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Observations on Bog and Pollen Stratigraphy of the Des Moines Glacial Lobe, Iowa[1]

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Abstract. As part of an investigation into the effect of environmental changes of landscape and soils on the Des Moines lobe (Cary till), three deep bogs (Colo, Jewell, Mc-Culloch) were examined in detail. The center profile of each has a surface peat underlain by deep, dark-colored, calcareous silts; these in turn are underlain by a second peat zone which passes into basal calcareous silts and eventually to till. Preliminary pollen data on the Colo bog shows six zones. The key zones are Zone 1 (0 to 75 inches), in which the pollen is of dominantly herbaceous genera indicating an open grassland environment, and Zones IV and V (102 to 155 to 212 inches) dominated by pollen of forest species. The changes in bog and pollen strata were probably related to a marked change from a cool climate in the early post-glacial to a warmer climate in the latter part of the post-glacial continuing to the present.

The Des Moines lobe represents the latest advance of the Wisconsin ice into Iowa and is regarded by Ruhe and Scholtes (1959) as being of Cary age. This large area of Cary till is characterized by poorly integrated drainage which is a continuing influence of the original morainal topography (Gwynne 1942; Ruhe 1950). As a result of this drainage pattern, a considerable proportion of the till surface is covered by peat bogs formed in small occluded drainage basins; these offer the opportunity of studying the vegetational and landscape changes since the retreat of the ice.

An early approach to the problem of postglacial vegetational and climatic history in Iowa was made by Lane (1931) in a preliminary analysis of pollen from the East McCulloch bog in Hancock County (referred to here as the McCulloch bog). Lane concluded that there were three postglacial climatic phases. The first was a warming phase marked by spruce, pine and fir followed by a gradual desiccation, as evidenced by a transition to oak and grasses. Amaranthus maxima at 8 feet and 4 feet indicated two peak desiccations during the prairie grassland period which continued to the present time. More recently, Ruhe, Rubin and Scholtes (1957) relocated Lane's profile and sampled peat for radiocarbon and analysis. It was shown (Ruhe and Scholtes 1959) that these dates and the related vegetational changes

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were consistent with post-glacial trends deduced from other evidence.

The present investigation is part of a project aimed at evaluating more specifically the effect of environmental changes on landscape and soils on the Des Moines lobe. Riecken (1945), Smith, Allaway and Riecken (1950) and Ruhe (1956, 1959) have drawn attention to the general principles underlying such changes as they affect soils, and recently, White (1953) and Wallace and Handy (1961) proposed that postglacial erosion and deposition have significantly modified the Cary till surface. There have not been, however, any specific studies integrating vegetation, landscape and soil changes on this surface.

Since the maximum record of vegetational, climatic and erosional history is preserved in enclosed peat bogs, a systematic study of these situations was begun on parts of the Des Moines

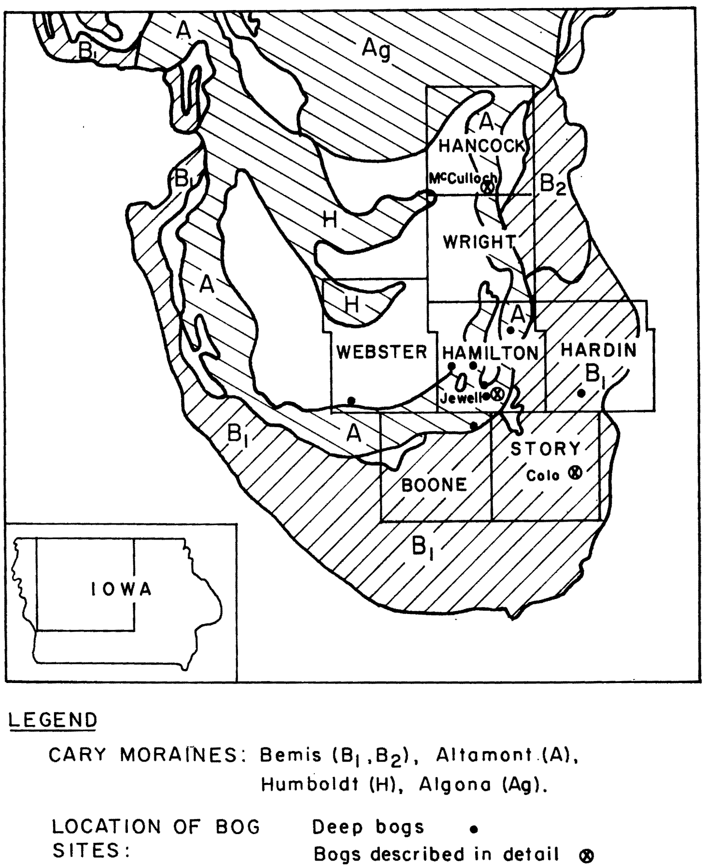


Figure 1. Location of the bogs in relation to the morainal systems of the Des Moines lobe (after Ruhe 1952).

lobe in Iowa. Some of the field evidence and pollen data relevant to the above problems are presented here.

General Bog Stratigraphy

All of the eleven deep bogs which were examined in the Bemis and Altamont moraines of the Des Moines lobe (fig. 1) showed a general similarity in stratigraphy at the bog center. The surface peat complex is 2 to 4 feet thick and non-calcareous; it consists of a black, finely divided muck underlain by a brown peat; often this passes into a black mucky peat at 30-inch depth which is slightly calcareous. Below the surface peat are black to dark gray, calcareous silt loams which contain numerous shell fragments; this zone is usually 6 feet thick but may be as much as 15 feet thick. A distinct second peat layer up to 6 feet thick occurs below the silts; it is a dark brown to black muck or peat in its upper zone but becomes almost entirely finely divided, softer and olive gray colored at depth. The second peat zone is usually non-calcareous to weakly calcareous. Below the second peat is a layer of variable thickness consisting of fine, soft, gray, calcareous silt loam; it passes abruptly into gray, calcareous, poorly sorted, gravelly deposits which mark the top of the Cary till.

Although variations occur in the thickness of the strata from bog to bog, and within a particular bog, the sequence of strata near the bog center is of the kind described above for depths of bog sediment exceeding 8 feet. Many shallower bogs were encountered but in these the central strata consisted only of surface peat overlying black to gray calcareous silts over till.

Bog locations

The locations of the eleven deep bogs are as follows:

Boone Co.	R-25W, T-85N, SE¼ sec. 20
Hamilton Co.	R-24W, T-89N, NE¼ sec. 35
	R-26W, T-88N, E½ sec. 33
	R-25W, T-88N, NE¼ sec. 34
	R-25W, T-87N, SE¼ sec. 35
	R-24W, T-86N, SW¼ sec. 17
Hardin Co.	R-21W, T-86N, E½ sec. 21
Webster Co.	R-30W, T-86N, SE¼ sec. 21

The remaining three bogs have been examined in detail and are given special designations.

Colo bog:	Story Co.; R-21W, T-83N, sec. 11
Jewell bog:	Hamilton Co.; R-24W, T-86N, crosses road between sections 18 and 19.
McCulloch bogs	Hancock Co.; R-24W, T-94N, S½ sec. 32

The position of the last three bogs in relation to the Cary moraines is shown in figure 1. The Colo bog lies toward the southern edge of the oldest or Bemis moraine, while the Jewell and McCulloch bogs occur at widely separated points on the Altamont moraine. The McCulloch is the bog for which Lane (1931 published pollen data and for which Ruhe, Rubin and Scholtes (1957) published radiocarbon dates.

Details of Strata

Details of central cores from each of the three bogs are shown in figure 2. The strata are described in soil terminology as set out in the Soil Survey Manual (1951); Munsell colors are for samples in the moist state. Although the profiles differ in thickness of materials, the sequence and nature of the strata are alike.

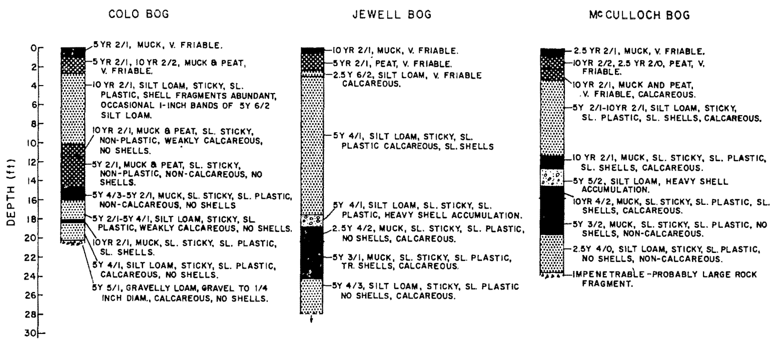
No serious attempt has been made here to relate these bog strata with those of classical bog profiles (see Dachnowski 1924; Dawson 1956). Superficially it seems that the basal layer above the till is a bottom sediment counterpart of the "blue clays" which are washed into depressions during the early stages of glacier retreat (Rigg 1940). The finely divided olive-colored peaty layers of the lower peat zone probably represent the remains of microscopic aquatic life (gyttja); Dachnowski (1924) noted the olive color and fine state of division of such deposits. A large part of the second peat zone is of dark, humified muck which appears like the muck of the surface layer. The more fibrous peat materials are also common in the second peat zone and contain leaf fragments. A significant property of the second peat zone, including the olive-colored layer, is the scarcity of faunal shells and the weakly calcareous nature of the deposits; these properties contrast markedly with the strongly calcareous, non-faunal nature of the basal silt loam deposits and the strongly calcareous, shell-rich, black, silty sediments between the peat zones.

The fibrous peat layer of the surface peat zone is characteristically of compressed leaves and other spongy plant tissue; it differs markedly from the overlying, finely divided, black surface muck in which there is little material of recognizable botanical form. The boundary between these two organic layers is distinctly undulating and abrupt; these facts suggest that the muck has resulted from decomposition of a fibrous peat subsequent to cultivation.

The three peat profiles of figure 2 have surface pH values in the range 6 to 7. This is a characteristic of eutrophic peats in a Ca-rich environment, calcareous till in this case, which have been built up by plants other than sphagnum moss.

Preliminary Pollen Analyses of the Colo Bog

The pollen data of the Colo bog in figure 3 are for samples taken from the core described in figure 2. Pollen percentage frequencies are presented in floristic groups at genus and family



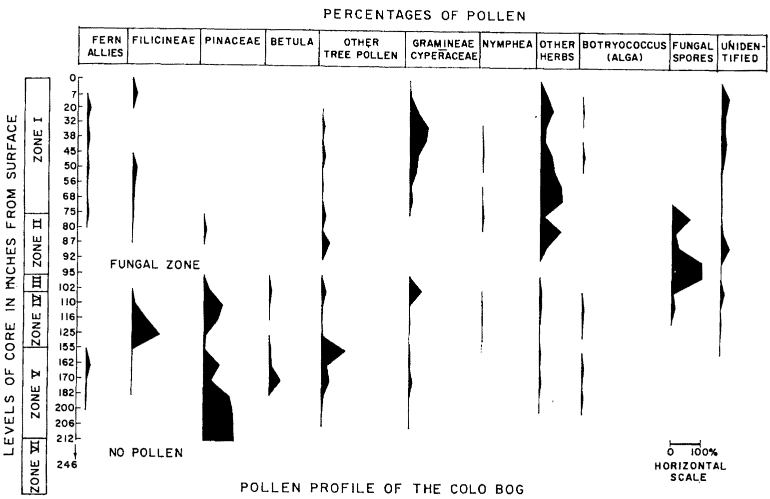


Figure 2. Descriptions of the center profiles of three deep bogs.
Figure 3. Percentage frequency data for pollen in the Colo bog.

level; a detailed investigation of the genera is now being undertaken and this information will be published at a later date.

Six zones are evident in the pollen diagram. Zone VI from 212 to 246 inches at the base of the profile has no pollen; the gray, calcareous silts of this zone were deposited either beneath the retreating ice or at a time when there was a minimum vegetational cover on the exposed till surface. Zone V from 155 to 212 inches is dominated by spruce (Pinaceae), birch (*Betula*), and other forest pollens. It is noted, however, that pollen of the Gramineae and other herbs continue to 212 inches as a low percentage. The pollen of the Pinaceae are capable of travelling greater distances than non-winged pollen, so that on percentage frequency diagrams they are likely to assume exaggerated proportions. Despite this qualification, the very great number of these pollen grains in Zone V indicates that forest was a significant component of the vegetation in this region during early postglacial time. Zone IV from 102 to 155 inches is characterized by an abundance of ferns (Filicineae) and pine pollen; some birch is also apparent. Wetter climatic conditions favoring forest growth are indicated for this zone. Zone III from 95 to 102 inches is dominated by fungal spores; a temporary increase in Gramineae and Cyperaceae is also evident. The ecological significance of this narrow zone is uncertain. Zone II from 75 to 95 inches is depleted of Gramineae and Cyperaceae pollen while "other herbs" are dominant; "other tree pollens" (maple, willow, oak, hazelnut, alder) and Pinaceae are in small quantity but fungal spores are well represented. A warmer, and perhaps drier, climate than prevailed for Zones IV and V is indicated. Zone I from 0 to 75 inches is dominated by Gramineae, Cyperaceae and other herbs, while tree pollen is in very small quantity. Open grassland conditions are indicated throughout this interval under a warm climatic regime comparable to the present.

Discussion

From the viewpoint of the present project, the significant stratigraphic features of the three bogs are their general similarity and their two major peat zones. Both the Colo and McCulloch bogs have minor components of interstratified mineral layers within the second peat zone; the thickness of the sediment separating the upper and lower peat zones, however, is the dominant feature of the profiles and serves to emphasize the discontinuity of the peat profile. Furthermore, the general sequence of the two peat zones is replicated by adjacent cores in the same bogs and by center cores in the other eight bogs mentioned previously.

The occurrence of two peat and two sedimentary zones is not a normal sequence and is indicative of a non-uniform environment during the development of the bog profile. Normal development as envisaged by Dachnowski (1924), Rigg (1940) and Dawson (1956) involves the evolution from lake sediments to marsh and bog stages, culminating in a continuous surface peat layer across the depression. Evidence from the eleven bogs on the Bemis and Altamont moraines of the Cary drift indicates that in postglacial time, this sequence developed but was interrupted at an advanced stage (represented by the lower peat zone) by a phase of strong mineral sedimentation. Eventually, however, the environment favored peat formation again as evidenced by the peat zone of 3 to 4 feet depth to the present surface.

The preliminary pollen profile at Colo coincides with the stratigraphic profile in that the major vegetational change from dominantly tree pollen to dominantly herbaceous pollen coincides with the reversion in bog sequence from the lower peat zone to the overlying dark-colored, calcareous silts. The two zones of mineral sediment probably relate to phases of instability on adjacent slopes of the till surface. The basal silts represent late glacial to early postglacial erosion under conditions of ice retreat and minimum vegetation cover, while the dark calcareous silts above the lower peat zone represent surface instability due to a major change in vegetation from forest to grassland. In both cases mineral sedimentation was dominant over peat deposition at the bog center. The two peat zones on the other hand represent conditions of relative stability on the surface such that accumulation of peat dominated the sedimentary environment at the bog center. The landscape, vegetational and climatic events of the Colo bog are summarized in table 1.

Table 1. A Summary of Landscape, Vegetational and Climatic Changes Represented in the Colo Bog

Substage	General stratigraphy	Vegetation	Climate
Present ↑	Upper peat zone: till surface stable; peat accumulates at bog center.	↑	↑
		Grassland	Warm
	Dark calcareous silts: till, surface eroded; mineral sedimentation predominates at bog center.		
		↑	↑
Postglacial	Lower peat zone: till surface stable; peat accumulates at bog center.	Forest	Cool (warming)
	Gray calcareous silts: sediments deposited at close of glacial.	Minimum vegetation	
Cary	Cary glacial till.		Cold

The vegetational sequence as shown by the pollen diagram at Colo is similar in general trends to Lane's pollen data for McCulloch and the climatic inferences are the same. Since the exact position of Lane's sampling site at the McCulloch bog is uncertain, and since no stratigraphy for this bog has been published, it is difficult to accurately correlate the present work with the published pollen data. It may, however, be more than a coincidence that the major vegetational change in Lane's pollen profile from spruce-pine-birch-fir to oak and grasses is at approximately 11 feet, that is, at the same depth as the boundary between the lower peat zone and the dark, calcareous silt layer of the McCulloch profile in figure 2 of this paper.

The radiocarbon dates of Ruhe, Rubin and Scholtes (1957) for the McCulloch bog place the coniferous-deciduous forest transition of Lane's data at 8,100 years B.P. If the profiles are comparable, this date would approximate the latest deposition of the second peat or the earliest deposition of the dark, calcareous sediments so that these sediments would relate to the earlier peak desiccation of the grassland or prairie environment and the associated gully erosion phase on adjacent hill slopes.

At this stage it is not known whether the Colo sedimentary and peat strata are synchronous with the corresponding McCulloch strata. However, since the sequence and thickness of strata are comparable and the position of the major change in each profile closely approximates the most significant changes in the pollen sequence, it is probable that the profiles and inferred climatic phases are synchronous.

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