

THE RELATIONSHIP BETWEEN SOIL AND NATIVE
VEGETATION IN ILLINOIS¹

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A reciprocal relationship appears to exist between soil and vegetation, in that the soil environment strongly influences the character of plant growth and the character of the plant growth strongly influences the character of the soil.

The factors which determine whether a grass or a forest vegetation will prevail are climatic environment and soil environment. Illinois offers an excellent opportunity to study the problems of plant distribution. We have a climatic environment throughout the State suitable for a timber vegetation, but a grass vegetation predominates over a considerable portion of the area. It therefore seems that we must look to the soil environment for an explanation of this peculiar situation.

The soils of Illinois have been derived from glacial drift, wind-blown loess, and alluvium. Not all the surficial deposits covering the area of the State are of the same age, however, for the evidence indicates a relatively rapid accumulation of several formations, each of which is separated by an interval of weathering.³ The age of parent materials in Illinois soils is very important in discussing inter-relationships, because inherited parent-material characteristics have not been dominated by environmental forces in most areas. The environmental factors which govern the conditions under which soil development takes place are climate, drainage, slope of the land surface, and organic activity, both vegetal and animal. The climatic environment of the State is that of a humid temperate zone, and although variable from south to north, is fairly uniform. Drainage conditions vary from nearly perfect to an almost entire absence of water movement. Slope of the land surface varies from nearly level-lying to steep slopes on which erosion is very active. It is not the purpose of this paper to discuss the action of the soil-forming processes, but it should be pointed out that the nature of these processes and, hence, the nature of their

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³ Leighton, M. M., and MacClintock, P. Weathered zones of the drift sheets of Illinois, *Jour. Geol.* Vol. 38, pp. 28-53, 1930.

product, the soil, is dependent upon soil environment and, further, that the character of the vegetation is likewise determined by soil environment.

It is generally agreed among pedologists that the prairie soils of Illinois are not a response to climatic environment; consequently, our dark-colored soils cannot be considered as climatic soil types, as are the famous Black Earths of Russia, South America, and of the Dakotas, Nebraska, Kansas, Oklahoma, and Texas.

The prairies of Illinois must be explained on some other basis and that basis appears to be complex, rather than simple, involving age, source of tree seeds, and drainage.

The ecological factors which are generally considered to control vegetation in a particular area are climatic, biotic, and edaphic. As stated above, the climate of Illinois varies somewhat from north to south, but the variation is not of sufficient magnitude to be a factor in determining the distribution of grass and timber. The work of Mosher⁴ and of Miller, Chapman, and Telford⁵ indicates that plant species are not confined locally because of climate, but are found generally distributed over a relatively large area. This evidence supports the suggestion that the existing climate is not an important factor in the present plant distribution over the State as a whole. Transeau's⁶ suggestion that the ratio of rainfall to evaporation from a free water surface determines the type of plant association to be found is not directly applicable to Illinois, because all other land areas on the earth having a ratio of rainfall to evaporation in a range between 60 to 80 per cent, such as exists in this State, have general vegetational conditions unlike those in Illinois. The partial elimination of both the climatic and biotic factors leaves the edaphic factor as the most important consideration in the distribution of plant species in Illinois. Topography is one of the edaphic factors, but because of the recognized correlation between topography and soil type in Illinois,⁷ we may conclude that soil is the primary factor governing native vegetation in the State.

In discussing geographical distribution and ecological relations of plant societies, Transeau⁸ used the term, "center of distribution." He did not imply by this that plants necessarily spread from certain centers but that existing climatic conditions in any given locality were

⁴ Mosher, E., *The Grasses of Illinois*, Illinois Agr. Exp. Sta. Bull. 205, 1918.

⁵ Miller, R. B., Chapman, H. H., Telford, C. J., *First, Second, and Third Rpts. on a Forest Survey in Illinois*, Illinois Nat. Hist. Surv. Bulls. 14, 15, and 16.

⁶ Transeau, E. N., *Forest Centers of Eastern America*, Amer. Nat. Vol. 39, pp. 875-889, 1905.

⁷ Norton, E. A., and Smith, R. S., *The Influence of Topography on Soil Profile Character*, Jour. Amer. Soc. Agron. Vol. 22, pp. 251-262, 1930.

⁸ Transeau, E. N., *The Geographical Distribution and Ecological Relations of the Bog Plant Societies in North America*, Bot. Gaz. vol. 36, pp. 401-420, 1903.

most favorable for a particular type of vegetation to make optimum growth there. Borrowing Transeau's idea, but changing it to include edaphic factors chiefly, we can use the term, "environmental center," to express the relationship which exists between the soil and native vegetation in Illinois. That is, the vegetation present is in response to the environment produced by the soil, which is itself partially the product of the operation of the climatic factor.

This statement suggests an answer to the frequently discussed question, "What is the origin of the prairie?" Many of the articles written on this subject must be considered fiction, particularly those accounts of most pioneers and early historians. Shimek's⁹ suggestion that the treeless areas were due to fires, Jones's¹⁰ statement that the prairies were due to rapid drainage of post-glacial waters, and Miller's¹¹ idea that animals reclaimed the prairies from the forest may be partially correct, for all these factors probably had some influence, but certainly only locally. Sampson¹² sums up the situation as follows, "Climatic factors are important in determining the general boundaries of distribution of the prairie, while edaphic factors are important in determining the origin and character of the prairie associations within the boundaries. The edaphic factors become more and more important toward the edges of the prairie, as in eastern Illinois. When a prairie association is once established, biotic factors and prairie fires are important in checking invasion by forest vegetation." Sampson's conclusion that climatic factors are important in determining the general boundaries of the prairies could not be accepted without qualification.

Expressed in terms of "environmental center," *Andropogon furcatus* and associated grasses were the predominating vegetation over much of Illinois at the time it was settled, because the features of the soil more nearly met the optimum requirements of these plants than those of any other species. Forests had not invaded the area, due chiefly to soil immaturity and lack of subsurface drainage or to the existence of a continued high water table.

The following evidence supports this viewpoint. (a) The geologically older portions of the State have been more heavily timbered than the younger portions. (b) Forests occurred on nearly every well-drained area of the State, irrespective of whether it had always been well drained or became well drained due to the extension of drainage into a previously nearly level-lying, poorly drained region. (c) Prior

⁹ Shimek, B., The Prairies, Lab. Nat. Hist., State Univ. of Iowa, Bull. No. 1, 1911.

¹⁰ Jones, P. M., Origin of the prairies of the middle west, Sci. Vol. LXVI, No. 1710, Oct., 1927.

¹¹ Miller, A. M., Origin of the Prairie, Sci., Vol. LXVI, No. 1722, Dec., 1927.

¹² Sampson, H. C., An Ecological Study of the Prairie Vegetation in Illinois, Illinois State Nat. Hist. Surv. Bull. 13, pp. 523-577.

to habitation, the drainage on most of the non-forested areas of the State was poor, resulting in water remaining on the land well into summer. Areas which have not been artificially drained still present this condition during wet seasons. (d) The characteristics of the soil in the transition area between the forest and the prairie exhibit a gradual change or evolution, suggesting that a change of soil environment allows the forest to encroach upon the prairie. (e) Trees grow remarkably well in the prairie when planted by man after artificial drainage is established.

The conditions in Fulton County illustrate the dominance of the drainage factor in determining the environment of plant associations in Illinois. All of the rolling, better-drained upland in the southern half of the county has been covered by timber, whereas, narrow, nearly level, originally poorly-drained necks of prairie have persisted between large timbered tracts, and in several places extend down to within less than a mile of the Illinois River bottom. It is true that some of the nearly level-lying areas in this region have been timbered, but these are small and are thought to be the result of improved drainage through headwater erosion. Furthermore, when a small area becomes entirely surrounded by forest, the timber will gradually establish itself in the area, despite somewhat unfavorable environmental conditions.