# MICROFOSSILS IN AN ARKANSAS PEAT AND THEIR SIGNIFICANCE.*

PAUL B. SEARS AND GLENN C. COUCH.

## OBJECT OF THE INVESTIGATION.

This is an extension of a series of studies by one of the authors and his associates (1) on fossil pollen in peats of the North Central States. The purpose of such studies has been to secure information concerning the general trend of climate in postglacial time, as an aid in interpreting present vegetation.

These previous studies have indicated that postglacial climate has been largely of continental type, cool at first and later warm. Separating the cool dry from the warm dry period there appears to have been a definite although brief period of greater humidity, relative if not absolute. A similar increase of humidity is believed to have occurred recently.

In the present study diatom remains, as well as pollen, have been considered. This was necessitated by the destruction of all carbonaceous matter in the upper layers by the fire which led to the discovery of the deposit.

The recent character of the deposit permits a study of the latter portion only of postglacial climate, but the results so far as they go, are consistent with those obtained elsewhere. We estimate the record to extend back at least 1800 years—basing this figure on the age of cypress stumps and a conventional figure of three centuries per foot of peat. This estimate seems quite conservative.

## MATERIAL.

Dark Hollow is a former lake bed at the northern edge of the Arkansas River terrace, 1 mile northeast of North Little Rock, Arkansas. The area is now drained by a large ditch and under cultivation, but its former character is shown by huge cypress logs. One stump still in position has a diameter of 4–5 feet above the buttresses. The existence of peat here was revealed by a subterranean fire early in 1931. The State Geological Survey thereupon sent specimens of this peat to

*Contribution from the Botanical Laboratory, Univ. of Oklahoma, NS No. 14.

Professor Albert W. Giles to whom the writer is indebted for knowledge of the deposit.

Collections were made in March, 1931, after the fire had ceased. The peat was then overlain by about eighteen inches of ash and slag and was itself so hard that the use of a borer was impracticable. Specimens were secured by cutting back steps at the edge of the machine-made ditch. About four feet of peat lay below the ash, all very clayey. This clay increased in stiffness downward until a layer of heavy blue clay without fossils was reached. Samples were taken at intervals of six inches.

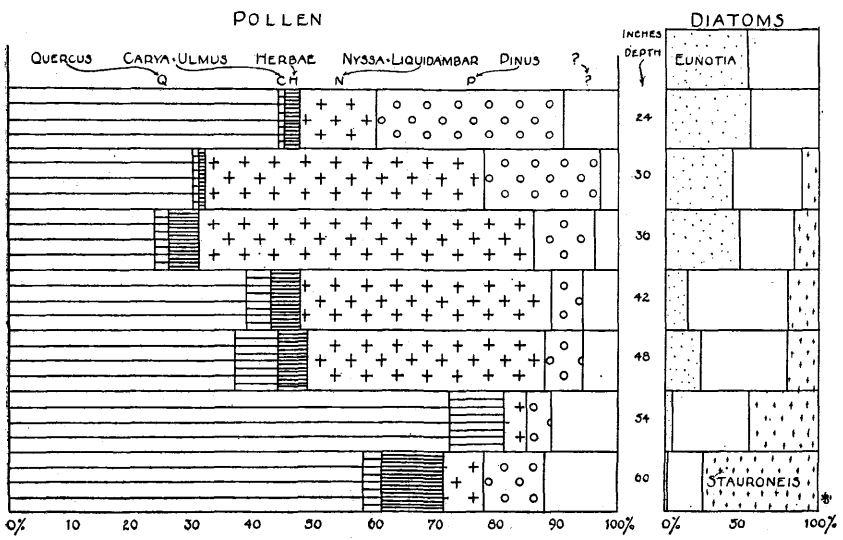


FIG. 1. Diagram showing changing percentages of fossil pollen and of fossil diatoms at successive depths in Dark Hollow peat near Little Rock, Arkansas.

## PROCEDURE AND RESULTS.

To permit study of diatoms, slides were prepared by nitric acid treatment in addition to those prepared with KOH for pollen study. Samples were centrifuged and mounted in glycerine jelly as in preceding studies (2). Slides were prepared by Miss Mabel Larcomb who also assisted with the pollen counts. All diatom counts were made by the second author.

The results, expressed as percentages, are given in Tables I and II, and summarized graphically in Fig. 1. Pollen of *Quercus* predominates up to the 48″ level. The 48″ to 30″ levels inclusive show a strong admixture of *Nyssa* pollen.

*Pinus* forms less than 10% of the whole until the 30″ level is reached, from there on increasing rapidly toward the top where with oak it is relatively abundant. Herbs (amaranths, composites, grasses) are most abundant at 60″. *Carya*, while never abundant is most nearly so at the 54″ level. Pollen

TABLE I.

PERCENTAGES OF FOSSIL POLLEN IN DARK HOLLOW (ARK.) PEAT.

| Depth in Inches | Amaranthus, etc. | Carya | Compositae | Gramineae | Liquadambar | Nyssa | Pinus | Quercus | Ulmus | Unknown | Pollen Frequency |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 24.... | ..... | .01 | .03 | ..... | .01 | .11 | .31 | .44 | ..... | .09 | 277 |
| 30.... | ..... | .01 | .01 | ..... | .02 | .44 | .19 | .30 | ..... | .03 | 645 |
| 36.... | ..... | .01 | .05 | ..... | .04 | .51 | .10 | .24 | .01 | .04 | 231 |
| 42.... | ..... | .04 | .05 | ..... | .01 | .40 | .05 | .39 | ..... | .06 | 49 |
| 48.... | .01 | .05 | .04 | ..... | .06 | .33 | .06 | .37 | .02 | .06 | 93 |
| 54.... | ..... | .09 | ..... | ..... | .04 | ..... | .04 | .72 | ..... | .11 | 62 |
| 60.... | .01 | .03 | .06 | .03 | ..... | .07 | .10 | .58 | ..... | .12 | 16 |

frequency (PF) decreases from values above 250 per sq. cm. of slide at the top to 16 at the 60″ level. In the blue clay below that level both diatoms and pollen are absent or exceedingly rare.

TABLE II.

PERCENTAGES OF FOSSIL DIATOMS IN DARK HOLLOW (ARK.) PEAT.

| Depth in Inches | Eunotia sp. | Melosira varians | Pinnularia lignitica | Nitzchia sp. | Stauroneis sp. | Pinnularia nobilis | Eunotia robusta | Cymbella sp. | Navicula amphiloba | Pinnularia major |
|---|---|---|---|---|---|---|---|---|---|---|
| 18..... | .54 | .17 | .05 | .05 | ..... | .04 | ..... | ..... | ..... | .26 |
| 24..... | .55 | ..... | .09 | .25 | ..... | ..... | ..... | ..... | ..... | .12 |
| 30..... | .43 | .07 | .07 | ..... | .11 | ..... | .05 | .08 | .07 | .11 |
| 36..... | .48 | .05 | .02 | ..... | .16 | ..... | ..... | .01 | .09 | .19 |
| 42..... | .14 | ..... | .02 | .04 | .20 | .06 | ..... | .04 | .04 | .45 |
| 48..... | .23 | .04 | .09 | .04 | .21 | .06 | ..... | .03 | ..... | .29 |
| 54..... | .05 | ..... | ..... | ..... | .45 | .36 | .05 | .05 | ..... | .05 |
| 60..... | .01 | ..... | .03 | ..... | .76 | .01 | ..... | ..... | ..... | .18 |

No pollen of *Taxodium* was certainly identified, although the area has been evidently occupied by cypress for at least 800 or 1000 years. This agrees with the experience of Lewis and Cocke (3) in the study of the Dismal Swamp, and illustrates one of the sources of difficulty in pollen analysis.

Among the diatoms *Eunotia* sp. shows a striking increase toward the top while *Stauroneis* sp. shows an equally striking decrease from the bottom upward. *Pinnularia major* appears in fluctuating percentages throughout, while *Nitschia* and *Melosira* are more abundant toward the top.

## INTERPRETATION OF RESULTS.

There is good reason to believe that the upper 18″ of burned material represents peat essentially like that in the 24″ layer. Not only the general similarity of diatoms is evidence of this, but also the fact that the 24″ layer consists largely of pine and oak—the characteristic vegetation of the region at present. Air dry peat from the 24″ level when burned in an electric muffle shows a linear shrinkage of 20% indicating that the 18″ of ash represents at least 22″ of original peat. Settling to a depth of several inches has occurred over the burned area.

The task of climatic interpretation would of course be greatly simplified if specific instead of generic distinctions of pollen could be made. Such distinctions will be possible when our knowledge of pollen taxonomy is extended and refined (4) and have already been employed in certain cases (5) (6) (7). But their use in any case will involve an enormous increase of labor, not justifiable as a practical measure until other means have been utilized so far as possible.

The very low pollen frequency just above the clay, together with the abundance of black humified globules suggests that the lower part of this peat was deposited under conditions so dry or so exposed that extensive oxidation occurred. The steady increase of pollen frequency upward might be due to a number of causes, but is at least not inconsistent with other evidence indicating a corresponding increase in climate humidity.

The most striking feature of the pollen profile is the small number of genera involved. *Juglans*, *Acer*, *Fagus*, *Fraxinus*, all of which preserve well and are characteristic of the more humid hardwood forest east of Arkansas are here missing. This suggests that no part of the column represents deposit from an adjacent vegetation any richer than that of the present in Arkansas. On the other hand if one goes west from Arkansas today the predominant upland forest of *Pinus echinata*, *P. taeda*, *Quercus* sp., *Carya glabra et* sp. gives way to one in which the pines are absent and oaks, notably *Q. marylandica* and *Q. stellata*, with some *Carya*, are dominant. The Dark Hollow

pollen profile exhibits just such a change from top to bottom. This warrants the inference that the 60″ and 54″ strata were deposited under climatic conditions approaching those of central or eastern Oklahoma, i.e. notably drier than the present climate of Central Arkansas, and that the upper strata accumulated under conditions of increasing humidity.

*Nyssa*, so conspicuous above the oak and below the oak-pine strata is prominent today in both the upland and swamp vegetation of Arkansas and eastern Oklahoma, but does not appear in abundance so far west as do the oaks. Whether its prominence at intermediate levels indicates an increase in swamp areas or an enrichment of the upland vegetation, or both, cannot be determined. In either case the indications favor a recent increase in climatic humidity consistent with the idea of the preceding paragraph.

Thornthwaite (8) in his studies of climates and soil types in Oklahoma has observed that present climatic boundaries do not correspond with the appropriate soil limits, but lie west of them. This too is quite consistent with our evidence of a recent increase in humidity, for the effect of climate on soil requires time to register.

Finally it is interesting and possibly significant to note that the diatom *Stauroneis*, so prominent at the base of the profile, is today abundant in central Oklahoma while *Eunotia* is rare there but abundant eastward. However, this statement is based on a limited number of collections.

## SUMMARY AND CONCLUSIONS.

The circumstances just discussed, to-wit: the succession from an impoverished oak-hickory fossil flora of low pollen frequency through a considerable *Nyssa* stage to an oak-southern-pine fossil flora of high pollen frequency, with a corresponding shift from *Stauroneis* to *Eunotia* in the diatom fossils are interpreted as indicating a recent increase in climatic humidity for central Arkansas. This agrees with earlier findings in the North Central States, and is of interest because the Dark Hollow peat lies far south of the glacial boundary.

## REFERENCES.

1. **Sears, P. B.** Postglacial climate in eastern North America. Ecology (in press).
2. ———Pollen analysis of Mud Lake Bog in Ohio. Ecology, 12, 4: 650-655. 1931.

3. **Lewis, I. F.** and **Cocke, E. C.** Pollen Analysis of the Dismal Swamp peat. Journ. Elisha Mitchell Soc. 45: 37–58. 1929.
4. **Wodehouse, R. P.** Personal communication. 1931.
5. **Sears, P. B.** A record of postglacial climate in Northern Ohio. Ohio Journal of Science, 30, 4: 213. 1930.
6. **Furrer, E.** Pollenanalytische Studien in der Schweiz. Beibl. Viertelj. Naturf. Ges. in Zürich. 72, 14: 1–38. 1927.
7. **Hormann, H.** Die pollenanalytische Unterscheidung von *Pinus montana*. *P. sylvestris* und *P. cembra*. Öesterr bot. Zeitschr. 78: 215–228. 1929.
8. **Thornthwaite, C. W.** Personal communication. 1931.