

States Geological Survey, as recently expressed, appears to strongly favor the use of *alluvial slope*, which thus takes its place in the genetically related series, alluvial fan, alluvial slope and alluvial plain.

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SPECIAL ARTICLES.

THE NORTHERN LIMIT OF THE PAPAW TREE.

WHILE the flora of the upper Mississippi Valley was yet in its primeval condition I had good opportunities to observe the northward geographical extension, and apparently the northern limit, of certain plants which reach full maturity of growth and fruitage farther south. Although the floral conditions which then existed in that region have been in part modified by the progress of civilization, the chief of the following statements are based upon conditions which still exist. Among the plants referred to is the papaw, *Asimina triloba*, which reaches its maximum size, that of a small tree, and its most abundant fruitage in the broad region of which the mouth of the Ohio River is near the center. Two of the many other trees which are associated with it there and which have accompanied it in their northward dispersion, are selected for special comparison. These are the persimmon, *Diospyros Virginiana*, and the pecan, *Carya olivæformis*.

It is of relevant interest to note that although these three species are commingled in the same flora in the valley of the upper Mississippi, their post-glacial dispersion into that region seems to have been from a pre-glacial flora which occupied the papaw area before mentioned and which was in part made up of trees from different districts. The districts which thus furnished the persimmon and pecan respectively are assumed to have been identical with their present respective areas of greatest abundance and fruitfulness. That is, the center of the area of greatest abundance and fruitfulness of the persimmon may be designated as within the state of Virginia, which is far east of the similar center of the papaw area, while it is in southern Texas and the adjacent part of Mexico, far from both the

persimmon and papaw centers, that the pecan reaches its greatest abundance and perfection. The persimmon apparently spread westward into the papaw area and thence northward; while the pecan ranged up into the Mississippi Valley, traversing the papaw area, and thence at least as far north as the forty-first parallel of north latitude, a thousand miles from the region of its fullest development. The unaided dispersion of the papaw seems to have been proportionately less than that of either the persimmon or pecan.

In 1846, pecan trees of moderately large size were yet growing and bearing fruit in fair abundance ten miles above Burlington, Iowa, and a number of persimmon trees of moderate size were also then growing and bearing fruit in its season a few miles below Burlington, on the Illinois side of the great river. Neither of these two trees was then common in that region and, so far as I could ever learn, the localities mentioned constituted the northern limit of their dispersion. It is pertinent to my present purpose to mention that both of those trees retained their fruiting function unimpaired in their most northerly extension, although the case was very different with the papaw. During many years I observed the last-named plant growing as a part of the local flora at numerous localities along the banks of the Mississippi, from northeastern Missouri to the forementioned locality north of Burlington, where the pecan grew, the distance between the two extreme localities being about seventy-five miles. In the southernmost of the Missouri localities referred to the plant reached almost arborescent size and frequently, but never abundantly, bore and matured its fruit. From there northward, however, although the vegetative growth of the plants was apparently healthful, they never fruited, and gradually diminished in size to shrubs, a few feet in height. It is true that some thrifty specimens which grew upon the Iowa bank of the Mississippi River, a few miles above Keokuk, occasionally flowered, but, although I frequently examined them in the flowering and fruiting seasons, I could never find any evidence that fruit had been formed, or that any ovaries had ever become

fertilized. Northward from that locality to its most northerly one, a distance of fifty miles, the papaw plants seldom flowered, and if one occasionally bore flowers, the ovaries never matured.

Here, then, is the case of a plant losing its power of reproduction from some natural cause, but still growing thriftily at short intervals along a stretch of more than fifty miles beyond its fruiting limit. It is not necessary to my present purpose to inquire into that cause, but the unfruitfulness of the plant was no doubt due to the failure of one or more of the various devices which nature provides for the pollination of flowers; and that condition, as well as the diminishing stature of the plant toward the north, was perhaps correlated with climatic change. This case of the papaw, however, is so unusual that one naturally wonders how that northern portion of its geographical dispersion could have been accomplished without the aid of the function of reproduction at every stage of its progress. It is necessary to assume that every one of those unfruitful papaw plants within the range mentioned originated from seed which was brought from a southward locality by some biological, and not a physical, agency. That is, the transportation could not have been effected by either air or water currents because the large, oblong, flattened seeds of the papaw are too heavy to be borne by the wind, and all the fluvial currents of that region are in an opposite direction. It is quite improbable that the seeds were transported by either birds or quadrupedal animals, because, while the ripe fruit-pulp would be greedily eaten by some of them, the seeds are evidently unsuited for the food of any; and because no frugivorous birds or other animals of that region have the migratory and garnering habits which such a suggestion requires. Moreover, the papaw ripens its fruit when southward, and not northward, bird-migration is impending. It, therefore, seems necessary to assume that the transportation of the seeds was effected by human agency; and because one fails to see how their germination and growth in those northern localities could have been ad-

vantageous to any human interests it further seems necessary to assume that their distribution was incidentally, but not intentionally, connected with the nomadic habits of the Indians. This suggestion is not wholly satisfactory when one considers only the ordinary conditions of Indian life, because the fresh, ripe fruit was never too abundant in any part of that region for immediate use, it is not suitable for preservation in camp, and the seeds have no obvious value. I, however, casually discovered what seems to be a sufficient explanation of the manner of transportation of those seeds and of the circumstances of their germination beyond the geographical limits of the natural fruiting of the species.

The Sac and Fox Indians were originally in possession of both banks of the Mississippi River from the confluence of the Missouri River to above that of Iowa River. This region includes the continuous range of the papaw from where it reaches full fruitage to the northernmost limit of its merely vegetative growth which already has been mentioned. Those Indians were in the habit of ranging all that portion of the great river in their canoes and of camping upon its banks. Upon one of my excursions I came upon one of their river-bank camps, when the men were away fishing or hunting and a small group of women were sitting in a circle on the ground playing a game which consisted of tossing a small number of papaw seeds in a basin. The hard, smooth seeds each bore a distinguishing artificial mark, upon one side only, the difference in the form of the marks as they appeared after each throw, evidently indicating differences of value in counting the game. As I and my companion stopped to watch the game I said to him 'those are papaw seeds.' One of the women looked up with a smile—she was perhaps a winner in the game—and said, 'yes, papaw,' and pointed to a quantity of the seeds that lay on a garment near her, evidently their stock for future games. Without doubt that game had been practised by the Sac and Fox Indians for centuries, and it is easy to understand how they could have procured the seeds by their southern journeys,

how a few of them might become lost at any camping place, and how they might germinate there by natural means.

It is true that all the floral districts of the earth contain plants the migratory introduction of which has been caused by the agency of man. As a rule, those plants are self-perpetuated in their new habitats by their unimpaired function of reproduction; and if they have lost that function from any cause their preservation is due to man's intervention for his own benefit. In the case of the papaw here mentioned its vegetative growth has extended far beyond its fruiting limits, a condition which savage man could have no interest in preserving. His gambling habit seems, therefore, to have been the accidental cause of that part of the dispersion of the papaw which it would not have attained by merely natural causes.

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THE PARASITISM OF *NEOCOSMOSPORA*.

A WILT disease was discovered by the writer in the ginseng gardens of Missouri in the summer of 1904, which proved to be caused by the fungus *Neocosmospora vasinfecta* var. *nivea* Sm. The fungus has been studied and described in a bulletin soon to be issued by the Missouri Agricultural Experiment Station. In the course of the investigation several new facts were ascertained concerning the parasitism of the fungus, which may properly be mentioned in this place.

The characters of this fungus have been studied principally by Atkinson and Smith. The former¹ first described the fungus in 1892, believing it to be a species of *Fusarium*. He stated the belief that it was a weak parasite, since it usually infected only such plants as had been previously attacked by another disease. Smith,² in 1899, published a detailed account of the entire life history of the fungus, giving it the name *Neocosmospora vasinfecta*. He found that there were three distinct physiological varieties which attacked

cotton, watermelons and cow-peas, respectively, and that cross-inoculations always failed. In contrast to Atkinson's assumption, Smith stated that all three varieties were parasitic, and especially the variety *nivea*.

Although I failed to obtain the perithecia, yet in all other respects the ginseng fungus agreed with the variety *nivea* (the watermelon fungus of Smith). The results related in the bulletin soon to be issued go far toward establishing Atkinson's theory that *Neocosmospora* is a weak parasite and only attacks plants which are first weakened by the presence of another fungus.

The facts upon which this conclusion is based are as follows: (1) In the field the wilt disease never appeared except where the ginseng plants had been previously attacked by an anthracnose. (2) Plants which were sprayed with the Bordeaux spraying mixture (and consequently free from anthracnose) were not attacked by *Neocosmospora*. (3) Watermelon seeds were planted in crocks of rich garden earth which certainly contained microorganisms, but had never been infected with *Neocosmospora*. Each crock received a test-tube culture of *Neocosmospora* at the time of planting seeds and three weeks later the melon seedlings were attacked by the wilt fungus. Microscopical examination of the wilted seedlings showed the pink mycelium and spores of *Neocosmospora* in the fibrovascular bundles of the hypocotyls. Other crocks filled with the same kind of soil were sterilized by steam in an autoclave. When cool they each received a tube culture of *Neocosmospora* and were planted with watermelon seeds. The wilt fungus grew abundantly in the sterilized soil, but at the expiration of twelve weeks none of the watermelon plants showed the slightest indication of the wilt disease.

These facts are interpreted to mean that *Neocosmospora* itself is a weak parasite, but when associated (as it usually is) with other fungi, *e. g.*, *Rhizoctonia*, *Pythium*, etc., it gains entrance into the watermelon plant. In the case of ginseng, its entrance seems to depend upon an anthracnose caused by *Vermicularia Dematium*.

¹ Bul. 41, Alabama Agr. Exp. Sta., 1892.

² Bul. 17, Div. Veg. Phys. and Pathol., U. S. Dept. Agr., 1899.