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PAPERS OF THE MICHIGAN ACADEMY OF
SCIENCE ARTS AND LETTERS

EDITORS

EUGENE S. McCARTNEY
UNIVERSITY OF MICHIGAN

PETER OKKELBERG
UNIVERSITY OF MICHIGAN

VOLUME XVII

“Pusilla res mundus est nisi in illo
quod quaerat omnis mundus habeat.”
—SENECA, *Naturales Quaestiones*

Ann Arbor

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AN ACKNOWLEDGMENT

ELEVEN years ago the manuscript for Volume I of
this publication was submitted to the Graduate
School of the University of Michigan for preparation for
the press. At that time six sciences were represented.
The task of editing would have been an arduous one for
a scientist of wide attainments, but for me, a classicist by
training, it was a real ordeal. As difficulties were
surmounted new problems were presented by the
addition of a second annual volume and by the
organization of new sections of the Academy. In spite of
obstacles improvements were made until eight volumes
had appeared.

When Volumes IX and X went to press Mrs. Alice Foster
began to read proof for the Plimpton Press. Before I had
finished work on the first installment of galley proofs,
which contained a long paper of my own, I knew that a
person of rare gifts was enthusiastically cooperating with
me. I had never seen proof reading raised to so high a
plane of scholarship. Since that time her interest and
her ardor have never waned. Her devotion to this work
is not excelled by my own. Mrs. Foster has never been
a reader save in name; she has been a fellow-editor,
although the responsibility and the decisions, both wise
and unwise, have naturally rested with the official editor.

In volumes of this kind there are always blemishes,
some of which represent reluctant concessions of the
editor, but his most efficient work amid the intricacies of
modern manuscripts is not even suspected unless the
reader happens to be also an editor. Technical papers

in fields of learning so diverse as those comprised in the Academy volumes create a maze of problems, many of which are difficult of solution. In all these subjects Mrs. Foster has been alert in detecting any lapse from the best form and equally resourceful in suggesting improvements. It is a real pleasure to make an acknowledgment of her unflinching aid.

I wish also to thank the entire staff of the Plimpton Press. For eleven years I have received whole-hearted assistance from its members. Their help and suggestions have always been welcome.

E. S. McC.

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FOSSIL PLANTS FROM THE POCONO (OSWAYO) SANDSTONE OF PENNSYLVANIA

CHESTER A. ARNOLD

ALTHOUGH the occurrence of plant remains in the rocks below the coal horizons in Pennsylvania has been known for a long time, contributions to our knowledge of them have been few. The only comprehensive treatment of these plants is contained in the third volume of Lesquereux's *Coal Flora*, published in 1884 (3), in which are listed all the fossil plants of the United States below the Permian then known. About twenty species are given from the Pocono sandstone from five localities in Pennsylvania and West Virginia. Aside from casual references to plants in the Pocono in the later literature, practically nothing more has been done with them. This lack of attention is due largely to the massive character of the sandstone and to the fact that the Pocono is relatively unimportant economically. There are few large quarries in this formation; those which are opened are operated for but a short time, and the plant remains, if they are uncovered, rarely receive scientific attention.

Quite recently the present author was fortunate in securing five fossil plant specimens which had been collected by Mr. Paul Stone from a small quarry in the Pocono (Oswayo) sandstone about two miles northeast of Port Allegany, McKean County, Pennsylvania. The material had come into the possession of Mr. J. C. Galloway of Port Allegany, who, appreciating its possible scientific value, very generously submitted it for study.

The quarry in which the plants were found, known locally as the DeLong Quarry, is situated in a hillside about one hundred feet above the valley floor. Underlying the valley is the Catskill (Cattaraugus) formation. The Pocono, which rests on the Catskill, commences somewhere between the quarry and the foot of the hill and extends to the top.

The lower ten or twelve feet of rock exposed in the quarry consists of hard massive sandstone cracked in various directions. Above this lies a bed, two feet or less thick, consisting of yellow mud and sand, with included fragments of charred wood, irregularly disposed. Some of the fragments are infiltrated with iron pyrites.

Though the Pocono has long been accepted as the basal member of the Mississippian in northern Pennsylvania, some recent stratigraphical studies have brought out evidence indicative of its Upper Devonian age (2). It is beyond the scope of this paper to deal with this subject at length, but the bearing of the plant remains upon it will be discussed.

THE PLANT REMAINS

The fossils consist of two impressions of fronds (*Archaeopterides*), an articulated leafy stem (*Articulatae*), a flattened strobilus (*Sigillaria?*), and a piece of pyritized wood (*Callixylon*).

One of the archeopterids is a portion from near the top of a sterile frond (Pl. X, Fig. 1). In most respects it agrees with *Archaeopteris Roemeriana* Goeppert forma *conferta*, as figured by Nathorst in his Plate 6, Figure 1 (4). The margins of the pinnules of our specimen are slightly toothed because of the outward projection of the individual veins. This feature is not apparent in Nathorst's figure and is not mentioned in the description, but such slight differences are often the result of preservation. Otherwise, the Pocono specimen conforms well with the description of this rather variable species.

Archaeopteris minor Lesq., which is claimed to bear some resemblance to both *A. Roemeriana* Goeppert and *A. hibernica* Forbes, is listed by Lesquereux (3, Vol. 3) from the Catskill and Pocono of Pennsylvania, but is inadequately figured and does not resemble our specimen as closely as do Nathorst's figures of *A. Roemeriana* Goeppert. All three of the species mentioned above are quite variable, and *A. hibernica* Forbes differs chiefly in having larger pinnules.

The other specimen from the DeLong Quarry, doubtfully referable to *Archaeopteris*, is the upper half of a single pinna closely resembling *Rhacopteris circutaris* Walton (6), from the Teilia Beds (lower Carboniferous) of Flintshire, Wales. The main difference is in the veins of the pinnules, which are about twice as numerous in our form. The pinnules are circular in outline, symmetrical or nearly so, and contract at the base to form a short foot stalk, which is set obliquely to the axis (Pl. X, Fig. 3). The entire specimen is fifteen centimeters long and tapers gradually to the apex (Fig. 30). The second and third pinnules at the lower left-hand corner of Figure 30 are shown enlarged in Plate X, Figure 3. Though this specimen bears some resemblance to *Rhacopteris*, it is often difficult, in the absence of fructifications, to distinguish between *Rhacopteris* and *Archaeopteris*.

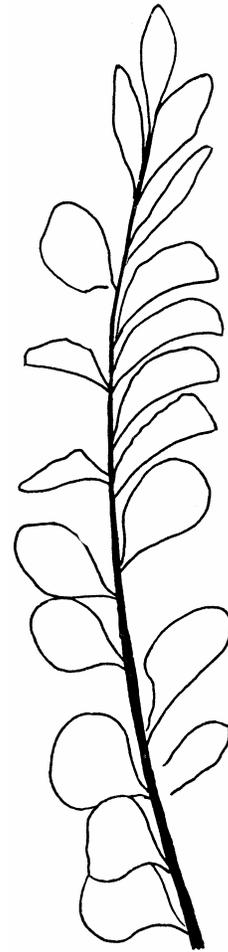


FIG. 30. Specimen resembling *Rhacopteris* sp., mentioned in text. Natural size.

Another specimen of considerable interest and probably having lycopodiaceous affinities is a flattened, partially carbonized strobilus measuring approximately three by nine centimeters and tapering slightly from the base to the apex. The sporophylls, which stand out at right angles from the axis, are in verticils, and those in adjacent verticils alternate with each other. The strobilus is attached to a stout peduncle about six centimeters long. The verticillate arrangement of the sporophylls suggests affinities with the articulated stem described above, but the sporangia are more suggestive of a lycopod, possibly *Sigillaria*.

Most of the wood fragments in the mud bed above the sand stone were bituminized or charred beyond ready identification. A few pieces had undergone partial pyritization, so that the pitting is preserved and discernible along the radial surfaces, and one specimen, when examined by reflected light, shows the grouping of the pits characteristic of *Callixylon*. The preservation is too poor to permit the examination of any other anatomical features of the specimen, or specific identification.

The term "Articulatae" was designed to include those pteridophytes, both living and fossil, with jointed stems. The only living genus of this group is *Equisetum*, but in

Paleozoic times it was represented by numerous forms such as *Calamites*, *Sphenophyllum*, *Pseudobornia*, and others.

One of the Pocono fossils of undetermined affinities, which, however, appears to belong to this group, is a portion of a jointed stem with whorls of linear leaves (Pl. X, Fig. 2). Although thin, the leaves appear to have been rigid, because instead of being appressed to the stem in the impression they stand out from it somewhat in their original position. Though this specimen shows certain features clearly enough to identify it as a member of the *Articulatae*, it is impossible to determine the nature of the plant or to refer it to any known genus. For convenience in reference it is placed tentatively in the genus *Trochophyllum*, which was founded by Lesquereux (3) for plants doubtfully referable to the *Calamariae*. Since this genus is indeterminate and may receive any form with whorled leaves, it is a convenient generic designation for our Pocono specimen.

***Trochophyllum breviinternodium*, sp. nov.**

(Plate X, Fig. 2.)

Stem slightly less than one centimeter in diameter; nodes two millimeters apart. Leaves about fifteen millimeters long, two millimeters broad at the apex and narrowing gradually to point of attachment; about twenty per whorl.

Formation and locality. — Pocono (Oswayo) sandstone; Port Allegany, McKean County, Pennsylvania.

EVIDENCES CONCERNING THE AGE OF THE POCONO

Although this meager flora can be of but small use in establishing the age of the Pocono as Upper Devonian, it seems to support the suggestion (2). *Archaeopteris* is the most indicative fossil in this respect, although the flora as a whole has the aspect of being an old one. The specimen referred to *Trochophyllum* bears no close resemblances to any of the well-known *Articulatae* of the Carboniferous and is probably one of the primitive forms of the group. The discovery of a strobilus resembling *Sigillaria* is not surprising, because there are several lycopodiaceous forms from Devonian rocks. *Callixylon* is relatively common in the upper Devonian rocks above the Tully Limestone in New York and is predominantly a Devonian genus, although the black shales of Indiana and some of the neighboring states which have yielded large quantities of the wood and branch impressions of *Callixylon Newberryi* (Dn.) Elkins et Wieland are probably of Mississippian age (1).

Several species of *Rhacopteris* are characteristic of certain lower Carboniferous horizons of Europe, and the single doubtful *Rhacopteris* specimen in our collection would of course indicate an age no older than basal Mississippian for the Pocono if there were no other Devonian forms associated with it. But since there is some uncertainty concerning its generic identity, and since it occurs associated with *Archaeopteris*, the

balance of evidence (so far as this meager flora permits one to judge) points to a Devonian age for the Pocono in this vicinity.

In Volume 3 of the *Coal Flora* (3) Lesquereux reports several species of *Archaeopteris* from the Pocono of Pennsylvania and West Virginia in association with forms which, if correctly identified, suggest an age later than Devonian. But he gives no Pocono localities in Pennsylvania north of Mauch Chunk, and since the range of many of the forms mentioned in his account is unknown, it is well to leave them out of consideration for the time being and to base our conclusions upon only the better-known forms. Neither is there any certainty whether the so-called "Pocono" of these more southern localities represents exactly the same facies as in the localities farther north. He also mentions numerous finely preserved and large specimens of *Archaeopteris* in the Red Shale (which is probably Catskill, instead of Pocono, as he supposed) along the Susquehanna River above Pittston and Meshoppen.

Since the Pocono is situated in close proximity to the boundary between these two great systems of the Paleozoic, the plant remains are of considerable phylogenetic and stratigraphic interest. A more complete knowledge of the Pocono flora would probably show considerable overlapping of upper Devonian and lower Carboniferous types, a situation similar to that revealed by the Elberfeld flora of Germany, where the early and late Devonian floras, formerly supposed to be distinct, were found to meet and overlap (5). Such a condition is indicated by the association of forms resembling *Archaeopteris* and *Rhacopteris* in the Pocono.

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PLATE X



FIG. 1. *Archeopteris cf. Roemeriana* Goeppert resembling forma *conferta* Nathorst. $\times 1$



FIG. 2. *Trochophyllum breviinternodium*, sp. nov. $\times 1$

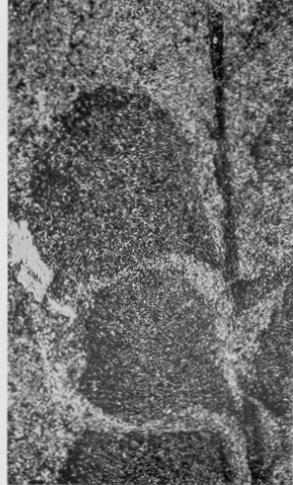


FIG. 3. Pinnules of *Rhacopteris* (?) sp. Enlarged to show detail. \times about $2\frac{1}{2}$. Compare text figure 30

All specimens are from the Pocono sandstone, Port Allegany, Pennsylvania