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"FOSSIL EVIDENCE OF WIDER POST-PLEISTOCENE RANGE FOR BUTTERNUT AND HICKORY IN WISCONSIN"—A REPLY

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In the March, 1943, issue of Rhodora, Dr. S. A. Cain published a critique of the paper "Fossil evidence of wider post-Pleistocene range for butternut and hickory in Wisconsin" by Wilson and Webster (1942). In this paper the authors recorded the discovery of a considerable amount of fossil hickory pollen in a peat bog near Winchester, Vilas County, Wisconsin. This bog is north of the present range of hickory and east of the then known range of butternut in Wisconsin. The authors suggested that because pollen of these trees was absent from the surface layers of the bog, their ranges may be at present narrower in Wisconsin than in the past. Dr. Cain has taken the view that such pollen as appeared in the bog may have been wind-borne. In the critique he states that his criticism is written "because of the realization that the science of pollen analysis can add valuable information to the history of the forest composition and areas providing, however, that the peculiar sources of error of the method are adequately considered and only justified claims are made." The authors are in full realization of the many problems that enter the study of pollen statistics. They feel, however, that the conclusions drawn are not beyond the scope of evidence presented, and that it is necessary to reiterate their views and present accumulated evidence that points toward confirmation of the theory.

The modern distribution of *Juglans* and *Carya* in Wisconsin

was shown to come within approximately 50 and 90 miles respectively of the Winchester bog. Potzger (1943) has since pointed out that *Juglans* grows on Mackinac Island northeast of the Winchester bog. It is known from the northwestern part of Wisconsin, and therefore its modern distribution can be described as sporadic and nearly surrounding the fossil pollen locality. Further search on the morainic soils north of the Winchester bog may even bring to light the genus existing there today.

The authors, following the usual procedure of paleoecologists, based their pollen diagram upon the counting of two hundred fossils at each level studied. Recognizing that this count by no means gives a conclusive picture of the forests and that it does not rule out the possible presence or absence of species not observed in the peat, the authors examined several thousand additional fossils from the critical levels. In the comparative counts, *Carya* appears as 0.5% in several levels and at its greatest abundance as 1.5%, or as one to three grains in a count of two hundred pollen fossils. Cain makes a point of this, stating "which means that their conclusion that these species once grew near the bog is based on finding one grain of each species under consideration, with the exception noted above where there were three grains encountered." The authors had stated that in further examination of the levels, many grains of the pollen in question were found even though it occurs as a relatively small part of the total fossil count. This frequency on the slides is as much as one grain of *Carya* per square centimeter, which is a greater pollen-frequency than *Quercus*, *Fraxinus*, *Ulmus*, *Tilia*, or *Acer* have in the surface sample. These last named genera are living near the bog at the present time, but according to Cain's argument, they might not be existing within the region, and might be represented only by wind-borne pollen from miles away. With regard to the abundance of the two genera of fossil pollen, Cain further states, "obviously, one must still depend upon the percentages for purposes of comparison." With this the authors are in full agreement, but the present problem is not one of comparing *Carya* pollen with any other species; *it is one of determining the paleogeography of Carya.* Potzger (1943), who has had wide experience in the field of pollen statistics, makes

the following statement concerning the significance of the fossil *Juglans* and *Carya* pollen in Vilas County, Wisconsin: "Their arguments [Wilson and Webster] very correctly claim that presence of certain genera, even though their pollen frequency is low, may be of important significance in the interpretation of former distribution of such genera as well as in reconstruction of climatic features which made such distribution possible."

While the authors' paper was awaiting publication, Sears (1942) published a paper on the postglacial migration of five forest genera. He states: "*Carya* pollen occurs in four profiles north of its present range, and in another profile in Itasca County, Minnesota, where its modern occurrence is sporadic. In all of these five profiles its behavior is identical. It shows as a trace, and only at the level of the distinct oak maximum which marks Period IV." Period IV of Sears corresponds to the upper part of the middle levels described in the Winchester peat. Since the publication of Sears' paper, three other papers (Potzger 1942, 1942a, 1943) have appeared, describing five additional peat deposits in northern Wisconsin north of the modern range of hickory. All but one of these show hickory present in the middle levels of the bogs and absent in the surface peat. The one exception to the above vertical distribution of *Carya* pollen is found in the bog described by Potzger (1943) as the Sunken Highway bog in Price County, Wisconsin. According to Dr. Potzger (personal written communication) the surface sample of peat contains gelatinous material. Such peat is usually not derived from the tops of living *Sphagnum*, therefore one might assume that the sample also contained some subsurface material and was consequently older. This bog is southwest of the Winchester bog, and therefore closer to the present known range of *Carya* in Wisconsin. In addition to the eight cited deposits showing only a near medial level occurrence of *Carya* pollen, the authors (1943) have described a ninth bog from northern Wisconsin with *Carya* present only below the surface level. *This number of similar spectra beyond the modern distribution of Carya must be given serious consideration and cannot be safely attributed to far distant pollen dispersed by wind. If the pollen of Carya was deposited by wind from a long distance to the south, certainly one must explain why it is not to be found in the receptive surface peat today.*

Winchester, Wisconsin is in a region where there are atmospheric "Highs" and "Lows" passing easterly, therefore no prevailing southerly winds are present to convey large amounts of *Carya* pollen necessary to appear persistently even in small percentages in the peat. That no such pollen has been found in the surface layers, even though a search was made for it, would suggest different conditions in the past. Either the winds were more prevailingly southern or *Carya* grew nearer to the bog. Regardless of the explanation, the fact remains that *Carya* pollen has not been found in the surface peat.

The problem of wind-borne pollen and possible distant origin for fossil pollen must be considered in the light of two lines of evidence: first, that pollen may be dispersed widely, and this is supported by actual controlled studies; second, that pollen, though dispersed widely, may not enter the picture of pollen statistics and modify the spectra unduly. This is supported by the uniformity of regional pollen spectra, and by surface peat studies at least in the Middle West.

One of the most remarkable cases of wind-borne pollen is described by Erdtman (1937). In that paper, records of pollen catches made on the Atlantic Ocean show that no part of the Atlantic crossing was free from air-borne pollen. One must point out that the catches were made over water where strong westerly winds traverse the area.

Cain cites the peat work of Hansen (1943) on Orcas Island, Washington. Here was found the fossil pollen of *Abies nobilis*, *A. amabilis*, *A. lasiocarpa*, and sporadically *Tsuga mertensiana*. These species apparently do not grow upon Orcas Island today, and Hansen states that although they may have once lived there, the pollen could also have been blown from Vancouver Island or the Olympic Peninsula. Granted that the latter may be true, it must be pointed out that here is another overwater route, and that the *Abies* pollen which is the most important pollen in question, has large air sacs that are supposed to be important in dispersal. Also in that particular region there exist on-shore winds that are frequently very strong.

Another instance of wide pollen dispersal is described by Erdtman (1935) for the region of Alberta, Canada. Pine (*Pinus banksiana*) in that region contributes about 50% of the pollen in

the surface peat, though in Alberta the tree is local in its distribution. Here seems to be a case where wind-borne pollen in peat is important, and probably may be correlated with comparatively strong winds blowing southeasterly over a plains topography where forest cover is not as dense as in the Middle West.

Contrary to Erdtman's finding, surface peat studies in Douglas County in northwestern Wisconsin (Wilson, 1938) have shown a close correlation with the vegetation map of that county. This is especially apparent in the case of jack pine (*P. banksiana*) whose greatest abundance is on the sand barrens in the southeastern part of the county. When the percentages in the surface samples of ten widely spaced peat bogs were plotted upon a map and isopolls drawn between these, the center of distribution of *P. banksiana* in Douglas County became apparent at once and a very steep isopoll gradient correlated with the actual boundary of *P. banksiana.* One of the interesting features of this map is the pollen evidence of a small island of jack pine nearly forty miles northwest of the main front of the species. This evidence tends to indicate that under certain conditions the isopoll map is quite accurate and would indicate that a few percent of pollen means actual inhabitance by a species in an area. In the above case it must be pointed out that frequent winds are from Lake Superior and the pollen showers would be directed away from the area where few or no *P. banksiana* trees live.

The study of pollen deposition in bryophytic polsters (Carroll, 1943) in the Smoky Mountains was cited by Cain as an example of how pollen grains may be abundantly represented in "pollen catches" though they must come from other climaxes. This interesting study has results similar to that study by Ludi (1937) who found that valley winds lifted pollen in significant quantity some 1,100 meters. Miss Carroll found such a lift to be about 800 meters in the Smoky Mountains. This fact might suggest the presence of prevailing upslope winds so common in mountainous regions. No exact mention of areal distances is given in the paper except that some of the tree species grew several miles distant and several thousand feet lower in elevation from the polsters. The vertical distance between the living trees of *Carya* and the polster catches of *Carya* pollen is given as 2,250 feet. The observations of Miss Carroll show that *Carya*

appeared as 2.7–6.5% of the total 150 pollen grains counted, whereas the Winchester peat percentages range 0–1.5%. Only a few more percent of *Carya* pollen is present in bryophytic polsters collected within "several" miles of living *Carya* than is present in a peat sample now ninety miles north of the modern range of the nearest known *Carya*. It would seem that either more *Carya* pollen would be found in Carroll's polster samples which are only several miles from living *Carya*, or that *Carya* must have grown closer than ninety miles to the Winchester bog.

A comparison of pollen catches in mountainous and drift plain regions is dangerous if the problems of physiography, prevailing winds, and forest ecology are not appreciated. Miss Carroll has recognized the danger and states, "More contamination would perhaps take place in a mountainous region because conditions, and consequently vegetation types, change within shorter distances. In flat country, contamination would probably not be so great."

If wide dispersal of pollen by wind is a major problem in pollen statistics, it is with considerable surprise that one finds in widely distributed bogs close consistency of pollen curves. Such high regional consistency is apparent in the paper by Dr. Sears, "Types of North-American Pollen Profiles" (1935). Investigation of the bogs in northern Wisconsin and Minnesota shows a predominance of white spruce in the basal levels; above, white spruce becomes a minor element, almost replaced by pine and hardwoods such as oak, elm, basswood, maple, ash, butternut, and hickory; then, near the surface, there is a slight shift back to white spruce, a reduction in the hardwood and frequently in the pine elements. Also, at least in Wisconsin, there is an important development of hemlock which accompanies the return of white spruce. Such consistent pollen profiles would probably not be found if wind-borne pollen was very abundantly and widely transported over land surfaces, for these trees have comparatively restricted geographic ranges in the Lake Superior region. The consistent curves must be taken to indicate shifts in vegetation, and those shifts may be indicative of climatic changes. The pollen profiles agree with many other evidences (see Cooper, 1942, 1943), and suggest a more moderate climate in mid-postglacial time than now exists. If such a warmer period existed,

it is not difficult to visualize a more northern distribution for *Carya* in Wisconsin.

In conclusion, the authors wish to stress that they do not maintain that in all cases where pollen occurs in relatively small percentages in the peats are those species inhabitants of the region. They do, however, maintain that one must carefully weigh the evidence and seek to confirm or discredit the possibility. In the present case it would be just as unscientific to eliminate the possibility of a more northern range for *Carya* in Wisconsin on the basis that some pollen is wind-borne, as it would be to dogmatically ignore the possibility of distant wind-borne pollen in peat under certain conditions.

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