String Bogs and Other Patterned Organic Terrain Near Seney, Upper Michigan

M. L. Heinselman

Ecology, Vol. 46, No. 1/2. (Jan., 1965), pp. 185-188.

Stable URL:
http://links.jstor.org/sici?sici=0012-9658%28196501%2946%3A1%2F2%3C185%3ASBAOPO%3E2.0.CO%3B2-X

Ecology is currently published by The Ecological Society of America.

Your use of the JSTOR archive indicates your acceptance of JSTOR's Terms and Conditions of Use, available at http://www.jstor.org/about/terms.html. JSTOR's Terms and Conditions of Use provides, in part, that unless you have obtained prior permission, you may not download an entire issue of a journal or multiple copies of articles, and you may use content in the JSTOR archive only for your personal, non-commercial use.

Please contact the publisher regarding any further use of this work. Publisher contact information may be obtained at http://www.jstor.org/journals/esa.html.

Each copy of any part of a JSTOR transmission must contain the same copyright notice that appears on the screen or printed page of such transmission.

JSTOR is an independent not-for-profit organization dedicated to creating and preserving a digital archive of scholarly journals. For more information regarding JSTOR, please contact support@jstor.org.

http://www.jstor.org/
Thu Jun 8 14:38:50 2006

STRING BOGS AND OTHER PATTERNED ORGANIC TERRAIN NEAR SENEY, UPPER MICHIGAN

M. L. HEINSELMAN[1]

Lake States Forest Experiment Station, Forest Service, U.S. Department of Agriculture
St. Paul 1, Minnesota

Abstract. Treeless string bogs and topographically oriented strips of bog forest have been discovered near Seney, Michigan, lat 46° 15′ N, perhaps the southern limit of patterned bogs on the North American continent. Patterned ground has developed through paludification of a sandplain dotted with extinct dunes and sloping about 8 ft/mile. Many peatlands in Michigan, Minnesota, and Wisconsin have similar slopes and exhibit patterning in various degrees. Thus the principles that can explain the patterns and bog-forming processes at Seney may apply to large areas of forested and treeless peatland. Studies should be directed toward the interrelations between vegetation, water chemistry, local geology, peatland topography, peat hydrology, peat accumulation, and physical geomorphic processes.

INTRODUCTION

Patterned bog features such as string bogs and topographically oriented forest "islands" have been known for some time from boreal and subarctic North America and Eurasia (Auer 1920, Troll 1944, Sjörs 1948, 1959, 1961, Drury 1956, Ritchie 1960). That these peatland types also occur in diminished form in subboreal sections of the Lake States is only now being recognized (Heinselman 1963). The most striking patterns yet seen in Upper Michigan are found in the Seney National Wildlife Refuge area, lat 46° 15′ N and long 86° 12′ W. This location may mark the southern limit of patterned bogs on the North American continent, although more exploration is needed to confirm this supposition.

The existence of patterned terrain at these low latitudes is of special interest because the patterns establish a kinship to more northern peatlands developed through bog-forming processes quite unlike the filled-lake successions once accepted as normal for the Lake States. The Seney peatlands are also of interest because some of this terrain has been misinterpreted as the product of forest and peat fires and other kinds of land abuse. The main purpose of this report, therefore, is to identify the Seney patterns, to relate these peatlands to similar terrain elsewhere, to discuss what is known of the genetic processes involved, and hopefully to stimulate new thinking in Lake States bog ecology. Phytosociological analyses, detailed stratigraphic studies, and water chemistry analyses have not been made, and this paper is not intended to be a definitive report.

PHYSIOGRAPHIC SETTING

The most outstanding patterned organic terrain observed in Michigan occurs on the Seney Refuge in T 45N, R 15W, south of state highway 28, southwest of Seney, and about 12 miles west of refuge headquarters. Two other areas occur on the same general landforms north of highway 28. Locally all are called "marshes": namely the Seney Marsh, Creighton Marsh, and Driggs Marsh. In a strict ecological sense, however, the patterned terrain is not marsh but a complex of bogs and fens. As with most patterned ground, the better examples can be reached only on foot, or by a combination of canoe and foot travel, unless transportation by muskeg tractor or helicopter is arranged.

The whole region in the vicinity of these peatlands is a vast and nearly level sandplain, grading S 15° E at 6-12 ft per mile (see Shingleton quadrangle, U.S. Geological Survey, for portions of the area). On the refuge this plain is about 740 ft above sea level, or about 140 ft above Lake Superior and 160 ft above Lake Michigan. A continuous peat blanket several feet in thickness covers much of the sandplain, and in many intervening areas a thin peaty veneer overlies gleyed sands. Although imperfect dissection has developed a pattern of widely spaced streams that flow southeastward, the water table is usually near or above the mineral soil. The peat surface has essentially the same southeastward slope as do the underlying mineral substrata. The peatlands are interrupted by numerous sand knolls spaced a few hundred yards apart which project above the peat blanket some 3-10 ft and average 60 by 200 ft in size.

The sandplain itself was produced by the deposition of glacial outwash as the last (Valders) ice receded. The area was then inundated by a high water phase of the glacial Great Lakes, probably in immediate post-Algonquin time (Hough 1958, 1963). The Seney plain must therefore have been reworked by shore processes during post-Algonquin time, perhaps between 9,500 and 10,000 years ago, according to recent C-14 chronologies.

The sand knolls appear to be extinct dunes, an interpretation made as early as 1936 by Bergquist. Dune formation probably occurred in post-Algonquin but pre-Nipissing time, about 9,500 years ago, most likely when the sandplain was first drained. On the other hand, the principal aeolian activity could have occurred later, toward Lake Nipissing time, if an exceptionally dry climate occurred then.[2] The latter seems to have been the case with the buried peats described by Zumberge and Potzger (1956) from South Haven, Mich. If this is true at Seney, the dunes might be no more than 4,000 years old. Carbon-14 dates from organic material buried by the dunes during their formation would date them precisely. For the present all one can say is that the peatlands have developed since dune activity ceased, probably between 4,000 and 9,500 years ago.

Beaver dams are plentiful both on the peatlands themselves and in the stream courses. Where the patterns are best developed on the refuge, however, there are no dams except on the streams and on manmade ditches.

From the logging era of the late 19th century until about 1930 the Seney area was subjected to destructive timber cutting, repeated fires, and ill-advised drainage and land clearing. Accessible areas, especially close to the ditches, had their original vegetation totally destroyed,

[1] Located at the Northern Conifer Laboratory, Grand Rapids, Minnesota.

[2] The preceding geological discussion is based on correspondence with Dr. J. L. Hough, University of Illinois, Urbana, Ill.

and sometimes even the peat burned. A legacy of these abuses is the doubt concerning the original cover on certain tracts. Many thought the treeless Seney "marshes" might once have been productive forested swamps. Some perhaps were. Fortunately, however, some of the patterned terrain was so wet and difficult of access and contained so little timber that roads and ditches were not built and the native vegetation is intact. This is true of the area studied.

Climatic Setting

Seney has a cool continental climate, slightly moderated by proximity to Lakes Michigan and Superior. The mean annual temperature is about 40° F; mean July, 65° F; and mean January, 15° F. Highest temperatures do not exceed 103° F, and the absolute minimum is near —47° F. The frost-free season averages only 73 days, with the last spring frost near June 15, and the first fall frost near August 27. Precipitation averages 27 in. annually, of which 16.5 in. comes in the warm season, April to September. Snowfall averages about 110 in. annually, and the winter snowpack often attains 30 in. or more. This heavy snowpack undoubtedly prevents deep freezing of the peatlands. Potential evapotranspiration averages about 21.5 in. annually (Thornthwaite formula), and the calculated annual moisture surplus is 9 in. Comparison of the Seney climate with that of the Lake Agassiz peatlands in Minnesota, where patterned terrain is more abundant, reveals small differences in the direction of greater continentality for the Minnesota area (Heinselman 1963). In general, the Seney area has smaller temperature extremes, more precipitation, greater moisture surplus, and distinctly greater snow depths.

Nature of the Patterns

The Seney Refuge peatlands are a unique complex of nearly treeless string bogs and topographically oriented forest "islands," the latter associated with the dune knolls described above. I first studied and photographed this area from the air in October 1962 and then visited it on the ground. Patterning is conspicuous on vertical airphotos (Fig. 1) and when viewed obliquely from an airplane (Fig. 2). One can also readily see the patterns on the ground once their nature has been disclosed by

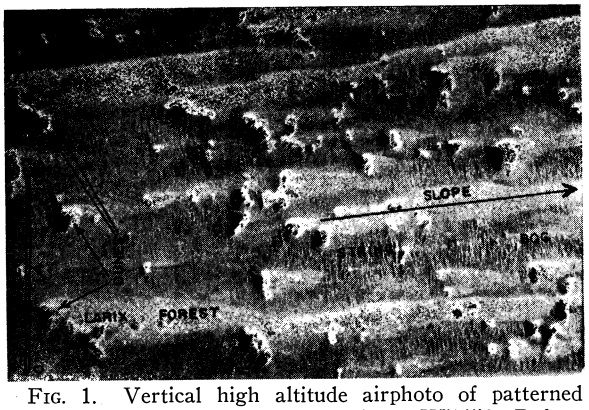

Fig. 1. Vertical high altitude airphoto of patterned organic terrain on the Seney National Wildlife Refuge (Secs 28 and 33, T 45 N, R 15 W, Schoolcraft Co., Mich.). Note general linear organization of vegetation types, areas of string bog, and strips of *Larix* forest located downslope from extinct dunes. The latter form sand knolls which support groves of pine. (U.S. Dept. Agr. photograph, 1953.)

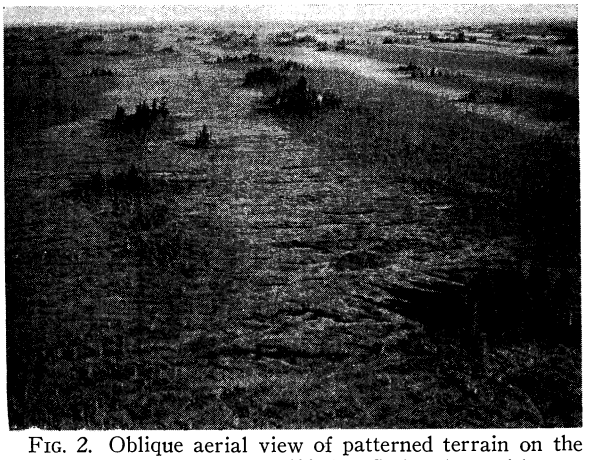

Fig. 2. Oblique aerial view of patterned terrain on the Seney Refuge, from about 400 ft. String bog with several good bog hollows (flarks) in foreground. Note strips of bog forest, chiefly small *Larix*, downslope from extinct dunes which support groves of white and red pine. This peatland has developed on a sand plain which slopes toward the camera.

aerial observation, but their scale is so large that they could easily be missed without this experience.

The first impression from the vertical airphotos is of the conspicuous banding of vegetation types—a banding perfectly adjusted to the major slope of the sandplain. On these photos one also notes many small ovoid dark areas (the dunes, supporting pine), most having long streamlined light gray "tails" trailing off downslope. These tails are strips of bog forest on peat, chiefly of tamarack (*Larix laricina*), with occasional black spruce (*Picea mariana*). Between these linear areas of bog forest are long winding ribbons of darker gray tones, with frequent sections showing a good pattern of wavy crossbanding. These areas are the treeless string bogs, which occupy about half of the terrain. This complex of patterned ground covers much of the sandplain between the Creighton River and Marsh Creek, south of highway 28. The best patterns are 3 miles southwest of the refuge's C-3 Pool.

In detail the string bogs consist of alternate low bog ridges (German *Stränge*) and wet sedgy hollows (Swedish *flarke*, English flarks). The bog ridges and hollows are oriented across the major slope of the peatland (and sandplain), at right angles to water movement, as is the case with all *Strangmoor* terrain (see Auer 1920, Troll 1944, Drury 1956, Sjörs 1959, 1961, Heinselman 1963). At Seney the slope of the peat surface is approximately 6-8 ft/mile. A completely satisfactory explanation for the origin and orientation of the ridges on this type of patterned ground has not been worked out, but physical forces such as frost heaving or downslope slippage of the peat seem essential, and biotic factors must also be involved. Some of the larger flarks are nearly devoid of vegetation, mud-bottomed, and about 18 in. deep (Fig. 3). The largest occur just upslope from the dunes, where they may occupy former blowout pits. In wet seasons many flarks contain standing water more than a foot deep. Even after the relatively dry summer of 1962 the fall rains brought water levels well above the peat surface, and the deeper flarks were too soft to support one's weight. Muddy organic matter in these depressions was stained a conspicuous orange, apparently by the precipitation of iron compounds.

FIG. 3. Ground view of a wet bog hollow (flark) in string bog (*Strangmoor*), Sec 33, T 45 N, R 15 W, Seney National Wildlife Refuge. The string bog here is essentially a "patterned fen," supporting sedges and other fen species in the hollows and *Betula pumila* and a few of the Ericaceae on the bog ridges (*Stränge*). In the distance are strips of bog forest on peat and pine islands on the dunes.

The vegetation of the *Strangmoor* areas marks them as intermediates between bog and fen. Perhaps they should be called "patterned fens" as Sjörs (1959) has called similar terrain in the Hudson Bay lowlands, and as I have termed certain areas in Minnesota. The ridges are built of *Sphagnum* and sedges, upon which grows a low shrub cover of bog birch (*Betula pumila*) and Ericaceae. In the flarks between these ridges most of the species are those of fens. Additional plants characteristic of the bog ridges include: *Chamaedaphne calyculata, Andromeda glaucophylla, Vaccinium oxycoccos, Potentilla fruticosa,* occasional willows (*Salix*), *Sarracenia purpurea, Iris versicolor, Pyrola rotundifolia, Aster* sp., *Osmunda regalis, Polytrichium juniperinum,* grasses, and a few stunted *Larix*. Plants common in the bog hollows include several sedges (*Carex*), *Dulichium arundinaceum, Andromeda glaucophylla, Vaccinium oxycoccos, Sarracenia purpurea, Aster* sp., *Equisetum fluviatile,* algae, and rarely willows.[3]

The strips of bog forest downslope from the sand dunes were dominated by *Larix* and had a dense tall shrub layer as well. Bog birch dominated that stratum. Within these forest belts the ground was hummocky but lacked the ridge and hollow pattern of the string bogs. Common plants comprising the bog forest community included: *Larix, Acer rubrum, Picea mariana, Pinus strobus* (rare, stunted), *Betula pumila, Chamaedaphne calyculata, Ledum groenlandicum, Rubus pubescens, Sphagnum, Calliergonella schreberi, Hylocomium splendens, Dicranum,* other mosses, grasses, sedges, and ferns. A shrubby zone only a few feet wide marked the ecotone between string bog and bog forest.

In contrast to these peatland communities, the extinct dunes supported xeric conifer groves dominated by white and red pine (*Pinus strobus* and *P. resinosa*). Other trees on the dunes included *Picea mariana* and *Thuja occidentalis,* and more rarely, *Betula papyrifera* and *Acer rubrum.* The ground cover was a thin sedge and grass sod interspersed with patches of bare sand and lichens. Bracken fern and *Vaccinium angustifolium* were also common.

A few peat borings were taken with a Hiller borer in treeless string bog and in bog forest to get a general idea of peatland history, and to make a comparison with the Minnesota patterned bogs which are much better known. In a string bog in Sec 33, T 45, R 15, one boring was made in a flark, another on a bog ridge. In the flark the total peat depth was 1.75 m, and the substratum a yellowish-brown medium sand. The peat here was a pulpy brownish-black well-decomposed sedge type —nearly an ooze, but containing plant fibers. No wood was found. Alternate bands of sand and peat marked a transition to the substratum in the basal 10 cm. A boring in a bog ridge nearby gave 1.80 m of peat, underlain by the same sandy substratum. Peat stratigraphy was as follows:

0-0.1 m	Loose undecomposed sedge and *Sphagnum.*
0.1-0.7 m	Brown pulpy sedge peat, more fibrous than at same depth in flark. Contains bits of wood, apparently from shrubs.
0.7-1.4 m	Olive brown to buff-colored amorphous peat containing some concretions and a few fine fibers. (Not marl, will not effervesce with dilute HCl.) No wood content. Possibly a former flark.
1.4-1.80 m	Brown fibrous peat, quite decomposed, possibly derived from sedges. Contains bits of woods. Alternate bands of peat and sand at bottom.

Another boring, taken in the center of a band of tamarack forest in Sec 27, T 45, R 15, gave a total peat thickness of 2.4 m, of which the upper 1.5 m was a somewhat decomposed mixed sedge and moss peat containing occasional logs and bits of wood as inclusions. From 1.5 m to the substratum the peat was a more decomposed brown fibrous sedge type, lacking any evident wood fragments. This horizon was very decomposed at its contact with a brown medium sand substratum.

NEW PROBLEMS IN REGIONAL BOG ECOLOGY

Three points stand out in the foregoing descriptions. (1) The Seney areas are true cases of patterned ground, exhibiting features common to boreal and subarctic peatlands. We thus must seek common explanations through regionally related bog-forming processes or, failing in this, explain how such parallels could result from different processes. (2) These peatlands are slanting, and their major vegetation types exhibit topographic alignment, suggesting controls over floristics by factors associated with the movement of bog waters across the sloping Seney plain. (3) The association of strips of bog forest with extinct sand dunes is a new feature demanding explanation.

First, let us consider the origin of these peatlands and of their string bog patterns. The geologic setting requires that these peatlands be post-Pleistocene in age, probably post-Lake Algonquin, and possibly even post-Nipissing. As with the Minnesota patterned ground, the patterns at Seney must therefore be accounted for by bog processes operative under recent and present climatic conditions. Certainly the string patterns are not products of permafrost. If frost action is responsible it must be seasonal frost, and the heavy snowcover at Seney requires that relatively shallow freezing be sufficient. Since

[3] Vegetation analyses were not made. The vegetation notes are intended only to characterize the broad vegetation patterns seen on the airphotos. The communities merit detailed study.

dune formation ceased, the entire Seney plain has been blanketed with more than a meter of peat. The process that produced this peat layer was not ordinary basin-filling because the peats rest on a sloping surface. Limited peat borings suggest that the first communities to form peats may actually have been sedge meadows subject to flooding, in places with a shrub cover like that of many shallow peat areas today. Beaver may have played a role in causing water tables to rise but could hardly have raised the water table over the entire plain. Instead it seems that a process of paludification similar to that in the Lake Agassiz region of Minnesota must be responsible for the continuous peat blanket. Certainly there are many parallels between the Seney area and the patterned terrain north of Upper Red Lake in Minnesota.

Consider the implications of the topographically aligned vegetation types. Why do the string bogs occur in strips oriented up and down the slope—strips that seem to be adjusted to the streamlines of groundwater movement? Why do the strips of bog forest have a similar alignment, and why do they occur chiefly downslope from islands of mineral soil? Are there properties of the bog waters that exclude trees from the string bogs, while changed properties permit certain species to invade downslope from the dunes? Perhaps there are important differences in content of metallic cations, oxygen, CO_2, or pH. But bog forests may not always have existed at these sites; in the peat boring only sedge peats lacking wood were found in the bottom meter of peat. This situation also prevails in most forest "islands" in the Minnesota bogs. Treeless fens may have once covered most of the Seney plain, excluding the dunes. Perhaps water chemistry now promotes more active peat decomposition where the string bogs are, and thus maintains a lower elevation of the peat surface, which in turn makes these sites too wet for trees.

Similar questions have arisen in interpreting the origin of patterned terrain in Minnesota. There, for example, one finds teardrop-shaped topographically aligned black spruce "islands" on deep peat, surrounded by treeless string bogs. But at Seney the bog forests occur chiefly downslope from the mineral soils of the dunes, while in Minnesota there are no mineral soil areas immediately upslope from the black spruce forests. In fact, the peat in Minnesota is usually just as deep upslope (often 1-3 m) as beneath the bog forests. There are also the "water-track" forests in Minnesota and elsewhere which seem related to the Seney patterns (Heinselman 1963, Watt and Heinselman 1964).

Whatever the causes for topographically oriented vegetation types, it is likely that the principles involved will apply to sloping peatlands throughout the Lake States and elsewhere. From recent work in Minnesota, Wisconsin, and Michigan it appears that a substantial proportion of the region's peatlands have significant slopes, so these questions are relevant in regional bog ecology. The answers are to be found in coordinated studies of the whole peatland-environment complex. The interactions between peatland communities, physiography, climate, bog topography, water-movement patterns, and hydro-chemical factors must be considered more fully. We must also consider how peatland topography, hydrology, and the chemical factors are themselves changed as plant remains accumulate and the peatland grows. Progress has been made on these problems in Europe, Scandinavia, and Russia by Malmstrom, Lukkala, Sjörs, Pearsall, Gorham, Kulcynzski, Piavchenko, and many others.

Literature Cited

Auer, V. 1920. Über die Entstehung der Stränge auf den Torfmooren. [On the origin of the Stränge in peat bogs.] Acta Forestalia Fennica 12: 23-145.

Bergquist, S. 1936. The Pleistocene history of the Tahquamenon and Manistique drainage region of the northern peninsula of Michigan. Michigan Geol. Surv. Publ. 40, Geol. Ser. 34, 141 p.

Drury, W. H. Jr. 1956. Bog flats and physiographic processes in the upper Kuskokwim River region, Alaska. Gray Herbarium, Harvard Univ., Contrib. 178, 130 p.

Heinselman, M. L. 1963. Forest sites, bog processes, and peatland types in the Glacial Lake Agassiz region, Minnesota. Ecol. Monographs 33: 327-374.

Hough, J. L. 1958. Geology of the Great Lakes. Univ. of Illinois Press, Urbana, Ill. 313 p.

———. 1963. Prehistoric Great Lakes of North America. Am. Scientist 51: 84-109.

Ritchie, J. C. 1960. The vegetation of northern Manitoba. V. Establishing the major zonation. Arctic 13: 211-229.

Sjörs, H. 1948. Myrvegetation i Bergslagen. [Mire vegetation in Bergslagen, Sweden.] Acta Phytogeographica Suecica 21: 299 p.

———. 1959. Bogs and fens in the Hudson Bay lowlands. Arctic 12: 2-19.

———. 1961. Surface patterns in boreal peatland. Endeavour 20 (80): 217-224.

Troll, C. 1944. Structure soils, solifluction, and frost climates of the earth. Geol. Rundschau 34 (7-8): 545-694. (Transl. from the German by H. E. Wright, S.I.P.R.E. transl. 43, 1958.)

Watt, R. F., and M. L. Heinselman. 1964. Foliar nitrogen and phosphorus level related to site quality in black spruce. Ecology. (In press.)

Zumberge, J. H., and J. E. Potzger. 1956. Late Wisconsin chronology of the Lake Michigan basin correlated with pollen studies. Bull. Geol. Soc. Am. 67: 271-288.