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TABLE OF CONTENTS.

DACHNOWSKI—A Cedar Bog in Central Ohio.....	193
DETMERS—A Floristic Survey of Orchard Island.....	200
NICHOLS—An Open Valley near Harrisburg, Ohio.....	210
HOOD—Some Economic Monocotyls of Ohio.....	214
DICKEY—Meeting of the Biological Club.....	216

A CEDAR BOG IN CENTRAL OHIO.*

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Ohio is one of the states of a central region in which the dominant vegetation is the deciduous forest. Our forests are a type of plant formation, with a distinct physiognomy and growth-form, both of which are an expression of certain definite conditions of life. Deciduous forests characterize all regions in which there is an abundant rainfall well distributed through the growing season, a relatively high percentage of atmospheric humidity, and a relatively high annual sum total of temperature exposure. Before settlement by immigrants from Europe, Ohio was almost completely covered by dense forests. Here and there, in ravines, in depressions between morainal hills, on the highlands of watersheds, were restricted areas of bog and marshland, sometimes many thousands of acres in extent, "filled in" ponds and lakes, another type of plant formations, of which the component species now tenanted such areas, and their relative proportion seemed more like an allusion to the distant north. Indeed they are relicts of a boreal vegetation which skirted the border of a great ice sheet covering almost all of Ohio. For reasons which will be stated in another paper these isolated areas of northern plant societies maintained themselves, and remained behind during the great migration of plants, while most of the plant societies adjusted to a northern climate, retreated northward with the glaciers as the winter conditions of the glacial period slowly changed to the present climate.

*By permission of the State Geologist. Contribution from the Botanical Laboratories of Ohio State University, No. 57.

During the past summer the writer was directed to obtain for the Ohio State Geological Survey an estimate of the extent and value of the bog and marshland in Ohio, to determine the depth of these vegetable accumulations, the general physical and chemical characters of the deposits, and to study them with a view to their commercial and agricultural utilization.

The uses of peat are many. There has recently been shown a renewed interest in the problem of peat utilization. In Europe this question receives the most careful and exhaustive study by trained specialists. Reports from Europe indicate the success of various new processes, and it is therefore a matter of the greatest importance to determine the extent of our own peat resources, the conservation of which should be second to none of the other economic sources of wealth. Peat can be employed as packing material, bedding, absorbent, fertilizer; as insulating material, for paper pulp and cardboard; in woven fabrics, artificial wood, paving and building blocks, for mattresses. There are certain chemical by-products derived from the distillation of peat as alcohol, ammonium sulphate, nitrates, and various dyes, the demand for which is steadily increasing. An interesting chapter in peat utilization is that of peat as fuel, power or producer gas, and coke. Many of our peat lands make our most productive agricultural soils when properly reclaimed. The most interesting studies are connected with the agricultural possibilities of peat soils; the nutritive value of peat to cereals and legumes, the character and variety of crops and garden plants which may be profitably cultivated on peat land; the sterility and the diseases of some of these soils; the nature of functional and structural responses in plants to such soils, and many other problems. This is a period of "intensive" agriculture, of investigation and discovery, and attention must sooner or later be turned towards our immense peat deposits.

The plants concerned in the formation and development of bogs and marshlands bear a relation of the utmost importance with reference to the purity, character, thermal, and physiological value of peat soils. The bearing of a floristic study upon the distribution of bog and marsh plants is also of considerable ecological and physiological interest. The aim has been, therefore, not only to present a list of the plants found in the various areas visited, but to show also the natural association of the plants into societies, and the order in which development and succession of plants in bogs proceeds. Moreover, the present bog and marsh plant societies are being destroyed so rapidly that some historical record is indeed of primary importance. In almost all places the work of man inaugurated conditions by cutting, clearing, fire, ditching, pasturing, and cultivation, which have destroyed much of the original flora of Ohio, and hence in many places a mixture

of arborescent plants, bog relicts, weeds, and invading plants has established itself. But even under such conditions an order of invasion and succession is to a certain extent characteristic in the movement of plants, and depends largely upon the extent to which the plants are especially enabled to cope functionally with the changing conditions and hold their ground. The time and chance factors, i. e., the opportunity for occupancy of the area, the relative amount of filling, and the degree of decomposition of peat which has occurred in the basin, are of equal importance in competition and maintenance. In all cases and at all times during the phases of the development of a plant formation the invasion, zonation, and succession of plant societies is intimately bound up with differences in available soil water content, and available food constituents which go concomitant with the degree of the decomposition of peat soils.

The most interesting of the many different kinds of bogs in Ohio is a Cedar bog near Urbana in Champaign County about forty miles west of Columbus. In a few places the character of the county is hilly, and in the depressions occur peat deposits. As a whole, however, the surface of the county is level and made up of plains. The general form is that of a broad shallow trough, lying north and south. Mad-River runs through the middle of it, and drains the main body of the territory.

On the east side of Mad River, in the southeastern part of Mad River Township, and extending largely over into Urbana Township (T5R11) in sections 31 and 32 is a tract of land known as the Dallas Cedar swamp. It is about six miles south of Urbana, and easily reached by means of the Ohio Electric Railway. The Cedar Swamp is a part of an area of cleared bog which comprises today about 600 acres. There was once an extensive deposit covering approximately 7,000 acres. On a small portion of land owned by M. and G. L. Dallas occur as described below groves of arbor vitae (*Thuja occidentalis*) in a good state of preservation. The groves occupy a habitat near which the soil water is derived from cold springs along the poorly drained river valley. A considerable number of soundings were made which disclosed for the first two feet a blackish brown compact, well decomposed, non-fibrous peat. At the third foot level the peat appeared dark brown, somewhat fibrous, with a considerable admixture of marl below. A number of well preserved logs and branches were encountered. At four feet the peat appeared brown and compact but fibrous in texture with fragments of rhizomes and roots. At the five feet level the sounding instrument encountered a coarse gravel with stones showing glacial striations. This rested on beds of quicksand and morainal till. The bog harbors a unique dependent flora which long thrived here unmolested and was once a favorable resort for botanists. Now the cedars and the accompanying undergrowth

are rapidly disappearing as the clearing of the area nears completion. The indications are that in a few years the last vestige of this interesting aggregation of plants will be destroyed.

This type of bog is distinctly northern in its distribution and has not been observed by previous writers to occur south of the central part of Michigan. The brief time which could be given to the locality made a more detailed study and the mapping of the area impracticable. Yet the notes and records made have revealed a considerable number of species hitherto supposed to be confined to the states north of Ohio.

In several places the groves of arbor vitae are dense pure stands or facies with scarcely any undergrowth. The association has only a single vertical layer in which the lowermost branches of the component individuals bear a common spacial relation to light. The ground is littered with cedar foliage and only occasionally small sprouts of the chokeberry (*Aronia arbutifolia*), and stunted seedlings of yellow poplar (*Liriodendron tulipifera*) or small plants of the spice bush (*Benzoin aestivale*), alders, and woodbine are visible; generally there are no members of a subordinate species other than a few mosses and liverworts. In more open stands in which the effects of fire and cuttings are still present the arbor-vitae is found here in association with the red maple (*Acer rubrum*), yellow poplar, (*Liriodendron tulipifera*), black ash (*Fraxinus nigra*), white walnut (*Juglans cinerea*), Sycamore (*Platanus occidentalis*), and wild cherry (*Prunus serotina*). The undergrowth is not only numerous in species but of exceptional height and in five layers. The poison sumach (*Rhus Vernix*) reaches frequently a height of twenty-five feet. Other members of this structural part of the formation, and determining more specifically the physiognomy of the layer, are the alders (*Alnus incana*, *A. rugosa*), the winter-berry (*Ilex verticillata*), the chokeberry (*Aronia arbutifolia*), and the round leafed dogwood (*Cornus circinata*). The inferior layers which seem to be entirely determined by the density of the mixture of facies are really overlapping communities of woodland and bog plants. There seems scarcely no relation to habitat factors. Seedlings and sprouts occur in all directions, in various degrees of abundance, and only the less hardy plants lose ground, thus producing examples of an indiscriminate alternation. The spice bush (*Benzoin aestivale*) is only of relatively less importance in the (second) stratum of bushes to the red bud (*Cercis canadensis*) and the elderberry (*Sambucus canadensis*).

The subordinate position with regard to the taller species is occupied by the cinnamon fern (*Osmunda cinnamomea*), the meadow rue (*Thalictrum dasycarpum*), the spikenard (*Aralia racemosa*), the bladder fern (*Cystopteris bulbifera*), and touch-me-not (*Impatiens* sp.). With them in varying abundance occur

as a lower herbaceous layer the maiden-hair fern (*Adiantum pedatum*), the dwarf raspberry (*Rubus triflorus*), wood ferns (*Aspidium cristatum*), miterwort (*Mitella diphylla*), wakerobin (*Trillium erectum*, *T. grandiflorum*), false solomon's seal (*Smilacina trifolia*), violet (*Viola blanda*), the star flower (*Trientalis americana*), the Indian cucumber-root (*Medeola virginiana*), manna grass (*Glyceria Torreyana*), and others.

In many places the various shrub layers immediately below the trees interpose as dense screens. These are often of sufficient density to reduce the light to a diffuseness which leads to frequent modification and a consequent rearrangement of the individual plants in the ground stratum. The number of such plants present is not large; they are all past flowering when shade conditions become extreme. The little mayflower (*Maianthemum canadense*) and various mosses and liverworts are the more resistant members of the living ground cover; they tend to disappear only when the shade condition approaches a light value similar to that of the pure stands of cedar.

To the east of the mature formation and adjoining it is an open area; in it occur a number of low wet places. The water of the cold springs is overcharged with carbonate of lime. The average soil moisture content is near saturation, and the soil temperature uniformly low throughout the year. In other places the water content is not quite so high, but higher usually than in any of the soils frequented by the cedars. Testborings indicate a surface layer of black non-fibrous peat about two feet deep, resting on a cream colored, fine grained marl, three feet in depth and underlain by sandy gravel. The marl is frequently of the nature of calcareous tufa. In the wetter habitat the plant association resembles that of an open sedge zone. The dominant plants are the rushes *Juncus brachycephalus*, *Eleocharis obtusa*, *E. palustris*, and *Scirpus americanus*. The physiognomy changes in places on account of an admixture of shield fern (*Aspidium Thelypteris*) and the parnassus (*Parnassia caroliniana*), with an occasional lizard's tail (*Saururus cernuus*), some goldenrods (*Solidago Riddellii*, *S. ohioensis*), the Canadian burnet (*Sanguisorba canadensis*), twayblade (*Liparis Loeselii*), water avens (*Geum rivale*), millet grass (*Milium effusum*), the marsh bellflower (*Campanula aparinoides*), lousewort (*Pedicularis lanceolata*), the golden ragweed (*Senecio aureus*) and swamp asters (*Aster puniceus*, var. *lucidulum*). Until recently orchids (*Habenaria psycodes*) and lady slippers (*Cypripedium hirsutum*, *C. parviflorum*) were not uncommon.

Nearer the cedar groves a low shrub society appears, among which the shrubby cinquefoil (*Potentilla fruticosa*), the bog birch (*Betula pumila*), several willows (*Salix discolor*, *S. petiolaris*), the buckthorn (*Rhamnus alnifolia*), and dogwoods (*Cornus stolonifera*)

fera, *C. alternifolia*), are the more characteristic members. The ground cover is almost throughout one of mosses such as *Hedwigia albicans*, *Anomodon rostratus*, and a species of *Chara*. In this association lateral zonation is most clearly in evidence and arises in part from the characteristic growth form of the respective species, and in part from the physical features of the habitat. Of the latter the factor chiefly concerned is the water content of the soil. The essential connection between this is evident where springs are the source of shallow pools. Tension lines in the vegetation (ecotones) are not well marked, however. The zones are too often incomplete or obscure. There is in consequence more or less of a transition from the ground layer of mats of mosses and algae to the lower grass and herbaceous layer and to the tertiary layer of bushes and shrubs.

The habitat across the road and south of the areas just described, bears less resemblance to extremes in water content. The cedars are of less mature age and size, and deciduous invaders are still lacking. Next to the arbor vitae the predominant trees are the yellow poplar and the red maple. The flora seems more distinctly related to a transition stage. This may be due to a former partial clearing of the area. (The young cedar trees average a height of ten to fifteen feet, and appear to occur in about equal abundance in every quadrat and line transect studied.) The shrubs resemble those of open bogs, *Aronia arbutifolia* and *Ilex verticillata*, being the most notable species. *Betula pumila* and *Potentilla fruticosa* are rare. The shrubs form a vertical layer nearly equal in height to the cedars. The interesting peculiarity of the ground layer is the frequent occurrence of mats of sphagnum (*Sphagnum cymbifolium*, *S. acutifolium*) with the round-leaved sundew (*Drosera rotundifolia*) clinging around the stems of small bushes of huckleberry (*Gaylussacia baccata*). These hummocks are often overgrown with the prostrate blackberry (*Rubus hispidus*). *Parnassia caroliniana*, the fringed gentian (*Gentiana circinata*), the marsh bellflower (*Campanula aparinoides*), violets (*Viola blanda*, *V. arenaria*) and St. John's wort (*Hypericum prolificum*) with the great lobelia (*Lobelia siphilitica*), and a similar but slender dwarf form (*Lobelia spicata*) are found indiscriminately, but usually near small pools in which the small bladderwort (*Utricularia minor*), mosses (*Hypnum*s) and Algae (*Chara* sp.), are some of the frequent species. The cat-tails (*Typha latifolia*) are still sparse.

Adjoining this open association is a clearing, now used for pasture, which was formerly burned over. The peat soil is black in color, non-fibrous but rather wet. The entire cleared area is densely covered with the shrubby cinquefoil (*Potentilla fruticosa*) averaging a height between three and four feet. In a few undisturbed places a succession is indicated with arbor vitae as the dominant tree. Seed-

lings of red maple and yellow poplar are close associates. The succession is virtually an indeterminate rejuvenation, that is, the habitat still dominates the formation. The degree of stabilization is still one to give expression to xerophytic forms. (The physical conditions are changing extremely slowly, remain unfavorable to invaders, and tend to preserve many of the most important early vegetation stages. The persistence and dominance of the cedar formation in this latitude follows for these reasons, but partly also on account of the predominance of the trees present; for the formation itself must be considered as an essential active factor, in furnishing seeds, and eliminating diversity. Largely, however, the dominance is an adjustment to the available soil water content. A competition with seedlings of deciduous trees other than the yellow poplar and red maple does not seem to ensue although the light relation is favorable. A relation of seed production to ecesis, i. e., to germination and establishment, is nowhere obvious. The various species of deciduous trees have a larger seed production and more effective dissemination contrivances, but so far as the actual number of seedlings is concerned the relative absence of them suggests some edaphic agency in selective operation.) There is some sort of correspondence in the arbor vitae, in plasticity of function, or in habitat form, to the life relations of the soil. Definite conclusions, however, can only be reached by experimental studies. The field observations would indicate that the nature of the primeval forest of this region did not consist of a combination of trees such as now exists on the drier areas described above. The deciduous arborescent facies in which the sequence is the development to the deciduous climax forest, is at present decidedly a mixture, and though a closed formation, yet one whose original members were allied more to the northern cedar bogs.

To Miss F. Detmers the writer is under many obligations for aid in the identification of plants.