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SUCCESSION IN A DUNE COMMUNITY AT MENTOR HEADLANDS, OHIO

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Mentor Headlands is located west of the mouth of the Grand River on the shore of Lake Erie at Fairport, Lake County, Ohio. The general topography of the surrounding locale is that of a gentle slope underlaid by the soft, blue-gray Chagrin Shale, which weathers to a fine clay loam.

During pre-glacial times the Grand River had followed a northern route, but was later diverted parallel, westward, along the lake boundary by glacial deposits and emptied into Lake Erie three and one-half miles west of its present mouth (Levenett, 1902). The old river channel came closest to the lake shore where there was only a soft, low ridge. Resistance to erosion was low enough at this point to allow the river to break through to the lake and create the existing outlet of the Grand River. This resulted in a headland area being surrounded by the former river channel (fig. 1), which is now passing through hydroseral stages to dry land. Present drainage of the old channel has been considerably aided by the recent construction of a drainage ditch to the lake.

Although the nearby shore line of Lake Erie is in general an eroding one, with fairly high bluffs, a beach has developed west of the Grand's mouth, composed mainly of washed sand from the lake. This extends approximately one mile west along the lake border where it ends with the gradual increase of land elevation. This is the dune area under observation, which lies between parallels 41°45′ and 41°46′ north latitude, with an elevation range 584 ft. to 614 ft. above sea level.

METHODS

Four belt transects (fig. 2) were made extending from the beach, inland to the original shore line that existed previous to the accumulation of the present sand deposits. All of these transects were 60 ft. in width, with lengths ranging from 987 ft. to 1581 ft. An attempt was made to place the transects where they would yield the characteristic composition of the area. Trees and shrubs were grouped into classifications based on diameter at ground level and diameter breast high to furnish a reasonable account of invading species, those becoming established, and the older dominant and past dominant forms. Scattered herb samples were taken within the belt transects from quadrates of one square yard. The herb samples were obtained basically to furnish the general herb composition of the successional area as a whole. All data were recorded between the months of July and October 1952, with herb samples taken in September and October of that year.

DISCUSSION

The inshore currents of the lake have an easterly set and the prevailing winds are from the northwest. Lake sand is, therefore, gradually, being deposited along this particular portion of shore line, with constant exposure to wind resulting in dune formations. These dunes appear typical and similar in their formation to those described by Bower (1911) and Kurz (1942) who state that the pattern of dune formation is the result of wind-blown sand that settles or becomes lodged in a quiet spot, such as under a stone or around a living plant. Accumulation of sand and increase in dune size is aided considerably by plants whose growth extends horizontally as well as upward. When such plants are perennials, as the most common grasses and seedlings here are, the year to year accumulation results

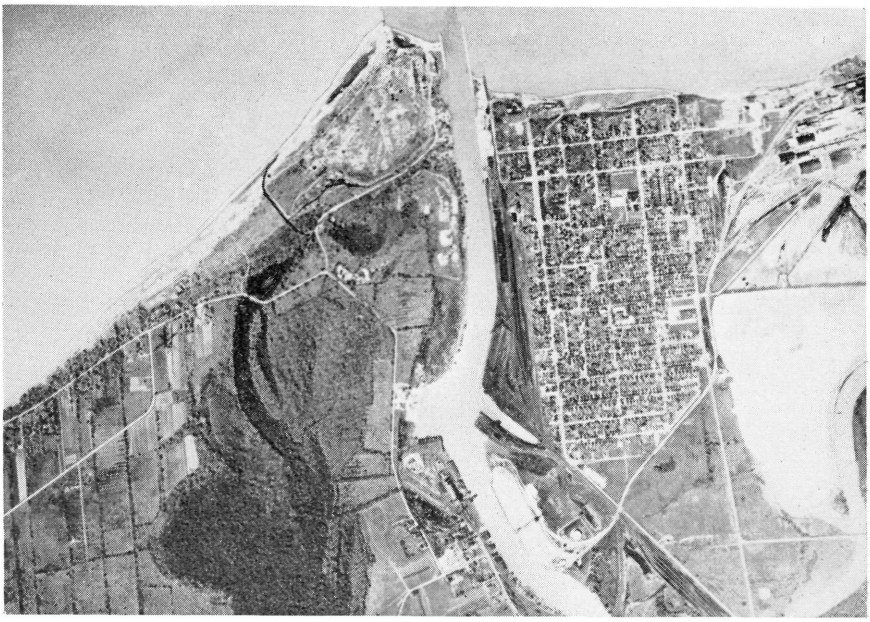

FIGURE 1. Mentor Headlands, Ohio. The Grand River and its former channel are clearly visible.

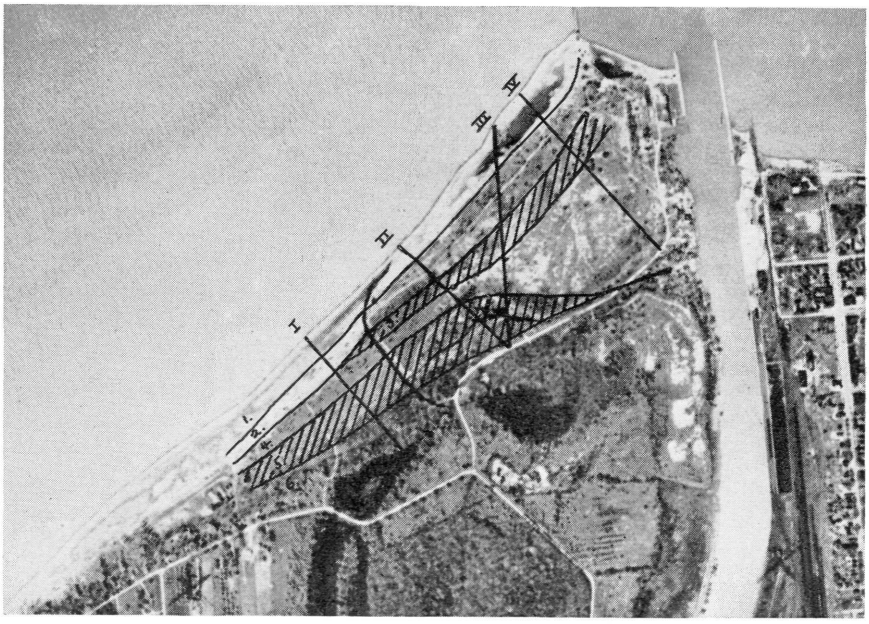

FIGURE 2. Dune community under observation. Illustrating location of the four belt transects and the six successional tree and shrub stages: 1. dune grass, 2. poplar, 3. poplar-aspen, 4. aspen. 5. aspen-oak, and 6. oak.

in gradual increase in the height of those dunes nearest the moving bare sand of the beach, while at the same time the extensive root systems anchor the dune, retarding its movement inland. In this case it means that the dune area has not extended inland by "moving dunes" or by "blowouts" and redeposition of the sand, partly because of the higher embankment along the former shore line and partly because of the relatively small area of the sandy beach. This series of dunes is the result of fairly recent sand deposition which has produced a change in the shore line. Inspection indicates that this deposition was brought about by the formation of the present river mouth and by breakwaters latter added, extending some 2700 ft. out into the lake. The older dunes, at the greatest distance from the bare beach,

TABLE 1

Frequency and percentage composition of shrubs and trees by stages in all four transects.

	STAGES											
	I		II		III		IV		V		VI	
	DUNE GRASS		POPLAR		POPLAR-ASPEN		ASPEN		ASPEN-OAK		OAK	
	No. per 1000 sq. ft.	%	No. per 1000 sq. ft.	%	No. per 1000 sq. ft.	%	No. per 1000 sq. ft.	%	No. per 1000 sq. ft.	%	No. per 1000 sq. ft.	%
Populus nigra var. italica (Muenchh)	.42	9.2	14.41	88.4	11.69	59.7	.07	.6	..	....	..	....
Populus tremuloides (Michx.)	1.92	42.1	1.43	8.7	3.77	19.2	8.42	78.9	3.16	23.0	1.03	6.8
Salix nigra (Marsh)	2.03	44.5	.34	2.0	.38	1.9	.80	7.5	.57	4.3	.06	.3
Ptelea trifoliata (L.)	....	....	.06	.3	.26	1.3	.39	3.6	2.80	20.4	.56	3.7
Quercus rubra (L.)	....	....	....	....	.03	.1	.19	1.7	3.60	26.3	6.92	45.8
Quercus coccinea (Muenchh)	....	....	....	....	....	....	.02	.1	.42	3.0	.63	4.1
Fraxinus americana (L.)	....	....	....	....	....	....	.02	.1	.08	.5	1.50	9.9
Quercus Michauxii (Nutt.)	....	....	....	....	....	....	....	....	.40	2.9	1.10	7.2
Viburnum dentatum (L.)	....	....	....	....	....	....	....	....	....	....	2.00	13.3
Populus alba (L.)	....	....	....	....	3.40	17.3	....	....	....	....	....	....
Others	.19	4.1	.05	.3	.04	.2	.75	7.0	2.65	19.2	1.27	8.4
TOTALS	4.56		16.29		19.59		10.66		13.68		15.07	

are firmly held in place by vegetation. They seem to be considerably flattened by erosion and to be beyond the point of growth by accumulation of blowing sand.

A definite successional pattern is present in the dune community. Extending from the bare beach area, where no plants were present, the following associations are recognizable: (1) dune grass, (2) poplar, (3) poplar-aspen, (4) aspen, (5) aspen-oak, and (6) oak. The developmental succession begins with the bare beach and then proceeds through the four major stages; (1) dune grass, (2) poplar, (4) aspen, and (6) oak. These occur in parallel associations along the entire dune community (fig. 2). Only the two ecotones marked stages three and five do not extend the entire length of the area. The shrub and tree composition in all the stages, taken from the transects, are listed in tables 1 and 2.

Primary invasion of the dunes is by the willows, *Salix nigra* and *Salix fragilis*, forming their colony-like assemblages along the beach. Where there are lagoons,

such as is crossed by two of the transects, the willows cluster within and about the lagoon area. It is only here, in the dune grass stage, that the willows appear in any large numbers. Throughout the general area scattered willow colonies appear in various sizes and age classifications, while maintaining a low but uniform distribution.

TABLE 2

Total numbers of individual shrubs and trees in each stage, from all four transects.

SPECIES	STAGES I	II	III	IV	V	VI	
	Dune Grass	Poplar	Poplar-Aspen	Aspen	Aspen-Oak	Oak	
Total Area	35,390 sq. ft.	75,900 sq. ft.	26,160 sq. ft.	82,050 sq. ft.	58,860 sq. ft.	29,880 sq. ft.	Totals
Populus tremuloides (Michx.)	68	109	99	691	186	31	1184
Salix nigra (Marsh.)	72	26	10	66	34	2	210
Populus nigra-italica (Muenchh)	15	1094	306	6	0	0	1321
Salix fragilis (L.)	6	4	0	12	15	0	37
Ptelea trifoliata (L.)	....	5	7	32	165	17	226
Quercus rubra (L.)	....	....	1	16	212	207	436
Populus alba (L.)	....	....	89	0	0	0	89
Morus alba (L.)	....	....	1	0	0	0	1
Fraxinus americana (L.)	....	....	....	2	5	45	52
Crataegus albicans (Ashe)	....	....	....	3	1	1	5
Ligustrum vulgare (L.)	....	....	....	5	6	1	12
Syringa vulgaris (L.)	....	....	....	1	103	6	110
Quercus coccinea (Muenchh)	....	....	....	2	25	19	46
Ilex verticillata (L.)	....	....	....	6	0	0	6
Rhus typhina (L.)	1	....	....	11	3	0	15
Prunus serotina (Ehrh.)	....	....	....	1	0	0	1
Quercus alba (L.)	....	....	....	7	0	0	7
Quercus Michauxii (Nutt.)	....	....	....	....	24	33	57
Ulmus fulva (Michx.)	....	....	....	....	5	8	13
Acer saccharum (Marsh.)	....	....	....	....	4	10	14
Carya ovata (Mill.)	....	....	....	....	8	5	13
Crataegus Macauleyae (Sarg.)	....	....	....	....	5	4	9
Crataegus Crus-galli (L.)	....	....	....	....	1	0	1
Crataegus macrosperma (Ashe)	....	....	....	....	2	0	2
Ulmus americana (L.)	....	....	....	....	1	0	1
Tilia heterophylla (Vent.)	....	....	....	....	1	0	1
Salix longifolia (Marsh.)	....	....	....	....	1	0	1
Salix candida (Flugge)	....	....	2	....	....	0	2
Viburnum dentatum (L.)	....	....	....	....	....	60	60
Acer rubrum (L.)	....	....	....	....	....	1	1
Cornus Amomum (Mill.)	....	....	....	....	....	1	1
Pyrus angustifolia (Ait.)	....	....	....	....	....	1	1
TOTALS	162	1238	515	861	807	452	3935

Scattered growth of *Populus nigra* var. *italica* occurs along the sand dunes, but large stands of this tree lie beyond the beach representing the first tree stage of the succession. Since it is known only in staminate form, reproduction is by sprouts and the presence of large concentrations of this tree is common. The poplar is the most numerous tree of the entire community even though it does not appear in the later stages of the succession. Distribution is heavy (88%, table 1.) in the poplar stage, then gradually decreases, ending abruptly at the aspen-oak association.

Rapid invasion into the poplar community is accomplished by *Populus tremuloides*. This results in an ecotone formation of poplars and aspens, followed directly by the aspen stage. *Populus tremuloides* composes the central stand of the entire seral development, being found in large numbers as early invaders of the sand dunes and as a well-established component of latter successional stages. Abundant distribution is common in all areas, reaching its peak of 78 percent (table 1) in the aspen community.

Reference was made previously to the original coastline. Along this area are large stands of oaks, along with many older aspens. This is the center of the oak stage. It is under the influence of two successional patterns. One of these is the sand dune succession from the shore line, and the other, the swamp succession of the former river bed. The oaks have gradually begun their invasion toward the lake, already establishing an ecotone stage between the oak and aspen concentrations.

As the tree and shrub stages change, there is a gradual corresponding change in the invaders and subdominant species of herbs. This was not clearly zoned to correspond with the tree stages, nor was this uniform. The dune grass area, although showing the most sparse scattering of herbs along the dunes and lagoons, or under the protection of small trees, contained a wide variety of species. Large stands of dune grass (*Ammophila arenaria*) grow along the entire dune area, also *Equisetum prealtum* and *Equisetum arvense* were common throughout the community. The weed or crop plant, *Melilotus alba*, is the main herb dominant of stages three and four. *Rhus toxicodendron* is well established throughout the entire oak stage.

SUMMARY

The accumulation of lake sand at the mouth of the Grand River resulted in the formation of a sandy beach. As the beach developed, dunes were shaped by wind action and occasionally trapped small areas of water, forming lagoons. The dunes and lagoons provided anchorage and shelter for various herbs and grasses. These early invaders began a successional pattern which later enabled the larger shrub and tree growth to become established.

In order to obtain the shrub and tree composition of the sand dune community, four belt transects were made; each began at the shore and were directed inland. Regardless of their position, all transects revealed identical sequence in the zonation of shrubs and trees in this dune succession, forming stratal stages extending from the beach inland. These established communities, named after the dominant species, were: dune grass, poplar, aspen, and oak. Two ecotones occurred which did not develop the entire length of the dunes, one between the poplar and aspen stage, and the other between the aspen and oak stages.

Using evidence of other local successional patterns and the present climatic conditions as a basis for judgment, a deciduous forest of beech-maple composition appears to be the probable climax of this successional pattern. Before this state is reached however, various groupings of mixed deciduous species will occur. Stages five and six furnish evidence for this development already. Possibly, an oak-hickory association could become one of the stages of fairly long duration during this period, if the drainage of the area improves.

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