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THE RELATIONSHIP BETWEEN OHIO PEATLAND DISTRIBUTION AND BURIED RIVER VALLEYS[1]

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ABSTRACT. From field, herbarium and literature surveys, 114 historical and extant Ohio peatlands were located. These peatlands, classified as either bog or fen communities, were plotted on U.S.G.S. topographic quadrangles, the glacial map of Ohio, the map of the Teays-age drainage in Ohio, and the map of buried river valleys in Ohio. These bog and fen communities are restricted to the areas glaciated by the Wisconsinan advances. While the distribution of Ohio peatlands is complex, approximately 50% occur on kame and esker complexes. Ninety-three (82%) of 114 peatlands investigated occur on or near buried pre-glacial river valleys.

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INTRODUCTION

Establishment of the Ohio Natural Heritage Program in 1976, assemblage of state rare species lists (Cooperrider 1982, Div. Natur. Areas and Preserves 1984), funding and support of biological distributions and ecological surveys by the Ohio Biological Survey (e.g. Whitney 1981), and preparation of a detailed classification of Ohio's plant communities (Anderson 1982) have placed the state of Ohio in a period of natural history renaissance. A far better inventory of the state's vascular flora and plant communities exists today than has ever existed before.

From these investigations, bog and fen communities and their characteristic floras have emerged as an important but disappearing part of Ohio's natural heritage. These peatland communities were never prevalent in Ohio. Dachnowski (1912) estimated that about 74,000 ha, or less than one percent of Ohio's land surface was in peat deposits at the time of the arrival of early European settlers. Presently only three classic tamarack-ringed bogs are known to remain in Ohio, while at the turn of the century nine were reported in the literature (Selby 1901, Dachnowski 1912). Moreover, one-fourth of Ohio's fens have been destroyed (Stuckey and Denny 1981). The rarity of the plant species of these communities has been discussed previously by Andreas and Host (1983).

In his comprehensive study, Dachnowski (1912) indicated that Ohio peat deposits occurred within glaciated Ohio. Stuckey and Denny (1981) mapped 20 fens in that portion of Ohio once covered by the continental ice sheet.

The purpose of the present study is to map 114 historical and extant peat deposits, each of which may be classified as a bog or fen community, on detailed glacial maps and other Ohio geological maps in order to establish possible relationships between peatland distribution and geology in Ohio.

BOGS AND FENS

The separation of bog and fen communities on the basis of differences in vegetation or differences in water chemistry, or both, can in some cases be difficult if not impossible, and the two have often not been differentiated but instead called "bogs" in the broad sense or "sphagnum bogs." In Ohio, the problem is compounded by the fact that glacier-created bogs and fens are at the southern edge of their North American range. Representative communities are small in terms of area covered, and neither bog nor fen communities are represented by classical examples of the types found in Michigan,

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northern Wisconsin, or Minnesota (Conway 1949, Curtis 1959, Heinselman 1970, Schwintzer 1981, Sytsma and Pippen 1981). Based primarily on water chemistry, peatland ecologists instead of using the terms bog and fen currently use categories such as weakly minerotrophic swamps, strongly minerotrophic swamps, poor fens, rich fens, semi-ombrotrophic bogs and ombrotrophic bogs to distinguish among the types of peatlands (Heinselman 1970, Moore and Bellamy 1974, Glaser et al. 1981).

Nevertheless, using the criteria below, it is generally possible to distinguish Ohio bogs from fens. These criteria are based on a survey of relevant literature (Jones 1941, Gates 1942, Aldrich 1943, Dansereau and Segadas-Vianna 1952, Curtis 1959, Mornsjo 1969, Moore and Bellamy 1974, Anderson 1982, Larsen 1982 among them), and on qualitative and quantitative field studies performed by the author in Ohio peatlands between 1976 and 1983 (Andreas 1980, Andreas and Host 1983).

For the peatlands presented in this study, a sphagnous bog is considered to be a habitat that (1) develops in an area where drainage is blocked and there is little or no circulation of water, (2) contains a *Sphagnum* dominated ground layer which accumulates to form a more or less continuous mat, (3) has a shrubby vegetation dominated by members of the Ericaceae and a herbaceous layer primarily dominated by members of the Cyperaceae, and (4) has a water pH between 3.5 and 5.5.

Typically, bog waters are brown due to the accumulation of organic material. In Ohio, plant communities with the above characteristics are referred to as *Sphagnum* mats, leatherleaf bogs, ericaceous shrub bogs, tamarack bogs, and more recently, ombrotrophic to weakly minerotrophic swamps (for example Herrick 1974, Whitney 1981, Anderson 1982).

A fen is characterized by having (1) relatively clear water coming from an artesian source which surfaces as springs or seeps, (2) a wet, springy calcareous substrate which supports minerotrophic species of *Sphagnum* and other bryophytes which do not accumulate to form a continuous mat, (3) vegetation dominated by members of the Cyperaceae, Compositae, Rosaceae and Gramineae with approximately 20% of the vegetation made up of shrubs, usually including *Potentilla fruticosa,* and (4) water pH between 5.5 and 8.0.

In Ohio, plant communities with the above characteristics are meadow-like and are referred to as sedge meadows, wet prairies, shrubby cinquefoil bogs, fen bogs, shrub carrs, tamarack fens, cedar bogs, and, more recently, moderately to strongly minerotrophic swamps (for example Stuckey and Denny 1981, Anderson 1982).

METHODS AND MATERIALS

Pertinent floristic literature was examined to compile a vegetational list of characteristic species for bog and fen communities (Curtis 1959, Gordon 1969, Schwintzer 1978, 1981, Andreas 1980, Stuckey and Denny 1981, Anderson 1982, Cooperrider 1982). From the above sources and from personal field observations, nine species were selected as bog indicators and nine species were selected as fen indicators. The bog indicators are *Calla palustris* L., *Carex trisperma* Dew., *C. oligosperma* Michx., *Chamaedaphne calyculata* (L.) Moench, *Eriophorum virginicum* L., *Larix laricina* (DuRoi) K. Koch, *Ledum groenlandicum* Oeder, *Nemopanthus mucronatus* (L.) Trel., and *Vaccinium macrocarpon* Ait. Fen indicators are *Betula pumila* L., *Carex incomperta* Bickn., *C. lasiocarpa* Ehrh., *Cypripedium reginae* Walt., *Geum rivale* L., *Potentilla fruticosa* L., *Salix candida* Flugge, *Sanguisorba canadensis* L., and *Solidago ohioensis* Riddell. The nomenclature above follows Fernald (1950). Ohio herbarium specimens at KE, CLM, and OS, and the Ohio Heritage Program data base (Div. Natur. Areas and Preserves, ODNR), were examined for locational data for the 18 selected indicator species. No single Ohio bog or fen contains all of the listed indicator species.

Additional bog and fen locations were taken from Herrick (1974) and Dachnowski (1912). Only those areas with adequate locational data and a list of plant species that could distinguish the peat deposit as either a bog or fen (rather than an organic soil deposit of graminoid or marsh origin) were used.

Between 1976 and 1983 field surveys were conducted throughout Ohio to locate additional peatlands and to establish the ecological status of previously known localities.

Bog and fen localities were plotted on 7.5 minute U.S. Geological Survey topographic quadrangles, the *Glacial Map of Ohio* (Goldthwait et al. 1967), the map of the *Teays Stage Drainage* (Stout et al.

1943), and the map of *Buried River Valleys in Ohio* (Cummins 1959). County-level glacial maps were examined for those counties where such maps were available. USDA soil survey maps were examined, but these contributed little to the study.

RESULTS

From the above procedures, 29 historical bogs, 27 extant bogs or bog remnants, and 19 historical fens and 39 extant fens or fen remnants were identified (table 1). While the list presented in table 1 may not include every bog and fen in Ohio, it is the most complete list to date. A historical locality is one that is known from either a pre-1950 herbarium record or a literature citation but for which no post-1950 information is known. A remnant refers to an area that was presumably a bog or fen, but in which currently only a small number of indicator species remain, or an area that is in the process of being destroyed.

Data accumulated from mapping Ohio peatlands on 7.5 minute topographic quadrangles reveal that most bog and fen communities form in the headwaters of drainage systems; that the elevation of Ohio peatlands varies from 110 to 218 m above sea level, and that, other than bogs occurring in kettle-hole depressions, there is no distinctive relief pattern associated with their occurrence. Due to the small average size of Ohio peatlands, approximately 36% of the localities inventoried do not appear as wetlands on topographic quadrangles.

Fig. 1 summarizes bog and fen distribution on glacial features. With the possible exception of a fen reported on glacial alluvium at the border of the Wisconsinan and Illinoian boundary (Heffner 1939), all bog and fen communities known from Ohio occur within the area glaciated by the Wisconsinan ice advances. Approximately one-half of the bog and fen communities in Ohio occur on kame and esker complexes. Approximately 19% of the areas surveyed occur on outwash deposits; 12% on lacustrine deposits, and the remaining 19% on ground and end moraines and alluvium (fig. 1 and table 1).

The 114 peatlands were also plotted on the map of the Teays Stage Drainage

TABLE 1

Peatland locations in relation to wetland type and geologic setting.

Peatland	County and Township	Type of Community	Glacial Feature	Underlain by buried river valley
1. Round Lake	Ashland-Lake	historical-bog	kettle lake	X
2. Grand River Terraces	Ashtabula-Morgan	extant-bog	lacustrine	X
3. Leon Bog	Ashtabula-Dorset	historical-bog	outwash	—
4. Morgan Swamp	Ashtabula-Morgan	extant-bog	lacustrine	X
5. Orwell Bog	Ashtabula-Orwell	historical-bog	lacustrine	X
6. Pennline Bog	Ashtabula-Richmond	extant-fen	kame-esker complex	—
7. Cedar Bog	Champaign-Urbana	extant-fen	outwash	X
8. Urbana Raised Bog	Champaign-Urbana	extant-fen	ground moraine	—
9. County Line Bog	Champaign-Harrison	historical-fen	kame-esker complex	—
10. Kiser Lake Fen	Champaign-Johnson	extant-fen	lacustrine	—
11. Brush Lake	Champaign-Rush	historical-fen	kettle lake	—
12. Baldwin Lane Fen	Clark-Moorefield	extant-fen	outwash	X
13. Medway Bog	Clark-Bethel	historical-fen	outwash	X
14. Prairie Road Fen	Clark-Moorefield	extant-fen	outwash	X
15. Springfield Fen	Clark-Springfield	extant-fen	outwash	X
16. Guilford Bog	Columbiana-Center	historical-bog	outwash	X
17. Watercress Marsh	Columbiana-Butler	extant-fen	moraine	X
18. Crawford Bog	Crawford-Chatfield	historical-bog	lacustrine	X
19. New Haven Bog	Crawford-Auburn	historical-bog	lacustrine	—
20. Pettibone Swamp	Cuyahoga-Solon	extant-bog	kame-esker complex	X

TABLE 1 (Continued)

Peatland	County and Township	Type of Community	Glacial Feature	Underlain by buried river valley
21. Solon Bog	Cuyahoga-Solon	historical-bog	outwash	X
22. Marl Bog	Darke-Harrison	extant-fen	end moraine	X
23. Edgerton Bog	Defiance-Farmer	historical-fen	ground moraine	—
24. Cranberry Marsh	Defiance-Highland	historical-fen	lacustrine	X
25. Lehman Lake	Defiance-Milford	historical-bog	kettle lake (?)	X
26. Castalia Prairie	Erie-Margaretta	extant-fen	lacustrine	—
27. Heffner Fen	Fairfield-Berne	historical-fen	alluvium	X
28. Borton Bog	Fulton-Chesterfield	historical-fen	end moraine	—
29. Fern Lake	Geauga-Burton	extant-bog	kettle lake	X
30. Kolicker Fen	Geauga-Munson	extant-fen	kame-esker complex	X
31. Lake Punderson	Geauga-Newberry	extant-bog	end moraine	X
32. Bender Fen	Geauga-Burton	extant-fen	end moraine	X
33. Snow Lake	Geauga-Troy	extant-bog	kettle lake	X
34. Pekin Road Fen	Geauga-Newberry	extant-fen	kame-esker complex	X
35. Simm's Bog	Greene-Bath	historical-fen	outwash	X
36. Spring Valley Bog	Green/Warren-Spring Valley	historical-fen	outwash	X
37. Bonnet Pond	Holmes-Washington	historical-fen	kettle lake	X
38. Kick Fen	Holmes-Washington	extant-fen	kame-esker complex	X
39. Washington Twp. Bog	Holmes-Washington	extant-fen	outwash	X
40. New Haven Marsh	Huron-Richmond	historical-bog	lacustrine	X
41. Bloody Run Swamp	Licking-Harrison	historical-bog	lacustrine	X
42. Cranberry Island	Licking-Licking	extant-bog	kettle lake	X
43. Utica Bog	Licking-Washington	historical-bog	kettle lake	X
44. Torrens Bog	Licking-Burlington	historical-bog	kame-esker complex	X
45. Black Lake	Logan-Miami	extant-fen	lacustrine	—
46. Dokes Lake	Logan-Union	historical-fen	kame-esker complex	—
47. Liberty Fen	Logan-Liberty	extant-fen	outwash	X
48. Mickey Fen	Logan-Union	historical-fen	kame-esker complex	—
49. Stocker Farm Fen	Logan-Liberty	extant-fen	outwash	—
50. Cambden Lake Bog	Lorain-Cambden	historical-bog	kettle lake	—
51. Irwin Prairie	Lucas-Spencer	extant-fen	lacustrine	X
52. Schwamberger Prairie	Lucas-Spencer	extant-fen	lacustrine	X
53. Garfield Bog	Mahoning-Goshen	historical-bog	outwash	X
54. Snyder Bog	Mahoning-Beaver	historical-bog	outwash	X
55. Seville Bog	Medina-Guilford	historical-bog	outwash	X
56. Silver Lake Fen	Miami-Bethel	extant-fen	kettle lake	X
57. Kibler Bog	Pickaway-Circleville	historical-fen	outwash	X
58. Asbury Fen	Portage-Hiram	extant-fen	kame-esker complex	X
59. Atwater Center Bog	Portage-Atwater	historical-bog	ground moraine	X
60. Barnacle Bog	Portage-Ravenna	extant-bog	kame-esker complex	X
61. Bird Farm Bog	Portage-Rootstown	extant-bog	ground moraine	X
62. Burned Bog	Portage-Hiram	historical-bog	ground moraine	X
63. Eckert Bog	Portage-Ravenna	historical-bog	kame-esker complex	X
64. Flat Iron Lake Bog	Portage-Suffield	extant-bog	kettle lake	X
65. J. Arthur Herrick Fen	Portage-Streetsboro	extant-fen	kame-esker complex	X
66. Gott Fen	Portage-Streetsboro	extant-fen	alluvium	X
67. Infirmary Road Bog	Portage-Mantua	extant-bog	outwash	X
68. Kent Bog	Portage-Brimfield	extant-bog	kame-esker complex	X
69. Mantua Swamp	Portage-Mantua	extant-fen	kame-esker complex	X
70. Mishler Road Fen	Portage-Suffield	extant-fen	kame-esker complex	—
71. Rockwell Bog	Portage-Franklin	extant-bog	kame-esker complex	X
72. Stratton Pond	Portage-Franklin	extant-bog	kettle lake	X
73. Streetsboro Bog	Portage-Streetsboro	extant-fen	alluvium	X
74. Triangle Lake Bog	Portage-Rootstown	extant-bog	kettle lake	X

TABLE 1 (Continued)

Peatland	County and Township	Type of Community	Glacial Feature	Underlain by buried river valley
75. Turnpike Fen	Portage-Streetsboro	extant-fen	alluvium	X
76. Way Fen	Portage-Shalersville	extant-fen	kame-esker complex	X
77. Forquier Bog	Richland-Cass	historical-bog	ground moraine	X
78. Blackwater Fen	Ross-Green	extant-fen	kame-esker complex	X
79. Immell Bog	Ross-Green	historical-fen	kame-esker complex	X
80. Spring Bank Fen	Ross-Union	extant-fen	kame-esker complex	X
81. Springville Marsh	Seneca-Big Spring	extant-fen	moraine	—
82. Brewster Bog	Stark-Sugar Creek	extant-bog	kame-esker complex	X
83. Canton Bog	Stark-Canton	historical-fen	kame-esker complex	X
84. Congress Lake Bog	Stark-Lake	extant-bog	kettle lake	X
85. Hartville Bog	Stark-Lake	extant-bog	kame-esker complex	X
86. Jackson Bog	Stark-Jackson	extant-fen	kame-esker complex	—
87. Lake Township Bog	Stark-Lake	extant-bog	kame-esker complex	X
88. Lyman Bog	Stark-Sugar Creek	extant-bog	kame-esker complex	X
89. Myers Lake	Stark-Canton	historical-fen	kettle lake	X
90. Stark-Case Prairie	Stark-Perry	extant-fen	kame-esker complex	X
91. Caston Road Bog	Summit-Green	extant bog	kettle lake	X
92. Copley Bog	Summit-Copley	historical-bog	outwash	X
93. Karlo Bog	Summit-Coventry	extant-bog	kettle lake	X
94. Luna Lake	Summit-Franklin	historical-bog	kettle lake	X
95. Mud Lake	Summit-Hudson	historical-bog	kettle lake	X
96. Myersville Fen	Summit-Green	extant-fen	kame-esker complex	X
97. Nimisila Fen	Summit-Green	extant-fen	kame-esker complex	X
98. Norton Bog	Summit-Norton	extant-bog	kame-esker complex	X
99. Railroad Bog	Summit-Twinsburg	extant-bog	kame-esker complex	X
100. Steinert Bog	Summit-Bath	extant-bog	kame-esker complex	X
101. Singer Lake	Summit-Green	extant-bog	kettle lake	X
102. Twinsburg Fen	Summit-Twinsburg	extant-fen	outwash	X
103. Turkeyfoot Lake Bog	Summit-Franklin	historical-bog	kettle lake	X
104. Bloomfield Bog	Trumbull-Bloomfield	historical-bog	lacustrine	X
105. West Swamp	Trumbull-Braceville	historical-bog	outwash	X
106. Tully Bog	Van Wert-Tully	historical-fen	ground moraine	X
107. Browns Lake	Wayne-Clinton	extant-bog	kettle lake	X
108. Fox Lake Bog	Wayne-Baughman	historical-bog	kettle lake	X
109. Orville Bog	Wayne-Baughman	historical-bog	alluvium	X
110. Mud Lake	Williams-Northwest	extant-fen	kettle lake	—
111. Nettle Lake	Williams-Northwest	historical-fen	kettle lake	—
112. St. Joseph Bog	Williams-St. Joseph	historical-bog	moraine	X
113. Big Spring Bog	Wyandot-Crawford	extant-fen	moraine	—
114. Crane Bog	Wyandot-Crane	historical-fen	moraine	X

(fig. 2). The Teays River was the major stream flowing across the southern half of Ohio in a southeastern-northwestern direction prior to Pleistocene glaciation. Named by Tight (1903), it originated in the Piedmont of Virginia and North Carolina, flowed across West Virginia, and entered Ohio near the present city of Huntington, WV. Stout et al. (1943) use the term "Teays Stage" or "Teays River System" in a general sense to "indicate the work of streams during that general period of erosion before glaciation. The term Teays is thus applied to the old stream designated by Tight as the Teays, but also to the work of all streams contemporary with it." Further details and recent references to the Teays River in Ohio are presented by King (1983).

The contemporaneous streams and tributaries of the Teays River, now buried in valleys under glacial materials, underlie

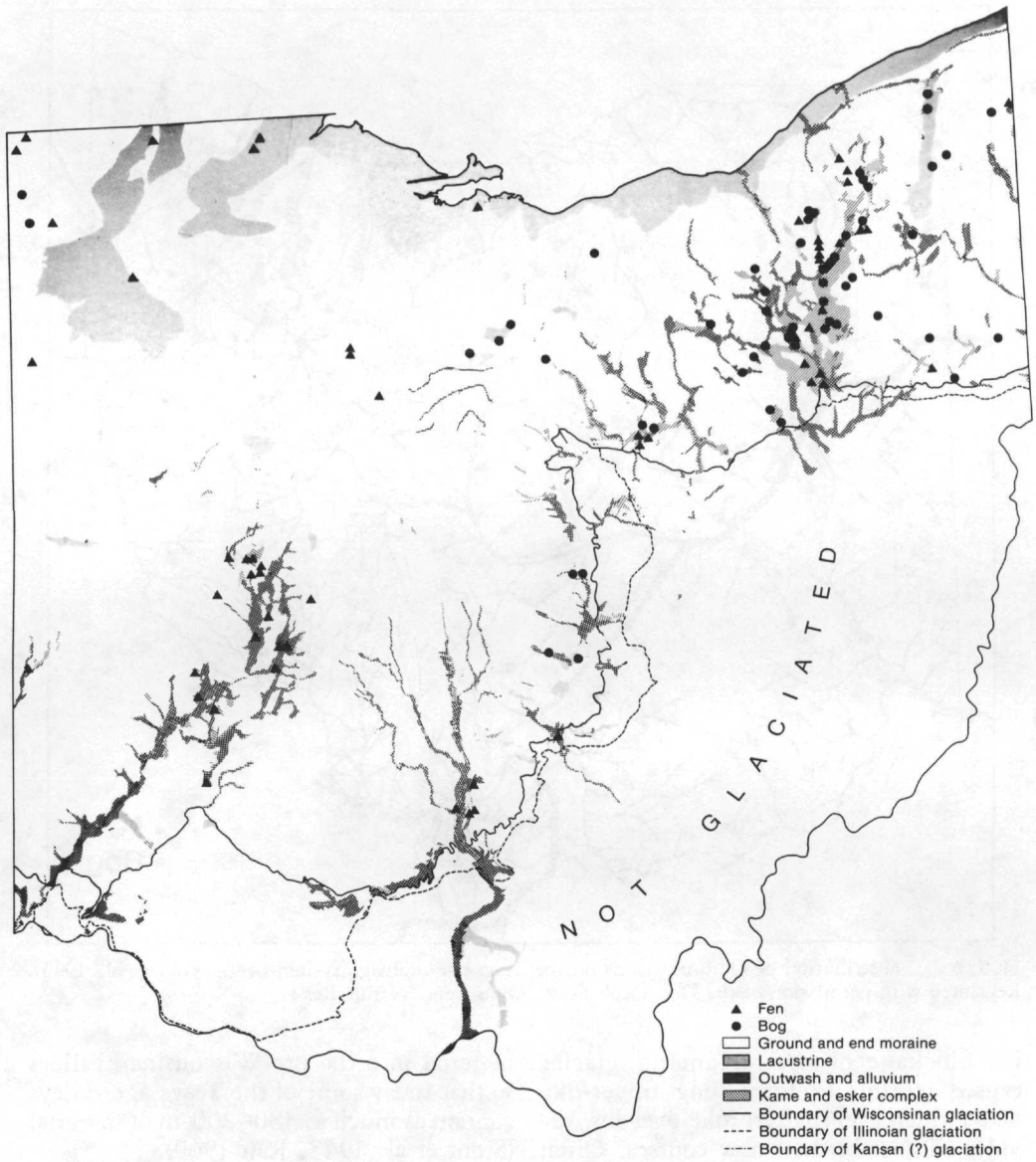

FIGURE 1. Distribution of Ohio peatlands on glacial features (modified from Goldthwait et al. 1967). Reprinted with permission of the U.S. Geol. Surv., Dept. of the Interior.

68 of the 114 study areas (fig. 2). These include some of Ohio's best known peatlands: Morgan Swamp and Grand River Terraces, in Ashtabula Co.; Cedar Bog, Champaign Co.; Prairie Road Fen, Clark Co.; Snow Lake-Fern Lake complex, Geauga Co.; Kick Fen, Holmes Co.; Cranberry Island, Licking Co.; Triangle Lake Bog and Herrick Fen, Portage Co.; Brewster Bog and Canton Bog, Stark Co.; and Browns Lake Bog, Wayne Co.

The Teays Stage drainage remained until Kansan or pre-Kansan ice advanced into northern Ohio. At that time the drainage systems of Ohio were altered. According to Stout et al. (1943) and Stout (1953), the

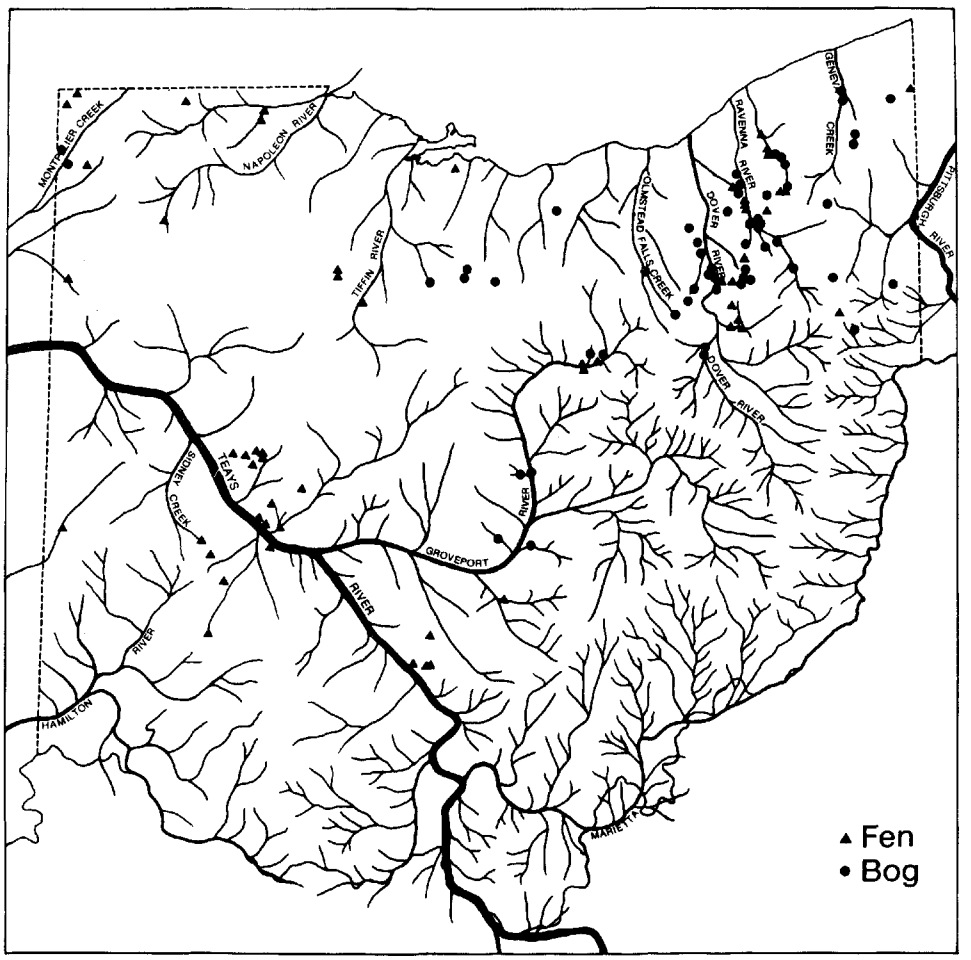

FIGURE 2. Distribution of Ohio peatlands on the Teays-age drainage system (from Stout et al. 1943). Reprinted with permission of the Div. Geol. Surv., Ohio Dept. Natur. Res.

ice blockage of the advancing glacier caused streams to form long finger-like lakes which eventually broke over low divides and established new courses. Often these new courses were in the valleys of the Teays but flowing in reverse direction. The old Teays channels were deepened, and that general period of drainage is referred to as the Deep Stage.

The Deep Stage drainage ended with the advance of the Illinoian ice sheet and the post-Illinoian drainage was interrupted by the Wisconsinan ice advances. All of the glacial advances deposited till and outwash material into the pre-Wisconsinan valleys so that today some of the Teays-age valleys contain as much as 180–200 m of material (Stout et al. 1943, Rau 1969).

The 114 bog and fen localities were plotted on the map of *Buried River Valleys in Ohio* (Cummins 1959) (fig. 3), which shows all known pre-Wisconsinan buried valleys. In examining the map of buried river valleys, there is an obvious lack of buried river valleys in northwestern Ohio. Cummins states that this does not mean that the valleys are nonexistent but rather indicates a lack of knowledge about their

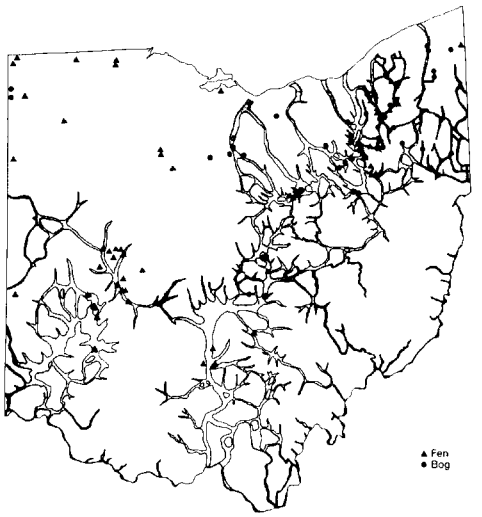

FIGURE 3. Distribution of Ohio peatlands on buried river valleys (from Cummins 1959). Reprinted with permission of the Div. Water, Ohio Dept. Natur. Res.

presence. This view is supported by others including Stout et al. (1943) and Norris and Spicer (1958).

When combining the map of the Teays Stage drainage (Stout et al. 1943) for the northwestern portion of Ohio with the map of buried river valleys in Ohio (Cummins 1959) for the remainder of the state, 93 of the 114 bog and fen localities plotted occur on pre-Wisconsinan buried river valleys.

DISCUSSION AND CONCLUSION

That the Teays River may have served as a corridor for the movement of some species into Ohio was proposed by Braun (1928, 1951) and Thompson (1939). Thoma and Jezerinac (1982) and Jezerinac (1983) relate the distribution of Ohio crayfish species with Teays-age drainages. Spooner (1982), in examining wetland distribution in an area of unglaciated southeastern Ohio formerly drained by the Teays-age Marietta River (fig. 2) and Teays-age tributaries, found that a majority of wetlands are associated with Teays-age drainage valleys.

Sears (1926) noted the relationship of natural vegetation to pre-glacial drainage patterns in northwestern Ohio. He wrote that, at least in some counties, "all or many of these prairies mark the course of deep, buried and silted pre-glacial valleys". His belief in the relation between natural vegetation and pre-glacial topography was so strong that he expected to see buried river valleys discovered in several Ohio counties where wet prairies were known to occur.

In line with those earlier noted distributional phenomena, I am proposing that a direct relationship occurs between bog and fen distribution in Ohio and the location of buried river valleys. Till and outwash materials deposited in buried river valleys, due to their depth or composition, were prone to the formation of kettle holes, kame-esker complexes and outwash terraces, the type of glacial features where bog and fen communities develop. Flint (1971) and White (1932) provide an interpretation on the formation of these glacial features in buried river valleys. Buried valleys were probably areas where ice masses remained while ice melted from the surrounding uplands. Meltwater from the upland ice deposited material on and around blocks of eroding ice in valleys, and this material formed kames, kame terraces, kettle holes and outwash.

Dachnowski (1912) described peat deposits as occurring in finger-like lakes that formed when moraines blocked drainage from the retreating ice. These finger-lake created basins left natural depressions in the pre-glacial valleys as till and outwash compacted. Drainage is poor on the surface of these glacial-filled buried valleys (Dashnowski 1912), another characteristic associated with the formation of peat deposits.

The distribution of Ohio's peatlands is complex. They are restricted to areas glaciated by the Wisconsinan ice advances, and they develop in areas where glacial features such as kame-esker complexes, outwash deposits and lacustrine deposits interfere with drainage. The Teays-stage and other pre-Wisconsinan drainages have had an effect on the distribution of Ohio

bogs and fens by providing a geological setting where they develop.

The relationship between bog and fen distribution to any geological feature is predicated upon the accuracy of the geological maps cited in this study. That all bogs and fens do not occur on pre-Wisconsinan drainage valleys may be related to the current level of knowledge of these buried valleys in Ohio. Since 93 of the 114 Ohio peatlands investigated occur on pre-Wisconsinan buried river valleys, this relationship provides a valuable tool to use in locating bogs and fens.

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LITERATURE CITED

Aldrich, J. W. 1943 Biological survey of the bogs and swamps in northeastern Ohio. Amer. Midl. Natur. 30: 346-402.

Anderson, D. M. 1982 Plant communities of Ohio: A preliminary classification and description. Div. Natur. Areas and Preserves, Ohio Dept. Natur. Res., Columbus. 183 p.

Andreas, B. K. 1980 The flora of Portage, Stark, Summit and Wayne counties, Ohio. Ph.D. Dissert., Kent State University, Kent, OH. 680 p.

——— and G. E. Host 1983 Development of a *Sphagnum* bog on the floor of a sandstone quarry in northeastern Ohio. Ohio J. Sci. 83: 246-253.

Braun, E. L. 1928 Glacial and postglacial plant migrations indicated by relic colonies of southern Ohio. Ecology. 9: 284-302.

——— 1951 Plant distribution in relation to the glacial boundary. Ohio J. Sci. 51: 139-146.

Conway, V. M. 1949 The bogs of central Minnesota. Ecol. Monogr. 19: 174-206.

Cooperrider, T. S., (ed.) 1982 Endangered and threatened plants of Ohio. Ohio Biol. Surv. Biol. Notes No. 16, Columbus. 92 p.

Cummins, J. W. 1959 Buried river valleys in Ohio. Ohio Water Plan Inventory Report No. 10, Div. Water, Ohio Dept. Natur. Res., Columbus. 2 maps.

Curtis, J. T. 1959 The vegetation of Wisconsin. Univ. Wisconsin Press, Madison, WI. 657 p.

Dachnowski, A. 1912 Peat deposits of Ohio: Their origin, formation and uses. Bull. Geol. Surv. Ohio, 4th Ser., Bull. 16. Div. Geol. Surv., Columbus. 424 p.

Dansereau, P. and F. Segadas-Vianna 1952 Ecological study of the peat bogs of eastern North America. I. Structure and evolution of vegetation. Can. J. Bot. 30: 490-520.

Division of Natural Areas and Preserves 1984 Rare species of native Ohio wild plants. Ohio Dept. Natur. Res., Columbus. 19 p.

Fernald, M. L. 1950 Gray's manual of botany. 8th ed. American Book Co., NY. 1632 p.

Flint, R. F. 1971 Glacial and quaternary geology. John Wiley and Sons, Inc., NY. 892 p.

Gates, F. C. 1942 The bogs of northern lower Michigan. Can. J. Bot. 12: 212-254.

Glaser, P. H., G. A. Wheeler, E. Gorham and H. E. Wright, Jr. 1981 The patterned mires of the Red Lake Peatland, northern Minnesota: Vegetation, water chemistry and landforms. J. Ecology. 69: 575-600.

Goldthwait, R. P., G. W. White and J. L. Forsyth 1967 Glacial map of Ohio. Misc. Geol. Investigation Map I-316. U.S. Geol. Surv., Dept. Interior, Washington, DC. 1 map.

Gordon, R. B. 1969 The natural vegetation of Ohio in pioneer days. Ohio Biol. Surv. Bull. Vol. 3. Columbus. 113 p.

Heffner, G. A. 1939 Vegetation survey of an area in central Ohio at the edge of the Allegheny Plateau. M.S. Thesis, Ohio State Univ., Columbus. 49 p.

Heinselman, M. L. 1970 Landscape evolution, peatland types and the environment in Lake Agassiz Peatlands Natural Area, Minnesota. Ecol. Monogr. 40: 235-261.

Herrick, J. A. 1974 The natural areas project [of Ohio], a summary of data to date. Ohio Biol. Surv. Info. Circ. No. 1, Columbus. 60 p.

Jezerinac, R. F. 1983 Possible correlations of present distributions of Ohio crayfishes (Decapoda: Cambaridae) with Teays-age drainages. *In:* C. C. King (ed.), Teays-age drainage effects on present distributional patterns of Ohio biota — an Ohio biogeography conference. Ohio Biol. Surv. Info. Circ. No. 11. Columbus. p. 4-5.

Jones, C. H. 1941 Studies in Ohio floristics. I. Vegetation of Ohio bogs. Amer. Midl. Natur. 26: 674-698.

King, C. C., (ed.) 1983 Teays-age drainage effects on present distributional patterns of Ohio biota — an Ohio biogeography conference. Ohio Biol. Surv. Info. Circ. No. 11. Columbus. 14 p.

Larsen, J. A. 1982 Ecology of the northern lowland bogs and conifer forests. Academic Press, NY. 307 p.

Moore, P. D. and D. J. Bellamy 1974 Peatlands. Springer-Verlag, NY. 221 p.

Mornsjo, T. 1969 Studies on vegetation and development of peatlands in Scania, South Sweden. C. W. K. Gleerup, Lund, Sweden. 187 p.

Norris, S. E. and H. C. Spicer 1958 Geological and geophysical study of preglacial Teays Valley in west-central Ohio. *In:* T. B. Nolan (Director), Contributions to the hydrology of the United

States. U.S. Govt. Printing Office, Washington, DC. p. 199-229.

Rau, J. L. 1969 The evolution of the Cuyahoga River: Its geomorphology and environmental geology. *In:* G. D. Cooke (ed.), The Cuyahoga River watershed. Institute of Limnology, Dept. Biol. Sci., Kent State Univ., Kent, OH. p. 9-40.

Schwintzer, C. R. 1978 Vegetation and nutrient status of northern Michigan fens. Can. J. Bot. 56: 3044-3051.

——— 1981 Vegetation and nutrient status of northern Michigan bogs and conifer swamps with a comparison to fens. Can. J. Bot. 59: 842-853.

Sears, P. B. 1926 The natural vegetation of Ohio. II. The prairies. Ohio J. Sci. 26: 128-146.

Selby, A. D. 1901 Preliminary list of tamarack bogs in Ohio. Ohio State Acad. Sci. 1: 75-77.

Spooner, D. M. 1982 Wetlands in Teays-stage valleys in extreme southeastern Ohio: Formation and flora. *In:* B. R. McDonald (ed.), Proceedings of the symposium on wetlands of the Unglaciated Appalachian Region, 26-28 May 1982. West Virginia Univ., Morgantown. p. 89-99.

Stout, W. 1953 Age of fringe drift in eastern Ohio. Ohio J. Sci. 53: 183-189.

Stout, W., K. Ver Steeg and G. F. Lamb 1943 Geology of water in Ohio. Ohio Geol. Surv. Ser. 4., Bull. No. 44, Ohio Dept. Natur. Res. Columbus. 694 p.

Stuckey, R. L. and G. L. Denny 1981 Prairie fens and bog fens in Ohio: Floristic similarities, differences and geographical affinities. *In:* R. C. Romans (ed.), Geobotany II. Plenum Press, NY. p. 1-33.

Sytsma, K. L. and R. W. Pippen 1981 The Hampton Creek wetland complex in southwestern Michigan II. Community classification. Mich. Bot. 20: 147-156.

Thoma, R. F. and R. F. Jezerinac 1982 New distributional records of crayfishes (*Cambarus* and *Fallicambarus*) from Ohio, including a new subspecies record. Ohio J. Sci. 82: 136-138.

Thompson, I. 1939 Geographical affinities of the flora of Ohio. Amer. Midl. Nat. 21: 730-751.

Tight, W. G. 1903 Drainage modifications in southeastern Ohio and adjacent parts of West Virginia and Kentucky. U.S. Geol. Surv. Prof. Paper No. 13, U.S. Geol. Surv., Washington, DC. 11 p.

White, G. W. 1932 An area of glacier stagnation in Ohio. J. Geol. 40: 238-258.

Whitney, G. G. 1981 The past and present vegetation of Browns Lake Bog. Ohio Biol. Surv., Survey Rept. Columbus. 35 p.