer the most suitable conditions for the best growth and highest development. Beyond seas, over mountain ranges, across the equator or past other equally effective barriers may lie plains, valleys, plateaus or even continents, where if once introduced, it might overbear all competition from the plants already there, extending its distribution a thousand-fold and the number of its individuals a million-fold. Let the barriers be but once passed and it enters into a new kingdom, as the various invasions of weeds amply testify.

The soil, the various factors of climate, the course of the seasons, and the actual composition of the plant-covering already present in the region, may be such that the intruder becomes an integral part of the flora, and it may indeed perish in its original habitat and in the places successively occupied by it, leaving us no clew as to its place of origin.

The value of a cultivated plant is fairly co-ordinate with the extent of its possible distribution and culture. Not only does its greater cultivation bring a greater total product, but the greater the crop the better developed may become the facilities by which it and all of its constituents are used to the fullest, and to the greatest economy by the human race.

Our conscious efforts to widen the range of distribution and extent of cultivation of species of interest and economic value facilitates and aids one of the most basal processes in the life of the plant, and it has before it the possibilities of limitless success, to compensate for the numerous failures which the worker must necessarily encounter.

Two main considerations confront us in the problems of acclimatization. First, a careful examination reveals the fact that nearly every species in the wider usage of the term includes several races or elementary species, which bear different hereditary qualities as to hardness, capability for accommodation, rapidity of growth and productiveness. Careful cultures enables a comparison to be made among a group of such forms and to select those which bear the desired qualities to make an introduction or acclimatization operation successful. Perhaps the necessary qualities may be discerned in separate races of elementary species, and by hybridizations these qualities are brought together into races or species capable of meeting the conditions to be encountered. To recount, or even adequately illustrate the triumphs and accomplishments of the horticulturist by methods for the most part very crude, during the last century, would be impossible.

Now, however, by the light of present knowledge, profiting by the splendid results of Nilsson with cereals, all such operations may be carried out with much greater exactitude and much more rapidly than by the old-time method of trial and error, most wasteful of skilled energy and time-consuming in human life. To-day we may expect as much from the breeder in ten years as he might have been able to accomplish in the previous half century. The realization has been tardily reached that if we are to make alterations in the hereditary qualities of the plants useful to us, we must make an accurate analysis to disclose the constituents of the species with which we are dealing, and having this information we may proceed with the exactitude of the chemist making compounds and extractions in his laboratory.

With so much to our credit in the way of advance made in knowledge of the nature of the plant and its behavior, the other important task which confronts us is that of making a similarly exact study of climate and of all of the factors which constitute the complex set of conditions which we term environment.

A simple analysis of the relations of a plant to external conditions will be useful for a better understanding of the character of the problems involved. The principal factors affecting vegetation are undoubtedly light, temperature, moisture, food-material and chemical composition and physical consistency of the soil. It is obvious to the veriest novice in gardening that certain intensities or concentrations of these agencies are necessary for the welfare of the plant, and that the combinations suitable for one are not for another.

It will be impossible to give even a brief consideration of the special relations of each of these factors to the plant, but we may gain an insight into their general character by a consideration of the more important details with respect to temperature, which is one of the most widely interlocking elements of climate. The conclusions derived from its consideration may be held to apply to the other agencies as well.

Living matter is an extremely complex substance and we must be prepared therefore to find that its relation to its environment is not simple; this is especially marked with regard to temperature.

CARDINAL POINTS IN TEMPERATURE.

All of us know by every-day experience that there is a certain general degree of heat at which any given species grows best, and a discrimination as to the application and regulation of temperature constitutes one of the most important features of the practice of greenhouse gardening. This temperature, which is customarily termed the *optimum*, may be ascertained to within a degree or two very easily. If the heat be increased in a greenhouse in which a plant is happily growing at the *optimum*, it will soon be found that such increase lessons the rate and amount of growth, and a continued increase will soon bring the thermometer to a point where a *supra-optimum* will be reached at which growth ceases. This may simply bring the plant to rest as might the cold of autumn, and with but slight damage. But if the heat be increased still further a third point will be found at which the plant is killed and by such a test we will have ascertained the point of *fatal heat*.

Starting again with a plant at the *optimum* it will be found that as the temperature decreases, growth slows down until an *infra-optimum* is reached at which growth ceases as it did at a certain point above; still, we believe this is the temperature of *fatal cold* at which living matter is totally disorganized.

Our efforts at acclimatization and our work in securing the feature of hardness in plants, with respect to temperature, consist in operations by which the position of the cardinal points of the plant with which we may be working may be altered on the scale of the thermometer. These cardinal points undergo wide changes in a state of nature, and it is by taking the inherited capacity for adaptation of any plant with regard to this particular into account that we may hope to make our greatest progress. First of all it is obvious that these five critical points in the life of any plant change with the development of the individual, and that the *optimum* slides up or down to scale, or all open out more widely. Take any plant such as the radish, wheat, squash or sunflower, and it has been found that seed or grains air-dry, and in resting condition, may endure the lowest cold that can be produced, that of liquid hydrogen at about 454 degrees F. below the freezing point of water, which proves that the fatal cold in such cases, is extremely low, and to have only a theoretical existence. The same seeds in a resting and dried condition may be subjected to the heat of boiling water at 212 degrees F., so that the points of fatal heat and cold lie far apart in this stage of the existence of the plant. Now give them a supply of moisture and start germination, and a radical change in the position and relation of the critical points ensues. A cold fatal to the active seedling will be found near the freezing point of water, and but slightly below the *infra-optimum*, the *optimum* will be found to lie between 80 degrees and 98 degrees F., the *supra-optimum* and cessation of growth will be found between 100 degrees F. and 120 degrees F. for most plants, although many species, especially those native to the desert, range higher, while a fatal heat comes within a few degrees above the *supra-optimum*.

As the plant nears maturity, the tissues harden, the protoplasm becomes more highly granulose and denser, and has an altered chemical composition, by which it again becomes less susceptible to alterations, and again the cardinal points take positions more widely separated from each other, and in the seed are again able to endure any cold which they may encounter.

THERMAL REQUIREMENTS OF A PLANT.

This brings us at once to the consideration of the practicability of some estimation of the thermal constant of any form, or the amount of heat necessary for its seasonal or cyclical development. The first effort toward fixing any such standard appears to have been made by Reaumur, the inventor of the thermometric scale which bears his name. He adopted the sum of the mean daily temperatures, as recorded by his thermometer in the shade, as an index of the amount of heat required to bring a plant to any given stage of development, using averages of the daily maximum and minimum to obtain his mean daily temperatures. According to Abbe, Reaumur calculated that the sum of the averages constituting the heat exposure of a plant at his locality in France during the 91 days of April, May and June, 1734, to be equivalent to 1160 degrees C., but in the following year it amounted to only 1015 degrees C.

Adansonn disregarded all temperatures below freezing, taking only the sum of the positive temperatures on the centigrade scale, and began the summation of heat exposures thus derived with the 1st day of the calendar year for any given season.

Boussingault attempted to derive the thermal constant of a vegetative period, or any part of it, by multiplying the mean temperature of the air by the duration in days.

Gasparin calculated thermal constants from temperatures obtained from insolation thermometers exposed to direct sunlight while lying on the sod, which would record 20 degrees C. to 30 degrees C. higher than shade temperatures, and showing a difference equivalent to three to six degrees latitude. By this method, the thermal constant required for the germination and maturity of the seed of wheat amounted to 2450 degrees C.

Variations in the method of calculation of the thermal constant have been made by various investigators, in which this standard has been obtained by multiplying the mean temperature by the square of the number of days involved, others multiplying of days by the square of the mean daily temperatures. Some begin this calculation of the heat exposure with the appearance of the earliest species to show sign of awakening activity.

As an application of the principle of the thermal constant many bio-geographers have attempted to explain distribution by the mean annual temperature to the regions concerned. Among the most notable of such works is to be mentioned that of Hoffman of Giessen, South Germany, who used the sum of the insolation temperatures from the 1st of January in calculating the thermal constants, and it is his data which are quoted so freely in all general treatises on plant geography and the thermal relations of vegetation. Drude uses the mean annual temperatures in his treatment of the subject, in which he is followed by Pound and Clement in their Phytogeography of Nebraska.

It need scarce be said that the data accumulated by the various methods described during the last century and a half is confusing on account of the highly empirical character of the principles upon which each separate investigation has been based, the different standards of thermometry and the utter lack of uniformity of technique. The last defect alone is sufficient to invalidate most of the results, which are nearly all valueless so far as any application is concerned, in this connection. Concerning the futility of research upon this subject it is most significant that Warming and Schimper refuse to recognize the thermal constant as a definable factor in the relations of plants to climate.

In the effort to outline some method for the calibration of heat exposure of plants growing in the open, the work of Herve Mangon seems to offer the most valuable suggestions. Mangon computes all shade temperatures from the time of germination of seeds of the plants produced were mature, disregarding all measurements in which the mean daily temperatures is less than 6 degrees C (42 F.). By this method he found the sum of mean daily temperatures necessary for the ripening of wheat in Normandy in 1870-1879 to vary between 2219 and 2517, and with the data of several seasons at hand it was possible to predict the date of ripening of wheat within three or four days.

The great variation shown by a plant with regard to the heat exposure calculated by Mangon's method is in all probability due to the faulty method of calculating such exposures. The performances of an engine are not to be calculated by the total averages of the steam pressure during its working days, but may be quite exactly determined by multiplying the pressure by the number of hours during which pressure was kept up and used.

A similar relation holds with regard to the use and effect of radiant energy in the plant, and although any method of estimation must be more or less arbitrary, yet it seems possible to select one which will be capable of wide application and corresponding value. In the evolution of such a method for plants in the temperate zone it seems less artificial to begin the calculation of the heat exposure with the winter solstice instead of January 1st, and as has been done by several writers, or if economic plants are under consideration, take the date of planting as a starting point. It also seems most convenient to use the temperature of the freezing point of water as a base line for the thermometry of the plant.

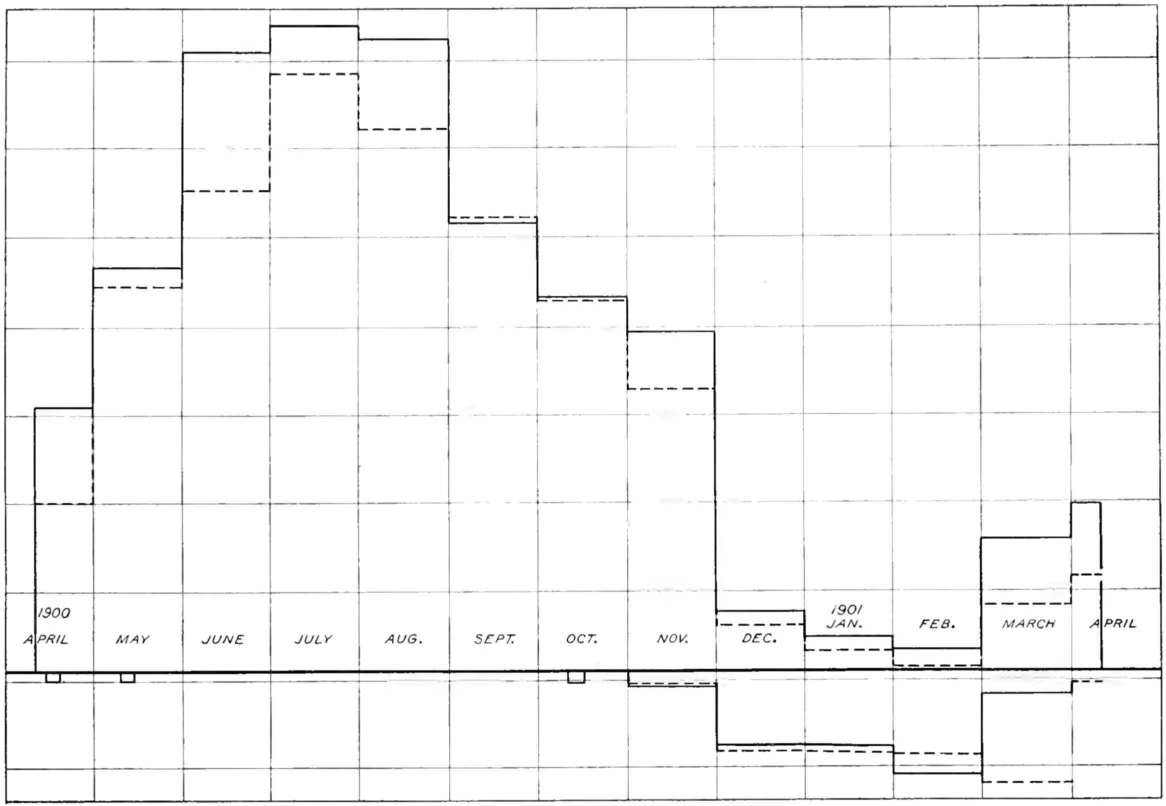

Figure 43. Total heat-exposure in N. Y. Botanical Garden, April, 1900, to April, 1901. The areas above the heavy base line enclosed by the solid lines represent the total heat exposures in hour-degrees-centigrade, of the herbaceous grounds. The areas above the base line limited by the dotted lines, denote the exposure in the hemlock grove. Exposures below the freezing point in both localities are similarly represented below the base line.

The application of the method then simply entails the calculation of the number of hours to which a plant has been exposed to temperatures above the freezing point from the winter solstice or other starting point until the stage of development, such as flowering or fruiting, under consideration has been reached. The time factor is then properly applied to the height of the thermometer above the freezing point during the period mentioned. In actual practice this may be easily done by computing the area enclosed by a thermographic tracing of the temperature and the base line of the sheet for the period over which the development of a plant is to be studied by means of a planimeter. It was found by this method that the flowers of *Acer saccharinum* were mature and ready for fertilization on March 26th, 1901, in the New York Botanical Garden, after 1100 hours' exposure to temperature above zero with a totality of 3109 hour-centigrade units: *Draba verna* attained the same stage something earlier in 974 hours, with 1644 hour centigrade-units exposure.

Now, it is by no means to be assumed that the above data represents the fixed and invariable constant heat exposure of the plants in question, for as has been described previously, the cardinal points, including the *optimum* for growth and development may be altered by other conditions which affect the plant. The variation on which a plant is capable represents its possible geographical range which may be mapped with fair accuracy. Thus the individuals of a species which live nearest the pole have made such accommodations that they are able to accomplish development with a minimum number of heat units, in a minimum number of hours. As the range of a species is traversed toward the equator or to lower elevations, a place is reached where the heat exposures are at an *optimum* for the plant, and beyond this, development is retarded until the southern limit of the species is reached. The actual limits are of course determined by the entire complex of conditions, of which insolation is also an important factor, but for the sake of clearness, attention is focussed upon temperature alone.

The gradual accommodation and acclimatization of grains to regions to the northward has nowhere been more systematically studied than in the Scandianvian peninsula, and Schubeler's consideration of available results led to the conclusion that corn from lower latitudes or elevations ripened earlier when taken northward and upward, although the light and average temperature was less. This precocity in development persisted for some time, when seeds were taken back to the southern localities. In some cases the seeds and sometimes the leaves reached a greater size if the conditions permitted full development in the northern extensions, but this accommodation was not carried to the first generation in plants in the south from northern grown seeds. It was also noted that the colors of various organs as well as the aroma was increased in plants taken northward if the introduction did not go beyond the limit of conditions allowing full development. (Schubeler, F. C. Viridarum Norvegicum. Norges Växtrage. Et Bidrag til Nord-Europas Natur-Og Kulturhistorie.1. Christinia, 1885. Rev. in Bot. centralb. :28 203.1886.)

The relation of the plant to negative exposures is one of endurance and not of performance, and the interpretation of the influence of cold upon distribution may not be made by the formula given above. The total amount of negative on cold exposure is undoubtedly the predominating one, but the minimum, the range in variation, and the occurrence of minima below the freezing point during the vegetative season, are also of importance in distribution and await the acquisition of additional data before their interpretation may be attempted successfully. Some of these factors are extremely localized, and the poleward limit of distribution in the northern hemisphere of many species is known to run in extremely irregular lines.

Some illustration of this is gained from the results of the comparative study of the climate in the hemlock grove of the

New York Botanical Garden and the meadow of the herbaceous grounds, not more than 500 yards distant made in 1900 and 1901. The data obtained shows that the meadow carpet received 78836 hour-degrees of heat during the year ending April 1, 1901, extending over 7282 hours of exposure to temperatures above the freezing point, while the hemlocks received but 68596 similar units with an exposure to temperatures above the freezing point for 7024 hours. The meadow was exposed to 5569 units of temperature below the freezing point and the hemlocks 5791 units. The herbaceous grounds were below the freezing point for 1478 hours, and the hemlocks for 1736 hours.

Here, then, in two localities within rifle shot are to be found two habitats for plants in which the difference in the length of the season as indicated by the number of hours above the freezing point amounts to nearly eleven days, the total number of heat units in the meadow being 13 per cent. in excess of that of the forest. The maximum and average maximum of the meadow are higher, and the minima and average minima are lower, the mean average of the hemlocks being lower, however, than that of the meadow. The value of such observations is greatly enhanced by the fact that they represent a comparatively narrow range of variation. Thus, in the several years in which observations were made as to the matter, the length of the period between the last frost of spring and the first of autumn lay between 167 and 171 days in the New York Botanical Garden.

The data upon which these conclusions rest are shown in the accompanying tables. The amounts given under "total exposure" represent the product of the number of degrees above freezing point multiplied by the number of hours. The value of the centigrade-hour-unit represented in such amounts is 9/1600, and of Fahrenheit hour units 81/8000. The number of hour units is therefore to be found by simple division. + indicates temperature exposures above freezing. — below freezing.

THERMOGRAPHIC OBSERVATIONS IN N. Y. BOT. GARDEN, 1900-01.

Date	HERBACEOUS GROUNDS. Total Exposure	Number of Hours	HEMLOCK GROVE. Total Exposure	Number of Hours
April 9 to 16	+4.25	149	+3.50	152
	— .14	19	— .08	16
April 16 to 23	+9.50	168	+8.47	168
April 23 to 30	+8.45	168	+7.56	168
April 30 to May 7	+7.75	168	+8.50	168
May 7 to 14	+9.45	164	+10.25	168
	— .02	4		
May 14 to 21	11.56	168	10.91	168
May 21 to 28	12.37	168	11.76	168
May 28 to June 4	12.50	168	11.66	168
June 4 to 11	12.85	168	11.77	168
June 11 to 18	13.00	168	12.10	168
June 18 to 25	15.21	169	12.93	169
June 25 to July 2	16.32	167	14.17	167
July 2 to 9	16.85	168	15.16	168
July 9 to 16	15.80	168	15.42	168
July 16 to 23	17.73	168	15.19	168
July 23 to 30	15.35	168	14.42	168
July 30 to Aug. 6	14.46	168	13.00	168
Aug. 6 to 13	18.86	168	15.94	168
Aug. 13 to 20	15.66	168	14.10	168
Aug. 20 to 27	15.27	168	14.29	168
Aug. 27 to Sept. 3	16.36	168	15.17	168
Sept. 3 to 10	15.84	168	14.93	168
Sept. 10 to 17	13.25	168	13.24	168
Sept. 17 to 24	10.21	168	9.81	168
Sept. 24 to Oct. 1	12.35	168	10.12	168
Oct. 1 to 8	13.30	168	11.80	168
Oct. 8 to 15	9.30	168	8.56	168
Oct. 15 to 22	+6.25	159	+5.95	168
	—0.15	9	....	
Oct. 22 to 29	+10.25	168	+9.90	168
Oct. 29 to Nov. 5	7.16	168	7.70	168
Nov. 5 to 12	+4.30	156	+4.50	168
	— .24	12	....	
Nov. 12 to 19	+4.40	138	+2.90	135
	— .41	30	— .50	33
Nov. 19 to 26	+7.50	168	+6.05	168
Nov. 26 to Dec. 3	+2.86	146	+2.80	155
	— .65	22	— .30	13
Dec. 3 to 10	+3.15	133	+1.95	138
	— .71	35	— .50	30
Dec. 10 to 17	+ .60	32	+ .35	22
	—3.60	136	—5.90	146
Dec. 17 to 24	+1.50	74	+1.27	48
	—2.25	94	+1.28	120
Dec. 24 to 31	+1.50	90	+ .90	65
	— .85	78	— .90	103

Date— 1901.	Herbaceous Grounds. Total Exposure	Herbaceous Grounds. Number of Hours	Hemlock Grove. Total Exposure	Hemlock Grove. Number of Hours
Dec. 31 to Jan. 7	+ .80	68	+ .50	40
	—2.10	100	+2.84	128
Jan. 7 to 14	+ .80	140	+ .60	126
	— .60	28	— .40	42
Jan. 14 to 21	+1.10	68	+ .65	46
	—2.60	100	—2.70	122
Jan. 21 to 28	+ .80	102	+ .50	42
	— .60	66	—1.00	126
Jan. 28 to Feb. 4	+2.25	20	+ ...	...
	—4.00	148	—3.55	168
Feb. 4 to 11	+ ...	...	....	...
	—4.30	—168	—4.80	168
Feb. 11 to 18	+ .50	— 56	+ .20	32
	—2.20	—112	—2.10	136
Feb. 18 to 25	+ .50	36	+ .20	14
	—1.50	—132	—3.00	—154
Feb. 25 to Mch. 4	+1.50	88	+1.20	76
	—1.20	— 80	—1.50	— 92
Mch. 4 to 11	+1.80	102	+1.20	108
	—1.70	— 56	—1.65	— 60
Mch. 11 to 18	+2.40	149	+1.40	145
	— .30	— 19	— .20	— 23
Mch. 18 to 25	+3.60	154	+2.70	149
	— .10	14	— .20	19
Mch. 25 to April 1	+7.56	162	+2.65	141
	— .10	— 6	— .25	— 27
April 1 to 8	4.70	168	3.41	168

STIMULATION AND ACCOMMODATION.

There yet remains to be considered the stimulative reactions and accommodations of the plant under changes in the environmental forces which act upon it. Generally speaking, it may be said that sudden changes in the intensity with which a force acts upon a plant results in stimulation, and that gradual alterations are followed by accommodations, and that such adjustments or adaptations may be produced by the long continued uniform action of any external factor.

A striking example of stimulation followed by accommodation is offered by the sensitive plant, and the well-known response of this plant to a touch or blow consists in folding movements of its leaves and leaflets. In repeating the test of it, perhaps this blow may be given by a drop of falling water, or by a slender pencil. Now place a healthy plant under a fine shower nozzle from which water not too cold will fall in thousands of repetitions upon the same leaves. The first of the mimic shower causes the leaves to undergo the characteristic movements. The steady, gentle tapping of the falling drops continue, however, and the leaves become so accustomed or accommodated to their shock that they no longer constitute a stimulus, with the result that in a few hours the leaves are fully expanded in the falling drops, the first touch of which caused a full and rapid closure of all of the leaves and leaflets. The accommodating is to falling drops only, since if the leaves are struck with a rod, or exposed to the action of heat from a shielded burning match, closure follows. The test may be repeated by arranging a clockwork to cause a small rod to strike the leaves or stems at frequent intervals, when accommodation will follow in the same manner. This is one phase of accommodation. A second is one in which a force is slowly increased. Thus, suppose that instead of suddenly exposing the plant to a shower of drops, we had placed it in a damp chamber and began spraying it from an atomizer in which the size of the particles of water was slowly increased until they became large raindrops. Treatment of this kind would be followed by no reaction movement, the protoplasm having ample opportunity to make the necessary adjustments to the size of the drops and the increased force of the blows.

An even much more familiar illustration of stimulation is that offered by the practice of storing dormant bulbs and tubers at a low temperature, then bringing them into a warmer room for sprouting. The change in the temperature is the shock which awakens the resting plant in such operations, and the difference between the storage pit and the growing chamber may be so great that it should be made in two steps to avoid damage. On the other hand the beneficial effects of such stimulation may be readily appreciated when plants are stored at temperatures too high to secure this shock by the change, and it also accounts in part for the slow, feeble action of some species when kept at an equable temperature during the entire year. But this stimulus is not to be thought of as always a change from a low to a high temperature, for the reverse may have a like effect. *Encelia farinosa* is a desert shrub which has been introduced into the austral plantation of the Desert Laboratory at 6,000 feet, being taken from a habitat at 2,500 feet and correspondingly warmer. It is a winter perennial, however, and its season of activity lies within the cool season of February to April, at which time it goes into a resting condition. Now, if the roots are taken up at this time and carried up to the 6000-foot level, the stimulus of change to the cooler temperature again causes it to awaken and put out a new set of shoots. Exact observations upon this stimulative reaction of any plant are possible, and many of the practices of the gardener are the results of long practical experience upon the matter. An interesting set of data have recently been obtained by Dr. B. E. Livingston with respect to the change from the *infra-optimum* to the *optimum* with regard to moisture from which it is seen that seeds of *Cereus*, *Fouqueria*, *Phaseolus* and *Triticum*, germinated when transferred from an air-dry condition to soil containing 15 per cent. of water, *Impatiens* in soil containing 20-25 per cent. *Raphanus* demanded 20 per cent., and *Trifolium* 25 per cent.

Gradual changes in the temperature, or in any of the other agencies affecting plants, may allow the protoplasm to make such adjustments of the living matter that the cardinal points are much changed and a species may accommodate itself to conditions ordinarily unendurable. Experimentation in this phase of the subject has been carried on most with bacteria and the simpler fungi, and it has been found that these organisms are capable of making such slow changes as to be able to undergo temperatures, comparatively very low and very high. The facility with which these organisms may be handled has also led to the result that they have been found to accommodate themselves to very great changes in the composition of the nutrient medium, and to endure the presence of poisonous substances, the concentration of which was increased very gradually.

In all such cases the power of endurance of the plant to an excessive or defective action of any one force is very much modified by the presence of or action of others. Thus, in the matter of the seeds, the endurance to extremes of temperatures is seen to depend directly upon the amount of moisture present.

Again the time element or the rapidity with which the intensity of external conditions is changed is a basal factor in all accommodation processes. As a plant accommodates itself to live at unwonted temperatures, or in unaccustomed soils, but little doubt exists that it undergoes changes in intricate structure, which, however, are not always to be demonstrated. So long as the species remains under the new and strange conditions the acquired structure will be retained from generation to generation, whether transmitted by cuttings or seeds. If the species is returned to its original habitat or to the normal conditions in which it originally grew, the acquired structures may persist for a time, but in accordance with the power of accommodation which originally brought them into existence, they will disappear when the inducing factors are removed.

The classical cultures of Bonnier made in the Alps and Pyrenees, twenty years ago, furnish us with the bulk of the systematic information available as to the influence of elevation on plants. From these it was seen that plants taken from lower to higher altitudes, up to about 7,000 feet, and not exceeding the *optimum* of the species, developed shorter internodes, the subterranean parts of the plant were relatively much larger, the leaves were smaller, more deeply colored, and the flowers were also more vividly tinted.

No better illustration of the changes in structure shown by plants, when accommodating themselves to habitats presenting strange external conditions, can be found than those found in the American water-cress (*Roripa Americana*), with which some extensive experimentation has been carried on. Originally taken from the muddy bottom of Lake Champlain, where it grows in water at a depth of 1-3 feet, it had been gradually accommodated to the propagating bed, the cold frame, and the hothouse in the New York Botanical Garden, from whence it has been success-

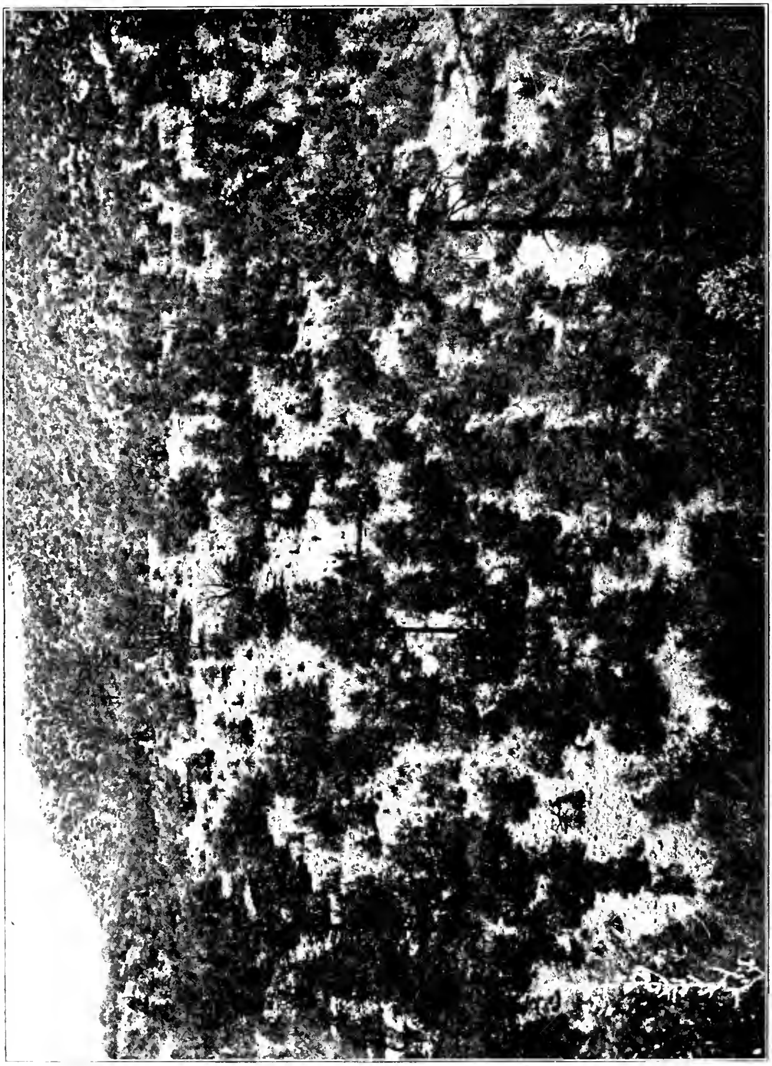

Figure 44. Location of austral plantation of Desert Laboratory among piñons and junipers, at 6,100 feet, on southern slope of Santa Catalina Mountains, Arizona.

fully transferred to the Laboratory at Cinchona, Jamaica, and to the alpine plantation of the Desert Laboratory in the Santa

Catalina Mountains in Arizona. During this dissemination it has substituted radish-like structures for the bunch of fibrous roots characteristic of it, and developed new forms of leaves and stems, while throughout it shows tissues and arrangements of tissues wholly unfamiliar to it; all of which has been brought about with comparative rapidity in five years. On the other hand, *Lysimachia terrestris* has been transferred from a terrestrial habitat to an aquatic, with similar sweeping changes by way of accommodation in even a briefer period.

So important are the possible results in this phase of experimentation held to be that the Department of Botanical Research of the Carnegie Institution of Washington has established plantations, under permits from the management of the National Forest, at 8,000 feet, in a moist alpine climate, and at 6,000 feet in an arid situation in the Santa Catalina Mountains, in connection with a small experimental farm, at 2,200 feet in the alluvial irrigated soil of the Santa Cruz valley near Tucson. Without going into detail at this time it may be stated in general that the experimental work carried on at these plantations involves an interchange of plants among the three stations, and also introductions from various locations in different parts of the world. In the two seasons that have elapsed since organized, ample reward has been obtained for the effort expended.

The methods and the results discussed above refer wholly to adaptive or responsive changes made by the bodies of plants subjected to any given environment, and forming accommodations to it. These alterations are of the greatest importance in the extension of the range of any plant, and by a study of them the accommodation response may excite the plant to increase the very feature of its structure of economic importance, and suppress those useless or harmful in its application to our needs.

Still a last possibility is to be taken into account in the great changes to which plants are subjected in acclimatization work. I have recently demonstrated that external agencies may be made to act upon the germ cells of plants in such manner that changes take place which are expressed in the progeny, and are heritable from generation to generation, constituting in fact the origin of new forms having the standing of species. The exper-

Figure 45. Alpine plantation of Desert Laboratory among spruces and poplars, at 8,000 feet, on a northern slope, Santa Catalina Mountains, Arizona.

imental methods used are fairly simulated by natural forces. Likewise Dr. Tower has been able to induce similar changes in the germ cells of potato beetles by the application of such stimuli as variations in temperature and moisture. It is to be said, therefore, that in taking plants from their native habitats to the uttermost extent of their possible ranges, we possibly subject them to forces which may be a most potent factor in the origination of new qualities and new lines of heredity.

GENERAL CONSIDERATIONS.

A more direct application of the ideas elaborated in the foregoing may be possible by a brief restatement of the more important generalizations.

The forces or factors affecting vegetation are simple physical properties capable of ready apprehension and easy measurement. Much is known as to the mode of response, reaction, accommodation and adaptation to such single factors or to a complex of them, and further experimentation upon the problems involved may be readily organized.

The thermal requirements of two plants, as indicated by the records of a season, have been tested, and with reasonable allowance for variation may be taken as characteristic of the forms in question. The method used consists in the measurement of the number of hour-degrees exposure, beginning with the winter solstice or with the germination of seeds.

The difference between localities only a few hundred feet apart at the same altitude may be sufficiently large to make existence in one impossible to a form which may find its *optimum* in the other.

The stimulative reactions of plants to sudden changes in environmental conditions form the basis of many important gardening practices. On the other hand the capacity of the plant for accommodation to conditions widely different from the average, following gradual changes, is very great and is perhaps the most important phase of the subject with respect to acclimatization. The more extensive studies in this problem have been concerned with the northward extension of the cultivation of fruits and cereals, and comparative cultures at low and high altitudes.

It is to be recalled in closing that but few plants occupy more than a fraction of all of the possible habitats by non-conscious distributional movements, and that the intelligent consideration of the factors of climate and a development of cultural methods may most readily secure the economic dissemination of plants from the localities in which they do grow to the full range of habitats where they may grow. Not only may species be carried and established in numberless new localities offering conditions equivalent to their natural habitats, but a study of the adjustments and accommodations of which the plant is capable enables or allows it to be introduced into unfamiliar conditions, under which the structural response may take on qualities more valuable than those usually shown by it.

The Desert Laboratory, Tucson, Ariz.

A ROUND TRIP FROM IOWA TO PUGET SOUND.

By Professor Bruce Fink.

III. EASTWARD BOUND.

Among the many interesting places in "the Alps of America," Glacier, British Columbia, and Laggan, Alberta, were selected for a week's collecting. The former lies in the Selkirk Mountains and the latter in Canadian Rockies. That tourists have gone into ecstacies over these places until the numbers that come often far exceed the present lodging accommodations, is not wondered at by anyone who has once seen the Illecillewaet Valley at Glacier, or Paradise Valley or the Valley of Ten Peaks at Laggan. A botanist of first rank, who has traveled extensively in the Alps says, "there is nothing finer on earth," and the Swiss guides and artists declare that the Alps are not superior for scenery. The Canadian botanists have given a good view of the lichens, mosses and the higher plants, and those interested are referred to the works of John Macoun and A. O. Wheeler for data.

Persons who have been employed indoors in prairie regions are rather poor mountain climbers the first day out. The tired school teacher starts with no appetite and a lagging gait, which can be scarcely kept up for a mile on the level prairie, but becomes hardened in eight weeks so that she can climb four or five thousand feet in vertical height over a poor trail in three or four

Figure 46. Bird's-eye view of the Illecillewaet Valley from Roger's Peak, showing the wooded areas toward the bottom of the valley and the numerous peaks, glaciers and snow fields at higher altitudes. To the left is Sir Donald, a sharp peak rising more than 6,000 feet above the valley. To the right of this is the great Illecillewaet Glacier, and still farther to the right the Asulkan Glacier.

hours. This gives astonishing evidence of the transforming influence of out-of-door life and careful training in climbing. It is only less surprising that one who can climb only moderately well at the start of such a trip will in the eight weeks become transformed into somewhat of a Mazama, and find himself able to climb seven or eight thousand feet in a day, it making little difference whether he has a trail or not. He finally becomes hardened into a veritable Muir, and will go up as long as he can get a hand or foot hold, absolutely oblivious to danger and never thinking whether he can get down or not. All this seems foolhardy in the narration, but not so when there are mountain tops ahead with glaciers, mountain lakes, great snow fields and other wonderful things to be seen.

When one is transported in twenty-four hours from several weeks of collecting at sea level and on small island elevations not exceeding 2,400 feet, with only a few alpine forms, to altitudes ranging from 4,000 to 10,800 feet, in a region that is all mountainous, the floral change is a remarkable one. With the writer it was the lichens that attracted attention as being nearly all of different species from those commonly seen at lower altitudes. Fortunate it was that the alpine lichens are so plentiful in the lowest parts of the Illecillewaet valley at Glacier and that there was no possibility of climbing to great height the first day on account of the time consumed in collecting them. Thus it happened that the first climb up a trail at Roger's Pass did not exceed 1,500 feet, barely reaching the lower end of an insignificant glacier, beyond which could be seen larger glaciers and snow fields in considerable numbers. The lichens seen were all familiar through herbarium specimens, but many of them the writer had never seen growing before, and the exhilaration of collecting them was sufficient reward for the first day's work. To another botanist, the alpine seed plants might be the source of satisfaction, to another the mosses or some other plants and thus we should all find something in the flora to impress us very forcibly.

On the second day the trail was followed to the base of the great Illecillewaet Glacier, thence along the left side of the glacier nearly to its summit, reaching an elevation of about seven thousand five hundred feet, or more than three thoasand feet above the Illecillewaet valley. The climb was hard enough, but still to the left, cut off by impassable glacial torrents, stood the snow-capped Sir Donald, another three thousand feet higher. Lateral moraines were examined, those nearest the side of the glacier being youngest and bearing no vegetation, the next bearing a few lichens and older ones more lichens, mosses and some small seed-plants, while still older morainic material, from a quarter to a half mile from the glacier bore some scrubby timber, under which lichens, mosses and small seed-plants grew in abundance. The only herbs collected and preserved are *Oxyria digyna* and *Sagina linnaei*. Other herbaceous plants were passed over for want of time.

Of the many lichens noted on the morainic material, we shall mention only a few of the rarest, such as the very rare *Verrucaria margacea*, growing on rocks in mossy glacial brooks and forming a beautiful pinkish-brown crust; *Cetraria islandica*, growing both on the ground and also on the low branches of the trees, where it is very rarely known to occur; *Rhizocarpon badioatrum*, a very rare lichen, so much like *Rhizocarpon petraeum* in external appearance as to be commonly passed over; *Lecanora cinereo-rufescens*; also a lichen very rarely collected; *Cladonia gracilescens*, only previously noted in one or two North American localities; and *Cladonia carneola*, not known from more than a half dozen North American localities.

After the severe exercise and exhilaration of the arduous climb, the latter part of the afternoon was spent in collecting lichens in the lower portions of the Illecillewaet Valley. Even here the lichens commonly seen are nearly all alpine or arctic species. Among the most interesting may be mentioned *Solorina crocea*, with its beautiful saffron-red lower side; *Cladonia bellidiflora*, which is also seen at much higher altitudes; *Cladonia coccifera*, in three forms; *Parmelia ambigua*, in two forms; *Parmelia centrifuga*, occurring very rarely; *Nephroma arcticum*, occurring very commonly on the rocks and earth, and with its large greenish-straw-colored thallus, producing a beautiful effect; *Alectoria fremontii*, in places covering the coniferous trees with its long pendulous, much-branched and dark-brown thalli; *Lecanora sordida* and *Lecanora ventosa*, the latter not often collected.

The third day was spent in a trip up the Hermit Mountain Trail, reaching about thirty-five hundred feet above the valley, a total elevation of about seventy-five hundred feet. This elevation gave a view of many glaciers lying before and on either side and making further climbing impossible alone, and probably not safe without alpinstock, rope and Swiss guide. The ascent leads by the most exquisite mountain brooks, some of them bare of vegetation and others with the most beautiful mossy beds, and all of them carrying the icy glacial water. Coniferous trees and wet meadows abound, and almost any kind of botanizing may be had in abundance at the right season. The lichens seen on the two days preceding were passed over, and only those not before noted were collected. Of these *Gryophora hyperborea* was most noteworthy, appearing on the rocks in great profusion. *Gyrophora angulata*, another rare lichen in North America, was also in evidence but rarely seen. In the mossy brooks at high elevations was collected an *Endocarpon* of peculiar aspect, which seems to be *Endocarpon miniatum fulvofuscum*, a form of the species very rarely seen. Besides these *Cladonia deformis* was seen more commonly than in any other area known to the writer, and with its scarlet fruits and bright-greenish *podetia*, produced a very beautiful effect upon the mossy and rocky ground.

One cannot visit this region without being impressed with the conifers. The principal ones are the subalpine fir, *Abies lasiocarpa*, a tree of symmetrical beauty and perhaps the most characteristic one of all the alpine trees of the Northwest; the Engelmann spruce, *Picea engelmanni*, well known in the mountains from British America southward to Arizona; the black hemlock, *Tsuga mertensiana*, also well known in the western mountains; the western hemlock, *Tsuga heterophylla*, having essentially the same range; the giant cedar, *Thuja plicata*, of the same range as the last two, all occurring from Alaska to California, but this one at lower altitudes for the most part; and finally the red fir, *Pseudotsuga mucronata*, which occurs from Alaska to Texas, and generally in valleys of the mountains or at low altitudes. Besides these are other trees and such a multitude of shrubs and herbaceous plants that one who is not familiar with an alpine flora must pass them over unless time is abundant. Even the heathers that appear at various seasons in the high altitudes are numerous and would require a considerable amount of study to do justice to them.

To one who has not seen them before, the glacial streams varying all the way from tiny rivulets to mighty rushing torrents; the lateral, terminal and ground moraines; the englacial and superglacial drift, which like that of the moraines consists of material ranging from the finest clay to huge angular blocks of rock; the great crevices in the glacier; the three miles of the Illecillewaet Valley between Glacier and Roger's Pass, with its beautiful vegetation and hundreds, doubtless thousands, of mountain glacial streams; and the mountains rising abruptly on both sides from three to six thousand feet, some of them as solid monoliths—all make a scene that can scarcely be surpassed for grandeur. A general view of the valley is shown in Figure 46. The snowfall varies from fifteen to forty-five feet per annum; the rainfall in summer is usually heavy and the streams from the glaciers add to the moisture so that the ecological conditions are moist and on the whole very peculiar. Lichens, mosses, hepatics, ferns, basidiomycetes, rusts, smuts, myxomycetes and seed-plants grow in great profusion in summer, and the place is an ideal one for general botanizing and for the study of plant ecology. But to do the work properly, two or more should go together and stay all summer, in order to have time to study the succession of vegetation, carrying tent, blankets and provisions. In this way valleys and mountains could easily be reached close at hand, which probably have never been seen by men.

But we must leave the wonderful Illecillewaet Valley, the towering Sir Donald, rising a mile and a quarter above the valley as a solid mass of rock, and such other peaks as Eagle, Avalanche, Macdonald, Cheops, Ross, Abbott, Afton, Dome, Castor and Pollux, Napoleon, Swiss Peaks, the whole Hermit Range and others quite as imposing, all of which enclose the Illecillewaet Valley from Glacier to Roger's Pass, only three miles away, and go from Glacier and the Selkirks to Laggan, in the Canadian Rockies, a distance of one hundred miles by rail. Here one is not impressed so much with the mighty grandeur, for the mountains are two or three miles away at Lake Louise, and the highest of the front mountains, Mount Fairview, reaches an elevation of only a little more than four thousand feet above Laggan, which itself stands over forty-nine hundred feet above sea level. But after one has ascended Mount Fairview and has counted more than a hundred other peaks, some of which are still three thosand or more feet above him; after he has looked upon the hundreds of glaciers and snow fields to be seen in all directions, of all sizes, and some of them three thousand feet above him, while others are as far below; after he has climbed six thousand feet or more in a day, often with no trail, sometimes finding his path of ascent or descent barred by hundreds of feet of perpendicular mountain face; after he has sent balanced rocks crashing down the mountain side four thousand feet; after he has looked at the blue waters of the mountain lakes, some of them more than a half mile below him; and after he has seen such an array of alpine plants, of whatever sort most interests him, as is rarely to be found, he is convinced that at least one other bit of scenery has not been, and cannot be, exaggerated by any sort of word-painting.

Space will allow nothing more here than a brief statement regarding the climbs of Mount Fairview, Mount St. Piran and two or three other peaks on two successive days, parts of the ascents and descents being made without trail and in places over very rough and dangerous mountain topography. The Rockies are by no means as well supplied with snow and water as the Selkirks, and the herbaceous plants did not impress the writer as being so numerous; but the lichens are more abundant and interesting at Laggan than at Glacier. At least a larger collection was made at Laggan, and the lichen flora seemed more interesting, both at lower and higher elevations, in spite of the fact that more time was spent at the former place. At Laggan, attention was directed chiefly to the lichens of the highest altitudes reached, perhaps two thousand feet above the tree line and four thousand feet above the lower limits of the glaciers. The highest elevation attained was something over nine thousand feet.

The writer longed to see the tops of other peaks three or four thousand feet higher, but doubts very much whether there would have followed any great additions to the excellent array of alpine lichens that was spread at his feet at the lower level.

One well acquainted with lichen species can collect them very rapidly, but the second day on St. Piran brought to light nearly as much of interest as the first day on the somewhat higher Mount Fairview. Both days revealed many lichens not seen at the lower elevations reached at Glacier and not previously known to the writer in the growing condition, and there is no thought that the species were nearly all collected. Among those of special interest, all found at the higher altitudes, are: *Parmelia stygia*, in much more characteristic and more closely crustose form than the specimens commonly seen from the White Mountains; *Gryophora cylindrica* and *Cyrophora proboscidea alpicola*; *Buellia papillata* and the fruticose *Lecidea pringlei*, a very rare North American lichen; *Parmelia lanata*, which looks enough like *Ephebe pubescens* to cause the two to be sometimes confused; *Parmelia encausta alpicola* and *Lecidea atrobrunea*; the rare *Thamnolia vermicularis*; *Rhizocarpon alpicolum*, occurring with the common *Rhizocarpon geographicum*, and with its beautiful greenish-yellow thallus, distinguishable from the latter only with the greatest difficulty; *Cetraria nivalis* and *Cetraria cucullata*, growing together and not easily distinguishable when one sees them in the field for the first time; the two remarkable and rare lichens, *Cetraria arctica* and *Cetraria madreporiformis*; and finally the scarcely less rare *Cetraria aculeata alpina*.

The Canadian botanist, John Macoun, has, in A. O. Wheeler's remarkable book, "The Selkirk Range," given a good view of the natural history of the Selkirk country, and I am under obligations to Mr. Macoun and the Canadian Government for a copy of Mr. Wheeler's extremely interesting and instructive book, for the privilege of reproducing one of the cuts used therein, and for a series of most excellent views and maps.

Miami University, Oxford, Ohio.

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THE MARINE BIOLOGICAL LABORATORY OF THE LELAND STANFORD JR. UNIVERSITY.

By Dr. Harry B. Humphrey.

To dwell at length upon the history and development of the Marine Laboratory at Pacific Grove would be idle, inasmuch as somewhat detailed accounts of the origin and early growth of the institution have received the attention of earlier writers. However, for the benefit of those who have never read the other accounts and to whom these may be quite inaccessible, it has been thought best to make a brief statement bearing upon this interesting point.

Fifteen years ago Timothy Hopkins of San Francisco bequeathed to Stanford University a sum of money sufficiently

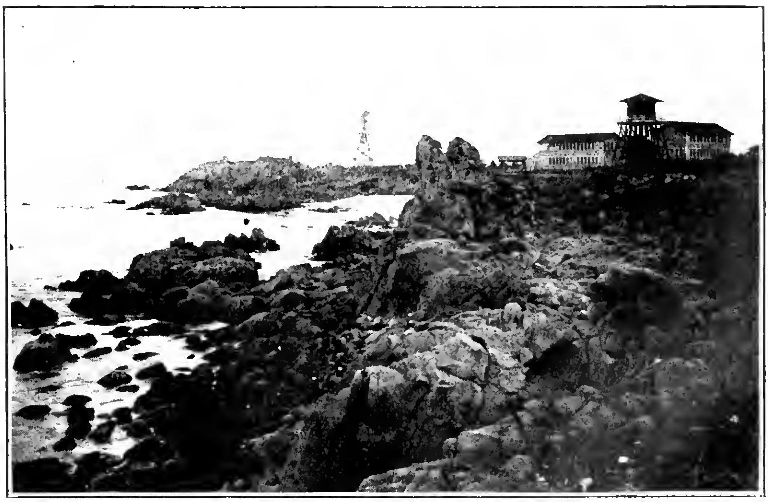

Figure 47. The Marine Laboratory of Stanford University, and nearby coast.

large to erect and equip what was at that time a first class marine laboratory. The site selected for the buildings was in Pacific Grove, Monterey County, one hundred and twenty-six miles down the coast from San Francisco. The buildings were erected in an open plot of ground directly overlooking the south shore of Monterey Bay, a most excellent site for such an institution.

The laboratory, shown in Figure 47, consists of two amply lighted, two-story buildings, one of them supplied with a well equipped basement with concrete walls and floor. Both buildings are piped for a full supply of both fresh and marine water, thus rendering possible a certain amount of experimental biology and the maintenance of aquaria. The buildings contain four general laboratories for class use. Aside from these there are seventeen private rooms especially fitted for investigators, a lecture room, and a dark-room for photography.

Little has been done along the line of equipping the laboratory with microscopes, books, or supplies of various kinds, but this is in a measure offset by the free use made of equipment brought to the laboratory each summer from the university of which it is a part. To be sure, the buildings are not so well equipped as those at Woods Holl or similar institutions on the Atlantic Coast, but this fact has not been a serious drawback to investigators who have already studied here.

Situated as the laboratory is, it possesses a peculiar advantage over those located in such places as are exposed to the much severe conditions of open ocean shores where the surf is so violent as to very much limit the flora to such rugged plants as the sea palm (*Postelsia*), the kelps, the *Fucaceae* and the larger of the *Rhodophyceae*. The coast line accessible to the laboratory offers a considerable variety of rock formation and numerous stretches of sandy shore all the way from Cypress Point around to Santa Cruz, across the bay. Granite, however, is the prevailing shore rock and furnishes a field for an exceptionally large fauna as well as flora. With the possible exception of Puget Sound, it is doubtful whether one could find anywhere along the coast a greater variety of marine plants or animals than are common in the various bathymetrical zones of Monterey Bay. Within easy access to the laboratory, the bay for some distance out, is quite shallow, and at the time of the lowest tides an array of rocks is uncovered, fairly teeming with life. Within ten minutes walk from the laboratory is Point

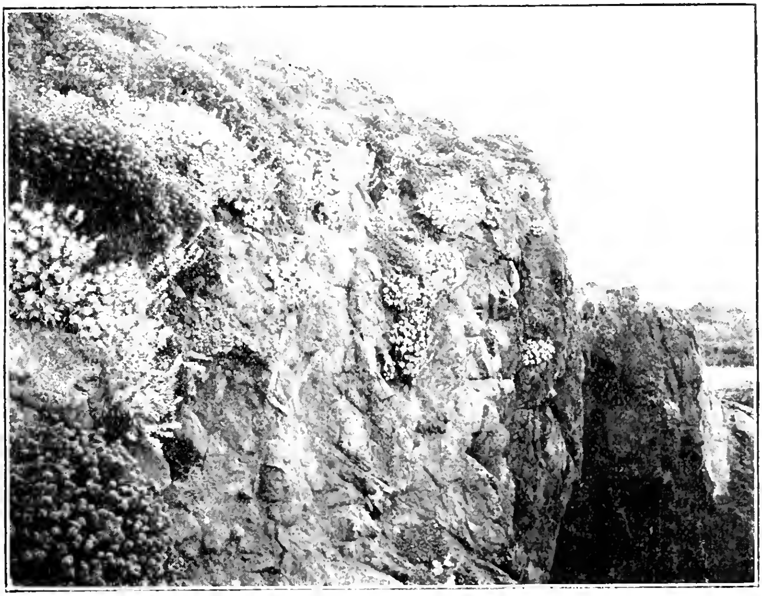

Figure 48. Ocean cliff vegetation, near the Marine Laboratory, consisting largely of species of Cotyledon, one species of Erigonum and one of Eryophyllum.

Pinos, a formidable, jagged granite ridge extending several hundred feet out into the bay. Here the collector will find a most interesting variety of conditions ranging from the quiet and warm tide pools near shore to the rocks exposed to the constant action of the surf. As one might expect, this variety of conditions such as temperature, light exposure, density of sea water, and exposure to wave action has resulted in an unusual variety of plants and animals. It is in the tide pools that one may find several interesting coralline algae as well as a number of species of *Cladophora*, a species of *Chaetomorpha* and several of the more delicate *Rhodophyceae*. In the same pool one is quite apt to see such animals as starfishes, sea-urchins, two or three species of crab, including the hermit crab, block chitons, limpets, shrimps, and certain interesting tide pool fishes. Growing in sheltered places on rocks, constantly bathed by the ocean swell, one meets with such interesting red algae as, *Spermothamnion*, *Griffithsia*, several species of *Polysiphonia*, *Callithamnion*, and *Ceramium*, forms scarcely ever occurring in a habitat suitable to such vigorous plants as *Lessonia*, or *Postelsia*.

Leaving town by way of the "Seventeen-mile drive" one may enjoy a delightful walk through three or four miles of pine forest, suddenly emerging from this directly upon open meadow land bordering the sea-shore. Here the drive follows the line of the coast, which for a stretch of nearly three miles is of granite formation quite as rough and sea-worn as the bit of coast shown in Figure 47. To the botanist it holds less of interest than to the zoologist, for the surf is so violent that only the larger plants can maintain a foothold.

The sea-lion is commonly seen off the coast at various points along the drive and the one-time interesting "Shag-rock" is a prominent feature along this stretch of shore, situated a short distance east of Cypress Point. This rocky islet only a year ago was the favored rookery of such sea birds as the oyster-catcher, sea-gull and cormorant. Unfortunately, being situated within rifle range of mainland, it has too often been raided by witless nimrods, and at present the rock is abandoned for another less accessible, farther down the coast.

There are something like fifty species of water birds found more or less commonly in Monterey Bay. These include grebes, loons, auklets, murrelets, guillemots, murres, gulls, occasionally terns and albatrosses, fulmars, shearwaters, cormorants, pelicans, mergansers, scoters and many ducks.

To enumerate minutely the great variety of forms of animal life common or peculiar to the waters of the bay is not within the scope of this paper, but it is interesting to note that something like twenty species of hydroids have been taken at varying depths; the coelenterates are represented by the sea anemone and a number of species of the jellyfish; of the Echinoderms, ten different species of starfishes have been collected here by students of the summer-school, and at least two species of sea-urchin occur all along the bay shore.

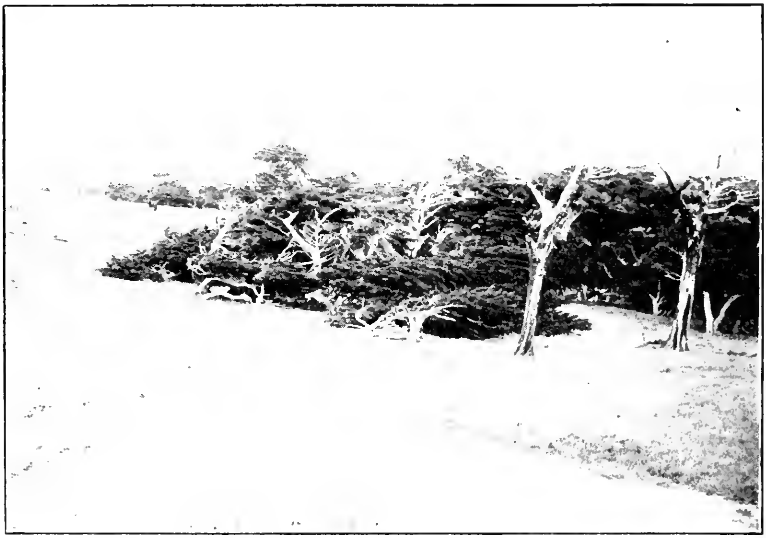

Figure 49. Cupressus macrocarpa, the Monterey cypress, growing near Monterey, under the influence of the sea winds.

Mr. Frank Weymouth, a student of Stanford University, has in two summers identified thirty or more species of crabs, some of which were taken only by dredging. More than one hundred species of molluscs commonly occur here including the abalone (*Haliotis*), sea cradle, keyhole limpet, the squid and many others.

Most of the collecting done here is along shore, though a gasoline launch is available for students of the summer-school and successful dredging trips constitute one important feature of the students' work while at the laboratory.

During the last session of the summer-school more attention has been given to the study of land fauna and flora than in former years. Monterey Peninsula is characterized by a variety of natural plant formations, and studies relative to the distribution of both plants and animals common to the peninsula are bound to prove unusually interesting. To the South and within six miles of the laboratory is the valley of the Carmel River, famous for the fertility of its alluvial soil. Here the student meets with many interesting forms of plants not occurring in any of the formations on the peninsula, and as he proceeds toward the source of the river he is enabled to note the distribution and habits of plants at increased elevations. Near the head waters of the Carmel River, well up towards the summit of the Santa Lucia Mountains, one meets with the beautiful San Lucia fir (*Abies venusta*) and many other interesting plants not occurring on the low lands near the ocean.

Early in July, students from classes in both zoology and botany camped four days in San José Cañon, a deep, narrow gorge running back from the ocean several miles into the Santa Lucia Mountains. It is of peculiar interest because of the rather unusual combination of factors brought to bear upon its flora. With instruments for recording precipitation, temperature, wind velocity, etc., a mass of most interesting data could be collected bearing upon the distribution of plants within a limited field.

Located as the laboratory is, in close proximity to an unusually rich fauna and flora and within easy access to land plants confined to the shore line and such formations as the sand dunes, the pine and cypress forests as well as alluvial and mountain zones, one may readily see why a laboratory so situated holds out unusual advantages and opportunities to the research student or to those fitting themselves as teachers of biological subjects.

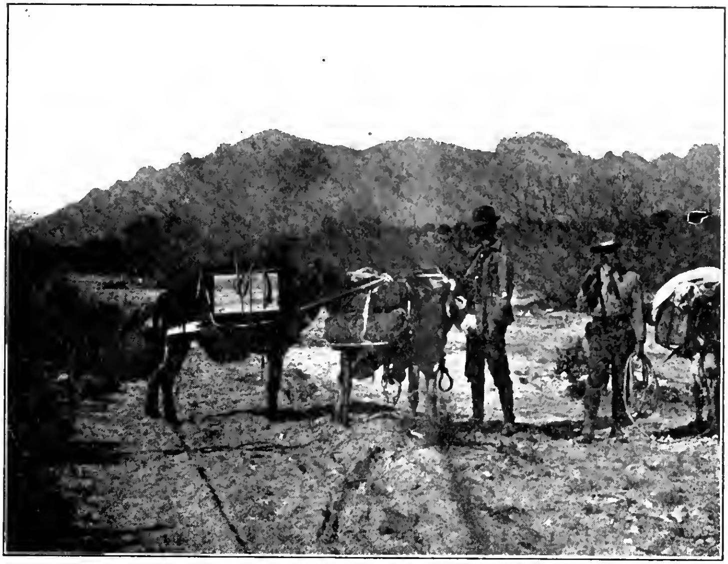

Figure 50. Burros laden with camping outfit. Castle Rock may be seen above and between the human figures.

PIMA CAÑON AND CASTLE ROCK IN THE SANTA CATALINA MOUNTAINS.

By Professor Francis E. Lloyd.

In company with Dr. W. A. Cannon and Dr. B. E. Livingston, I recently made a trip to Pima cañon in the Santa Catalina Mountains, distant some eighteen miles from the city of Tucson, Arizona. The stretch of country between Tucson and the mountains, though really considerable in extent, looks to the eye like the proverbial morning's walk. It is indeed only after making the distance on foot that one appreciates the real extent of the country. It is a hard walk of six hours, part of the way through the level mesa and part through the rough and stony foothills which rise by a gentle gradient to the more sudden slope of the mountains themselves.

The mesa is clothed with a growth of Mexican greasewood with here and there a clump of cholla, and occasionally plants of a species of tree opuntia (*O. spinosior*) with yellow or magenta flowers. These are two quite closely related species which grow in the same habitat, an example of a principle which is now under discussion among biologists. As we approach the foot hills along the margin of which flows the Rillito River—though one might more properly speak of the Rillito wash, since no water flows on the surface except during short periods of the year—the mesa slopes downwards very gradually. In the lower levels grow the mesquite and cat's claw, and two species of acacia, which are readily distinguished by their flowers, the former having cream-colored flowers in a raceme about an inch long and without fragrance, the latter, the huisache, having bright, yellow flowers in a rather close head, and giving out a sweet fragrance which loads the air. Along the wash, cottonwoods grow together with a species of ash and the desert willow, a relative of the catalpa. Crossing the dry and sandy bed of the Rillito the road follows a tributary wash, or rather draw, in which the large-leafed palo verde (*palo brella*) is a conspicuous figure. As one approaches the wash the quail in great numbers take flight and jack rabbits run for their burrows. On a really warm desert day there is no place like a draw of this kind to get the full value of the heat, and the walking becomes rather hard, both on account of the intense heat and the sand under foot.

Climbing the low escarpment one comes at once into an entirely different kind of country, as indicated both by the stony soil and by the vegetation. Here we find the giant cactus and the prickly pears in great abundance. A tree-like cactus (*O. versicolor* and others) is found on every hand. Occasional level stretches of loose, stony soil are covered with a growth of *Franseria deltoidea*, a low half woody shrub with canescent leaves and flowers rather similar to, though smaller than, those of the cockle burr. These patches of Franseria are favorite places for the cottontails, which readily hide behind the bushes. Occasionally the air becomes laden with a delicate perfume, the source of which I found very difficult to trace until some days later I discovered it to be the large species of *Krameria*, a shrub with small, rather wooly leaves, related to our eastern milk-wort (*Polygala*). This plant has very beautiful purple blossoms, delicately marked with yellow, which resemble leguminous flowers, and in fact even some of the elect have been deceived by them to the extent of placing this plant among the Leguminosae. In some places another, a smaller species of *Krameria*, very similar but quite distinct, occurs with it, giving another example of two closely related species growing in the same habitat.

As the mountains are approached, the ridges, which run up to the steeper slopes become more pronounced, and as we gain a somewhat higher altitude we find an even more abundant vegetation in which acacias form the more important element. In one spot at the foot of the mountains, somewhat to the east of the mouth of Pima cañon is a grove of iron wood, palo fiero (*Olneya tesota*) which can be recognized at a very considerable distance by the dark green foliage. Close to the mountains the vegetation becomes again rather more scant; and one of the prominent plants in this region is a shrub, which, on account of its edible fruit, we named the "plum duff bush," but which, in dignified language, is a species of *Simondsia*. One rather easily mistakes this plant at first glance for the Manzanita, as it simulates the latter in the character of its leaves and in its general habit of growth. The hard, woody stems, however, are nearly black, and the plant has, when cropped by cattle, a very compact habit. Its leaves stand on edge and are glaucous, and furnish a type adapted to a high degree of insolation, recalling as regards position the familiar example of the prickly lettuce.

As we approached the mouth of Pima cañon we found here and there a number of circles of stones, sometimes singly and sometimes in twos and threes. Within each circle was a shallow pit and in this and among the stones forming the circle was usually to be found considerable charcoal. These we found later to be old mescal pits made by the Pima Indians for the purpose of roasting the short, thick stems of a species of agave (*A. palmeri*) or century plant and of the sotol. These mescal pits are found in the cañon for a distance of a mile or so from the mouth, the old ones nearer the mouth, and those which have been in more recent use, further up the cañon. The last camp made by the Indians for the purpose of roasting meseal had been placed at the mouth of the first branch cañon about a mile from the mouth, and was occupied this last spring. Here we found a lodge of boughs, some racks made from sotol flower stalks, apparently for drying some products which the Indians had gathered, some circles of brush in the center of each of which was a little fireplace, and one large recently used pit in which were still to be found remnants of the cooked meseal.

At this point the agave which the Indians used is fairly abundant still, and it would seem that the older meseal pits date back to the time when the plant was abundant nearer the mouth of the cañon. For the purpose of roasting, the Indians choose those plants which are about to flower, and on climbing the steep slopes in the neighborhood of the recent camp we found quite a number of plants out of which the stem and bud had been cut. The base which remains is evidently appreciated by the field mice, which in every case had gnawed out a depression in the pulpy flesh of the stem. The most characteristic plant in the cañon on the lower slopes is a large species of Sotol (*Dasylirion wheeleri*), shown in Figure 51, which makes a magnificent showing, the strong flower stalks rising to a height of fifteen feet. This is also used for making meseal. The leaves of the Sotol are used by the Papagos for weaving a coarse sort of basket, and this material was one of their desiderata, as we judged from an incomplete basket which we found.

Higher up and forming in places a nearly continuous mat covering many acres in extent, is a smaller species of agave, the "amole" (*A. Schottii*). One who climbs up to any height in these mountains becomes only too well acquainted with this plant, for its leaves are armed with a sharp spine and are placed at just the right height to puncture one's shins and knees in trying to pass over it. It seems to one going up hill as bad as it can well be, but is really a very great deal worse when coming down. This is one plant with which we could very well do without. Still higher, *Agave Treleasii*, discovered by Professor Toumey, is said to occur.

During a considerable portion of the year the cañon is well watered, and along the moist reaches one finds an abundance of very beautiful flowers, among which I may mention especially a species of *Salvia*, a large, highly colored pentstemon, and in the moist crevices of the rocks a scarlet-flowered saxifrage (*S.*

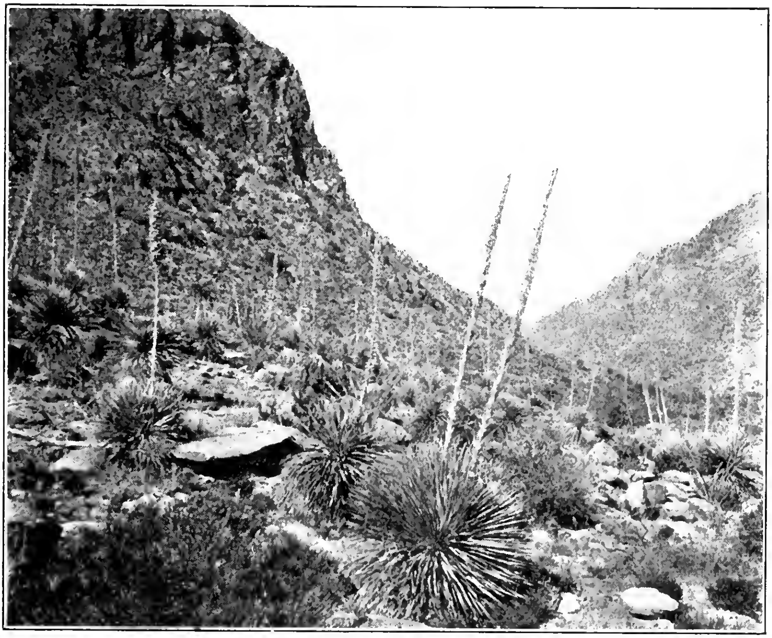

Figure 51. Looking toward the mouth of Pima Cañon. The conspicuous plant is the sotol, Dasylirion Wheeleri, the base of which is cooked with that of Agave, by the Papago Indians in making mescal.

coccinea). Higher up the cañon, perhaps two miles from the mouth, are live oaks which afford a grateful shade when the sun beats down during the warmer hours of the day.

It was part of our purpose in visiting Pima cañon to make an ascent of Castle Rock, an obliquely set table-like eminence of rock having an altitude of six thousand feet, three thousand feet above the mouth of the cañon. We made our permanent camp, from which we took our start to make the climb, in a group of cottonwoods near to the Indian camp, which I have already spoken of. This was a delightful spot for camping, having plenty of shade and running water, and fairly abundant forage for our burros. One of these cottonwoods offers a very curious condition of affairs. Some time ago, perhaps several years, a branch had been broken off from the under side of an obliquely placed trunk. The tree had made some attempt to heal the wound thus formed, but failed. The interesting feature, however, lies in the fact that the tree commenced to bleed from the surface of the wood, and this continued for so long that a thick calcareous deposit was formed upon the wounded surface. The bleeding had been so rapid that at the time of our visit I counted half a dozen drops a minute. On account of a ridge in the wood the dropping of the water gradually became confined to one line until there were formed a number of stalactites quite after the fashion of those formed in a limestone cave. The exuding water is distinctly unpleasant to taste and smell, and does not seem to be heavily charged with salts, nor does the tree seem to be growing in heavily charged soil, since it is right on the bank of a mountain stream. The whole thing suggests an artificial nectary, in which the sugars are replaced by salts. The similarity of the calcareous deposits formed about the water pores of certain leaves is perhaps still closer. At any rate, without attempting a final explanation of the phenomenon it is, so far as I know, a unique example. The amount of water which the tree gives off is suggested by the circumstance that when by accident the corner of my blankets got underneath the wound the corner of my bed got soaking wet during the night. At this well-watered spot we found huge grape vines climbing some of the cottonwood trees, a passion flower and a small, wild cucumber, the seeds of which are nearly globose, and very bitter.

The ascent of Castle Rock is made from this point in about four hours. As there is no trail one has to make his way as best he can. For about a thousand feet we passed along rocky ledges bearing very much the same kind of vegetation that we find on foot hills, the giant cactus, ocotillo, a species of acacia, palo verde and *Simondsia* being the prevalent forms of larger size. At the altitude of four thousand feet the sotol (*Dasylirion Wheeleri*) becomes quite abundant and the live oaks make an open forest on the more horizontal benches. The old flower stalks of the sotol are the nesting places of a large carpenter bee, which we often noticed flying in pairs. From this point on, the climb is rather severe, especially on account of the dense growth of the small amole (*Agave Schottii*). We had to make about a thousand feet of steep, stony ridges, with scarcely anything growing on them but this plant. This part of the climb brought us to the main ridge and to the tremendous outcrop of granite rock which forms Castle Rock. The vegetation here changed abruptly.

The trees now consisted of juniper and nut pine (*Pinus Cembroides*), interrupted by huge rounded rock masses and by here and there a chapparal of manzanita. As we moved along the rough ridges we passed from time to time deep chasms in the northwestern face of the rock, extending to a depth of from one to two thousand feet, sometimes in an almost vertical line. As we gained the still higher altitude we found a species of Cereus very similar in general appearance to the *Cereus Fendleri* of the foothills. The flowers of this species, however, are of a more coreaceous texture, scarlet in color, with violet stamens. We brought some specimens of this plant back with us and succeeded in bringing them into flower after we returned to Tucson. We found also a few plants of a *Yucca*, probably *Yucca radiosa*, and on the summit, bear grass, a few prickly pears, *Agave Schottii* and *Sotol* growing together.

The tip-top of Castle Rock is an almost flat area of perhaps an acre in extent, clothed with large-sized junipers and pines, under which there is a deep vegetable humus. The northwestern face of the rock is a sheer precipice of great depth. When we threw stones from the edge the sound of their impact reached us after an interval of four and a half or five seconds. From the edge of this precipice we get a most magnificent view of the surrounding country. Immediately at our feet is the broad wash of the Cañada del Oro, beyond lie the Tortolita Mountains, which, though of fairly respectable size, can scarcely be distinguished under the noonday sun as anything but irregularities in the general surface. Off fifty miles to the south-

Figure 52. On the top of Castle Rock. Live oak and pine on the left, juniper and piñon pine on the right, Yucca and bear grass in centre, with a century plant, Agave Palmeri, in the right foreground. The slender flower stalk is that of the amole.

west, beyond the Tucson Mountains eighteen miles distant, we see the Baboquivari Mountains and the Coyotes; to the south the Santa Ritas with their wonderful extent of foothill country sloping off towards the west; and midway between, the Sierritas; to the northwest rise the Superstition Mountains, and to the west, beyond the Maricopa, divide the Big Horns. The view extends in a circle, except where it is interrupted by the Catalina range back of us, with a radius of 175 or 200 miles, and everything is spread out before us like a map. From the other edge of Castle Rock we see the whole extent of Pima cañon with all its side cañons, and ridge after ridge of the Santa Catalina range, all but the outer and lower ones clothed with a dense forest of bull pine and Douglas spruce. Peak after peak, crags and precipices, make up a landscape of stupendous dimensions, a country frightfully difficult to negotiate, but beautiful to the eye beyond description. The descent from the summit of the rock, though no less interesting, is much more trying and occupies almost as much time as the ascent, and we are glad to be again in camp, tired and hungry and thirsty as we are. Many more things might be said by way of details concerning this bit of country and its vegetation, but these must be suppressed in the interest of brevity.

Hacienda de Cedros, Mazapil, Zac., Mexico.

SOME OBSERVATIONS ON THE DATE.

By Dr. A. E. Vinson.

For thousands of years the date has furnished great groups of the human family with their principal foodstuff. It has, however, seldom been made the subject of scientific study, but botanists and chemists are not wholly to blame for such neglect. Until recently this remarkable fruit has been accessible only in the somewhat remote oases of the burning deserts of Africa and Asia, or where carried by the early Spanish adventurers into the semi-arid wastes of northern Mexico, Lower California and the west coast of South America.

Another drawback to our knowledge of this fruit has been the inability of the same investigator to have at his disposal the different varieties of dates. This circumstance once led Professor Lindet, a noted French agricultural chemist, to criticise a fellow worker who, after analyzing a number of Mesopotamian dates, announced that the date contained invert sugar only. It happened that Lindet had examined some North African dates which contained 38% of cane sugar with only 23% of invert sugar, and he immediately pointed out the great danger of infering the chemical nature of a fruit from a limited number of analyses, because climate, condition of season, and state of maturity influence this factor so greatly. As a matter of fact these differences were due to inherent physiological functions peculiar to the variety itself and not to external causes. Thanks to the U. S. Department of Agriculture, the more important varieties have been imported from all the date growing regions of the world and placed in The Co-operative Date Orchard at Tempe, Arizona, where they are easily accessible from the laboratory of the Agricultural Experiment Station at Tucson.

The fruit of the date forms an almost ideal material for research. Through it we see the main processes of fruit ripening as through a microscope. Phenomena which in other fruits are so slight as to be overlooked or considered as accidental, here take on such proportions that they are unmistakable. Thus the minute quantity of cane sugar which has been observed at times in the cherry, certainly must play here the same physiological role as the startling amount, 12% and over, which the invert sugar date exhibits at a corresponding period. Furthermore the two types of dates exemplify the two types of non-starchy fruit in general, the cane sugar and the invert sugar types. While the large amount of dry matter in the date has been favorable to the study of the carbohydrate relations, the even more fortunate distribution of the tannin has favored not only the study of that substance itself, but also of the enzymes.

The tannin is doubly interesting because it can be observed and studied so easily. If you cut a thin slice transversely from a commercial date and look through it, you will observe with the naked eye three zones: an outer transparent zone containing no tannin, a narrow reddish brown opaque zone containing much tannin, and an inner transparent portion again free from tannin until it blends into the so-called "rag." If you now stir this pulp with considerable water in a glass vessel, allow it to rest a moment, and then observe the vessel from below, the contents of these opaque cells will appear on the bottom as minute reddish brown granules which can be separated mechanically in a fair state of purity. They are composed, presumably, of the insoluble tannin, but, unless the dates are very fresh, no longer give the tannin reaction even after boiling with acids. It is believed that the tannin in the persimmon is distributed in the green stages throughout the fruit and that on ripening it segregates into specialized tannin cells. There it becomes insoluble and consequently the puckery taste disappears. This is also true of the date, excepting that the tannin is confined in all stages to the narrow zone of giant cells where it is originally formed, and no segregation takes place. The rats at the Tempe orchard discovered this also, for they found that the outer shell of a green date was edible down to this layer. Dates with half their skins eaten away mature normally, but had it not been for this protecting layer the seed would undoubtedly have been injured.

The development of the fruit takes place in three stages. After fertilization very little change in the fruit itself can be observed for several weeks, but during this period the entire energy seems to be expended in building a long massive stem. When this is nearly completed, the fruit starts to grow and the seed to mature. When the fruit has reached its full size, but is still green, it corresponds very closely in chemical character to any other non-starchy fruit, and contains about 20% of dry matter. The third stage now begins and additional sugar is heaped into the fruit at a rapid rate without any apparent change in size until upwards of 60% dry matter is present. It then softens, the tannin becomes insoluble with consequent loss of astringency, and the fruit is ripe. The writer has recently shown that for theoretical considerations this sugar probably enters the fruit as maltose, but is very rapidly converted into cane sugar which in certain varieties, as Deglet Noor and M'Kentichie Degla, remains cane sugar, but in Rhars, Birket el Haggi, Amari, Amreeyah and other varieties is converted by contact with invertase into invert sugar. They all contain invertase sufficient to change many times their weight of cane sugar to invert sugar, but in some manner the sugar and the enzyme fail to reach each other: that is, the enzyme is localized. This is notably true with the Saffraia variety, which, when ripe, retains a relatively small but permanently residual amount of cane sugar.

Arizona Agricultural Experiment Station,
Tucson, Arizona.

AN ELECTRIC THERMOREGULATOR FOR PARAFFINE BATHS AND INCUBATORS.

By Dr. W. A. Cannon.

The electric thermoregulator to be described here has been in use for several months and has proved so satisfactory that an account of it at this time seems warranted. It may safely be employed for controlling the electric heating device for temperatures ordinarily employed in the laboratory. With the stove and oven used in this instance the amplitude of the range of temperature does not surpass two or three degrees Centigrade, and the regulator itself is sensitive to one-tenth of a degree or less.

The entire heating and controlling device consists of the primary or lighting circuit with the stove, and the secondary circuit with the automatic switch and regulator. The stove is of the ordinary type, with a flat upper surface upon which the oven stands. A single cell of the Edison Primary battery proved very satisfactory for generating the secondary current. As in the case of the stove and battery, so in that of the automatic switch, any good type may be employed. The switch used, however, is a stock automatic one which is remodeled so that it is operated by a two-way in place of a three-way secondary circuit, and is peculiar in having stationary poles made of copper combs with four teeth in place of the troublesome carbon or expensive platinum usually used. A copper wedge, insulated from the arm that bears it, is pulled by the magnet in the secondary circuit into the space between the poles, and thus makes the primary circuit. When the secondary circuit is automatically broken a spring forces the wedge back to its former position, breaking the primary circuit. This device is shown diagramatically in Figure 53.

The thermoregulator is constructed of glass and consists of an elongated bulb to be immersed in the water of the oven jacket, to which a U-shaped tube of 6 mm. bore is attached by a short horizontal tube of the same diameter. The upper end of the bulb is provided with a stop-cock by means of which it may be opened or closed. The U-shaped tube is sealed at the

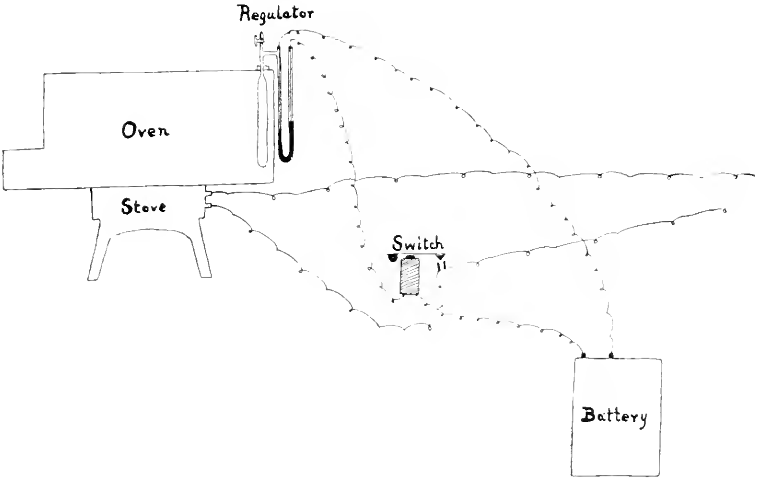

Figure 53. Diagram showing arrangement of a new electric thermoregulator.

end nearest to the bulb and open at the other. The poles are arranged as follows: A platinum-tipped copper wire is sealed into a small tube, which in turn is pushed into the arm of the U-tube and sealed in place, thus closing the latter. The platinum point is placed about halfway between the middle of the U-tube and its base. The other pole is moveable in the open arm of the U-tube. It may be so adjusted that when the main circuit is broken the secondary will also be broken, automatically and at any desired temperature. The main points in the construction of the regulator and in the setting up of the apparatus are shown in the diagram, which is self-explanatory.

In setting up the regulator, the bulb, connecting tube and U-tube are first filled with oil (a heavy paraffine oil has served well), and then clean mercury is poured into the open end of the U-tube. In this operation some oil will escape at the open end of the U-tube. A little oil is left in this arm of the tube to prevent oxidation. The bulb should next be immersed in water of the desired temperature. When the oil has taken the temperature of the water, the mercury meniscus of the closed arm of the U-tube is brought just into contact with the stationary pole, this being accomplished by means of a rubber tube temporarily attached to the open end of the U-tube. When this is done the stop-cock is closed. Subsequent adjustment is easily made after the apparatus is in place in the oven.

The Desert Laboratory, Tucson, Arizona.

EFFECT OF FIRE ON AN APPLE TREE.

About the middle of August last a pile of dry weeds was burned underneath an apple tree, the heat from the fire shriveling the leaves to the top of the tree on the exposed side. A month later the tree came into bloom wherever the leaves had been fire-killed, but the blossoms failed to set fruit. I have heard that strawberry growers sometimes fire the beds after the crop has been gathered and that this treatment results in the production of a second crop.—A. O. Garrett.

The response obtained by burning and drying the leaves and twigs of the apple tree above mentioned is probably an example of the similarity of the effects produced upon plants by cold and dryness. The thorough drying out of the buds by the action of the fire appears to have produced the same effect as the long winter period of low temperatures. In a somewhat similar way, an abnormally dry summer and early autumn often produces late autumn flowers upon plants which had their normal period of bloom in the early spring. In the same class of physiological responses belongs the rapid development of flowers in the case of azaleas and the like, which have been subjected to the action of an anaesthetic such as ether. It may be that the similarity of response to these apparently different conditions is due to a real similarity in the conditions themselves for low temperature, thorough drying out, and the action of an anaesthetic all act upon the plant to bring about almost a complete cessation of the various life processes, and this enforced period of rest may possibly bring about the unseasonable flowering.—B E. L.

DISEASE OF SYCAMORE TREES.

In the issue of Plant World of September, 1907, there appeared an inquiry from Miss Broadhurst concerning the diseased condition of sycamore trees in the Eastern States. The disease referred to was explained by Lloyd as due to the fungus recently described by Murrill.

During the past summer, the undersigned made a personal examination of these diseased sycamore trees and found that this condition was not due to a fungus but to late spring frosts. On none of the branches did any fungus occur, but all the appearances of the dead twigs showed striking instances of frost injury. A detailed description of this disease has been prepared and will appear within a very few days in the annual report of the Missouri Botanical Garden.—Hermann von Schrenk.

A TERATOLOGIC FLOWER OF CAMPANULA ROTUNDIFOLIA.

A very interesting and lovely flower of *Campanula rotundifolia* was found here recently. It is terminal on a stem about fifteen inches tall. The corolla is one and one-half inches across, not at all bell-shaped but open and somewhat flat, though plaited and quite sinuate on the margin. It has twenty lobes, about half the usual width, and apparently an equal number of stamens, although it is difficult to count these without injury to the flower. There are seventeen sepals. The pistil is a flat column about one-fourth of an inch wide with a row of flat stigmas at the top. On the same stem are two buds with six divisions of the corolla, one having four and one five sepals. The other buds promise to produce the normal form of harebell. —Mary H. Danfum.

ROSELLE.

In Farmers Bulletin No. 307 of the U. S. Department of Agriculture, P. J. Wester gives an account of the culture and uses of the roselle (*Hibiscus sabdariffa L.*), a tropical plant related to cotton and okra. This plant is quite extensively grown in Queensland, Australia, and has been introduced in Florida and California. It produces the roselle fiber of commerce and the thickened, reddish calices, which surround the seed pods, are used for the manufacture of jams and jellies. The calyx contains nearly the same constituents and in nearly the same proportions, and possesses the same flavor, color, and jelly-making properties, as the cranberry. It is suggested that roselle may become of importance in the south as a substitute for this fruit.—B. E. L.

At the instigation of Professor L. Cockayne, the well known New Zealand botanist, the Board of Governors of Canterbury College has decided to establish a sub-alpine station in the Southern Alps of New Zealand where the mountain flora can be studied under natural conditions. This, it may be believed, is the most important step in botanical teaching and investigation which has yet been taken in Australasia. Professor Cockayne is the author of a report on the botany of Kapiti Island, rightly regarded as a Natural History Sanctuary in that part of the world. It is much to be hoped that the work so well commenced will be extended to the whole of New Zealand, and that the Government will exercise wisdom and foresight in affording means for the continuation of the survey. The present active interest on the part of the Government in enabling a large body of scientists to visit otherwise more or less inaccessible parts, such as Auckland and Campbell Islands, indicates a real and proper concern on the Government's part, in the progress of pure science, which, we believe and hope, will be productive of sustained effort along the lines above indicated. New Zealand contains so many secrets which the scientific world is eager for, and there must be so very much of great economic importance to be discovered, that no effort should be spared for their disclosure by competent men.—F. E. L.

The fourth international fishery congress will be held at Washington, D. C., September 22-26, 1908, and in connection with it there have been arranged a number of competitive awards for a number of investigations relative to marine life. The New York Botanical Garden offers a cash prize of $100 for the best essay on the interrelation between marine plants and animals. The New York Academy of Sciences offers a prize of similar amount for the contribution of greatest practical value to the fisheries or fish culture, and the American Fisheries Society the same amount for the best paper embodying the most important original observations and investigations regarding the cause, treatment and prevention of disease affecting fish under cultivation. The New York Aquarium offers the same amount for an exposition of the best method of combating fungus disease in fishes in captivity.

A new text-book of Physiology and Ecology, by Professor F. E. Clements, has just been issued by H. Holt & Co. of New York.

Mr. Leslie M. Gooddnig and Mr. Reimenschneider are camped in the Santa Rita Mountains, Arizona, where they are making large collections of seeds of the native economic grasses and trees for shipment to the Transvaal Government, South Africa. Mr. Gooddnig has been in the employ of the Transvaal Government for about a year, having collected in the country about Chihuahua, Mexico; Douglas, Arizona, and Silver City, New Mexico.—J. J. T.

The government irrigation and drainage work of the Office of Experiment Stations of the U. S. Department of Agriculture has been divided into two sections, following the resignation of Dr. Elwood Mead, who has been in charge of this work, but has been called to Australia to direct government work of a similar nature there. Dr. Samuel Fortier, irrigation engineer in charge of the Pacific District of the Irrigation and Drainage Investigations, and stationed at the University of California, has been appointed Chief of Irrigation Investigations. Mr. C. G. Elliott, for several years engineer in charge of drainage investigations, has been made Chief of Drainage Investigations. The work in these two lines will follow the general plan mapped out before they were separated.

Contributions from the U. S. National Herbarium, Volume XI, Flora of the State of Washington, by Charles V. Piper, is a recent publication. In addition to the list of species, which is large, including flowering plants and ferns, the author has included notes on the early botanical explorers, and a brief discussion of the physiography and geology of the region. Simple keys to genera and species are given, which greatly facilitate the use of the volume. Professor Piper's study of the plants of Washington extends over a period of twenty years.—J. J. T.

Mr. E. Griffon has described his experiments on herbaceous grafting among the Solanums (Bul. Soc. Bot. France **53**: 699-704, 1906). From grafts of the potato upon the tomato, the tomato upon the potato, the egg plant upon the tomato and the tomato upon the egg plant, the author was able to obtain no evidence of any influence of stock on scion or of scion on stock. Variations in form and structure which were observed occurred as frequently on ungrafted plants grown under the same conditions as on the grafted ones.—J. J. T.

Dr. E. M. Freeman will leave the Bureau of Plant Industry of the U. S. Department of Agriculture at the end of the present year and return to the Botanical Department of the University of Minnesota.

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EVAPORATION AND PLANT DEVELOPMENT.*

BY DR. BURTON EDWARD LIVINGSTON.

By far the greater portion of the water absorbed by growing plants merely makes up for the loss occasioned by transpiration. This water is absorbed by the root system, transmitted through the conducting tissues, and escapes into the air whenever moist cell walls are exposed. The daily water loss from any individual plant at any stage of its growth is largely determined by the evaporating power of the air. At any given time in the development of the plant, and under the corresponding conditions of soil moisture, there is a maximum rate of water supply to the transpiring tissues, and when the evaporating power of the air is so great as to cause the rate of loss to surpass that of supply, the plant wilts and is injured or killed, unless, indeed, it is provided with water storage organs, which may temporarily free it from dependence upon external supply. In ordinary plants a quiescent existence can be maintained when the rate of transpiration approaches or equals that of supply, but under these conditions very little or no growth can take place.

The evaporating power of the air depends upon three factors, humidity, temperature, and wind velocity. Although numerous attempts have been made to derive a formula for

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*This article is mainly abstracted from a paper presented at the meeting of the Horticultural Society of New York, October 1, 1907, which will be published in the Proceedings of the Society.

calculating evaporation from measurements of these factors, our knowledge along this line is at present so incomplete that such formulas are not of great practical use. Furthermore, even though we could calculate the evaporation from data of humidity, temperature and wind, the direct measurement of evaporation would still be the simplest and most satisfactory method for the physiologist; the atmometer* is much more simple and more easily operated than the instruments for recording the above factors, the data obtained are much more readily handled, and, finally, the evaporating power of the air is the *directly* controlling factor in water loss from plants. The atmometer may be regarded as an artificial plant, of course without the plant's** mechanisms for regulating the water loss from the interior.

The effect of evaporation as a climatic factor in influencing the behavior of a number of different species growing in soil which was kept nearly at its optimum moisture content, was studied in an experiment carried on at the Desert Laboratory, at Tucson, Arizona, during the summer just past. Narrow beds were prepared in the open ground and were watered by lateral sepage from irrigation trenches which were filled once or twice daily. The water stood in the trenches only a few hours at a time and the soil, a heavy clay, did not at any time become waterlogged. Among the plants tested were the garden nasturtium (*Tropacolum*), morning glory, marigold, sun flower (*Helianthus annuus*), mustard, castor bean, muskmelon, teasel (*Dipsacus sylvesris*), and Jimson weed (*Datura stramonium*.)

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*On account of seniority and correct etymology, the term atmometer is here used in place of the hybrid term, *evaporimeter*, *evaporometer*, and *evaporameter* (only the latter of which is etymologically even possible.) Although atometer was adopted by the International Metiorological Congress at Venice in 1874, evaporimeter, etc., are largely used in America.

**On the matter of regulatory responses, see the author's paper. The relation of desert plants to soil moisture and to evaporation. Publication No. 50 of the Carnegie Institution of Washington, 1906. Also, Relative transpiration in cacti. Plant World, 10: 110-114. May, 1907.

The atmometer used in these studies was a modification of the instrument described in Publication No. 50 of the Carnegie Institution· It consists essentially of an exposed porous clay cup connected with a reservoir at a lower level. The cup is about thirteen centimeters long by two and a half centimeters in diameter, closed and rounded at one end, and

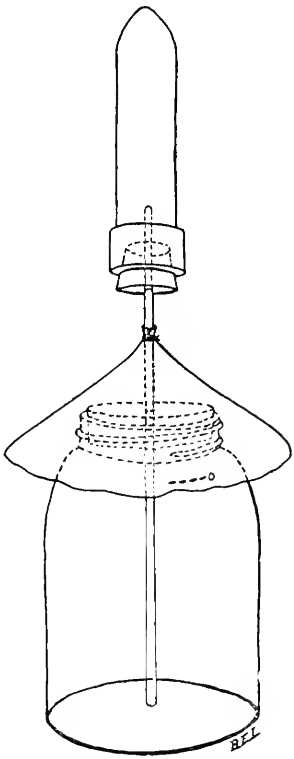

Figure 54. Sketch showing the arrangement of the parts of the new instrument for measuring evaporation.

reinforced at the other by a thickened rim. The wall is about four millimeters in thickness. The open end is closed by means of a perforated rubber stopper bearing a glass tube some thirty centimeters in length, which extends through a cork stopper nearly to the bottom of a glass jar of the "Mason" pattern. The cork stopper fits the jar somewhat imperfectly, or has a slight groove cut in its margin to allow access of air. Above the jar the tube passes through a conical cap of cloth coated with shellac, which serves to shed rain water and prevent its direct entrance to the apparatus. A file mark is made on the wall of the jar near the shoulder, and the tube is pushed into the cup far enough to allow its free end to reach the bottom of the jar and still leave a space of ten centimeters between the file mark and the base of the cup. A pint, quart or half-gallon jar is used, according to the evaporation rate and the time period during which the instrument is to operate between fillings. The crudeness of the instrument is counterbalanced by its simplicity and by the ease with which all parts excepting the cup may be obtained in almost any locality. The arrangement of the parts is shown diagramatically in fugure. The file mark on the jar is indicated at O in the figure.

In setting up this atmometer, the jar is partially filled with distilled water, the cup (after being soaked in distilled water for a short time to remove air) is filled and its stopper pushed home, the tube is filled, and the free end of the latter is quickly thrust to the bottom of the jar, or until the cork stopper rests on the edge of the latter, care being taken that no air bubbles enter the tube. The jar is next filled to the file mark, the cork stopper placed in position, and the instrument is ready for operation.

When the porous clay of the cup is saturated with water, as it is when the cup is filled, the surface tension of the water films closing the pores at the outer surface is so great that air cannot penetrate, and the cup remains filled, although it is above the level of the water in the jar. Evaporation proceeds from the surface of the wet clay, and water is drawn into the pores to replace what has been lost. The water thus removed from the cavity of the cup is in turn replaced by more from the jar below, this being raised by atmospheric pressure upon the free water surface.

After the lapse of a time period the cork stopper is loosened, slightly raised and slipped sidewise as far as the tube will permit (its lower surface resting on the edge of the jar) and distilled water is poured from a graduated vessel into the jar till the water level is brought again to the file mark· The amount of water required for refilling is the amount which has been evaporated during the preceding period.

Only pure water can be used in this atmometer, on account of a rapid clogging of the pores of the cup due to the formation of crystals when impure water is used. Water from an ordinary still is satisfactory. To prevent bacterial and algal growth in and on the cup, which might result in the clogging of the pores, the addition of about three per cent of formaldehyde to the water is recommended. This has no perceptible effect on the operation of the instrument.

The cups as received from the factory are of course not uniform in their porosity, and it is necessary to standardize them by comparing there evaporation rates under the same conditions. A coefficient of correction is thus obtained, which is applied to the direct readings after the instruments have been placed in the localities to be studied. In standardizing, a certain cup (or several cups with equal rates) are set aside as standard, and not used excepting for these tests. Suppose cup A and Standard cup S to evaporate under the same conditions and in the same time the quantities a and s respectively. Then $K = \frac{s}{a}$, where K is the coefficient of correction for the cup A. When A is in operation it is only necessary to multiply the readings obtained therefrom by this coefficient, to obtain the reading which cup S would have given for the same time and place; from the above equation, $s = K a$. While the cups do not appreciably alter their porosity during several months of use with pure water, as has been established by experiment, yet it is well to restandardize them at the end of a season's work.

The instruments used in these experiments stood in tin cylinders plunged in the soil to such a depth that the file mark on the jar was level with the soil surface.

The method above described for setting up the atmometer allows rain to fall upon the cup but prevents its direct entrance to the jar. As long as the outer surface of the cup is covered with a water film, as is the case while it is raining, the movement of water through the tube is reversed and water actually flows into the jar, but at a very low rate, determined by the height of the cup above the water level in the jar. This introduces an error into the records, an error depending, not on the *amount* of precipitation, but on the *length of time* during which the outer surface of the cup is kept wet. Correction can be made for this feature if records are taken of the duration of the periods of precipitation, records which are also necessary for a proper study of the relation of rainfall to soil moisture, and hence to plant growth. Of course the error mentioned here can likewise be avoided by placing a small screen over the cup, but such a screen would alter the evaporation rate to some extent, even though made of glass, and since the influx of heat from the sun varies to such a great degree in different regions, such a screen is undesirable. This error is so small that it is neglected in these studies.

Seeds for the experiment were sown in May and from that time the drought conditions continually increased in severity till July 6, when the season of summer rains set in. From May 13 to July 1 the weekly average of the daily temperature maximas rose from 87 degrees to 107 degrees Fahrenheit, while the corresponding average of minima rose from 45 degrees to 75 degrees. For the same period the weekly averages of maxima and minima of relative humidity decreased from 45 per cent (maximum) and 32 per cent (minimum) to 31 per cent (maximum) and 17 per cent (minimum). During the summer rainy season, which lasted from July 6 to about September 1, the temperature and humidity averages were about 100 degrees and 80 degrees, and 95 and 59 per cent. The average evaporation rate for the second period of the experiment was only 57 per cent of that for the first period.

With the exception of castor bean and muskmelon, which developed quite normally from the first, all of the plants practically ceased to grow after the development of a few leaves, and remained quiescent till the coming of the season of lower evaporation. They did not wilt, and appeared healthy except for lack of growth.

With the advent of the rainy season all the plants responded in a marked manner, with the exception of *Tropaeolum* and *Dipsacus,* which finall succumbed in spite of the change in seasons. Castor bean and muskmelon increased their rate of growth, which was rapid before, and the other forms suddenly began to develop rapidly and soon came into flower and fruit.

The meaning of this experiment may be stated briefly in this way, that the castor bean and melon were able to absorb and transmit water to their foliage faster than it was lost by transpiration, and hence were able to carry on a vigorous growth even during the intense drought. *Tropaeolum* and *Dipsacus* failed to provide the excess of water needed for growth even in the rainy season. The other forms of the experiment were unable to provide the needed excess in the season of high evaporation rate, but provided it in a normal way when that rate decreased. Only in castor bean and muskmelon was the power to absorb and transmit water adequate for growth during the dry season.

That the responses just described were due to the change in the evaporation power of the air is hardly to be doubted. There was not a sufficiently great alteration in temperature conditions to explain them, and, as has been stated, the conditions of soil moisture were kept practically constant throughout the entire experiment. The weight of evidence, both from this experiment and from a number of observations on the behavior of the native desert plants, is decidedly in favor of the conclusion that the evaporating power of the air is an important factor in controlling desert vegetation, aside from its indirect influence through the conditions of soil moisture.

Desert Laboratory, Tucson, Ariz.

WILD FLOWERS OF THE "TIP-TOP BOTTOM."

By Felix J. Koch.

There is one excursion out from San Diego, (Calif.), down to the tip-top bottom of the country, where the United States, Mexico and the Pacific meet, that is made by comparatively few persons. This is owing, first, to the expense of hiring one's own vehicle; to the time, in that it takes an entire day, and, finally, to the fact that a permit must first be secured from the Mexican alcalde at Tia-Juana, for only the smuggler or the border jumper is supposed to have real occasion for going here. As a matter of fact, however, this corner of the southwest affords an exhibition of the flora of that section that is unexcelled.

Leaving San Diego early on a February morning, blooming almond trees and trumpet vines grace the several gardens. Then, where one passes out of that city into National City, a suburb to all intents and purposes, tall eucalyptus, or "blue gums," flank the way, these with their deep green, willow-like leaves occasionally interspersed with leaves of actual blue, or else a grape-like bunch of seeds. Here, too, every home has its garden, and now and then there is an olive grove. Yellow daisies and prickly pears grow at the road-side and here and there a pepper tree, laden with scarlet berries, throws its shade.

Out here in the Sweet-Water Valley the scattered plantations are set with lemon or orange groves and these, then, lined with dense, tall firs, here and there cut into box-hedges, to keep out the winds of the sea, which often cause the trees to scale. Lemons are more popular than oranges here, and the ground between the trees is sown with sweet-peas, that fill the air with fragrance—a fragrance made the more piquant by the added whiff from the fir hedge. Some few years ago the Sweet-Water River went dry, and so irrigation, by means of runs resembling the return-chutes of a bowling alley, was employed. The remains of these runs still survive in the orchards.

Again and again, too, more of the tall eucalyptus trees rise, coming right up, even when cut low, the leaf stem is a gaudy, bright yellow, and contrasts well with the darker lace-like pepper-trees. Here and there a place has palms to hedge its lemon-groves, and then one is at Nestor. From here on, the road grows more lonesome and the real country flora begins. Dry, fairly green brush covers the hill ranges along the frontier, and in the grass at the road there are innumerable yellow daisies with leaves like that of the camomile, small blue flower, and shrubs of various sorts. Then, where the mountains trend in, there is sumach and a low sage brush, while cypresses rise above.

Among the gnarled stocks of a little vineyard yellow California poppies thrive, otherwise brush covers everything except in the sunnier fields where the wild tobacco and the wild cucumber grow over all. The ice-plants, too, are numerous—their fleshy leaves covered with sweat-like drops as of an ice pitcher in hot humid weather. Now and then, the white cyclamen, too, joins in the medley. Tangles of dry, wiry weed, and of prickly pear are here, and there is a beautiful tiny blue flower of five petals and center of white, rising from moss in the grass.

At almost the last house this side of the border, ivy grows up the porch, and the flat meadows to the sea are filled with the deep green ice-plants, and very low cypresses, so small, in fact, as well nigh to resemble herbs. Off toward the sea there is a prarie with the ice-plants, the clover and such low plants only, and this is traversed by one line of trees. In summer this land is baked, and so, in spots, it is quite barren; in other places there are only the low cypresses. Just over the line is the first house in Mexico, deserted since no man knows when. A blue gum in front and two other smaller trees shade it, and among the cypresses in the garden is a single palm.

Beyond this house, the low scrubby fields have not alone the ice-plant, but a low aloe, provided with thorns on the leaf margins, and boasting a tall flower-stalk with green fruit in bunches much like those of tiny bananas. Then there are the beautiful yellow daisies of the camomile-like leaf, Black-eyed Susans, and a low white flower, much like the sweet alyssum, and other tiny white flowers, like diminutive bachelor's-buttons. In fact, some fifty-eight varieties of flowers have been found here at one gathering. Attractive indeed are these wild flowers if from their numbers only. The yellows, however, are so far in the majority, as to make yellow the general hue.

Areas of prickly pear extend oceanward, and the grass is filled with yellow daisies and the larger yellow camomile. At the end of the valley there is a great cluster of cactus, a very spiny variety which the guide explains is a "cacti and not a cactus."

On the sand a wiry grass and an aloe-like ivy with blue flowers thrive. Down here is the border monument, the "tip-top bottom" of the republic. A great white paling encloses it, and inside this the ground is bare save for a few yellow daisies, the southwesternmost flowers in the country.

THE MALIGNANT EFFECT OF CERTAIN TREES UPON SURROUNDING PLANTS.

By Howard S. Reed.

A casual examination of the lawns and gardens of any community will show many cases in which the ground for some distance around the base of trees supports scanty vegetation or none at all. In many cases the inquirer is told that special efforts have been repeatedly made to raise grass or flowers around the base of the tree, but that in most cases vexatious failures were the result. The more persistent gar-

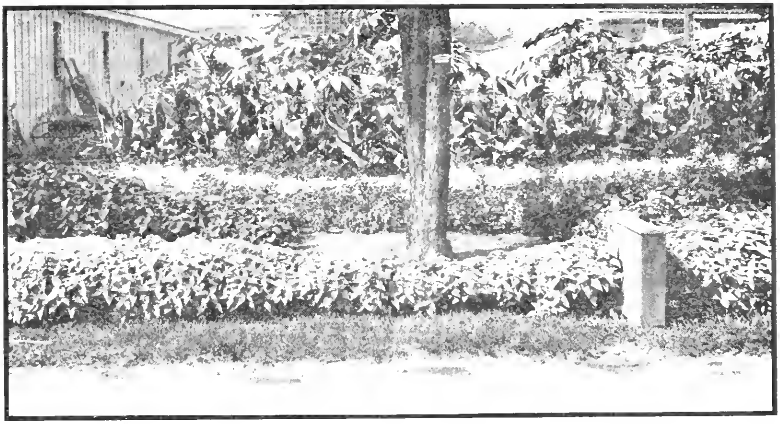

Figure 55. The effect of Kentucky coffee tree on Coleus.

deners have usually applied fertilizers in liberal quantities to the soil and set out partially developed plants, but sooner or later the vegetation languished and died, leaving the former unsightly bare spaces around the base of the tree.

The accompanying illustration shows a typical example of the way in which trees often affect surrounding vegetation. The specimen of the Kentucky coffee-tree was growing in a garden surrounded by rows of coleus and other ornamental plants. The garden had received a liberal application of stable manure and the plants were given a good start in the green-house before being transplanted to the garden. The soil was carefully cultivated and watered as often as necessary during the growing season. In spite of this excellent care it will be noted that the plants around the base of the tree made a poor growth and those closest to the tree were finally pulled up on account of their failure to grow. The illustration shows that the plants in each row were regularly larger as the distance from the tree increased, until, at a distance of eight to twelve feet, no more dwarfing effects were evident.

The cause of the diminished growth near the base of the tree cannot be entirely ascribed to the lack of suitable plant nutrients for, as stated above, the garden received a uniform application of stable manure. Neither can it have been due to the removal of water by the tree because the poorest plants were closest to the tree and hence not in competition with the most active zone of fibrous tree roots which obtain most of the food and water supply for the tree. Furthermore, water was applied as often as necessary to maintain the optimum conditions for plant growth. The effect of shade can not be considered as one of the main causes of dwarfing, at least in this case, because the Kentucky Coffee-tree does not cast a dense shade. Furthermore, the poorest plant growth occurred on the south and south-west of the tree, where scarcely any shade was cast.

If, then, the various physical factors can not be regarded as mainly responsible for the poor growth of the surrounding plants, it is evident that one must look to the tree itself as the malignant factor. The most important factor which can exert a malignant effect upon the soil at the base of the tree appears to be the washings from the bark of the tree. It is evident that the soil at the base of the tree must receive most of the rain water which trickles down the branches and trunk of the tree. During heavy rains small pools may be formed about the base of a tree, from which the water percolates through the soil or flows over the surface.

If the washings from the trees be collected before they come in contact with the soil, they will often be found more or less dark in color. This discoloration is mainly due to soluble material which the rain water has removed from the bark of the tree and would contain tannin, phenols, terpenes, etc.

The toxicity of water which has been in contact with the bark and leaves of trees was shown by Livingston in a recent bulletin of the Bureau of Soils.*

It was found that water which had been sprayed upon the bark of oak, chestnut, and pine trees and then carefully collected was very harmful to plants. In the light of this fact it is easy to see how the soil about the base of a tree may become charged with substances deleterious to plant growth. The writer has frequently observed that on sloping lawns the grass was only lacking on the soil below the tree over which the run-off from the tree flowed during rains. It seems to make little difference whether or not this area lies within the region shaded most densely by the tree; well lighted areas are often entirely destitute of grass.

The roots of the trees may also exert a harmful effect upon surrounding vegetation by substances excreted during the process of growth. Jensen** has shown by a series of experiments in pots that even small trees may exert quite a harmful effect upon wheat growth in the pots during the seasons of active tree growth, but that the harmful effects of the tree roots largely vanished when the trees entered upon their dormant condition in autumn.

Summing up the foregoing remarks, it may be said that the effect of the tree on the common conditions of plant growth, such as water, plant nutrients and light, is not sufficient wholly to account for the harmful effects often noted upon surrounding vegetation. The more malignant effects

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*Bulletin 36, Bureau of Soils, U. S. Department of Agriculture, 1907.

**Science 25: 871, 1907. See also Bulletin 40, Bureau of Soils, U. S. Department of Agriculture; 1907.

appear to be due mainly to organic substances washed from the bark of the tree by rain waters and left by them in the soil. Deleterious substances may also be excreted from the roots of trees and, in certain cases, exercise an influence upon surrounding plants.

Bureau of Soils, U. S. Department of Agriculture,
Washington, D. C.

COLLECTION OF ALASKAN PLANTS.

By C. H. Ascuith.

A very complete collection of Alaskan plants is being assembled by a man who has never in his life opened a book of botany, and who has been guided in his collections solely by his quickness of eye and his tenaciousness of memory. Gustave Gervais, a prospector of Whitehorse, during the summer of 1905 and that of 1906, has accumulated a series of Alaska's plants numbering 1540 species, of which about 50 are said to be new to science. He expects to add fully 500 more during the esason of 1907.

Gustave Gervais was born in Quebec some forty years ago, and went north with the gold rush of 1897. He He dropped off at Whitehorse, where he found indications of copper which induced him to give up further journeying into the eldorado beyond. So he built a cabin and settled at the headwaters of the Yukon, where he has made a comfortable stake and has justified his earlier judgment.

Gervais is not at all an educated botanist but has a strong love for the wild flowers, grasses, shrubs and trees which he meets in profusion on his prospecting trips, and he has made a fad of collecting these. Every form that is new to him is taken carefully back to his cabin and mounted. Following this hobby only as an amusement, he has been able to bring together a collection of mounted plants so large and valuable that he was unwilling to submit to the conditions of the recent wild flower competition in Dawson City. In order to compete for the two hundred dollar prize the competitor was required to agree to the use by the committee of his collection until after the Alaska-Yukon,Pacific Exposition to be held in 1909. As Gervais is constantly adding to his collection, and since he values it at $2,000.00, he was unwilling that it should leave his possession before the exposition.

Owing to the climatic conditions it is very difficult to make anything approaching a complete collection of the flora of the Yukon region. Many seeds lie dormant in the ground for years, until an unusual season brings them to germination. A particularly dry or moist spring, a warm or early spring, a wet summer or late autumn may each cause the appearance and development of forms of vegetation which in more normal years would not be seen at all. For example, during the summer of 1905, which was abnormally suitable for plant growth, numerous species were seen in abundance which were not present at all in the visible flora of the country during the following summer. It is thus apparent that the collecting of botanical specimens in the Yukon presents difficulties not often met with outside of desert or arctic regions, and involves much time and patience as well as special aptitude of the collector.

"I took this up as a pastime," said Gervais. "I sometimes spend three weeks at a time on a prospecting trip, often without horse or boat, and under these conditions find it very hard to pack about with me, in a rough country a prospector naturally negotiates, these specimens of dried plants, which must be handled with much care to avoid injury. I find that my memory is to be relied upon for telling whether I have already in my collection any species I may come across, for it is very rarely that I collect a plant thinking it a new one, only to find that there is already a specimen at the cabin.

"I am told that there are only three men in America who can name and classify the plants of my sets. One of these is at Ottawa, another at Washington, and a third at St. Louis. I expect to go East as soon as possible to have the collection worked over by a botanist, for I have been told by those who have seen it and who know something of plant life that there are in it some fifty species not yet named, and it is to the best interest of science to have these recorded."

The collection comprises only thirteen trees, a statement which will be surprising to some, for within a few hundred miles to the southward of the Yukon one would find eight or ten times this number. While only the hardiest trees flourish in the north, the herbaceous plants, which have only the short summer for their activity, thrive nearly or quite as well as their relatives in milder climates. The flora of the southern United States is well represented north of the fifty-third parallel, and there are few marked gaps in the roll call.

A beautiful portion of the Gervais exhibit comprises the mosses. Some of the northern mosses are of as fine a texture as any fur. The tree moss, black and silky, the variegated reindeer moss, and the cabin moss, form as fine contrasts in color, texture and habit as anything in the North.

The wild rhubarb of Alaska is probably larger than any of the cultivated forms and it has been suggested that the Alaskan plants might furnish a valuable addition to the garden. The wild hay of the Yukon is also unsurpassed. There is a wild clover which the writer has not met with elsewhere. The latter resembles ordinary red clover, but it does not stand nearly as tall and has a shorter and more slender stem, with a flower as large as the largest white clover. Animals seem to thrive on this clover as well as on the best pasture of the South. Indeed, three White Pass horses which escaped and passed three winters in the open were in better condition when captured than stable fed stock. The hungry wolf packs of the spring probably have more to do with the disappearance of such escaped horses than does lack of food.

From a utilitarian standpoint the most interesting of the Gervais plants are the cereals. These grains have been introduced, as is usual in a new country, along the freight trails, and plants of wheat, oats, barley and other northern cereals are quite often seen in the summer. These make an apparently normal growth, and it seems entirely possible that in the future wheat fields may take the place of much of the wilderness now visited only by the lonely trapper or prospector.

THE PEDREGAL

A region comprising several square miles of broken lava slopes encountered a few miles south of the City of Mexico is known as the Pedregal, (meaning colloquially a rocky river-bed). The surface is very irregular, the streamways labyrinthine in their branching, while every-

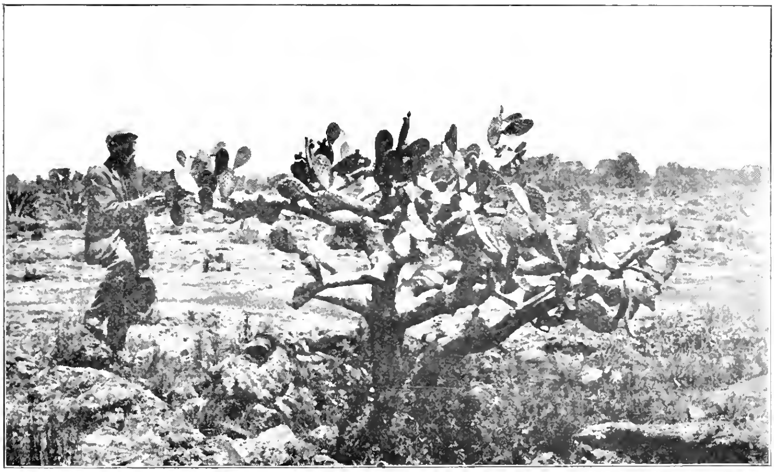

Figure 56. Dr. C. G. Pringle examining a new prickly pear.

Figure 57. A pit in the Pedregal near the City of Mexico. Dr. J. N. Rose on margin.

where are pits and caves from the size of a bucket to that of a dwelling house. The disintegration of the volcanic rocks makes a fertile soil and the caverns great and small serve as reservoirs, which collect water and allow it to escape slowly. The general surface is that of a desert, but the walls of the pits afford all possible combinations of shade and dripping moisture with the result that some of them are fairly choked with vegetation.

The walls are clothed with mosses and ferns, luxuriant woody perennials and herbaceous species find lodgment in the soil on the floors and in the crevices of the rocks, among which are the pepper tree (*Schinus mollis*), a clematis and a woody senecio.—D. T. MacDougal.

Nature and Development of Plants, by C. C. Curtis, is the title of a new book recently put out by Henry Holt & Co. This is a reading book in general botany, pp. VII—471, which is stated in the preface to be for the purpose of acquainting "the reader with the more essential aspects of the subject. Especially have we in mind to make familiar our common plants—which knowledge we believe to be fundamental in any botanical work................. It is not put forth as a text book but it is hoped that the discussion will give the student such a comprehension of the subject that he will come to the lecture room in proper attitude and that he will approach his laboratory work with a desire for investigation." This quotation, which may be regarded as Dr. Curtis' platform, has been consistently and closely followed throughout the book.

The work is evidently an outgrowth of Dr. Curtis' long experience with undergraduates at Columbia University; it is divided into an introduction and two parts. The introduction, six pages, treats of the nature of protoplasm and of the plant cell. The first part, 129 pages, takes up the subjects of the leaf, the root, the stem, and the flower, fruit and seedling. All of these topics are viewed not only morphologically, which is the chief point in mind, but with regard to their function as well. Thus the student learns not only that the root, for example, has a certain structure, but also that the structure may be active in the absorption of food stuffs, or it may be capable of transporting these materials, or it may act as a store house for foods, or it is sensitive to various stimuli, etc. The second part, 215 pages, is concerned with classification and the development of the great groups of plants .

There are 342 figures, most of which were made expressly for the work and some of them, notably figure 57, are so good that very likely they will be seen again.

Dr. Curtis' work will be especially welcomed by all teachers who find it difficult to interest a certain and too common class of youths, those that are *blasé,* of our city schools; and it should be in the hands of every student who is taking a truly general course in the essentials of botany.—W. A. C.

Dr. A. A. Lawson has resigned his position as Assistant Professor of Botany in Stanford University to accept a position in the University of Glasgow, where he will give a course of lectures on the evolutionary history of Gymnosperms.

Professor R. W. Clothier, formerly of Florida State University, has entered upon his duties as Professor of Agriculture at the University of Arizona.

Dr. C. F. Wheeler, of the Bureau of Plant Industry, U. S. Department of Agriculture, who is widely known as a specialist on sedges, will spend the greater part of the coming winter in the vicinity of Los Angeles. He expects to devote considerable time to botanical work.

Assistant Professor George P. Burns, of the Botanical Department of the University of Michigan, has been granted leave of absence till the Thanksgiving holidays to continue studies in Europe.

The Botanical Department of the University of Chicago is soon to have a laboratory garden. About four acres near the corner of Washington Park and the Midway Plaisance have been set apart for this purpose. The proximity of this lot to the Hull Botanical Laboratory as well as to the park make this an admirable location for such a garden.

Henry Holt and Co. have recently published a text book on Plant Physiology and Ecology, by F. E. Clements, pp. XV—315.

It is at once a laboratory manual, a text book and a work of reference; it is intended for use with classes in second year botany in college and university. It aims to present the physiological foundations for the phenomena associated with the distribution of plants as well as the principles which underlie their distribution. It is clearly an introduction to a more extensive study in ecology and evidently presupposes a knowledge of plant development and plant morphology.

The reviewer does not see that any advantage has been gained by making physiology the handmaiden of ecology. Even if the character of the physiology given in the book be acceptable to physiologists it will generally be considered best without doubt to still give it as a separate subject and as full as possible, after which this abundant account may be drawn on, as one draws on his account at the bank, for whatever purposes he may desire, whether this is ecology, morphology or cytology. Both ecologists and physiologists will take much interest in the result of Professor Clement's new "merger."—W. A. C.

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