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By
Henry P. Hansen

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# THE TAMARACK BOGS OF THE DRIFTLESS AREA* OF WISCONSIN

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*The work upon which this paper is based was done in the laboratory of the University of Wisconsin under the supervision of Dr. N. C. Fassett.

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## INTRODUCTION

The collecting, identifying, and recording of the flora found in a certain region or area is always an interesting and valuable piece of botanical work. The work that has been done in this phase of botany will become more valuable as time goes on because the progress of civilization is slowly wiping out the virgin and native flora of many areas. In a short time, if not already, it will be impossible to obtain a complete representation of the flora that exists in these areas. The work that has been carried on and is being carried on at the present time in this field is of priceless value. This work is of still more importance if an attempt is made to correlate the present flora with the ecological conditions that have existed in the past and those that exist today, so that a fair knowledge of changes that have taken place and are taking place may be obtained and preserved.

The Driftless Area of Wisconsin is one of the areas that offers a large number of ecological problems. The flora of this region is by no means fully represented in any herbarium, and it is fast becoming extinct. In fact, it will hardly be possible to obtain a complete set of the plants that have existed here in recent times.

One of the specific problems offered by this area is that of the tamarack bogs which are of rare occurrence in the Driftless Area. The writer has spent two years in collecting and assembling the data, facts, and theories that are given in this paper. It is an attempt to preserve some knowledge of the conditions that exist in these bogs today and to record facts which will, in a few years, be lost to mankind forever, as civilization slowly encroaches upon and erases all traces of these bogs.

The writer wishes to take this opportunity to express his sincere thanks and appreciation for the inspiration and helpful suggestions of Dr. Norman C. Fassett of the University of Wisconsin. Dr. Fassett has worked to obtain, as near as possible, a complete collection of the native plants of Wisconsin, before it is too late. The writer wishes to also thank Dr. F. T. Thwaites of the Department of Geology for his assistance in amplifying and correcting the geological facts cited.

### GLACIATION IN WISCONSIN

One of the important factors in determining plant distribution and plant ranges in Wisconsin is the fact that a portion of the state was not covered by the several glaciers that existed on the continent of North America during Pleistocene time (Map 1).

MAP. 1.—The maximum glaciation in North America shown approximately by stippled area. The solid black areas represent unglaciated areas within the region of glaciation.

The invasions of the ice did not touch the southwestern part of Wisconsin, so there is an area of about twelve thousand square miles that has not been affected by the glaciers as have other parts of the state (Map 2). The adjoining portions of the states of Illinois, Iowa, and Minnesota were also spared this invasion. Several reasons have been


MAP 2.—The general distribution of the three major rock types of Wisconsin. The limestone in the eastern part of the state is mostly covered with glacial drift, while in the southwestern part the streams have cut through the limestone layer, into the sandstone. The bogs of the Driftless Area, that are situated within the limestone region, are found in wide sand-filled valleys.

offered for the absence of the glaciers from this area. One is that the advancing ice was deflected from its course by the Green Bay and Lake Michigan basins on the east, and the Lake Superior basin on the west and north.[409] The ice was thus split and was not able to join again within the state. It is not thought that the ice ever surrounded this area at one time, but it is believed by some geologists that the ice would have gradually crept in if warmer weather had not become general throughout this region. It is unlikely that the entire ice-front advanced simultaneously, for it was split into several lobes that either receded or pushed ahead independently of each other, as is shown by the location of the terminal moraines.

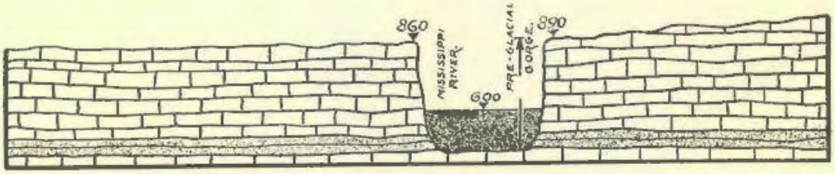



FIG. 1.—A diagramatic cross-section of the Mississippi River Valley, showing how the pre-glacial gorge has been filled to a depth of several hundred feet with glacial outwash. *(From Physical Geography of Wis.)*

As the ice moved along the ground, rock and soil became imbedded in it. This material was ground and smoothed by the action of the moving ice, and when the ice stopped its advance in the warmer seasons, this material was dropped by the ice as it melted. Such material is called drift.

If the ice-front remained in a fixed position for any length of time, there was a piling up of this drift, forming moraines. When the melting of the ice resulted in a large amount of water that flowed away from the base of the glacier, the streams carried a great deal of glacial outwash down their courses, which filled the stream valleys to a considerable depth.[410] Where these streams flowed through the Driftless Area, this outwash was deposited in large quantities. The valleys of the Wisconsin and Mississippi rivers were filled to a depth of several hundred feet in some places (Fig. 1).

[409]Martin, 1916, p. 103.
[410]Ibid., p. 199.

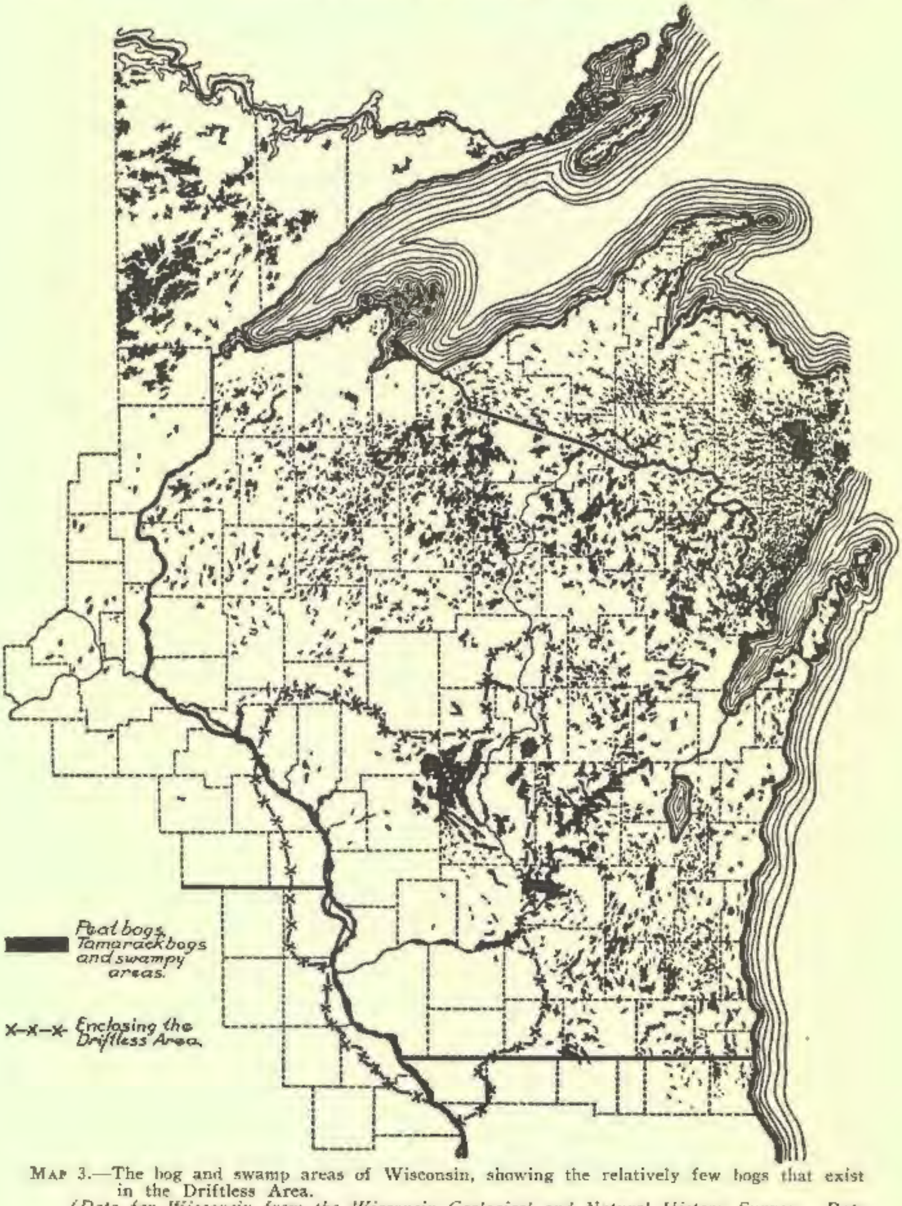
## TOPOGRAPHY AND GEOLOGICAL FORMATIONS IN THE DRIFTLESS AREA

The topography of the Driftless Area is decidedly different from that of the rest of the state (Plate 39). This region is very rugged, corrugated by ridges and valleys that were not leveled or filled by the action of the ice, and well drained, with few standing bodies of water. There are many steep cliffs and crags which are largely absent from the glaciated region.

The highest extensive formation is the Ordovician limestone which covers much of the southern part of the state. This formation is overlain by several small areas of Silurian limestone. Beneath the Ordovician limestone is the St. Peter sandstone, which in turn overlies the Oneota limestone. Under this limestone are found the Cambrian sandstones which extend from the northwestern almost to the southeastern part of the state. These formations overlap each other like shingles. The Oneota limestone follows along the Mississippi River, but is broken by a broad expanse of the Cambrian sandstones near the mouths of the La Crosse and Black rivers. The crystalline or Archean rock area of northern Wisconsin reaches the northeast corner of the Driftless Area, and extends in armlike fashion down what may have been a former course of the Wisconsin River (Map 2). In summing up the physiography of the Driftless Area, one can readily see that there is a wide variation both as to the geological and topographical features, which provides an equally wide variation in the ecological conditions for the existence of plants.

## CHARACTERISTICS AND DEVELOPMENT OF BOGS IN THE GLACIATED REGION

The topographic and physiographic features of the glaciated region are very different from those just described in the Driftless Area (Plate 39). Instead of being a rugged and well-drained type of country, the glaciated region is comparatively smooth, gently rolling, poorly drained, and is dotted by thousands of lakes and undrained depressions. Most of these undrained depressions and many of the lakes have been changed into bogs, which support a bog plant society (Map 3). This flora consists chiefly of the following plants: Sphagnum Moss (*Sphagnum* spp.), Pitcher Plant (*Sarracenia purpurea*), three species of Sundew (*Drosera*




MAP 3.—The bog and swamp areas of Wisconsin, showing the relatively few bogs that exist in the Driftless Area.

*(Data for Wisconsin from the Wisconsin Geological and Natural History Survey. Data for Michigan from the Michigan Geological Survey. Data for Minnesota from the Minnesota Geological Survey.)*

*rotundifolia, D. intermedia,* and *D. anglica*), two species of Blueberry (*Vaccinium canadense and V. pennsylvanicum*), two species of Cranberry (*Vaccinium macrocarpon* and *V. Oxycoccos*), Huckleberry (*Gaylussacia baccata*), Bog Rosemary (*Andromeda glaucaphylla*), Leather Leaf (*Chamaedaphne calyculata*), Labrador Tea (*Ledum groenlandicum*), Pale Laurel (*Kalmia polifolia*), Wintergreen (*Gaultheria procumbens*), Creeping Snowberry (*Chiogenes hispidula*), Buckbean (*Menyanthes trifoliata*), Swamp Birch (*Betula pumila glandulifera*), and Tamarack (*Larix laricina*). Two other trees, Black Spruce (*Picea mariana*), and White Cedar (*Thuja occidentolis*), are often associated with bogs. The Black Spruce is found in the northern bogs, while the White Cedar is common in the bogs in the eastern part of the state, but the Tamarack remains the most common tree in the bogs of Wisconsin. There is an abundant deposit of peat in these bogs which has been formed as the plant-growth has gradually changed the original lakes into bogs.

The bog plant society is one that requires a cold, xerophytic habitat. The bog is apparently a hydrophytic habitat, but in reality it is physiologically xerophytic because the coldness of the water and the acidity of the soil cause a dry condition as far as the moisture income and outgo of the bog plants are concerned. Many of the bog plants in Wisconsin can be found outside of bogs at higher altitudes farther north, which indicates that the bogs offer a favorable environment for these plants south of their ordinary range.[411]

In many cases, the general tendency for a lake or undrained depression, is to change gradually into a mesophytic habitat, which condition is brought about by the plant growth itself. In tracing the plant changes leading up to this point, we find that there seems to be a definite order of succession in most cases.[412] The first step in changing a shallow lake into a mesophytic habitat is the entrance of free-floating aquatics such as Duckweed (*Lemna* spp.), Algae, etc. Next follow the submerged plants with roots fastened to the bottom, and then forms having roots on the bottom and a large part of their stems and leaves above the water may enter. These include such plants as Bulrush (*Scirpus* spp.), Cat-tail (*Typha latifolia*), Pickerel-weed (*Pontederia cordata*) and Arrow-leaf (*Sagittaria* spp.). By this time a well-defined substratum

[411]Transeau, 1903, p. 408.
[412]Waterman, 1926, pp. 255-272.

has been deposited on the floor of the lake by the preceding vegetation, so that the herbaceous bog plants may get a start along with various species of Sphagnum. The growth of the Sphagnum produces the acidity of the substratum that is essential for the existence of the rest of the bog plant society. The herbaceous growth is followed by the entrance of the bog shrubs which generally constitute the principal flora of the bog. The shrubs are usually followed by the bog trees, but sometimes the bog remains in the shrub stage with few or no trees gaining a foothold. It is during the existence of the Sphagnum in the bog that extensive peat deposits are made. Little decay takes place because of the lack of oxygen, and consequently the plants that die add to the ever-thickening accumulation of peat. This accumulation may reach a depth of thirty feet or more depending upon the rate of deposition and the age of the bog.

When a sufficiently thick layer of peat has been built up, Tamarack may enter, and in some cases Black Spruce or White Cedar. The entrance of these species often marks the beginning of the end of the smaller bogs. Many of the bog shrubs are intolerant of shade, and as a result they are crowded out by the trees. Leather Leaf is especially affected by the shade of other species, and is often found as the principal woody plant in an entire bog. By the time the bog trees have gained a foothold, hardwood trees may enter and gradually take over the bog. The first are: Alder (*Alnus incana*), White Birch (*Betula alba papyrifera*), Yellow Birch (*Betula lutea*), Red Maple (*Acer rubrum*), and several species of Willow (*Salix* spp.). Mesophytic shrubs such as Red-osier Dogwood (*Cornus stolonifera*), and Poison Sumach (*Rhus Vernix*), may enter about the same time.

## GLACIATION IN RELATION TO THE PRESENT DISTRIBUTION OF NORTH AMERICAN BOGS

It is very evident that the North American bogs are associated with the glaciated region. During the glacial period, most of the plants common to the bogs are thought to have skirted the glacier, and these plants were the first to follow the receding ice sheet.[413] At the present time, there do not seem to be any of these bogs in existence south of the farthest invasion of the glacier, except in the Driftless Area of Wis-

[413]Dachnowski, 1911, pp. 1-33.

consin. The bogs found in northern Illinois are outlying representatives of their kind, for the bogs found on mountain tops in the tropics very likely have no connection with the North American glaciers. They do suggest, however, that a relatively cold climate is necessary for bog existence.

It is impossible to trace the migrations of the bogs and bog plant societies during the inter-glacial periods. As has been previously stated, the ice did not cover the entire glaciated region at one time, but advanced in lobe-formation leaving areas uncovered by ice between the lobes. Thousands of years later, these areas may have become covered, while the formerly covered areas were free of ice. These movements gave the bogs and bog plants a chance to change their positions in relation to the ever-changing positions of the lobes of the ice-sheet, thus preserving the bog plant society down to the present day. That the bog plants remained on the southern margin of the glaciated region until the ice had retreated permanently is doubtful, as the species common to the bogs are such that they could have withstood the cold climate caused by the presence of the ice. Because most of the bog species are heavy-seeded, the bogs probably had their most rapid spread when the ideal ecological conditions for their growth were the most common type of conditions in their present area of distribution. The common method of seed dispersal is by birds and water so that if the conditions suitable for the existence of bog plants are widely separated, there is little chance for the extension of the range of this type of flora.

## PHYSIOGRAPHIC FEATURES OF THE SITES OF THE BOGS IN THE DRIFTLESS AREA

A recent paper on Wisconsin plants gives the impression that bogs exist only in the glaciated portion of the state, except on the bed of Glacial Lake Wisconsin.[414] This, however, is not true as they are fairly common in the Driftless Area (Map 4). These bogs do not com-


MAP. 4.—Location of bogs in the Driftless Area, showing that they exist on the floodplains of the larger streams. These streams are either tributaries of the Wisconsin and Mississippi rivers, or closely associated with them.

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[414]Fassett, 1929, p. 257.

pare in extent with those in the glaciated region, and because they are isolated, they present some perplexing problems as to the time and method of their origin. The bogs of the glaciated region doubtless came into existence as the glacier receded, but did the bogs in the Driftless Area have their origin in pre-glacial, inter-glacial, or post-glacial times? In this paper, the writer will discuss some facts and theories obtained from the study and observations of these bogs during the summers of 1930 and 1931. One cannot demonstrate in all cases the time of origin, but one can raise certain questions and advance theories that will stimulate more research and perhaps some day show more definitely when and how they came into existence. We can readily prove that some of the bogs in the Driftless Area are post-glacial in origin, while others must be left in some doubt.

There is no doubt that the bogs of the glaciated region owe their existence to the favorable conditions that were brought about by the climatic, geologic, and physiographic changes occurring in the wake of the glacier. If bogs and bog plants existed before the glacial invasions, they were associated with conditions uninfluenced by glacial phenomena. In other words, given the essential ecological conditions, bogs may start whenever the seeds are transported to that particular place. Although the evidence points to the fact that the bogs of the Driftless Area are post-glacial, there is a possibility that some of the bog plants found in this part of the state have remained there since inter-glacial times.

The bogs of the Driftless Area tend to avoid the limestone regions, being confined to the wide sand-filled valleys (Map 2). The deep mature valleys extend well into the Cambrian sandstones, and the floors of these valleys are covered with a heavy layer of sand which has been washed into them from the cliffs and from tributary valleys. These valleys also contain many stream terraces. The lower terraces are very little dissected and are a result of the last or Wisconsin stage of glaciation. Some of the higher terraces are much eroded, and the extensive weathering shows that they were formed earlier.[415] Few of these pre-Wisconsin terraces extend across the valleys, because they have been largely removed since their deposition. This erosion has lowered the rock floors of the valleys 50 to 100 feet and has removed all traces of the pre-Wisconsin terraces in the narrower valleys. The much younger

[415]Thwaites, 1928, pp. 622-641.

Wisconsin terraces are still quite intact and are mostly a result of local filling due to the aggradation of the stream beds. This aggradation was caused by the rising of the baselevel of the streams due to the deposition of glacial outwash in the main valleys into which these streams flowed. This means that the bogs located in these valleys were formed since the Wisconsin ice sheet and consequently are post-glacial in origin.

The observations[416] of L. S. Cheney relative to the distribution of the Tamarack in Wisconsin coincide with those of the writer. However, Cheney's records include the northeastern part of the Driftless Area which the writer did not study to any great extent. If Tamarack indicates the presence of bogs, they are here situated on the Central Plain, which was largely covered by Glacial Lake Wisconsin.[417] This fact immediately places their origin in post-glacial time and may identify them with the bogs of the glaciated region as far as their time of origin is concerned. During the existence of the glacier, the Wisconsin River was apparently dammed by ice near the present site of the city of Baraboo, which resulted in the formation of Glacial Lake Wisconsin, a short-lived lake (Map 5). The vale north of the escarpment of the Oneota limestone is covered with sand deposited on the floor of the lake or by streams that flowed away from the lake. Thus, we find a large eastern portion of the Driftless Area covered with glacial outwash, and any bogs that occur on this plain are of post-glacial formation. These bogs are probably the connecting links between the bogs in the glaciated region and those in the western part of the Driftless Area. In other words, bogs were formed soon after the ice retreated from the glaciated region and then spread upon the bed of Glacial Lake Wisconsin, whence some of the bog plants might have migrated into other parts of the Driftless Area. Although the bogs in the Driftless Area appear to be older and well on the way toward extinction, because of the mesophytic vegetation and lack of bog plants, they may be, as a matter of fact, younger. The rate of extinction has been materially augmented by the deforestation and cultivation of the surrounding hillsides, which has increased the transportation of alkaline soil into the bog (Plate 43, fig. 2).

[416]Fassett, 1930, p. 178.
[417]Martin, p. 318, fig. 132, p. 319.


MAP. 5.—Glacial Lake Wisconsin and the bogs of that area. The approximate limits of the lake are shown by the stippled area and the Black River outlet is indicated. The present bogs occurring on the bed of the lake are shown by black dots.

## METHOD OF ORIGIN OF BOGS IN THE DRIFTLESS AREA

Whereas the bogs of the glaciated region have been formed in undrained depressions produced as a direct result of the action of the ice, those of the Driftless Area have an entirely different origin. There are few lakes in this area, and most of these are lagoons associated with the Mississippi and Wisconsin rivers. In most instances, the bogs of the Driftless Area owe their formation to ox-bow lakes. Ox-bow lakes are formed by meandering streams which straighten their course by cutting through a narrow neck of land enclosed by a wide bend, leaving a crescent-shaped lake in the old channel (Fig. 2). The stream often moves to the other side of the valley at a considerable distance from the lake (Plate 41, fig. 1). In most cases, the meandering of the streams that head in the Driftless Area has been, and is at the present

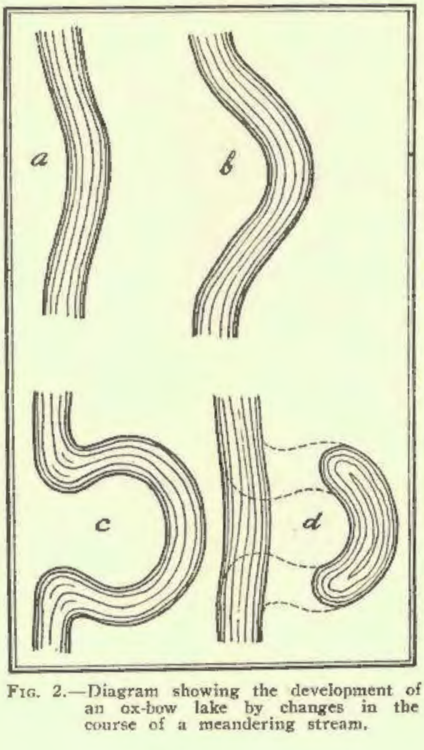



FIG. 2.—Diagram showing the development of an ox-bow lake by changes in the course of a meandering stream.

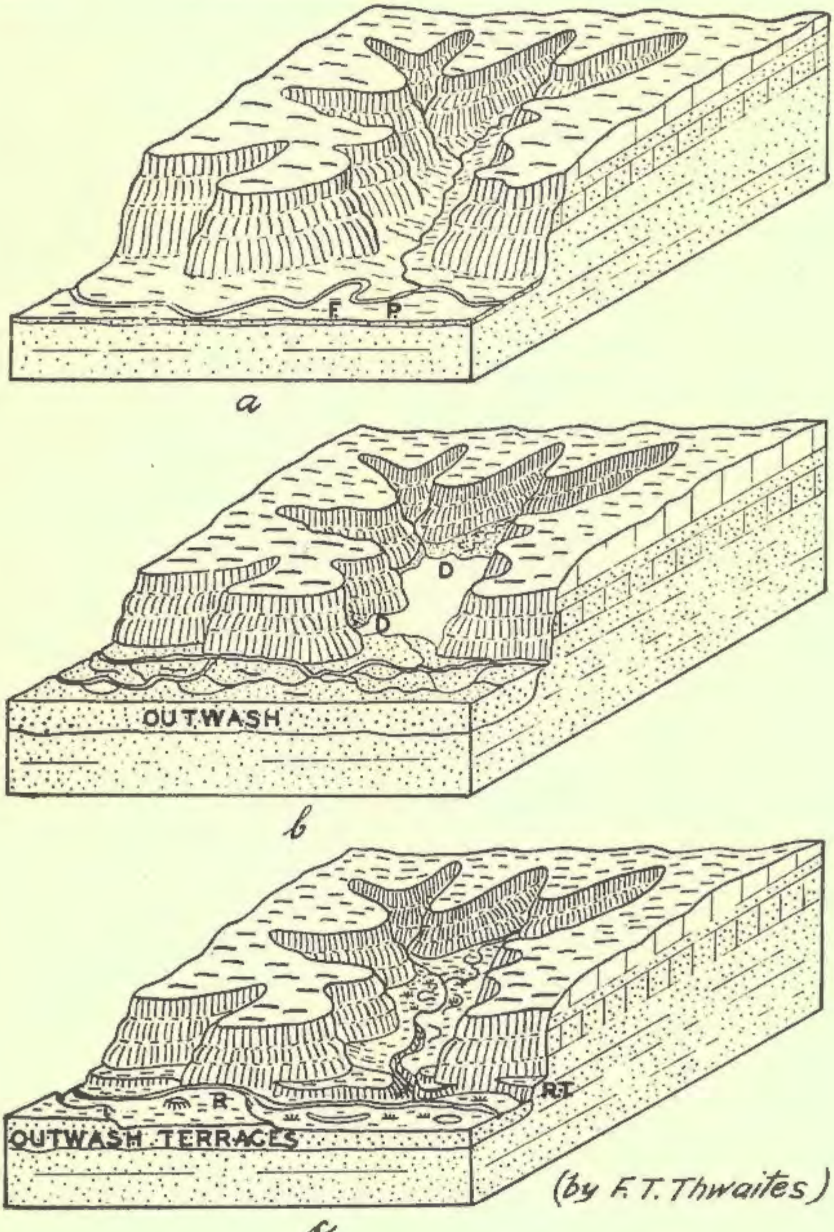



FIG. 3.—Diagram showing development and erosion of terraces in valleys of streams in the Driftless Area

time, on the valley fill resulting from both local erosion and from the aggradation of the stream beds due to glacial outwash deposited in the main valleys. As a result of this meandering, both the pre-Wisconsin and the Wisconsin terraces have been deeply dissected, and in some cases the stream has superposed itself upon the rock that underlies the terraces.

As previously stated, the Mississippi and the Wisconsin river gorges were filled to a considerable depth with glacial outwash deposited by those tributaries that had their sources at the margin of the melting glacier. This means that the water in these large rivers rose to a much higher level than that of the present time, forming lakes or swamps near the mouths of their tributaries. This is shown by the terraces that are found along the Mississippi and Wisconsin rivers.[418] The tributary streams built deltas in these lakes which, in some cases, eventually filled the entire depression.

Fig. 3a shows part of the valley of a large stream in the Driftless Area with a tributary valley. The main valley has a thin floodplain **F. P.** on which the stream is meandering. Swamps and bogs may occur in the abandoned ox-bows on this floodplain, but not to any great extent along the tributary.

Fig. 3b. A second diagram showing later conditions when the main stream carried water from the melting of the glacier, and filled the main valley with outwash and gravel. This filling blocked the tributary valley forming a lake, and the smaller streams deposited deltas **D** in the lake. Above the lake the streams aggraded their beds to maintain a slope to the ends of the growing deltas. In some localities conditions were static long enough to permit entire filling of the lakes formed in this way. In places the main stream swung against the rock bluffs and undercut them.

Fig. 3c. A third diagram showing the present conditions, after the ice has receded, and the main stream has eroded the outwash into terraces. **R. T.** is a rock terrace formed where the stream had once cut into the bluff, but changed its course before erosion began. At **R.** the main stream cut into rock and rapids were formed. The lake was drained and its bed became a swamp through which the tributary meandered to meet the main stream. As time went on the lower part of the tributary cut down its bed into the lake bottom and drained the swamp. Bogs may occur thus:

*a*) in undrained parts of the old lake bed,

*b*) in abandoned ox-bows in the lake bed,

*c*) abandoned parts of the main stream, and

*d*) abandoned ox-bows on the floodplain of the tributary which are higher than the highest outwash remnants in the main valley.

The above sequence of erosion and filling occurred in all of the streams of the Driftless Area that are tributaries of the Wisconsin and Mississippi rivers. Remnants of floodplains formed before the last glacial period may have survived at the heads of some valleys.

Above the deltas, the streams aggraded their beds with material

[418]Ibid., p. 151.

eroded from the slopes of the adjacent hills. Some of the sites of the bogs that are situated along these tributaries were covered by backwater from this glacial water-level, especially near the mouths of the valleys in which they occur. The bogs situated near the sources of these tributaries were, however, never covered by glacial water from the Wisconsin stage, but were formed in abandoned ox-bows of streams which meandered on the valley floor, on the new floodplain, or between alluvial fans deposited on the floodplains.

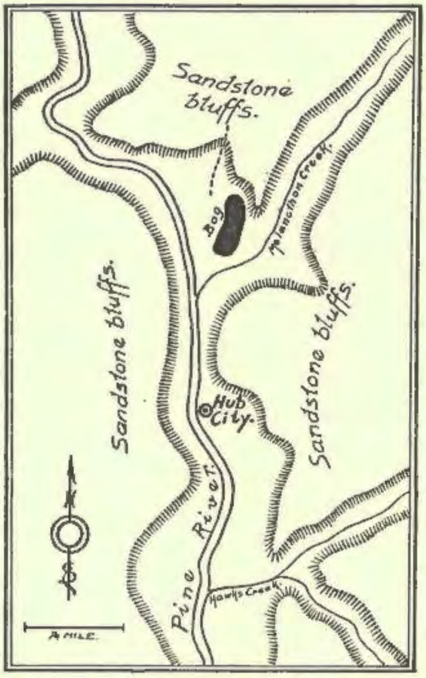
## EXISTENCE OF BOG PLANTS ON SANDSTONE BLUFFS IN THE DRIFTLESS AREA

An important factor in the problem of the preservation of the bog plants and their migration from one area to another is the fact that some of these plants will survive on dry sandstone bluffs; for the same physiological conditions are furnished by sandstone bluffs as by the bog — a dry, acid habitat. This fact is evidenced by the conditions existing in and around a bog near Hub City in Richland County (Map 6). This bog is situated in the valley of Pine River less than a quarter of a mile north of the junction of Pine River with Melancthon Creek, a short tributary that enters the river from the northeast. Sheer sandstone bluffs rise from near the edge of the bog (Plate 42, fig. 2). On these bluffs the following plants common on bogs are found: Labrador Tea, two species of Blueberry, Tamarack, Huckleberry, and Wintergreen. In the bog itself only three essentially bog plants seem to be present: Tamarack, Swamp Birch, and Sphagnum. The Sphagnum is very limited in the bog and can be found only a few places near the Tamarack. The depth of the peat varies from four to eleven feet, underneath which is a layer of loose sand about a foot in thickness, resting upon hard sandstone. This sandstone is neutral with a pH (hydrogen ion concentration) of 7.0[419], and the surface, consisting of silt and oxidized peat, also has a pH of 7.0. Peat samples taken with a Davis Peat Sampler, at one foot intervals, from just beneath the surface to the bottom, tend to be slightly acid, with a pH ranging from 6.5 to 7.0, and small areas of Sphagnum have a pH from 4.5 to 5.5. The sandstone on the bluff is decidedly acid with a pH ranging from 4.0

[419]These readings were made with the assistance of Mr. James Cunningham, Junior College, Kansas City, Mo.

to 5.0, which indicates that an acid condition is essential for these plants. Other sandstone bluffs in the Driftless Area in the vicinity of bogs were tested for the pH, and they were found to be neutral or slightly alkaline. Such bluffs did not have any plants present that are common to the bogs of the glaciated region.

Sandstone bluffs are continuous between the Driftless Area and the glaciated region and offer an excellent path for the migration of bog plants from one area to the other. Two species of Blueberry and one of Huckleberry are common on the sandstone bluffs in the central and eastern parts of the Driftless Area, and Labrador Tea is occasionally found with these same plants (Plate 43, fig.1). Sandstone bluffs offer a more variable type of ecological condition from one end of the growing season to the other than do the bogs so that most of the bog plants

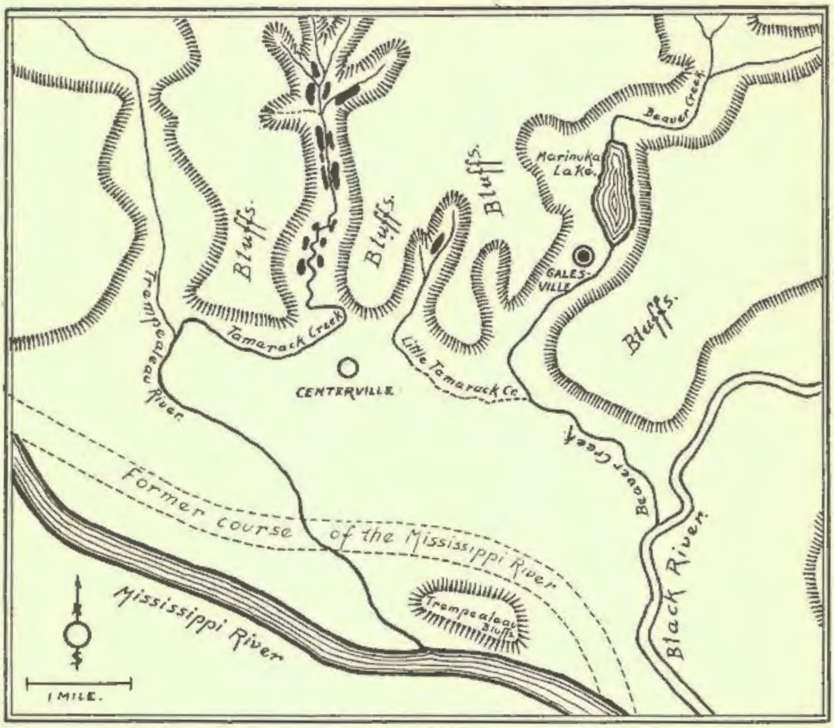



MAP 6.—The bog at Hub City, Richland County, showing the proximity of the bog to the sandstone cliffs, and also the lack of terraces. (*Based on Richland Center quadrangle of U. S. Geol. Survey.*)

probably could not survive on these bluffs. It is difficult to say what conditions existed during the glacial periods, but it may be possible that certain bog plants existed on sandstone bluffs in the Driftless Area while the ice covered other parts of the state. The bluffs are pre-glacial, but the bog itself is doubtless post-glacial as will be shown later.

## TAMARACK CREEK BOG

**Plate 40; Map 7**




MAP. 7.—Tamarack and Little Tamarack bogs, Trempealeau County. Lake Marinuka is an artificial lake. *(Based on Galesville and Fountain City quadrangles of U. S. Geol. Survey.)*

The most northern bog studied in the Driftless Area is the one situated in the valley of Tamarack Creek (Map 4). This creek has its source in the south-central part of Trempealeau County, and flows south to the town of Centerville, where it makes an abrupt turn to the west, and then empties into the Trempealeau River several miles above the junction of the Trempealeau and the Mississippi. The bog, or rather series of bogs, begins several miles north of Centerville and extends approximately five miles north, almost to the source of the creek. This bog is the largest seen in the Driftless Area with the exception of those on the bed of Glacial Lake Wisconsin. The southern portion of the bog has been formed in a series of ox-bow lakes that seem to alternate from one side of the creek to the other, and the northern part was evidently formed in lakes caused from the aggradation of the stream bed when glacial waters flooded the gorge of the Mississippi River. In glacial times, the Mississippi River flowed on the northeast side of the Trempealeau Bluffs, instead of the southwest as it does at present.[420] The large terrace now covered with sand dunes, between the Trempealeau Bluffs and the mouths of the Trempealeau and Black rivers, and Tamarack, Little Tamarack, and Beaver creeks, was then at the level of the glacial Mississippi. The mouths of the Trempealeau and Black rivers were only a few miles apart, and the large amount of sediment deposited at the mouth of Tamarack Creek caused the base-level of its valley to be raised, so that the stream was aggraded almost to its source. Lakes were formed in the northern end uf the valley and existed for some time, as there is a lacustrine-like deposit of clay and sand underneath the peat. Much later the stream cut through the sandy deposits, leaving ox-bow lakes near the mouth of the valley in which bogs were formed. Today the stream is gradually intrenching itself. The highest elevation, near the northern part, of the bog is 800 feet, while the lowest, at the southern end, is 760 feet above sea level. The depth of the peat near the north end is from nine to eleven feet, whereas the peat near the south end reaches a depth of only four feet. This is because the northern portion of the bog is older, since the lakes were formed before the ox-bows near the mouth of the valley. A sandy, alluvial sediment beneath the peat near the south end indicates that the ox-bows developed into bogs before the lacustrine deposit was laid down. From these physiographic features, it can readily be seen that the bog has been formed since the last glaciation and therefore is post-glacial in origin.

There is a larger representation of bog flora in the Tamarack Creek bog than any other known bogs in the Driftless Area with the exception of those on the bed of Glacial Lake Wiseonsin. The size of the bog is an important factor in the preservation of the bog plants, because of the adverse environmental conditions under which the plants must exist

[420]Martin, pp. 136, 137.

as the bog gradually becomes smaller. The fact that this bog is relatively large probably accounts for the preservation of the comparatively large number of bog plants. (For bog flora *see* table on page 288.) The seeds from which the bog plants started, were doubtless transported down the Mississippi and Black rivers.

## LITTLE TAMARACK CREEK BOG

**Map 7**

To the east of Tamarack Creek and separated by a single ridge is Little Tamarack Creek which flows east into Beaver Creek, which in turn empties into the Black River. Little Tamarack Creek becomes an intermittent stream when it reaches the old Mississippi River channel, because of the porosity of the sandy soil. This bog has about the same elevation as Tamarack Creek bog and is of the same origin, although considerably smaller. No collection of plants was made, but the bog is covered with mesophytic vegetation, and the Tamarack is almost extinct.

Small bogs near the mouth of the Trempealeau River Valley, in which the Pitcher Plant has been collected,[421] may be identified with the Tamarack Creek bogs as far as the method and time of their origins are concerned.

## HUB CITY BOG

**Plates 41, 42; Map 6**

The Hub City bog, (Map 4), previously mentioned in relation to the discussion of bog plants on sandstone bluffs, was apparently formed in a lake resulting from an alluvial fan built at the junction of Pine River with Melancthon Creek. Further investigation, however, shows that it rests upon solid sandstone, indicating that the stream superimposed itself on the sandstone underlying the material that has been washed into the valley from the upper Pine River and its tributaries. These facts show that it was formed in an ox-bow lake left by the meandering stream, as also does the crescentic shape of the present bog. The site of the bog is eighty feet higher than the junction of the Pine with the Wisconsin River twenty miles to the south. The stream has cut small terraces in the valley, the material of which is doubtless of the Wisconsin stage or later. Although this upper part of Pine River Valley was not invaded by a lake resulting from outwash deposited in the Wisconsin River Valley, the bog is probably of postglacial origin, formed in an ox-bow developed upon a fill of locally derived material resulting from the changed base-level.[422] The ten-foot accumulation of peat is somewhat oxidized near the bottom, and the

[421]Specimen collected by Towne Miller, of the Milwaukee Public Museum.
[422]Thwaites, pp. 621-642.

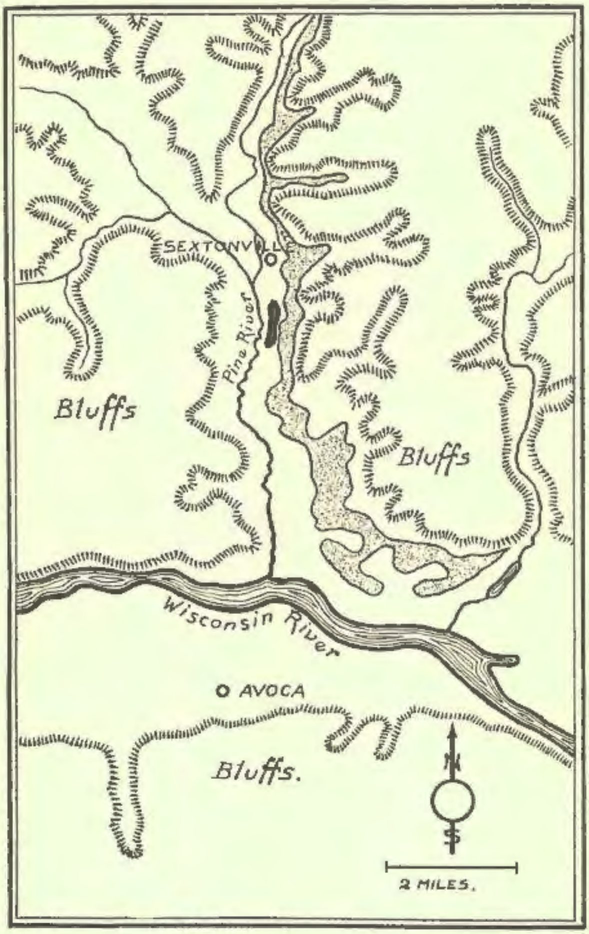
surface is covered in places with a layer of silty sand. The water-table is well above the bottom of the bog, as samples taken within three feet of the bottom were so moist as to cause difficulty in bringing them to the surface intact.

There is a heavy growth of mesophytic vegetation (Plate 42, fig. 1), and it will not be long before the bog will become extinct. The presence of the bog plants on the sandstone bluff adjacent to the bog might be explained in two ways. First, they may be pre-Wisconsin relicts that have existed there since before the last stage of glaciation; or second, they may be post-Wisconsin plants that have migrated from the bogs in the glaciated region since the last glaciation in Wisconsin.

## SEXTONVILLE BOG

Map 8

There is another bog located in the valley of Pine River, in Richland County, about one-half mile south of the town of Sextonville and several miles north of the junction of Pine River with the Wisconsin River (Map 4). The Richland Center quadrangle of the U. S. Geological Survey shows that there is little or no difference in elevation between the Wisconsin and Pine rivers at this point. Terraces along Pine River above the bog are twenty feet higher than the bog. Since this bog is situated so near the mouth of the Pine River Valley, where it is eroded in a terrace of Wisconsin age, that was formed at a level below that of the Wisconsin River when it was raised by glacial waters, it is post-glacial in origin. Samples taken from beneath the peat consist of a lacustrine-like deposit of blue clay and sand, while on top of this material is an alluvial sediment mixed with plant remains, which was probably deposited by the river at flood-stage in the early history of the bog. The lacustrine deposit seems to be typical of most of the bogs in the Driftless Area and closely resembles bottom samples obtained in the glaciated region near Lake Mills in Jefferson County. The chief difference is that bottom samples from bogs in the glaciated region contain small gravel mixed with the lacustrine deposit. The peat in the Sextonville bog is not over seven feet in depth and is fairly well oxidized, especially within three feet of the bottom, which height is reached by the water-table. No peat is being formed at the present time, since there is a foot of brown clay and sand deposited on top of the bed, which has been washed down from the high bluffs that form the sides of the valley. This bog may have had its start from seeds transported down the Pine River from the bog at Hub City.

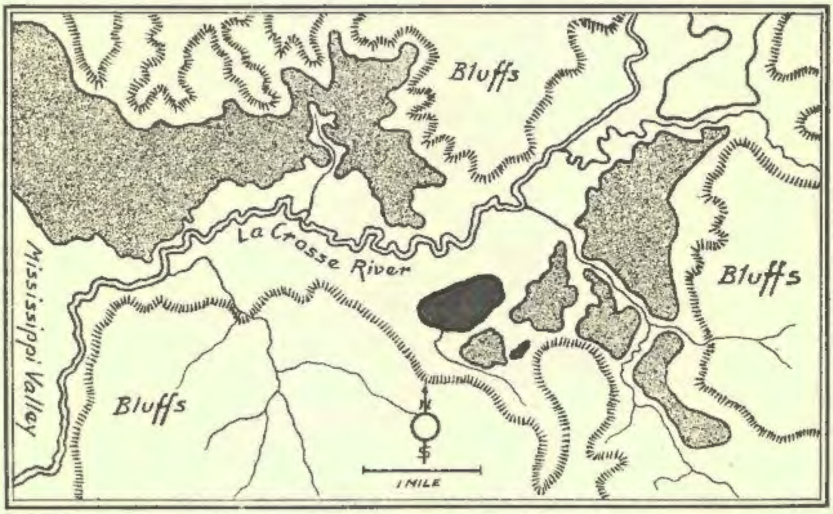



MAP 8.—Sextonville bog; the stippled portions represent the re-*mains of the eroded terraces. Based on Richland Center quadrangle of the U. S. Geol. Survey.)*

## BOGS IN THE VALLEY OF THE LA CROSSE RIVER, LA CROSSE COUNTY

Maps 9, 10

There are two bogs on the floodplain of the La Crosse River in La Crosse County (Map 4). One is on the southeast side of the river about eight miles northeast of La Crosse (Map 9), and the other is about one mile north of West Salem (Map 10). Both of these bogs are undoubtedly post-glacial because there is evidence that the back-



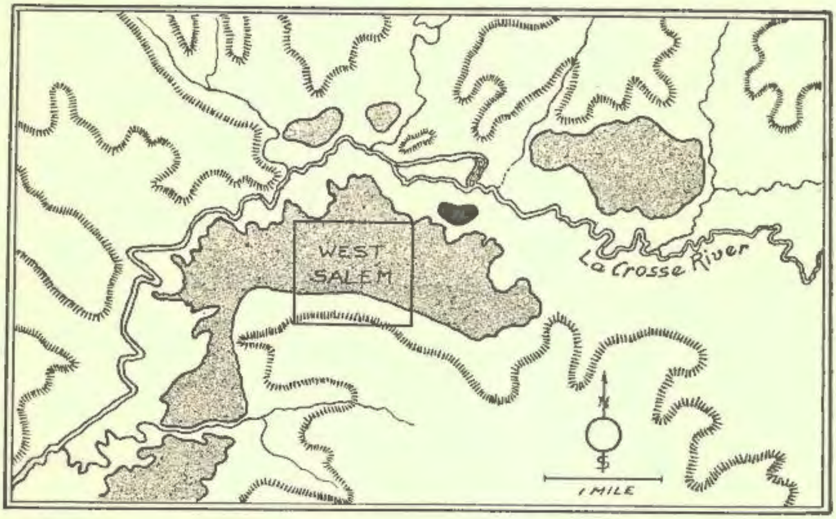

MAP 9.—Bog eight miles northeast of La Crosse. The La Crosse River floodplain is over a mile wide at this point, and subject to annual spring floods. *(Based on La Crosse quadrangle of the U. S. Geol. Survey.)*

water from the Mississippi River covered the sites of both of these bogs during the glacial period. The La Crosse River was aggraded well toward its source during the Wisconsin glaciation as is shown by wide, sandy terraces reaching almost to its headwaters.[423] The valley of the river has been filled with alluvial sediment to a depth of 112 feet at West Salem,[424] and there are twenty-foot terraces rising from the

[423] Ibid., 629.
[424] Martin, p. 185.

edge of the bogs. The writer has seen the water from the Mississippi back up into the bog eight miles northeast of La Crosse, when the spring floods have been higher than usual. In the spring of 1930, it was almost impossible to enter the bog because of water from the spring flood. These constant floodings drown out the bog plants and deposit a layer of silt on top of the peat, both of which tend to destroy the hog.

There are also several bogs situated near the headwaters of the La Crosse River in Monroe County[425] that the writer did not study.

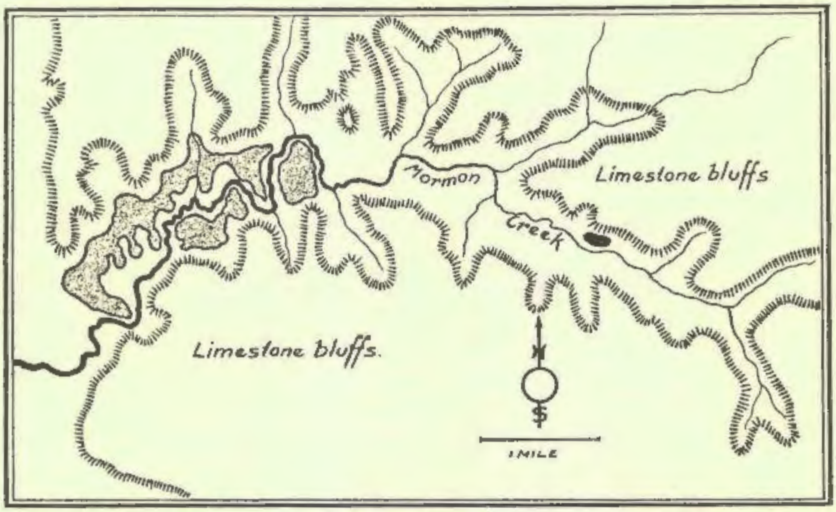



MAP 10.—Bog near West Salem showing the close association of the bog with the sand terraces which border the floodplain of the La Crosse River. *(Based on La Crosse quadrangle of the U. S. Geol. Survey.)*

[425] Information from Mr. F. T. Thwaites.

## MORMON COULEE BOG, LA CROSSE COUNTY

Plates 43, fig. 2; 44; Map 11




MAP 11.—Bog in Mormon Coulee, showing the Wisconsin terraces extending along the stream only half the distance to the bog.

The bog located on the floodplain of Mormon Creek, La Crosse County, is widely separated from any other of its type in the western part of the Driftless Area (Map 4). Mormon Creek flows directly into the Mississippi River about five miles south of La Crosse. Terraces along the river reach an elevation of forty feet above the water level and extend into Mormon Coulee for a distance of about three and one-half miles. Here they abruptly end but the stream has intrenched itself for a distance of six miles further causing the gradient to be constant almost to its source. There is a difference in elevation of 120 feet between the Mississippi River and the bog, which indicates that the site of the bog was not covered by backwater from the river during the Wisconsin stage of glaciation. However, the origin of this bog seems to be similiar to that of the Tamarack Creek bog; that is, the creek bed was aggraded by the deposition of glacial outwash in the Mississippi River Valley so that lakes were formed in the upper part of the coulee. At the present time, there is a swamp farther up the valley which is apparently in a young stage of plant succession as there is an abundant growth of Cat-tail and Arrow-leaf (Plate 44, fig. 1). Downstream, in the terrace area, there are several bog-like areas that have been formed in old ox-bows, similar to those in the lower part of the valley of Tamarack Creek. Although there are no Wisconsin terraces near the site of the bog, the upper valley has been filled with materials eroded from the hillsides so that the bog is resting upon deposits which are probably post-Wisconsin. Peat samples show that the characteristic lacustrine deposits of clay and sand are present on the bottom, above which is a layer of sandy silt mixed with alluvial sediment. The sand is probably a result of local erosion from the Cambrian sandstone that lines the lower sides of the valley. The peat is somewhat oxidized and is occasionally broken by thin layers of alluvial sediment. The upper part of the peat deposit is well preserved and is covered by a heavy layer of clay which prevents the rain and melting snow from soaking in very readily. Borings taken in a cornfield that borders the bog on the north slope show that the bog has been covered at this point to a depth of several feet with soil washed from the hillside. The present extent of the bog is about one-half mile in length (Plate 43, fig. 2), but old residents claim that it was formerly at least two miles in length, and that much of the tamarack has been cut down. The present depth of the peat in the center of the bog is not over ten feet, and it is oxidized near the bottom.

There are very few bog plants in the bog at the present time (Bog flora table, p. 288). This is perhaps due to the isolation of the bog, and also because the soil washed into it produces an alkaline condition in which the bog plants do not exist. There is a heavy growth of mesophytic vegetation reaching to the center of the bog consisting of Birch, Maple, Oak, Sumach, etc., which flourishes readily on the heavy layer of clay on top of the peat. On the north edge of the bog, a power line has been cut through, and in the clearing made for the posts, a heavy growth of mesophytic vegetation has sprung up (Plate 44, fig. 2).

The remainder of the bogs in the Driftless Area that were observed and studied are located on the bed of Glacial Lake Wisconsin and present no problems in regard to the time of their origin, as they are doubtless post-glacial (Map 5).

## PAST EXISTENCE OF BOG PLANTS IN THE DRIFTLESS AREA

As previously stated, the bogs seem to avoid the limestone areas (Map 2), and are found in the wide sand-filled valleys. Each spring, when the streams rise to floodstage, much silt is washed into the bogs, covering the peat deposits and tending to destroy whatever bog plants may exist. This has been especially true since the deforestation and cultivation of the surrounding hillsides. For this reason, the bogs have begun to die out since the settlement of the Driftless Area by the white man. In a letter to the writer, the late Dr. L. H. Pammel of Iowa State College stated, "The bogs in La Crosse County are filled with sand, and the peat is covered with sandy silt. The bog plants seem to have disappeared." Dr. Pammel collected in these bogs twenty-five years ago, and then he found such plants as Sundew, Pitcher Plant, Cranberry, Blueberry, Creeping Snowberry and Pale Laurel. The writer was unable to find any of these plants in the La Crosse County bogs during the summer of 1930, and they have probably become extinct in this region.

The bogs situated on the bed of Glacial Lake Wisconsin contain more species of bog plants than those near the Mississippi River. In fact, the bog plants are very scarce in the western bogs with the exception of Sphagnum, Tamarack, and Swamp Birch, all of which are abundant in the Driftless Area. The reason for this may be that these plants are not destroyed by the deposition of silt; the Birch and Tamarack being too large, and the Sphagnum more adaptable.

## SUMMARY OF THE GENERAL CHARACTERISTICS OF THE BOGS IN THE DRIFTLESS AREA

In the following discussion and summary, the principal differences between the bogs of the Driftless Area and those of the glaciated region are cited and the reasons for these differences given. Most of the features of the Driftless Area bogs here discussed are merely summarized with the object of comparing the general conditions of the bogs in these two areas.

1. The bogs in the Driftless Area are situated in a region that has never been covered by glacial ice as far as the geological evidence indicates, whereas the bogs of the glaciated region owe their existence to the fact that this area was once covered by glaciers.

2. Because of this fact, it has been a problem to determine the time of origin of the bogs of the Driftless Area. The bogs situated on the bed of Glacial Lake Wisconsin are undoubtedly post-glacial and are similar to the bogs of the glaciated region both as to the time and method of their origin. The rest of the bogs of the Driftless Area are also very probably of post-glacial origin as has been shown by the evidence heretofore discussed.

3. The bogs of the glaciated region were formed in undrained depressions, many of which were at first lakes left in the wake of the receding ice. The bogs of the Driftless Area have had several methods of formation. First, those situated at the higher elevations, near the sources of the streams, were formed on floodplains which resulted from the aggradation of the stream bed in attempting to accommodate itself to the level of the glacio-fluviatile deposits in the valleys of the Wisconsin and Mississippi rivers into which these streams flowed. Second, those situated at lower elevations near the mouths of the streams were formed in ox-bow lakes which resulted from streams meandering through the sandy deposits of the beds of lakes formed when the outlet was blocked by glacial outwash. Other bogs lie in valleys eroded in the glacial outwash lake beds and aggraded tributaries. These streams are still meandering, and in some instances, they have cut through old peat deposits. These indicate that the bogs in the Driftless Area were once more common than at the present time, and that many of them have been drained by down-cutting of the streams, washed away, or buried.

4. The bogs of the Driftless Area are located in deep valleys with steep slopes which in many places rise from the edge of the bog. This permits the washing of silt, sand, and clay from the hillside into the bog, and also seepage of spring water containing lime from the Oneota limestone formation which caps many of the bluffs above the bogs. This constant addition of water brings oxygen to the substratum, allow-

ing bacterial action to take place and oxidizing the peat, especially near the bottom. The addition of the dissolved limestone brings about alkalinity of the peat, under which conditions the bog plants will not grow. A heavy layer of sand and clay deposited on top of the peat sometimes makes an almost impervious layer which prevents rain, melting snow, and water from the slopes from soaking into the peat very readily. As a result, the bogs in the spring are covered to such a depth with water as to prevent the sprouting of the herbaceous plants in season. Instead of the physiologically xerophytic habitat as afforded by the peat, there is a hydrophytic habitat that fosters an early growth of hydrophytic plants such as Arrow-leaf, Cat-tail, and Marsh Marigold (*Caltha palustris*), which tends to suppress the growth of bog plants later in the season. In July and August, the surface of these bogs becomes dry and hard, and this condition may prevent capillary action from bringing moisture to the surface. The more level topography of the glaciated region is not subject to so much erosion.

5. The size of the bogs in the Driftless Area is limited to the width and length of the lakes in which they are formed. These lakes were very small in comparison with the large depressions in which the bogs of the glaciated region occur. The largest bog seen in the Driftless Area, with the exception of those on the bed of Glacial Lake Wisconsin, is the one on the floodplain of Tamarack Creek in Trempealeau County. This series of bogs has a length of about five miles and a width in some places of possibly a third of a mile. The small size of these bogs is one of the reasons why they are disappearing. The proximity of the bogs to mesophytic plants on the hills (Plate 43, fig. 2), allows the entrance of these plants whenever the conditions are favorable, and they rapidly encroach on and take over the bog. The bogs in the glaciated region often cover many square miles and are not endangered by the proximity of mesophytic flora to any great extent. The bogs of the Driftless Area are molested by man, washed by floods, burned by fire, pastured by cattle, and the Tamarack is cut for lumber. Many of the bogs in the glaciated region do not have to contend with all of these disadvantages.

6. The streams on the floodplains of which the bogs in the Driftless Area occur, are gradually intrenching themselves. This intrenchment lowers the water table in the bogs and has the same effect as

drainage. Also, some of these bogs are being artificially drained so as to reclaim the land for cultivation. While many of the bogs of the glaciated region have been artifically drained, few or none have been effected by intrenched stream drainage.

7. The peat of the bog affords an acid condition which is essential for the best development of the bog plant society. This condition is brought about by the accumulation of dead vegetable matter in the absence of air, which prevents bacterial action. It is evident that bogs avoid the limestone in both areas, but the limestone in the glaciated region is covered by glacial drift which provides the essential conditions for the starting of a bog. Tests of the surface material in bogs of the Driftless Area show alkalinity, and this is probably another factor that is causing the bog plants to become extinct in this area. The surface of the bogs in the glaciated region is largely covered with Sphagnum which creates a strongly acid condition.

8. The two regions vary in the depth and kind of peat. The depth of the peat in the glaciated region is as much as 30 feet as shown by cores taken by Mr. H. V. Truman, of the Botany Department, of the University of Wisconsin, at Lodi, Wisconsin. The depth of the peat in the Driftless Area is much less, and in no case has the writer found more than eleven feet. Also, the characteristics of the peat vary to a large extent. In the Driftless Area, there is generally a thick layer of sand and clay mixed with peat on the surface. Next comes the main peat deposit which may vary from three to eleven feet in thickness. The upper part of this layer is generally typical peat, but toward the bottom, the peat becomes oxidized and more like muck. At intervals in the peat are found thin layers of alluvial sediments, especially near the bottom. These may indicate that the bog has been flooded from time to time, interrupting the accumulation of peat. Under the peat may be a layer of sandy silt or a lacustrine-like deposit, consisting of sand and sufficient blue clay to cause plasticity. The bogs occurring near the mouths of valleys, which were evidently formed in ox-bow lakes, have a sandy silt deposit. The bog situated near Hub City is resting upon solid sandstone. The bogs in the glaciated region have still a wider variation in the type of material beneath the peat.[426] Some rest on rock, and others rest on soil formed in situ from the disinte-

[426] Riggs, pp. 267, 268.

gration of rock. Other materials found underneath the peat are yellow clay, blue clay, gravel, and in some cases, a mixture of gravel and blue clay. From these observations, it can be seen that glacial deposits are not necessary for the formation of a bog. The water in the center of lakes upon which the surrounding bogs have not yet encroached may be alkaline,[427] showing that the acidity of the hog is produced by the plant growth itself.

10. The bogs of the Driftless Area, being small, are rapidly being invaded by a mesophytic vegetation consisting of Oak, Maple, White Birch, and Ash (*Fraxinus* sp.), which are gradually crowding out the Tamarack and other bog plants (Plate 41, fig. 2). Plant succession is an important factor in the life of a bog, as is shown by Dachnowski in his paper[428] on Cranberry Island, Ohio. He writes that peat deposits, upon which a mesophytic vegetation exists at the present time, show that the bog plant society formerly occupied this area. Many boreal species formerly found in the bogs in that vicinity are now extinct, including Pitcher Plant, Bog Rosemary, Leather Leaf, Labrador Tea, Pale Laurel, and Tamarack. These observations tend to show that the bog plants are forced out of existence by the encroachment of mesophytic vegetation. This is probably the case in many of the bogs in the Driftless Area that show a well developed mesophytic flora reaching almost to the center. It is probable that a large number of bog plants have existed in these bogs in the past, but because of the increasingly unfavorable conditions and age, they have become extinct.

11. There is a great difference in the number of bog plants in the Driftless Area as compared with the glaciated region.[429] The bogs in the northern and eastern part of the Driftless Area seem to have a larger number of species than those in the western part. The eastern bogs are located on the bed of Glacial Lake Wisconsin and may be identified with those in the glaciated region as far as their origin is concerned. From these bogs, certain species were able to migrate westward, probably by means of the sandstone bluffs, and some of these plants found favorable conditions in the valleys. The northern bogs, including the one in Tamarack Creek Valley, perhaps had their origin from seeds transported down the Mississippi and Black rivers. The

[427]Fassett, 1930, pp. 158, 165.
[428]Dachnowski, pp. 23-33.
[429]Bog flora table on page 288.

northern bogs are apparently younger, as the peat is less oxidized and the washing of soil into the bog has not been so great. It is improbable that the bog plants migrated into the Driftless Area from the west because the southern part of Minnesota consists largely of prairies, and there are no known bogs in the southeastern part of that state.[430]

*In a few words, the bogs of the Driftless Area are undoubtedly post-glacial in time of origin, and a relatively few bog plants have found their way into these isolated spots and have been able to eke out an existence up to the present day.*

[430]The Peat Deposits of Minnesota. Minn. Geol. Survey, Bull. XVI, p. 45, 1916.

## RANGES OF BOG PLANTS IN WISCONSIN

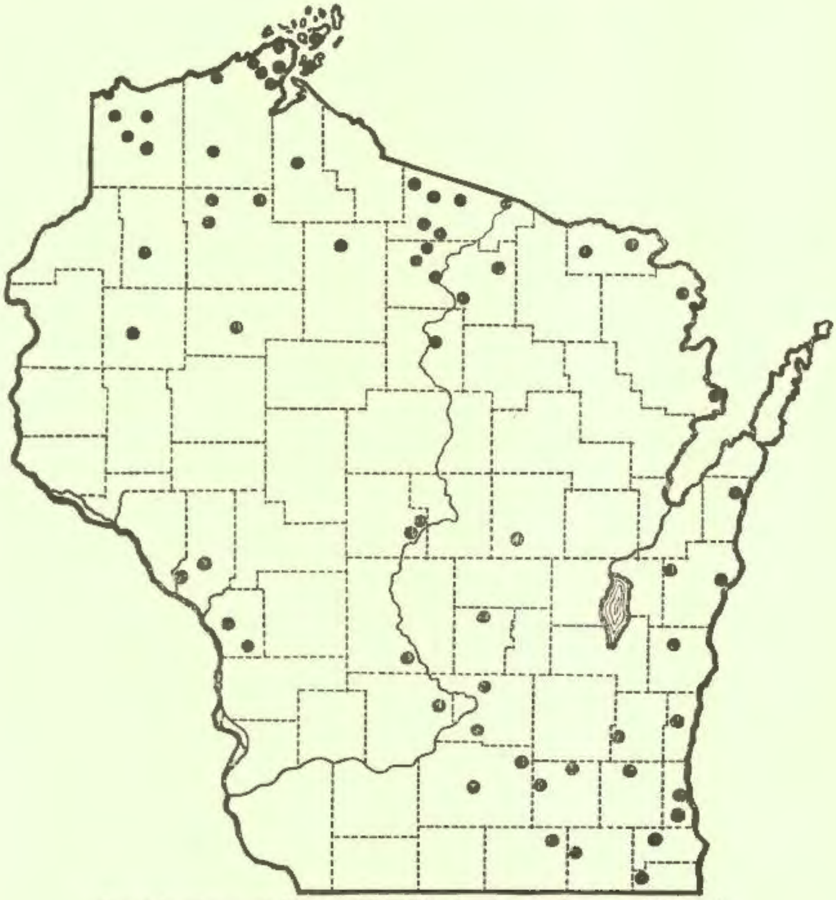
Following are brief discussions of the bog plants in the Driftless Area, with maps of their ranges throughout the state. These maps are compiled from herbarium specimens in the herbaria of the Milwaukee Public Museum, of the University of Wisconsin, and of Mr. S. C. Wadmond, Delavan, Wisconsin.

MAP 12.—Range of Tamarack *(Larix laricina)* in Wisconsin.

TAMARACK (*Larix laricina*). Map 12. This is the only bog tree that is found in the Driftless Area. It is fairly common, but it seems to avoid the alkaline soil as shown by pH tests. The Tamarack is fast dying out because the bogs are being reclaimed for cultivation (Plate 40, fig. 2), and it is easily uprooted when the stands become thin.

MAP 13.—Range of Swamp Birch *(Betula pumila glandulifera)* in Wisconsin.

SWAMP BIRCH (*Betula pumila glandulifera*). Map 13. This plant is probably one of the most common bog plants in the Driftless Area, with the exception of the Tamarack. It seems to be well distributed over the entire state but tends to avoid the limestone areas. It is probably more common in the state than the present collections indicate.



MAP 14.—Range of Pitcher Plant *(Sarracenia purpurea)* in Wisconsin.

PITCHER PLANT (*Sarracenia purpurea*). Map 14. The Pitcher Plant seems to have a northern and eastern range in the state, but it should be found to be common in the central part on the bed of Glacial Lake Wisconsin. It is rare in the Driftless Area.

MAP 15.—Range of Wild Calla *(Calla palustris)* in Wisconsin.

WILD CALLA (*Calla palustris*). Map 15. This is a northern plant that comes south in the wet mucky bogs. It is not common in the Driftless Area nor the central part of the state; the writer's collections being the only records from the Driftless Area.

MAP 16.—Range of Round-leaved Sundew *(Drosera rotundifolia)* in Wisconsin.

ROUND-LEAVED SUNDEW *(Drosera rotundifolia)*. Map 16. The Sundew seems to have about the same range in Wisconsin as the Pitcher Plant. The two crosses in La Crosse County indicate collections made by the late L. H. Pammel.

MAP 17.—Range of Labrador Tea *(Ledum groenlandicum)* in Wisconsin.

LABRADOR TEA (*Ledum groenlandicum.*) Map 17. Labrador Tea is mostly northern but comes south to the Dells of the Wisconsin River and to Pine River in Richland County where it grows on sandstone ledges. It will probably be found to be more common on the sandstone bluffs in the northern and eastern parts of the Driftless Area.

MAP 18.—Range of Pale Laurel *(Kalmia polifolia)* in Wisconsin.

PALE LAUREL (*Kalmia polifolia*). Map 18. Mostly northern, in bogs well covered with Sphagnum. The crosses in La Crosse County are collections made by L. H. Pammel.

MAP. 19.—Range of Bog Rosemary *(Andromeda glaucophylla)* in Wisconsin.

BOG ROSEMARY (*Andromeda glaucophylla*). Map 19. There are no recorded collections of this plant from the Driftless Area.

MAP 20.—Range of Leather Leaf (*Chamaedaphne calyculata*) in Wisconsin.

LEATHER LEAF (*Chamaedaphne calyculata*). Map 20. Rare in the Driftless Area where it has been collected on the bed of Glacial Lake Wisconsin and in the upper valley of the Black River which served as an outlet for that lake.

MAP 21.—Range of Wintergreen *(Gaultheria procumbens)* in Wisconsin.

WINTERGREEN (*Gaultheria procumbens*). Map 21. Rare southward in the Driftless Area where it can be occasionally found on sandstone bluffs growing under small stands of White Pine (*Pinus Strobus*).

MAP. 22.—Range of Creeping Snowberry *(Chiogenes hispidula)* in Wisconsin.

CREEPING SNOWBERRY (*Chiogenes hispidula*). Map 22. Mostly northern and rare in the Driftless Area where it was collected by L. H. Pammel in La Crosse County.

MAP 23.—Range of Huckleberry *(Gaylussacia baccata)* in Wisconsin.

HUCKLEBERRY (*Gaylussacia baccata*). Map 23. Huckleberry is common southward where it is abundant on the sandstone bluffs and the bed of Glacial Lake Wisconsin. It does not seem to be present in the western part of the Driftless Area, probably because of the large areas of limestone.

MAP 24.—Range of Early Sweet Blueberry *(Vaccinium pennsylvanicum)* in Wisconsin.

EARLY SWEET BLUEBERRY (*Vaccinium pennsylvanicum*). Map 24. This plant like the Huckleberry is common southward and in the Driftless Area. It is common on sandstone bluffs, and it is almost always found growing with the Huckleberry. The crosses in La Crosse County indicate collections made from bogs by L. H. Pammel.

MAP 25.—Range of Velvet-leaf Blueberry *(Vaccinium canadense)* in Wisconsin.

VELVET-LEAF BLUEBERRY (*V. canadense*). Map 25. This plant is not as common in the Driftless Area as the two preceding species, but it is occasionally found on sandstone bluffs with them, and also in the bogs. Blueberries are fairly important as a commercial crop.

MAP 26.—Range of Small Cranberry *(Vaccinium Oxycoccos)* in Wisconsin.

SMALL CRANBERRY (*V. Oxycoccos*). Map 26. Restricted to the northern part of the state and does not enter the Driftless Area.

MAP 27.—Range of Large Cranberry *(Vaccinium macrocarpon)* in Wisconsin.

LARGE CRANBERRY (*V. macrocarpon*). Map 27. The Large Cranberry is common in the north-central part of the Driftless Area although collections from this area have been few. Cranberries are an important crop in Wisconsin. The crosses represent collections made from the Mormon Coulee and La Crosse bogs by L. H. Pammel.

## BOG PLANTS IN THE DRIFTLESS AREA
## DISTRIBUTION TABLE

| PLANTS | LOCALITY | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mormon Coulee | La Crosse | West Salem | Tamarack Creek | Hub City | Denzer | Wis. Dells | Sextonville | Mauston | Hustler |
| *Sphagnum spp.* | X | X | X | X | X | ..... | X | X | X | X |
| *Larix laricina* | X | X | X | X | X | X | X | X | X | X |
| *Betula pumila glandulifera* | X | X | X | X | X | X | X | ..... | X | X |
| *Vaccinium pennsylvanicum* | X* | X* | ..... | X | X | ..... | X | ..... | X | X |
| *V. canadense* | ..... | ..... | ..... | X | X | ..... | ..... | ..... | ..... | ..... |
| *V. macrocarpon* | X* | X* | ..... | X | ..... | ..... | X | ..... | ..... | X |
| *Kalmia polifolia* | X* | X* | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| *Gaultheria procumbens* | ..... | ..... | ..... | X | X | ..... | ..... | ..... | ..... | ..... |
| *Gaylussacia baccata* | ..... | ..... | ..... | X | X | ..... | X | ..... | ..... | X |
| *Sarracenia purpurea* | X* | X* | ..... | X | ..... | ..... | ..... | ..... | X | ..... |
| *Calla palustris* | ..... | X | ..... | X | ..... | X | ..... | ..... | ..... | ..... |
| *Menyanthes trifoliata* | ..... | X | ..... | X | ..... | ..... | ..... | ..... | ..... | ..... |
| *Potentilla palustris* | X | ..... | X | ..... | ..... | ..... | ..... | ..... | ..... | X |
| *Drosera rotundifolia* | X* | X* | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| *Chiogenes hispidula* | ..... | X* | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| *Ledum groenlandicum* | ..... | ..... | ..... | ..... | X | ..... | ..... | ..... | ..... | ..... |

*Collected by the late L. H. Pammel.

## PLANTS COLLECTED IN BOGS OF THE DRIFTLESS AREA

| | | | |
|---|---|---|---|
| HC | Hub City. | S | Sextonville. |
| L | LaCrosse. | TC | Tamarack Creek. |
| MC | Mormon Coulee. | WS | West Salem. |

*Acer Negundo* (Box Elder), MC.
*Acer saccharinum* (Soft Maple), MC, S.
*Adiantum pedatum* (Maidenhair Fern), S, L.
*Agrostis alba* (Red Top), MC.
*Alisma Plantago-aquatica* (Water Plantain), WS.
*Alnus incana* (Speckled Alder), HC, MC, S, TC, WS.
*Amphicarpa monoica* (Hog Peanut), MC.
*Angelica atropurpurea occidentalis* (Angelica), L, S.
*Aralia nudicaulis* (Wild Sarsaparilla), MC.
*Aralia racemosa* (Spikenard), MC, TC.
*Arctostaphylos Uva-ursi coactilis* (Bearberry), HC (In the bog and on the sandstone cliffs above the bog).
*Asclepias incarnata* (Swamp Milkweed), MC, S, WS.
*Betula papyrifera* (White Birch), MC.
*Betula pumila glandulifera* (Swamp Birch), HC, MC, S, TC, WS.
*Betula Sandbergii* (Swamp Birch), TC.
*Calla palustris* (Wild Calla), L, TC.
*Caltha palustris* (Marsh Marigold), TC.
*Campanula aparinoides* (Marsh Bellflower), MC.
*Carex hystericina* (Porcupine Sedge), MC.
*Carex stipata* (Awl-fruited Sedge), MC.
*Carex vulpinoidea* (Fox Sedge), MC.
*Chelone glabra* (Turtlehead), TC.
*Chelone glabra linifolia* (Turtlehead), MC, WS.
*Claytonia virginica* (Spring Beauty), HC.
*Clintonia borealis* (Clintonia), HC.
*Cornus alternifolia* (Alternate-leaved Dogwood), S, TC.
*Cornus canadensis* (Bunchberry), HC, S, TC, WS.
*Cornus femina* (Panicled Dogwood), MC.
*Cornus stolonifera* (Red-osier Dogwood), L, MC, S, TC.

*Corylus americana* (Hazelnut), S.
*Cyperus strigosus* (Galingale), S.
*Cypripedium acaule* (Pink Moccasin Flower), HC, TC.
*Cypripedium reginae* (Showy Lady's Slipper), HC, MC, TC.
*Dioscorea villosa* (Wild Yam-root), MC, S.
*Epigaea repens* (Trailing Arbutus), HC (Sandstone cliffs above bog).
*Epilobium coloratum* (Purple-leaved Willow-herb), S, TC, WS.
*Epilobium densum* (Linear-leaved Willow-herb), MC, S.
*Eupatorium falcatum* (Joe-Pye Weed), MC.
*Eupatorium maculatum* (Joe-Pye Weed), S, WS.
*Eupatorium perfoliatum* (Boneset), MC, S.
*Gaultheria procumbens* (Wintergreen), HC (Sandstone cliffs above bog), TC.
*Geum canadense* (Hairy Avens), S, TC, WS.
*Geum virginianum* (Bristly Avens), TC.
*Glyceria canadensis* (Rattlesnake Grass), WS.
*Habenaria hyperborea* (Leafy Green Orchid), MC.
*Habenaria psycodes* (Purple Fringed Orchid), S.
*Hydrocotyle americana* (Water Pennywort), WS.
*Hypericum virginicum* (Marsh St. John's-wort), WS.
*Ilex verticillata* (Black Alder), MC.
*Impatiens biflora* (Touch-me-not), MC, S, WS.
*Juncus effusus* (Common Rush), TC, WS.
*Juniperus communis depressa* (Common Juniper), L, TC, WS.
*Larix laricina* (Tamarack), HC (In the bog and on sandstone cliffs above the bog), L, MC, S, TC, WS.
*Lathyrus palustris* (Marsh Vetchling), S.
*Ledum groenlandicum* (Labrador Tea), HC (On sandstone cliffs above bog).
*Lilium michiganense* (Turk's Cap Lily), HC, S.
*Linnaea borealis americana* (Twin-flower), TC.
*Lobelia inflata* (Indian Tobacco), MC.
*Lobelia siphilitica* (Great Lobelia), MC, TC, WS.
*Lonicera dioica* (Glaucous-leaved Honeysuckle), MC.
*Lysimachia quadrifolia* (Whorled Loosestrife), HC.
*Lysimachio terrestris* (Bulb-bearing Loosestrife), WS.
*Lysimachia thyrsiflora* (Tufted Loosestrife), L. MC, TC.

*Maianthemum canadensis interius* (Canada Mayflower), TC.
*Mentha arvensis canadensis* (Wild Mint), S.
*Menyanthes trifoliata* (Buckbean), TC.
*Mimulus ringens* (Monkey Flower), MC, S.
*Onoclea sensibilis* (Sensitive Fern), S, WS.
*Osmunda cinnamomea* (Cinnamon Fern), S, TC, WS.
*Osmunda regalis* (Royal Fern), HC.
*Parnassia caroliniana* (Grass of Parnassus), TC.
*Pedicularis lanceolata* (Swamp Lousewort), TC.
*Pinus Strobus* (White Pine), HC.
*Polemonium reptans* (Jacob's Ladder), HC, TC.
*Populus tremuloides* (Trembling Aspen), MC.
*Patentilla norvegica hirsuta* (Rough Cinquefoil), S.
*Potentilla palustris* (Marsh Cinquefoil), MC, S, WS.
*Prunella vulgaris* (Heal-all), MC.
*Prunus virginiana* (Choke Cherry), HC.
*Pyrola asarifolia* (Shin Leaf), TC.
*Pyrus melanocarpa* (Chokeberry), TC.
*Quercus macrocarpa* (Bur Oak), MC.
*Ranunculus pennsylvanicus* (Bristly Crowfoot), MC, S.
*Ranunculus septentrionalis* (Swamp Buttercup), L, MC.
*Rhamnus alnifolia* (Buckthorn), S, WS.
*Rhus Toxicodendron* (Poison Ivy), MC.
*Rhus Vernix* (Poison Sumach), MC, S, TC, WS.
*Ribes americanum* (American Black Currant), S, MC.
*Ribes Cynosbati* (Prickly Gooseberry), S.
*Ribes hirtellum* (Smooth Gooseberry), HC.
*Rubus pubescens* (Dwarf Raspberry), HC, MC, TC.
*Sagittaria latifolia* (Arrow-leaf), TC.
*Sagittaria latifolia obtusa* (Arrow-leaf), L, MC, S. WS.
*Salix longifolia* (Sandbar Willow), L.
*Sarracenia purpurea* (Pitcher Plant), TC.
*Saxifraga pennsylvanica* (Swamp Saxifrage), L, MC, TC.
*Scirpus atrovirens* (Bulrush), MC, S, WS.
*Scutellaria epilobifolia* (Marsh Skullcap), S, TC, WS.
*Smilacina racemosa* (False Spikenard), L.
*Smilacina stellata* (Star-flowered Solomon's Seal), MC.

*Sphagnum spp.* (Sphagnum Moss), HC, L, MC, S, TC, WS.
*Spiraea salicifolia* (Meadow-sweet), S, WS.
*Stachys palustris* (Woundwort), MC, S.
*Steironema ciliatum* (Fringed Loosestrife), TC.
*Steironema quadriflorum* (Linear-leaved Loosestrife), TC.
*Streptopus longipes* (Twisted-stalk), HC.
*Symplocarpus foetidus* (Skunk Cabbage), HC, TC.
*Taxus canadensis* (Yew), L, TC, WS.
*Thalictrum dasycarpum* (Meadow Rue), MC, S.
*Thelypteris cristata* (Crested Shield Fern), WS.
*Thelypteris palustris pubescens* (Marsh Shield Fern), L, TC.
*Thelypteris spinulosa americana* (Spinulose Shield Fern), S.
*Tilia glabra* (Basswood), MC, S.
*Trientalis borealis* (Star Flower), HC, TC.
*Typha latifolia* (Cat-tail), L, MC, S, TC, WS.
*Ulmus fulva* (Slippery Elm), S, WS.
*Vaccinium canadense* (Velvet-leaf Blueberry), HC (Sandstone cliffs above bog), TC.
*Vaccinium macrocarpon* (Large Cranberry), TC.
*Vaccinium pennsylvanicum* (Early Sweet Blueberry), HC (Sandstone cliffs above bog and in bog proper), TC.
*Verbena hastata* (Blue Vervain), S.
*Viburnum Opulus americanum* (Highbush Cranberry), L, WS.
*Viola pallens* (Sweet White Violet), TC.

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EXPLANATION OF PLATE 39.

Topographical map of Wisconsin. The Driftless Area is enclosed by the dot-and-dash line. (Based on the relief map of Wisconsin made for the Wisconsin Geological and Natural History Survey by W. D. Hotchkiss and F. T. Thwaites. Modeled by E. H. J. Lorenz, 1910).

## EXPLANATION OF PLATE 40.

FIG. 1. The north part of Tamarack Creek bog, showing woodland-like appearance of the bog. In the foreground can be seen Skunk Cabbage (*Symplocarpus foetidus*). Wild Calla (*Calla palustris*), was found just in front of the spot where the writer is standing.

2. The same bog from the western edge. The Tamarack stumps have been grubbed out in preparation for cultivation, and the land is being drained. The peat in this portion of the bog is from seven to ten feet in depth.


1


2

## EXPLANATION OF PLATE 41.

FIG. 1. The Hub City bog from the north bluffs. The general ox-bow effect can readily be seen as well as the mesophytic flora. In the background can be seen the sandstone bluffs to the east of the bog. This picture was taken from the cliff appearing at the right of the schoolhouse in Plate 42, figure 1.

2. The Hub City bog from the west. Burned-over sedge bog in the foreground, and Speckled Alder (*Alnus incana*), on the edge of the Tamarack. Cat-tail (*Typha latifolia*), can be seen between the sedge bog and the Tamarack.


1
2

## EXPLANATION OF PLATE 42.

FIG. 1. The Hub City bog from the east bluff. Mesophytic flora on the edge of the bog.

2. Sandstone bluffs to the east of the Hub City bog, on which are found plants common to bogs. Figure 1 of this plate was taken from this bluff.

## EXPLANATION OF PLATE 43.

FIG. 1. Labrador Tea (*Ledum groenlandicum*), growing on a sandstone bluff near the bog at Hub City. This bluff is on the east side of the bog.

2. Mormon Coulee bog from the limestone cliffs that cap the bluffs rising from the north edge of the bog. The small size of the bog can be seen and also the cultivation of land adjacent to the bog, which allows washing of soil into the bog.

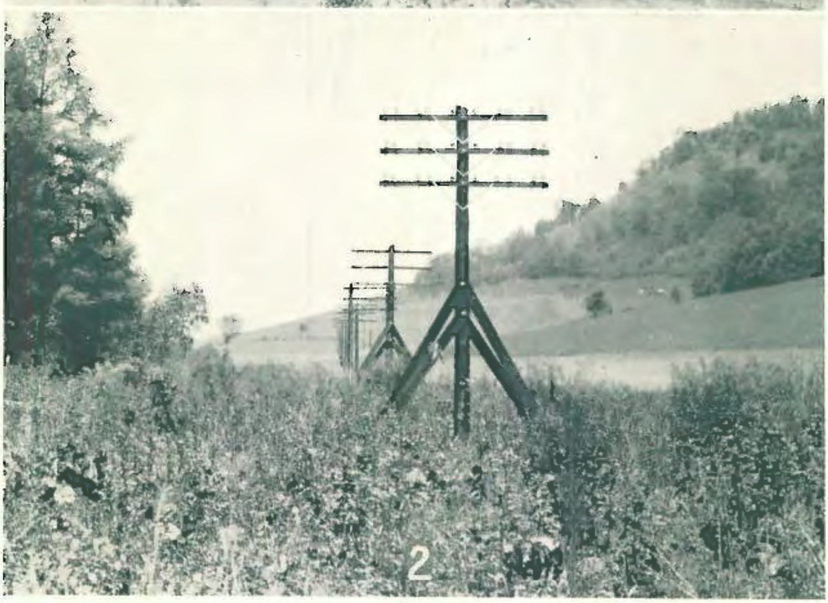

2

## EXPLANATION OF PLATE 44.

Fig. 1. A sharp meander in Mormon Creek about one-half mile above the bog, as seen from a neighboring bluff. The swampy area at the base of the bluff is apparently an old ox-bow lake formed by the meandering stream.

2. The north side of Mormon Coulee bog, showing the wide swath of Tamarack cut for the installation of the power line. In the background can be seen the high bluffs capped with limestone.


1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