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ISOLATION OF PLANTS IN THE OKLAHOMA FLORA**

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Much has been written regarding this interesting subject in the flora of various parts of North America and particularly in those of certain sections of the United States, but it seems that especial thought should be given to some particular problems regarding the isolation of certain plants within our own state. Each year botanical field exploits yield several plants whose presence in a specific locality gives cause for meditation regarding their occurrence there. The familiar exclamation of enthusiasm, "See here, can this be_____? And what is it doing in this part of the state?" is entirely pleasing to the ear, but the speaker, more often than not, is inclined to leave the matter at that, and to publish his "find" (or, more frequently, not to publish it!) without giving a theory to account for its presence.

It is my purpose in the following paragraphs, to elucidate the various theories which have been put forth to explain the unique distribution of certain plants in various regions of Oklahoma, and briefly to discuss the plausibility of each. The entire subject of endemism in our flora cannot be satisfactorily solved until our knowledge is broadened by more abundant field work and by more specific facts pertaining to historical geology. In endeavoring to solve any such phytogeographical problem as this, the botanist needs accurate data from both the geologist and the zoologist; the three must work cooperatively.

In the Wichita Mountains of southwestern Oklahoma there are two stations for *Arabis viridis* (Hopkins, 1937), a plant having a typical Alle-

*Contributions from the Zoological Laboratory of the University of Oklahoma, No. 187.

**Contribution from the Botanical Laboratory, University of Oklahoma, No. 49. Field work was made possible by a research award from the American Association for the advancement of Science through the Oklahoma Academy of Science.

ghenian distribution from southwestern New England south to the mountains of northern Georgia and southwestward to the Ozark Mountains of Missouri, Arkansas and northeastern Oklahoma, a range well within the limits of an annual rainfall of 40 inches. This plant prefers limestone soils, as do most members of the Cruciferae, and is most frequently found on calcareous ledges and cliffs. It also thrives on granite and sandstone bluffs so that its occurrence in the Wichitas, which are composed chiefly of granite formations, can most readily be explained by the "relic flora hypothesis," which in brief postulates that during past periods of a more humid climate — approximately about 4000 B. C., many plants had a continuous range from east to west, and that with the advent of a more xeric condition, such as that found today in the Wichita Mountains, those plants preferring a moist environment were unable to exist in their former habitats, excepting in certain sheltered and protected places, and hence have completely disappeared, excepting at those endemic stations where they have been cut off from their nearest relatives. Theoretically, we should expect to find *Arabis viridis* in the Arbuckle Mountains, 60 miles east and slightly more to the south, for this region of limestone hills most certainly should offer a veritable paradise for the plant. Since the Arbuckles are lower than the Wichitas, in reality a limestone plateau raised above the floor of the prairies around them, there are few places where the plant could remain and obtain sufficient moisture for its needs. Plant collecting in these hills has been exceedingly active, due to their close proximity to several collegiate institutions, and students on field trips in taxonomy, in ecology, in geology and in zoology have perused the area with considerable zeal. Surely *Arabis viridis* would have been found by this time if it occurred there, for the habitats where it might be expected are numerous.

To say that "birds dropped the seeds" (as some people do) is hardly compatible with the facts. The plant possesses small, narrowly winged seeds averaging 1.5 mm. in diameter; no bird would find them palatable and even should one eat them by chance, it is exceedingly doubtful that they would pass through the digestive tract unscathed by the grinding action of the gizzard. Nor could wind disperse them, at least for any great distance. From the most eastern Oklahoma station for the plant (Cherokee County) to the Wichita Mountain area is approximately 200 miles "as the crow flies" and in view of the structure of the seeds, it would be well nigh impossible for them to be carried so far away, even on several air currents and with numerous stops. In dealing with birds, wind and water as agents of seed dispersal, one must be familiar with the type of seed possessed by the plant under discussion. Clearly, it would seem, the requirement of moisture appears to be the sole factor which limits the range of this plant in Oklahoma and the "relic flora hypothesis" most satisfactorily accounts for its occurrence in the Wichitas.

The well known canyons of Caddo and Canadian counties in the central part of the state contain many interesting eastern plants which are apparently isolated there. The sugar maple, *Acer saccharum*, is the most famous of these, but the lop-seed, *Phryma leptostachya*, and the green dragon, *Arisaema dracontium*, the latter two found also in the Wichita Mountains, are likewise familiar. The willow-weed, *Epilobium coloratum*, is another, but this plant reaches its southwestern limit in Missouri and Kansas, only recently having been discovered in Devil's Canyon by E. L. Little, Jr., which appears to be its first recorded Oklahoma station. It is possible to postulate for all these plants that wind carried the seeds from their habitats in the eastern part of the state, although *Phryma leptostachya* possesses fruit which is a berry, but it is unique that said wind should select Devil's Canyon as the focus at which to drop them. Perhaps they

were dropped at intervals between the canyon and eastern Oklahoma and merely found these localities unsuitable for germination and growth, but to any botanist who is familiar with modern phytogeographic theories, such a supposition appears improbable. Nor could birds have carried them, except the fruits of *Arisaema dracontium*, which undoubtedly are attractive to most birds, but again it seems incredible that birds should have dropped the seeds in Devil's Canyon and in the Wichitas but at no other point. To my mind, again, the "relic flora hypothesis," described above for the *Arabis*, most beautifully fits the situation in Devil's Canyon. Little[4], in an admirable but unpublished paper, has adequately discussed this theory in connection with the Caddo County canyons, and states that, in his opinion, it offers the only possible explanation. Sears[8], and Clements[2], both writing at an earlier date, concur. I can offer no other idea which fits the facts so well and it would appear reasonable to accept it.

Another plant which seems isolated in the Oklahoma flora is *Juniperus mexicana*, inhabiting the calcareous ridges and open crests throughout the Arbuckle Mountains, where it has become completely dominant on the outcrops of limestone, and apparently not found, except very locally, between these hills and those of the Edwards Plateau of southwestern Texas. To the east and north it occurs in the Ozark Mountains of southwest Missouri and northwestern Arkansas, and in northeastern Oklahoma near Salina, in Mayes County. As one approaches the Arbuckles from the flat prairie region at their base, where the soils are either sandy or of clay, *J. virginiana* is the only cedar to be seen, but as one begins the slight ascent to the summit, it disappears completely, its place being taken solely by *J. mexicana*. I have collected well over 100 specimens of cedars from that region during the past year and at no place have I ever found the two growing side by side, although it has been brought to my attention by C. E. Garee of Noble, Oklahoma, that at Price's Falls, several miles away, both junipers occur. My own collections from that station are few, because botanically it offers no such treasures as one finds at Turner's Falls in the "heart" of the Arbuckles, and although I do not recall seeing *J. mexicana* there, and have no records of it, that does not mean that it is absent. It has never been reported from the Wichitas, although it has at least once been anticipated there by Matoon and Phillips[5], but of approximately 25 specimens of cedars from that area in the herbarium of the University of Oklahoma, all appear to be ordinary *J. virginiana*. Palmer and Steyermark in their Flora of Missouri[7] distinctly say of *J. mexicana* "calciphile" and Buckholz[1], describing the plant as a new species (he describes it as *J. Ashei* although that plant has since been shown by Palmer and Steyermark[7] to be synonymous with *J. mexicana*) says: "confined to the zone of dolomitic and calcareous outcrops and bluffs of the White River basin in Arkansas." He goes on to say that it occurs in association with *J. virginiana* but that it is more limited in its distribution than the latter. A glance at the known stations for the plant today will indicate that it seems to be found only where there is abundant limestone and that it is definitely a calciphilous plant.

If birds carried the seeds of *J. mexicana* and dropped them at intervals between southern Texas and the Ozarks, obviously the plant could only grow where there was sufficient lime in the soil to make possible its maturity. It is quite plausible to suggest that such was actually the case, and that from the germination of one or two seeds in the Arbuckles, all the present day trees found there arose. But the question which immediately arises seems to be: could the same thing have happened in the limestones of Missouri and Arkansas and northeastern Oklahoma, with their different climate and much greater rainfall? Furthermore, could the plant have eradicated *J. virginiana* on the Arbuckles so completely that no specimen

of it occurs there now? Answers to both these questions seem to be negative. From the view point of phytogeography it would be logical to assume that there was a former connection, now buried, between the Ozark and the Arbuckle and Texas stations, but geological evidence informs us that there was no such connection, and even if there had been, it would probably have been at least in the Paleozoic, and all traces of it would doubtless be unknown to us now. This, according to paleontological research, would automatically exclude possibility of coniferous plants being on the earth at that time. And to my mind, it seems absurd to postulate that birds could be responsible for such a migration of the plant northward, especially when the facts show *J. mexicana* to be so dominant on the Arbuckles. If one is to accept the bird theory, *J. virginiana* must surely have occurred there at some time, because it occurs elsewhere in southwestern Oklahoma and the Wichitas are covered with it. Nor can I apply the current interpretation of the "relic flora hypothesis" to this case, because the range of the plant is quite incompatible with the data with which that theory is concerned. Palmer[6] has already pointed out the similarity of the flora of the Arbuckle Mountains with that of the Edwards Plateau in Texas and has written elsewhere that the Arbuckles represent an incursion of the southwestern flora across the Red River. But he fails to tell us how or why such an incursion occurred. The only logical theory which will fit the facts in regard to *J. mexicana* seems to be something like the following. There was a Cretaceous sea which extended from Mexico and Texas into the interior of Oklahoma and possibly over the Arkansas valley. Its extent in Arkansas has not been definitely proved but the evidence tends to indicate that it extended that far north. Such a sea occurred in either the upper or lower Cretaceous, but it was definitely not available to plants until the recession of waters in the Eocene. If we assume that the Mexican cedar came into existence at that time, and inhabited the limestone soils of that seabed we would have a continuous range for the plant through Mexico, Texas, Oklahoma and the Ozark region. In later Tertiary this limestone seabed was eroded back so that at present it is found as the calcareous outcrops with which we are familiar, or in other words, the Mexican Plateau, the Edwards Plateau in Texas, the Arbuckles and the limestones of the Arkansas valley. Naturally, when this seabed was eroded the juniper could not exist on the acid soils, and hence was wiped out, excepting at those localities where the calcareous outcrops remained. Such stations are today the habitats of the plant. This theory is in perfect accordance with geological evidence, and appears to explain, quite simply, the present range of *Juniperous mexicana*.

There are many other examples of isolation in the plants of Oklahoma, but space does not permit the discussion of these. I have mentioned only the most important cases, and those with which we are most familiar. In future papers the topic will be perused more extensively and in greater detail.

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