

angles and the end allowed to rest against the smoked surface of the cylinder. A pin driven in the pillar prevents the wire from turning to one side because of the friction of its end with the cylinder. As the root absorbs water the pressure upon the column of mercury increases, causing it to rise in the tube lifting the cork and indicator with it. The indicator then marks a continuous spiral course on the cylinder. The hourly variation can be studied by observing the distances between the lines. The supply of water given to the plant must be kept constant. An eight day clock should be used and the apparatus need scarcely be touched until the plant is exhausted.

THE DISTRIBUTION OF TROPICAL FERNS IN PENINSULAR FLORIDA. BY LUCIEN
M. UNDERWOOD.

To one who makes a visit to Florida for the first time, constant surprises appear on every hand; sand, palmetto and spanish moss were expected, but the excess of dry pine lands over hamaks, the multitudinous lakes of every size and shape, the comparative purity of the waters, and the variety of elevation apparent in short distances, formed elements that were not looked for and that serve to modify the botanical features of the country to a considerable extent. The river systems are mostly in a north and south direction, and the rivers are sluggish and often rather deep. Throughout the interior of the state, lakes of all sizes are abundant; twenty-five to thirty lakes in a single township (six miles square) is not unusual. Most of the small lakes are without outlets, and frequently stand in deep hollows. Sometimes you may find two lakes a half mile or so apart with a difference of elevation from 50 to 100 feet. Except for a slight discoloration from roots, the water is remarkably clear and few algæ were seen. With the exception of river borders where clay and black mud are found, there is everywhere the loose gray sand that rolls under foot of man or beast, making progress slow and tedious, that supports no turf and only a scattered vegetation, that absorbs moisture rapidly, and that contains a fine dust that filters through the clothing and renders one black and grimy after even the shortest tramp. Occasional swamps occur where a former pond has given way to a bog, or where a small stream is choked up and thus overflows its usual bounds; here a variety of deciduous trees stand thick together interwoven with the omnipresent and exceedingly spiny

Smilax of many species. Here and there are occasional overflows of larger streams where the cypress flourishes, but pine is the prevailing forest growth. From Gainesville southward through Ocala and on toward the center of the state is found higher ground which, long before the phosphate fiend had bored the rocks for paying phosphate, was pitted with natural sink holes and caves where moisture is ever present and where the frosts rarely penetrate. These extend to Brooksville and beyond, and are found on either side of the Withlacoochee river. Further southward and including the lower fourth of the peninsula are the low everglades with saw grass lakes and scrub-palmetto barrens soaked with water during the spring rains, which is reduced to scattered shallow ponds in the dry season.

Although Florida possesses a larger number of ferns than most of the states of the Union (43), and of these more than half (24) are found in no other state, one who visits the state in the winter season will be impressed with the rarity of ferns unless the state is reached before the usual December frosts have cut down the fronds. Along the rivers and wherever moisture is abundant *Woodwardia virginica* grows luxuriantly in its season as the most abundant fern. With it appear two of the *Osmundas* though far less abundant than in northern swamps. It seems out of harmony with our preconceived notions to find the fertile fronds of *O. cinnamomea* growing from a circle of older sterile ones, but this condition is common even in January. Farther down the state *Blechnum* and *Aspidium unitum* and some other species are occasional, but are rarely abundant, at least in the upper two-thirds of the peninsula. In drier land *Pteris aquilina* grows in a more or less stunted condition, but in the more tropical parts of the state it grows occasionally to an excessive height. Next to *Woodwardia* it is probably the most abundant species. *Polypodium incanum* is everywhere found to a limited extent on tree trunks, but is found in profusion only in the southern third of the state. At Orange Bend we found the *mucronata* form of *Marsilia vestita* in abundance rooting in sand and mud. While this is more or less common from Oregon and Dakota to Southern California and Texas it has never been reported before from east of the Mississippi. Its presence in Central Florida becomes almost as interesting a problem as that of its congener, *M. quadrifolia*, in Northwestern Connecticut. No fruit could be found in January, but in the latter part of March fruit was found in great abundance.

The uncertainty of frosts makes the collecting period difficult to predict. Sometimes the fall frosts hold off until January, and often cease to be

troublesome after the middle of February. In other years they appear anywhere from December to April. Often they are local, while again there will be a general freeze that will cut down all tender vegetation. The "great frost" of March, 1886, was sufficiently severe to kill the young fruits of the cocoanut as far south as Lake Worth, and killed out much of the *Vittaria* as far down the gulf side as Manatee. During last winter several frosts appeared in January as far south as the lake region, and on the 8th of April the *Woodwardias* along the St John's from Sanford to Palatka were all drooping from a cutting frost. Of course in secluded places ferns may be found at any season, but only in comparatively frostless winters can they be seen to advantage in the northern half of the state.

The rarer ferns of Florida are tucked away in inaccessible quarters and are not to be found without much searching. Of the ferns peculiarly tropical three groups may be considered: (1.) The swamp species. (2.) The epiphytes. (3.) The lime-rock ferns. Of the swamp species, *Blechnum serulatum* is perhaps the most common; ordinarily this species grows from two to three feet high, but toward its northern limit along the outlet of Lake Dora we found robust forms six and seven feet high. *Nephrolepis exaltata* we found in profusion at the same place growing on decaying stumps and logs. In fact this seems to be its usual habitat instead of palmetto trunks, as so often stated. *Aspidium unitum* has much the same range. *Polypodium phyllitidis* comes north on the gulf side as far as the Manatee river and we found it not uncommon at Lake Worth. *Acrostichum aureum* frequents the brackish borders of tidal streams occasionally encroaching below high water mark. In the west coast it comes up as far as Tampa, and on the Atlantic coast it is more or less common throughout the Indian river country and comes well up to the coast above Titusville. We did not find *Asplenium serratum* in any part of the state visited, though Garber reported it from Manatee in 1879. It more properly belongs in the really tropical portion of Florida.

Of the epiphytic species *Vittaria* and *Polypodium aureum* come furthest north. We found abundance of the former between lakes Griffin and Harris; the latter may be seen occasionally in the vicinity of Lake Monroe, though it is more common below Titusville on the east and Tampa Bay on the west. *Vittaria* grows pendent on palmetto trunks at every height and in every stage of growth from prothallus to mature plant.* Its northern

*It may be of interest to state that a species of liverwort, *Riccia reticulata*, was based on the prothallus of this fern.

limit as we found it is in Lake county. *Polypodium aureum* usually grows just under the clustered leaves of the cabbage palmetto, often at a height of twenty-five or thirty feet. *Ophioglossum palmatum* comes as far north as Manatee where we found the sterile fronds in February after a weary search, for it grows well up on the palmetto trunks, burying its roots deeply between the old decaying bases of the palmetto leaves. He who attempts to climb the palmetto trunk is not usually anxious for the second trip.

The *Ophioglossum* fruits in April or perhaps the last of March and is the most peculiar member of its order, since most of its congeners are terrestrial in habit. The remaining epiphytes have not been found north of the tropical portions of Florida, which include the Keys and the region of Biscayne Bay.

The rock-loving species have a more extensive distribution as they grow in places beyond the reach of ordinary frosts; in the high hamak region to which allusion has been made, several of the tropical species linger in portions of Florida, too cold even for the successful culture of the Orange. In the various limestone sinks about Ocala may be found *Pteris cretica*, *Asplenium rhizophyllum*, *Asplenium firmum*, *Polypodium pectinatum*, *Aspidium patens* and *Adiantum tenerum*. From this same region the rare *Phegopteris tetragona* was collected, but its discoverer holds the exact locality in secret, and furnishes herbarium specimens at 50 cents apiece. While this method of procedure is not what is expected among botanists, one who knows the difficulty and expense of securing some of the rare Florida ferns can scarcely have the heart to criticise too harshly.

A still more interesting locality for the rock ferns is on the Withlacoochee river, two and a half miles below Istachatta. This town which makes considerable display on the maps, consists of two houses and a store and must be reached from Pemberton the nearest railroad station by boat or private conveyance. As the exact locality has never been defined it was by merest chance that we met Mr. F. M. Townsend, the proprietor of the store at Istachatta, who conducted Donnell Smith to the same location in 1883. The locality, which is on the premises of Mr. George K. Allen, was reached just at nightfall. Here, besides a much greater profusion of the species found at Ocala, are found the rare and variable *Phegopteris reptans* and a great profusion of *Aspidium trifoliatum*. Other stations are found near Brooksville and farther down the river on either side. In these sheltered sink holes, protected from frost and so far removed from sunshine as to retain moisture in the driest season, these relics of a tropical flora still

persist, never attracting the attention of either the native "cracker" or the northern migrant, both of whom stare alike at the botanist and his outfit and doubtless wonder what he can want of "ferns." While the higher flora of the tropics does not begin to appear until we reach the Manatee on the west coast and Lake Worth on the Atlantic seaboard, these outliers of the tropical flora extend from two to three degrees farther north, and represent the stragglers in the southern retreat that has marked the southern extension of the peninsula from reef to key and from key to everglade.

With all the information that could be gathered before starting we found that the experience of the winter was necessary to learn the peculiarities of the country and the best localities for exploration and especially how to reach them after they were made known, for of all English speaking countries to learn how to reach a given point Florida is one of the worst in our experience. To point out some of the best localities for future exploration is partly the object of this paper. We would like also to protest against the stupid method of sending out collectors to look simply for the higher vegetation of a new region. Mosses and hepatics, algae, lichens and fungi form just as much a part of the flora of a country as do the seed plants and ferns and often furnish more valuable information regarding the true character of a region than can be gained from a study of the higher flora alone.

Four distinct regions in Florida suggest themselves as likely to yield not only more interesting tropical ferns than have yet been brought to light, but a rich harvest of new facts and species illustrating the nature and distribution of the tropical flora of the peninsula. This, however, will only be possible when the critical botanist gets away from his dried herbarium fragments and studies the flora face to face in its native fastnesses. Then only can biological surveys prove a success. These regions are:

1. *The river regions of West Florida.*—The Withlacoochee, especially from Pemberton Ferry to the mouth, and including lakes Tsala Apopka and Penasoffkee on either side, the Manatee, the Myakka and the Peace. Explorations along these rivers can best be made in boats* and are likely to well repay the cost, for while nearly all have been somewhat visited by botanists, the country has been *skimmed* rather than explored.

2. *The interior lake region of South Florida.*—This would involve a trip from Kissimmee southward down the chain of lakes to Okeechobee and

*The region of Lake Tsala Apopka and Lake Penasoffkee could best be explored with a horse and wagon, though the development of phosphate beds in Citrus county is likely to extend the public means of conveyance. Railroads in Florida are too slow and uncertain for much dependence for short trips.

and then westward through the drainage canals and the Caloosahatchee river to Punta Rassa. This means from 200 to 250 miles by boat, subjection to considerable hardship, and could only be undertaken by a party.

3. *The Keys*.—Within the triangle whose base is a line running from Key West to Key Largo, and whose apex is at Punta Rassa, there are myriads of small islands, all lying in the tropical portion of Florida, which have never received anything like a thorough botanical exploration. These can only be explored by boat. A small sailing craft can be obtained at Tampa, Manatee, or Key West, for \$40 a month furnished with a sailor who will also act as cook. Board is cheap, for game and fish are abundant, while other supplies will have to be obtained at the point of embarkation. The scattering trips that have already been made to this region have yielded some of the rarer ferns, to say nothing of extensive additions to the higher flora of the state, ranging from a new genus of palms down. Unless it be among the algæ not a single specimen of the lower cryptogams has been collected in this region.

4. *The Biscayne Bay region*.—The fairest spot we found in Florida during last winter was Lake Worth. The northern tourist who leaves this out misses the best of the state. Here the climate is that of Southern California, mild and balmy like all Florida, and yet with the invigorating tonic that nearly all the rest of Florida sadly lacks. Here, too, if you are fortunate enough to stop at Oaklawn on the mainland, you will find as we did the first square meal in Florida, served by the genial judge of Dade county, who is also the proprietor of the best hotel on the lake. Here was the first real taste of the tropics. Tropical fruits and cocoanuts in profusion, mangoes without trunks set up on spider-like roots, banyans, and a profusion of strange shrubs and trees. It was only when too late to avail ourselves of the trip that we learned how to reach Biscayne Bay from the Atlantic side. Of course it could be reached from the Gulf side by boat,* but in vain did we try to learn whether there was an overland passage from Miami to Lake Worth. Here we found that a solitary mail carrier tramps the distance (about 60 miles) once a week, thus bringing the two settlements of Dade county within reach of each other. He goes up and down the beach, for there is no other path. Life saving stations are scattered along the coast at intervals of about 25 miles, and the only places where there is real danger is at the inlets, which, during the high seas are difficult to nav-

* Miami may be reached from Tampa by a tri-weekly mail steamer to Key West (fare \$10), thence by sailing vessel which carries bi-weekly mail to Miami (fare \$4).

igate in the frail barks that serve for ferries, and the inlets are usually infested with both sharks and "gators." The best collecting ground is usually within 300 yards of the coast line. The ordinary guide books state that "there is nothing of interest below Lake Worth," but one who has seen the country below from a botanical standpoint says "there is nothing above Lake Worth." Botanically this is doubtless the most interesting region of all Florida. The part between Lake Worth and Miami has so far as we know never been trodden by a botanist. Around Miami and on the neighboring Keys have been found most of the remaining tropical ferns of Florida, viz.: *Polypodium Swartzii*, *Asplenium serratum*, *A. dentatum*, *Nephrolepis acuta*, *Pteris longifolia*, *Ternitis lanceolata* and *Aneimia adiantifolia*.

SOME ADDITIONS TO THE STATE FLORA FROM PUTNAM COUNTY. By LUCIEN M. UNDERWOOD.

While the higher flora of Indiana seems to be fairly well known, it is surprising to find so little on record regarding the lower cryptogams of the state. Except a short paper on "The Mildews of Indiana,"* a few bulletins from the experiment station relating to some injurious fungi, a short list of mosses and lichens from Richmond,† and a few scattering notes in the *Botanical Gazette*, nothing has been placed on record, which, however, is far from saying that nothing has been done in this direction. It is a question whether as teachers of botany we have not swung the pendulum too far in training our students to become expert section-cutters and discriminating histologists and have thereby left out of their course that *cultural* feature of botany that comes only from bringing them in direct contact with nature. I plead for considerable field work as an invaluable adjunct to laboratory instruction. In a year's study of botany a student ought to become fairly proficient in the manipulation of the microscope and at the same time learn how and where plants grow (and especially the less conspicuous plants), and where their position is in the system, thus gaining a love for nature as well as a knowledge of the methods of manipulation. Botany ought to be a *cultural* study as well as a purely *technical* one. When we

*J. N. Rose, *Botanical Gazette*, XI, 60-23 (1886).

†Mary P. Haines, 8th, 9th and 10th Ann. Reports, Geol. Survey, 235-239 (1879).