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Author(s): Henry Allan Gleason

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## THE RELATION OF FOREST DISTRIBUTION AND PRAIRIE FIRES IN THE MIDDLE WEST \*

BY HENRY ALLAN GLEASON

In a previous paper (1912),<sup>†</sup> referring to the location of certain isolated groves in central Illinois, it was shown that they were uniformly situated on the eastern side of prairie sloughs, and the conclusion was advanced that their existence in these places was due to the protection against prairie fires furnished by the water barrier. Since the publication of this paper, a number of similar facts have come to hand, all serving to indicate the efficiency of ponds or streams in protecting forests from the incursions and destructive effects of prairie fires. In general it may be said that the location of forests throughout central and northern Illinois, and also through the adjacent states, is closely correlated with prairie fires.

It is well known that the prevailing winds throughout most of the Middle West come from the west, varying from northwest to southwest. Prairie fires would, therefore, in most cases travel toward the east, and would attack the forest on the west side. Doubtless there were frequent cases where fires were driven in other directions, but these must have been of vastly less importance than the very numerous fires travelling toward the east. In the different descriptions of prairie fires which have been consulted, and in the information furnished by eye-witnesses of them, there is no specific mention of fires travelling in any direction except east.

\* Contribution No. 141 from the Botanical Laboratory of the University of Michigan.

<sup>†</sup> Henry Allan Gleason, An isolated prairie grove and its phytogeographical significance (with two figures). The Botanical Gazette, vol. 53, pp. 38-49. Chicago, 1912.

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It is also a matter of record that the fires did destroy some of the trees at or near the forest margin, and thus gradually drive back the forest toward the east. The margin of the forest in Illinois was originally characterized chiefly by hazel, a shrub which is not seriously affected by repeated burning. Inside of the hazel zone the forest was composed chiefly of oak, especially *Quercus velutina* and *Quercus imbricaria*, neither of which produces a very dense shade. There seem to be no authentic data on the matter, but it is entirely probable that even within the hazel margin there were numerous grasses, sufficient to feed a more destructive fire than the usual litter of leaves and dead twigs. At the present time, at least, various prairie species are found within the forest margin (1910, pp. 119, 123, 124)\* and their number and density is greatly increased by even a small increase in the amount of light. The only undisturbed contact of typical virgin prairie and forest observed by the writer in Illinois has been so long protected from fire that the forest margin has grown up to an almost impenetrable thicket of several species of shrubs, whose prevailing mode of dispersal may indicate their recent arrival in the habitat.

It has generally been the idea that prairie fires were vast conflagrations, driven before the wind at an incredible rate, and consuming everything in their path. Such fires doubtless occurred, but the violent winds necessary for driving them are not common in the Middle West in the early autumn, when the fires were most abundant. When such fires did occur, they naturally created a more vivid impression in the mind of the observer, so they were chosen for printed description.† The

\* Henry Allan Gleason, The vegetation of the inland sand deposits of Illinois. 6 illustrations, 20 plates. Illinois State Laboratory of Natural History Bulletin, vol. 9, pp. 23-174. Urbana, 1910.

† An anonymous author describes a prairie fire in these words (Travels through the United States and Canada, London, 1828, p. 187): "The flames advanced very rapidly, continued to spread, and before they had arrived opposite to the place where I stood, formed a blaze of fire nearly a mile in length. How shall I describe the sublime spectacle that then presented itself? I have seen the old Atlantic in his fury, a thunder storm in the Alps, and the cataracts of Niagara; but nothing could be compared to what I saw at this moment. The line of flame rushed through the long grass with tremendous violence, and a noise like thunder; while over the fire there hovered a dense cloud of smoke. The wind, which even

ordinary prairie fire, on the contrary, was a slowly moving fire, with its flames reaching heights of three to ten feet, or rarely more. When such a fire reached the margin of the forest, with even less fuel, its intensity and destructive power were still further decreased, so that it is doubtful if mature trees were ever killed by a single fire. But the seedlings must certainly have been destroyed in large numbers, and the repeated charring of the bark of the larger trees led after a few years to their death. Statements to this effect may be found in several of the older books of travel. Loomis (1825)\* states: "I have observed that on the western edges or borders of all the large prairies a thick growth of young timber is springing up, whereas on their eastern borders no underbrush is found within many rods of the open lands. The heat and fury of the flames driven by a westerly wind far into the timbered land . . . destroying the undergrowth of timber, and every year increasing the extent of prairie in that direction, has no doubt, for many centuries added to the quantity of open land found throughout this part of America." Brackenridge (1814, p. 109)† makes a similar statement: ". . . the progress of the fire can be traced; the first burning would only scorch the outer bark of the tree; this would render it more susceptible to the next, and the third would completely kill." And as a last quotation, the rather explicit statement of Jones (1838, p. 90)‡ may be given: "This yearly burning consumes all the new trees and shrubs, and leaves the ground entirely unencumbered. The old trees, likewise, are annually diminishing in number. Scarcely a tree but is marked with fire, and when once the bark is penetrated by the fire, and the wood of the tree seared, the fire takes a readier and deeper hold thereon, until at last it overpowers and destroys it, and the tree falls with a startling crash, and generally consumes before the fire dies out, unless a violent rain extinguishes it, and leaves it for previously had been high, was increased by the blaze which it fanned; and with such vehemence did it drive along the flames, that large masses of them appeared actually to leap forward and dart into the grass, several yards in advance of the line. It passed me like a whirlwind, and with a fury I shall never forget."

\* Chester Loomis, *Notes of a journey to the Great West in 1825*. Pamphlet.

† H. M. Brackenridge, *Views of Louisiana*. Pittsburgh, 1814.

‡ A. D. Jones, *Illinois and the west*. Boston, 1838.

food for the next annual passage of the devouring element. I have beheld many a line of ashes, marking the spot where the entire trunk of a massy oak was consumed the previous autumn."

The first invasion of forests into the Middle West was undoubtedly along the stream courses, where the more rapid erosion of prairie humus, the looser prairie sod, and the protection from excessive insolation and wind favored the germination of tree seeds and the growth of the seedlings. The forests migrated up the streams, following rather closely the valley and the adjacent bluffs, usually as far as the effects of erosion were obvious. They also migrated laterally from the valleys toward the uplands, where they soon encountered the denser prairie sod, which materially checked their further extension. The general result of this forest invasion, as seen a century or more ago, was the presence of a belt of forest along all the larger water courses, varying in width with the size of the stream.

It is not necessary to hazard an opinion as to the probable date of the first prairie fire or its possible cause. It may be stated that the writer has no record of a prairie fire produced by lightning. If such a cause ever produced fires, they must have been at widely separated intervals, and could have produced no appreciable effect on the forests. But it is definitely known that the Indians habitually started fires, and the prairie fire as a phytogeographical factor dates back to the entrance of the Indian or to the origin of this habit.\* Since that time, the forests were attacked practically every year on their western flanks by prairie fires, and occasionally also on their eastern sides as well, unless they were protected by some unusual feature of the topography or by standing water.

The effects of prairie fires from the east upon the forests are

\* One of the first statements to this effect was made by Hennepin (*Voyage ou nouvelle decouverte d'un tres-grand pays, dans l'Amerique enter le nouveau Mexique et la mer glaciale*, 1704, pp. 183, 184, 185), in describing his travels across Illinois in 1679. "Ce ne sont que de grandes campagnes decouvertes, dans lesquelles il ne croit que de grandes herbes, qui sont seches ordinairement dans la saison, que nous y arrivames. Les Miamis les avoient brulées en chassant aux boeufs ou taureaux sauvages." "Ils y avoient mis le feu dans les herbes fanées pour tuer plus facilement les taureaux & les vaches sauvages." "Les Sauvages ayant mis le feu dans les herbes seches de toutes les preries de notre route."

negligible. The isolated prairie groves described in an earlier paper are all open to the east, but they have persisted because of their western protection by sloughs.

But the fires coming from the west have made a great effect upon the forests, and indirectly upon the soil as well. They have in some cases completely cut off portions of the forest from the main bodies with which they were formerly connected, producing thereby isolated groves. A second effect is seen in the exemption of certain portions of the prairie from fires, upon which habitats forests have developed after the introduction of fires. A third effect is seen in the general restriction of forests on the west side of streams to narrower belts than are found on the east side of the same streams, and a fourth in the apparently complete removal of thousands of acres of forest and its conversion into prairie. These results of fires will be discussed in turn.

I. Isolated prairie groves are of common occurrence in central Illinois, and doubtless also in other parts of the Middle West. The description of one such grove has already been cited. The location of others may be determined by reference to county histories, and more exactly by the original land surveys of the various counties. These surveys, made between eighty and ninety years ago, show the location of the forests with considerable accuracy, if at all, but in some counties no definite mention of the forests is made, and in a few cases some of the groves have been omitted. These are mostly of small size, and while of considerable significance to the phytogeographer, were probably not considered by the surveyor worthy of mention.

Copies of the original surveys have been examined and tracings made for eight adjacent counties in central Illinois, Champaign, Coles, De Witt, Douglas, Macon, Moultrie, Piatt, and Shelby. They indicate over twenty such isolated groves, of various shapes and sizes, and located in various habitats. Every one of these which has been visited by the writer, except two referred to under the next general effect of fires, is in some way connected with a stream or series of sloughs. Those which are located along streams are probably remnants of a former continuous strip of forest which has been cut in sections by fire. In

each case examined the portion of the river valley from which the forests have been removed is shallow and without prominent bluffs, while those portions in which the forests are still standing show more pronounced effects of erosion. The bluffs and ravines of these more rugged valleys have doubtless been of great importance in protecting the forests from the fires.

Some of these isolated groves are still in a pioneer condition, with oaks as the chief or sole component of the forest, as in Bur Oak Grove, described in an earlier paper. Others had reached a climax stage before the fires separated them from the main body of the forest, and contain such typical mesophytes as *Acer Saccharum*, *Tilia americana*, *Quercus Muhlenbergii*, and *Cercis canadensis*. This is especially true of Big Grove, adjacent to the city of Urbana in Champaign County. Those groves farthest up stream are usually especially characterized by *Quercus velutina*, *Quercus imbricaria*, or other similar xerophytes.

In some cases, also, the stream valley between the isolated grove and the main body of forest has in recent times grown up to a narrow fringe of trees, in which *Ulmus americana* is usually most abundant.

II. There are two groves in Champaign County of such peculiar nature that only recently a satisfactory explanation for them has been obtained. These are Mink Grove, situated just west of Rantoul, and easily visible from the Illinois Central Railway, and Linn Grove, four miles southeast of Philo. Their most remarkable feature is the complete absence of the genus *Quercus*, a phenomenon which probably could not be duplicated in any other forest area of equal extent in the state. Mink Grove, the smaller of the two, is located on a low morainic hill, surrounded on three sides by low ground. Before drainage this slough was usually full of standing water and was marked on the original survey (with some slight errors of shape) as a lake. Obviously it was easily protected from fire. The nearest forest at the present time is about six miles away. The characteristic trees are *Carya cordiformis*, *Gleditsia triacanthos*, *Ulmus americana*, *Ulmus fulva*, *Prunus serotina*, *Juglans nigra*, *Celtis occidentalis*, *Morus rubra*, and *Crataegus* sp. Of these nine species four

are distributed by birds, two by wind, and the other three have edible pods or nuts.

Linn Grove received its name from the presence of the linn or basswood. It is situated on a high morainal hill, surrounded by unusually rolling land, with thin or no prairie humus. It probably owes its immunity from fire to the poverty of the prairie vegetation. The trees in this grove are *Tilia americana*, *Ulmus americana*, *Ulmus fulva*, *Juglans nigra*, *Prunus serotina*, *Carya cordiformis*, *Morus rubra*, *Gleditsia triacanthos*, *Gymnocladus dioica*, *Celtis occidentalis*, and *Crataegus* sp. The similarity of this list to the flora of Mink Grove is striking. Linn Grove was for many years left practically untouched, although a few trees were taken out for firewood. The undergrowth was of a mesophytic climax type, with *Asimina triloba* and *Cercis canadensis* as the common shrubs, and a rich herbaceous flora with such characteristic mesophytes as *Trillium declinatum*, *Sanguinaria canadensis*, and *Adiantum pedatum*.

The only explanation which can be offered for these two groves is that seeds of certain forest trees were carried by birds (or by Indians?) to these protected spots. With the development of a forest cover, other species gradually immigrated, while the relatively immobile oaks have never been able to cross the intervening fire-swept prairies.

III. The third general effect of prairie fires upon the forest is seen in the generally narrower belt of forest along the western side of streams. In some places the forest is completely limited to the eastern side, in almost every case it is notably narrower, and the widest strips of forest are invariably found where a bend in the stream has afforded protection from both the west and the south. Neither is this feature limited to central Illinois, where the attention of the writer was first attracted to it. It seems to be a common feature of the forests throughout Illinois and eastern Iowa, at least, and is excellently shown by McGee in his map of the forests and prairies of northeastern Iowa.\*

On the west side of streams running north or south, the forest

\* W J McGee, The Pleistocene History of Northeastern Iowa, U. S. Geol. Surv. Ann. Rep. 11, pt. 1: 199-577. Pl. 22. 1891.



seldom extended beyond the line of bluffs, and was composed quite generally of the more hydrophytic species of the river bottoms. On the east side it frequently extended out upon the uplands to a considerable distance, and was there composed of the more xerophytic species, especially the oaks and hickories. A careful estimate of the forest areas in Champaign County, based on the original land surveys, indicates that about 68 per cent. was located at the east and north, and only 32 per cent. at the west or south.

Closely allied to this effect of prairie fires is the shape of the extremities of the forest farthest upstream. These were originally not narrow tongues, composed of permobile species, but were broadly rounded in shape, and characterized chiefly by the less mobile species, as the oaks and hickories. Along the three rivers which rise in Champaign County, it is never more than two miles from the end of the forest to mesophytic associations with basswood, papaw, and sugar maple. On these three rivers, also, the forests extend upstream just as far as there is a marked contrast between upland and flood plain. Beyond, where base-leveling has not been prominent, the prairies were continuous on both sides of the stream. Since in general the mobile species migrate farther up the streams at present, it may be concluded that the former extremities of the forest belts have been destroyed by fires.

IV. The belief of the writer that the forests in central Illinois, and probably in many other parts of the Middle West, formerly occupied a much greater area than at present has already been stated. It seems probable that these forest belts extended up the streams a little farther toward their sources than at present; that their width was greater; and that there were also extensive forests developed along the more rugged moraines. The evidence for the latter statement demands some explanation.

There are in central Illinois even at the present time various places where forests are developed on the moraines, independently of streams. Such is the case on the Bloomington moraine between Bloomington and Peoria. On other moraines now unforested there are frequently various species of plants which

are usually characteristic of the forest. Some of these, as *Claytonia virginica*, *Erythronium albidum*, and *Trillium recurvatum*, are geophytes of the prevernal season, which complete their annual cycle of development before midsummer, and at the usual time of prairie fires are already in the resting stage. In that condition they would not be injured by fires and, since their methods of seed dispersal are not very efficient, they suggest very strongly that their present habitat was formerly covered by forest. If they were recent introductions from the forest, they might be expected most abundantly near the forest, and on other types of soil besides the morainal hills. However, the only records of these species growing together, and the only prairie records of any sort known to the writer for *Erythronium* and *Trillium*, are from morainic hills at a considerable distance from existing forests.

It has already been mentioned that the hazel was a characteristic plant of the forest margin, and that it was not seriously injured by fire. If the forest was completely removed by fire, it might be expected that the hazel would be the last forest shrub to disappear. There is one record known to the writer of a large hazel thicket, covering several acres at the western edge of an upland forest, and several such records of scattered thickets of hazel in the middle of the prairie, but always on moraines.

All three lines of evidence point to the same conclusion, and it may even yet be possible to determine the migration route of the morainal forests from other forests along the river systems.

In conclusion, it seems evident that prairie fires have been the deciding factor in determining the distribution of forests in the Middle West. With prairie fires eliminated, the forest is naturally dominant, and tends to spread over wider areas at the expense of the prairie. Under the attack of prairie fires, the forests have been driven back or destroyed, except in those areas where the favor of morainic or fluvial topography has enabled them to resist the encroachments of the prairie.

UNIVERSITY OF MICHIGAN