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PALEOECOLOGY OF THE SEMINARY AND MIRROR POOL PEAT DEPOSITS

John H. McAndrews

Introduction

In other papers of this volume concerned with the south end of the Lake Agassiz basin, John Brophy has summarized the geological deposits and C.T. Shay has reviewed the paleoecology. Brophy mentioned two buried peats, one in the Fargo-Moorhead area (Seminary site of this report and Moorhead Station No. 2 of Rosendahl 1948) that represents a subaerial interval between phases I and II of Lake Agassiz. The second buried peat, the Mirror Pool site, overlies Lake Agassiz II clay along the Sheyenne River in the Sheyenne delta region (Fig. 64). Both peat deposits have been Carbon-14 dated and contain pollen as well as plant macrofossils, especially wood and seeds. In this paper these data will be used to reconstruct the peat-forming communities that followed the drainage of phases I and II. This reconstruction will then be related to the contemporary upland vegetation.

The modern natural vegetation of the south end of the Lake Agassiz basin is a prairie grassland. The finer-textured soils are dominated by such grasses as big bluestem, little bluestem and porcupine grass along with such forbs (broad-leafed herbs) as white sage and purple prairie clover (Dix and Smeins 1967). On the sandy soils of the Sheyenne delta the chief grasses are needle-and-thread, sandhill bluestem, Kentucky bluegrass and junegrass, and among the principal forbs are the wind-pollinated white sage, perennial ragweed and narrow-leaved goosefoot (Wanek and Burgess 1965).

Forests occur along the Red and Sheyenne Rivers. Burgess (1964) reconstructed the natural presettlement vegetation in a township (T.136N., R. 52W.) in the Sheyenne delta using the notes of the land survey of 1870-71. Most of the township was prairie but a wooded belt one to two miles wide occurred adjacent to the river. Bur Oak savanna occupied well drained soils while less well drained and more fire protected sites adjacent to the river had a wholly deciduous forest of bur oak, american elm, green ash, cottonwood, basswood, ironwood, hackberry, willow and probably box elder.

Aquatic plant communities occur where surface water is present for part of the year (Stewart and Kantrud 1967, Dix and Smeins 1967). Wet meadows, dominated by northern reedgrass, sedges and spike rushes and containing rough cinquefoil, wild mint and waterhorehound, occur on saturated soils where surface water is present only for a few weeks in the spring. Marshes of emergent biennials and perennials grow on sites where several inches of water persists throughout

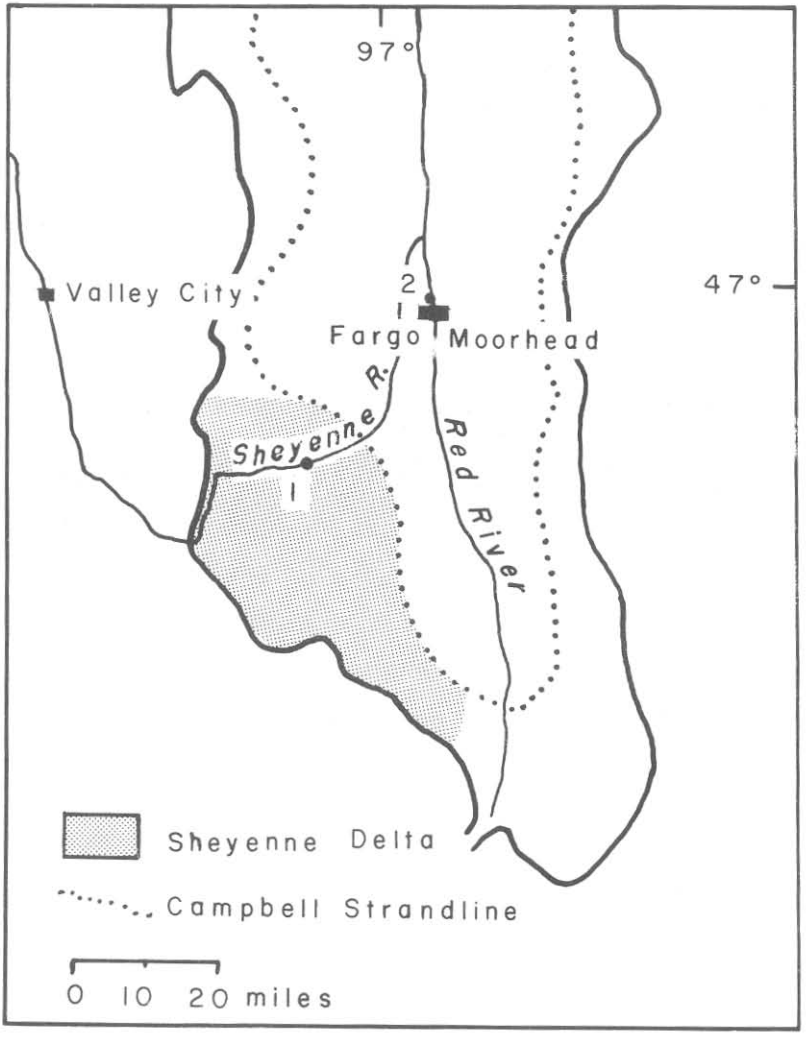

Figure 64. Location of Mirror Pool site (1) and Seminary site (2).

the spring and summer; they are dominated by cat-tail, bulrush and spikerush. Where water is deeper, emergent aquatics are sparse and there occurs an open water community of such submerged aquatics as pondweed, mare's-tail and watermilfoil. During drought years when marshes and meadows dry out during the spring and summer there is formed a mud flat community dominated by such annuals as golden dock, red goosefoot and beggarsticks (see Table 19 for common names and their botanical equivalents). Our use of botanical nomenclature follows Fernald (1950).

Methods

Fossil pollen from the Seminary site and the Mirror Pool site was concentrated from about one cc samples (of each level) with successive treatments of HCl, KOH, HF and acetolysis solution, then mounted in silicon oil. The basic sum for the pollen percentages includes trees, shrubs and wind-pollinated upland herbs. Pollen types outside the basic sum were individually added to the basic sum before their percentages were calculated thus insuring that the percentages of locally abundant aquatic herbs did not exceed 100%. Percentages of the main pollen types are graphed in Fig. 65 and the minor types are given in Table 20.

Macrofossils were concentrated by treating the peat with 10% HCl and then sieving through a 0.5 mesh screen. Seeds were picked from the residue with a small brush and stored in a mixture of glycerine formalin and water. Identifications were made by comparison with documented modern material. The macrofossil data from the Moorhead and Seminary sites is given in Table 21. The number from the Seminary peat was obtained from a single sample of about 13,500 cc. Mirror Pool peat macrofossils (number per 100 cc. samples) are given in Table 22 and also listed in Table 21. The herb macrofossils are arranged according to their main habitat occurence, *i.e.*, open water, marsh, mud flat and beach, as given by Stewart and Kantrud (1967) and Fernald (1950).

Seminary Site

This peat layer is exposed at Fargo, Cass County, North Dakota, along the Red River in a diversion cut made in 1960 by the Corps of Engineers for flood control. It is on the grounds of the Catholic Seminary in the NW ¼, SE ¼, sec. 20, T. 140N., R. 48 W. The top of the cut has an elevation of 890 feet m.s.l. Twenty-seven feet of Lake Agassiz II silts and clays overly the 15 cm. layer of peat. Underlying the peat to a depth of about 70 feet (only the upper few feet are exposed in the cut) are silts and clays of Lake Agassiz I.

TABLE 19

COMMON NAMES AND BOTANICAL EQUIVALENTS OF GENERA AND SPECIES REFERRED TO IN THE TEXT

TREES

Conifer	
Pine	*Pinus*
jack	*P. banksiana*
Spruce	*Picea*
black	*P. mariana*
white	*P. glauca*
Tamarack	*Larix laricina*
Hardwoods	
Ash	*Fraxinus*
black	*F. nigra*
green	*F. pennsylvanica*
Basswood	*Tilia americana*
Box elder	*Acer negundo*
Cottonwood	*Populus deltoides*
Elm	*Ulmus*
american	*U. americana*
Hackberry	*Celtis occidentalis*
Ironwood	*Ostrya virginiana*
Oak	*Quercus*
bur	*Q. macrocarpa*
Poplar	*Populus*
balsam	*P. balsamifera*

TABLE 19--Continued

SHRUBS	
Alder	*Alnus*
speckled	*A. rugosa*
Birch	*Betula*
dwarf	*B. pumula*
Hazel	*Corylus*
Soapberry	*Shepherdia canadensis*
Wolf-berry	*S. argentea*
Willow	*Salix*
HERBS	
Upland	
Bracken fern	*Pteridium aquilinum*
Goosefoot and Amaranth families	Chenopodiineae
goosefoot, narrow leaved	*Chenopodium leptophyllum*
Grass	Gramineae
bluestem	*Andropogon*
big	*A. gerardi*
little	*A. scoparius*
sandhill	*A. hallii*
junegrass	*Koeleria cristata*
kentucky bluegrass	*Poa praetensis*
needle-and-thread	*Stipa comata*
porcupine	*S. spartea*
Purple prairie clover	*Petalostemon purpureum*

TABLE 19--Continued

HERBS (continued)	
Ragweed	Ambrosia
perennial	A. coronopifolia
Sage	Artemisia
white	Artemisia
Aquatic	
Arrowleaf	Sagittaria
Beggarticks	Bidens
Cat-tail	Typha
Cinquefoil, rough	Potentilla norvegica
Dock, golden	Rumex maritimus
Goosefoot, red	Chenopodium rubrum
Mare's tail	Hippuris vulgaris
Marsh fern	Dryopteris
Mint, wild	Mentha arvensis
Pondweed	Potamogeton
Reedgrass, northern	Calamagrostis inexpansa
Sedge family	Cyperaceae
Bulrush	Scirpus
Sedge	Carex
Spikerush	Eleocharis
Water horehound	Stachys
Water milfoil	Myriophyllum

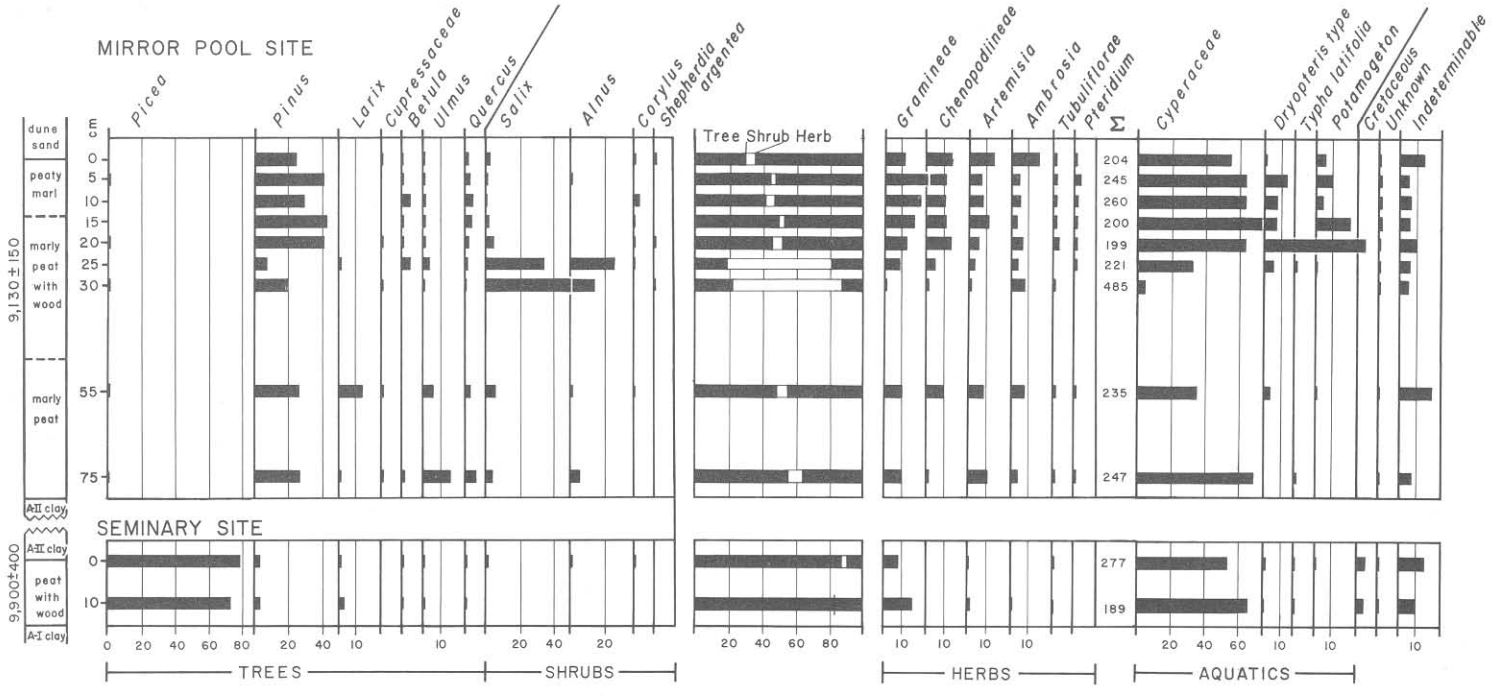

Figure 65. Pollen diagram of Seminary and Mirror Pool peat deposits.

TABLE 20

MISCELLANEOUS POLLEN AND SPORES FROM MIRROR POOL AND SEMINARY SITES

		Trees							Shrubs		Wind Pollinated Herbs			Miscellaneous Herbs												
	depth (cm.)	Ostrya/carpinus	Fraxinus nigra	F. Pennsylvanica	Populus	Acer negundo	Tilia	Celtis	Vitis	Ephedra	Xanthium	Iva ciliata	Iva xanthifolia	Ligulifloraе	Sarcobatus	Thalictrum	Galium type	Umbelliferae	Amorpha	Petalostemum purpureum	P. candidum type	Equisetum	Labiatae	Sparganium type	Sagittaria
Mirror Pool	1			0.5				0.5	0.5					1.5						0.5	0.5				
	5										0.4		0.4	0.4						0.4	0.4				
	10	0.4				0.4		0.4		0.8		0.4	0.4				0.4								
	15							0.5							0.5					0.5					
	20												1.0	0.5	1.0				1.0		1.0				
	25	0.9																							
	30	0.2																	0.2					0.2	
	55	0.4					0.4								0.4		0.4		0.4	0.4		0.4			0.4
	75	0.4			0.4								0.4	0.4	0.4	0.8		0.4		0.4		0.8	0.4		
Seminary	1		0.7		0.4								0.4												
	10																	0.5						0.5	

TABLE 21

COMPARISON OF MACROFOSSIL ASSEMBLAGES OF VASCULAR PLANTS FROM LAKE AGASSIZ I-II INTERVAL PEAT IN THE FARGO-MOORHEAD AREA AND THE POST LAKE AGASSIZ II PEAT AT THE MIRROR POOL SITE. MOORHEAD FROM ROSENDAHL 1948; THE NUMBER OF SEEDS IN A 13,500 cc. SAMPLE IS GIVEN FOR THE SEMINARY SITE. + = PRESENT, - = NOT IDENTIFIED, * = UNCERTAINTY WHETHER SEED, LEAF OR WOOD

	Moorhead	Seminary	Mirror Pool
TREES			
Picea glauca	*	-	-
Larix laricina	*	-	-
L. laricina needles	-	1	+
Picea-Larix wood	-	+	-
Fraxinus pennsylvanica	*	-	-
Populus balsamifera	*	-	-
SHRUBS			
Vaccinium angustifolium	+	-	-
Salix bud scales	-	-	+
Alnus rugosa bracts and seeds	-	-	+
Betula pumila bract	-	-	+
cf. Betula	-	-	+

TABLE 21--Continued

	Moorhead	Seminary	Mirror Pool
HERBS			
open water			
Najas flexilis	-	1	-
Potamogeton foliosus	+	-	-
P. richardsonii	+	-	-
P. zosteriformis	+	-	-
P. pectinatus	-	1	-
P. spp.	-	5	-
Ranunculus flabellaris	+	-	-
R. sect. Batrachium	-	2	+
Hippuris vulgaris	+	473	+
Myriophyllum sp.	-	8	-
marsh			
Typha sp.	-	-	+
Scirpus validus type	+	318	+
S. acutus	+	-	-
Sagittaria cuneata	+	3	-
S. latifolia	-	4	+
cf. Sagittaria	-	66	+
Eleocharis cf. palustris	+	1727	-
E. acicularis	+	-	-

TABLE 21--Continued

	Moorhead	Seminary	Mirror Pool
HERBS (continued)			
Carex cf. rostrata	+	485	+
C. sp.	-	-	+
Juncus canadensis	+	-	-
Sparganium eurycarpum	-	-	+
Polygonum amphibium	+	-	-
Ranunculus sceleratus	-	138	+
R. spp.	-	-	+
wet meadow			
Eleocharis intermedia	+	-	-
Potentilla norvegica	+	3	-
Lycopus americanus	-	6	+
Mentha arvensis	-	203	-
Ranunculus gmelini	+	-	-
Stachys sp.	-	-	+
Menyanthes trifoliata	-	1	-
Sium suave	-	2	-
Carex sychnocephala	+	-	+
C. cf. bebbii	+	213	-
C. cf. disperma	+	29	-

TABLE 21--Continued

	Moorhead	Seminary	Mirror Pool
HERBS (continued)			
mud flat			
Cyperus erythrohizos	+	-	-
Chenopodium sp.	-	3	+
Rumex maritimus	+	2	-
Bidens cernua	+	1	-
Polygonum lapathifolium	+	71	-
sandy beach			
Polygonum cf. ramosissimum	+	2	-
Coripsermum hyssopifolium	+	-	-
Equisetum arvense stem	+	-	-
unknown	-	20	+

MACROFOSSILS PER 100 cc. OF PEAT FROM THE MIRROR POOL SITE.

	Open Water			Marsh									Wet Meadow			Mud Flat	Trees and Shrubs						Varia		
depth (cm.)	Potamogeton sp.	Ranunculus sect. Batrachium	Hippuris vulgaris	Sparganium eurycarpum	Sagittaria latifolia	cf. Sagittaria	Typha sp.	Scirpus validus type	Carex rostrata	C. sp.	Ranunculus sceleratus	R. sp.	Carex sychnocephala	Lycopus americanus	Stachys sp.	Chenopodium sp.	Salix bud scales	Alnus rugosa	A. rugosa bracts	Betula/Alnus type	B. pumila bract	Larix needles	Unknown 1	Unknown 2	Miscellaneous unknown
0-10							5	13																	3
10-20							1	741	226								6							16	
20-30	1							20	5				2			1	5	22	14	14	1	8		9	21
30-40							2	200										2		2					
40-50								13														1			3
50-60								1				7											178		
60-70			8		1	13	17	51	2		1	1					1			1		5			5
70-80		1	6	6	4	20	45	150	1	2				5	11									2	6

The peat layer is gray-black in color and can be traced for 100 feet or more along the cut. The most prominent element characteristic of this peat are pieces of wood up to 3 feet long which lie parallel to the bedding plane. The wood tends to be flattened while the smaller pieces have a grainy, weathered surface. The wood cells contain pyrite. The peat is highly humified and mixed with calcareous silt. Pollen are neither abundant nor well preserved in contrast to the abundant wood and seeds.

Before further discussion it is necessary to correlate the Seminary peat with the "vegetable stratum" of Moorhead Station No.2 (Rosendahl 1948). According to Brophy (personal communication 1967) the Moorhead site was exposed at the Sewage Lift Station No.2 when it was enlarged in the 1940's. The top of the excavation had an elevation of about 895 feet but it is unclear from Rosendahl's account whether the level of the peat stratum was 25 feet or 45 feet below the top. Thus the Moorhead peat is either at an elevation of 870 feet or 850 feet. Both these elevations are comparable to the 863 feet elevation of the Seminary peat when possible local topographic irregularities are taken into consideration. In addition to these elevation uncertainties a second difficulty in correlation arises from diverse Carbon-14 dates. Three Carbon-14 dates have been reported for these two sites, all on wood. From the Moorhead site Arnold and Libby (1951) obtained a solid-carbon date of 11,283 ± 700 (C-497). A rerun of the same wood but with the more reliable gas-carbon technigue gave a date of 9,930 ± 280 years ago (W-388, Ruben and Alexander 1958). A date by the gas-carbon technique on wood from the Seminary peat was 9,900 ± 400 (W-993) years ago. Thus the dates produced by gas-carbon technique are essentially identical for the two sites.

The two spruce dominated pollen spectra indicate that the peat was formed during late glacial times, a period characterized by boreal type spruce forest domination. The woody plant pollen flora is depauperate for it lacks appreciable poplar, black ash, willow and soapberry which are important in contemporaneous pollen assemblages in northwestern Minnesota (McAndrews 1966) and central North Dakota (McAndrews, Stewart and Bright 1967). Poplar and ash pollen could be lacking because their relatively delicate grains were not preserved, but an additional and more persuasive explanation for the lack of a variety of tree and shrub pollen is that the peat was formed by a treeless and shrubless marsh-meadow vegetation.

Rosendahl (1948) believed that the wood and other plant debris was derived from beaches and moraines 15-20 miles distant from Fargo-Moorhead. However, all the species represented by macrofossils (Table 21) except white spruce, green ash and blueberry are today found in lowland sites where peat accumulates. Because most of the species are part of treeless aquatic communities the evidence points to only the wood being derived from the upland surrounding the lake. The terminal moraines of the uplands around the Agassiz basin were composed of buried ice during the time of Lake Agassiz I (*cfr* Clayton 1967). As the buried ice melted, the superglacial drift, which bore a spruce-tamarack-poplar forest, collapsed and the forest disintegrated. Runoff from meltwater and precipitation carried wood into Lake Agassiz I. During the subaerial I-II interval the wood was stranded on the lake bed, and the drying bed developed marsh and meadow vegetation.

Except for blueberry all identified seeds belong to species typical of aquatic or seim-aquatic habitats, all of which are native to eastern North Dakota and/or northwestern Minnesota. The most well represented communities, both in species and numbers of seeds, are from marsh and wet meadow habitats. The sandy beach habitat is least well represented probably because there were no local beaches. All these plant communities may have been contemporaneous in the immediate vicinity of Fargo-Moorhead or they may represent successional stages of drying and filling of the lake. While most of the species are adapted to fresh or slightly brackish water, there is no evidence of saline conditions (Stewart and Kantrud 1967).

The presence of balsam poplar, black spruce and tamarack cannot be excluded, but no rooted stumps were found and, except for one tamarack needle, no conifer needles were present in the Seminary peat sample.

Mirror Pool Site

The Mirror Pool site is an 80 cm. thick peat exposure on the south bank of the Sheyenne River in Ransom County, North Dakota, NE ¼, NE ¼, sec. 8. T. 135N., R. 52 W. The sequence of events (simplified from Brophy, this volume) leading to the formation, and burial and exposure of the peat begins with the deposition of delta sands in Lake Agassiz I by the Sheyenne River prior to 9,900 years ago. During the Agassiz I-II low water interval the river trenched its former delta. Rising waters of Lake Agassiz II deposited lacustrine clay in the trench and upon retreat of phase II, peat ceased to accumulate when aeolian sand of delta origin spilled into the trench, covered the peat-forming vegetation and preserved the peat. Subsequent river erosion has exposed the peat and about one foot of the underlying clay.

The moderately humified peat contains abundant wood, especially in the upper 50 cm., as well as bedded herb fragments. Pollen is not well preserved in this peat, particularly below 30 cm. The peat is gray in color due to the presence of marl. Because there is little inorganic material in the peat our interpretation is that there was no appreciable local aeolian or alluvial action while the peat was forming. A piece of wood from this peat has been Carbon-14 dated at 9,130 ± 150 years ago (I-1982).

The nine postglacial pollen spectra (Fig. 65) form an assemblage dominated by 20-40% pine and 50% herbs and characterized by 2% bracken fern and occasional grains of wolf-berry. A similar assemblage, but with only 20% pine, centering around 9,000 years ago in northwestern Minnesota was interpreted as prairie (McAndrews 1966). However, in the Mirror Pool site peat the higher pine values suggest that jack pine in open stands with associated bracken fern may have grown on the sandy soil of the delta although most of the vegetation was typical of prairie.

The peat contains two distictive macrofossil assemblages, an earlier assemblage (from the 60-80 cm. levels) dominated by marsh species and a later assemblage centering around 25 cm. that is dominated by bog shrubs. The assemblage from the lower levels indicates an initial marsh community similar to that at the Seminary site except that cat-tail is abundant, sedge low and spikerush absent.

At 25 cm. and 30 cm. the relatively high pollen values of willow and alder correspond with the presence of willow bud scales and speckled alder seeds and bracts. Dwarf birch is present and together with willow and alder probably dominated a shrub bog community. These three genera still occur in the Sheyenne delta region (Stevens 1950). On the other hand, tamarack, whose needles occur at three levels, does not occur today in North Dakota. It was a member of the spruce-dominated late glacial vegetation (McAndrews, Stewart and Bright 1967) and apparently persisted in local bogs after the disappearance of spruce.

Discussion and Conclusions

Our pollen analyses herein reported show that the Lake Agassiz I-II subaerial interval occurred during the late glacial vegetation period, a period when upland sites had a boreal-type forest and type vegetation. Also indicated by our pollen analyses is the interpretation that the disappearance of the boreal-type forest and change to postglacial vegetation occurred during the time of Lake Agassiz II 9,900 to 9,100 years ago, Carbon-14 dates on lake mud deposited during the transition from late to postglacial vegetation are 11,000 years ago in northwestern Minnesota (McAndrews 1966) and 10,670 years ago in northeastern South Dakota (Watts and Bright 1967). The younger minimum age of the late-glacial (from the Seminary site) of 9,900 years is a date on wood. This wood date may be more accurate than the older mud dates because for mud may contain rock-derived pre-Pleistocene carbonate (*cf.* Ogden 1966, and Ogden personal communication 1967).

Our evidence indicates that the southern Lake Agassiz basin was never generally forested during the late glacial I-II interval nor during the early postglacial period of final lake shrinkage. On the widespread soils of slow drainage, marshes and meadows prevailed. During the earliest postglacial, late glacial plant species may have persisted on protected sites within the basin while pine, which was common on sandy soils east of the basin, may have occurred in the Sheyenne delta region. It is probable that the vegetation of the southern Lake Agassiz basin assumed a modern aspect some 7,000 to 9,000 years ago.

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