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TRIASSIC FLORA FROM THE DEEP RIVER BASIN, NORTH CAROLINA

BY

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AND

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Illustrations

TRIASSIC FLORA FROM THE DEEP RIVER BASIN, NORTH CAROLINA

by

R.C. Hope* and O.F. Patterson, III**

Abstract

New records for late Triassic plant distribution are provided by a deposit of plants in a light-tan to reddish-brown siltstone about 400 feet above the base of the Pekin Formation. The locality is the Boren Clay Products clay pit one and one-half miles northwest of Gulf, Chatham County, North Carolina. Almost all the fossils are compressions. Among the most common fossils found are Neocalamites virginiensis (Fontaine) Berry, Otozamites powelli (Fontaine) Berry, Lonchopteris virginiensis Fontaine, Cladophlebis microphylla Fontaine, and Phlebopteris smithii (Daugherty) Arnold.

This material supports paleontological correlation of the Pekin Formation with the Monitor Butte Member of the Chinle Formation of Arizona.

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Introduction

Acknowledgements

Appreciation is expressed to Dr. Theodore Delevoryas, Curator, Paleobotany Division, Peabody Museum and Professor of Biology at Yale University for reading this paper.

Further it would not have been possible to collect many of the materials presented here without the kindness and assistance of Mr. E.L. Rummage of Rummage Construction Company, Pleasant Gardens, North Carolina.

Locality

The fossils described are from the Boren Clay Products Company quarry one mile north of Gulf, North Carolina. Gulf is on the Piedmont Plateau some four miles from the geographic center of the state; about fifty miles southwest of Raleigh and ten miles north of Sanford.

Almost all of the fossils are compressions: even so at the present time attempts to recover cuticles and epidermal cells for stomatal study have been largely unsuccessful. This is material which hopefully, with future study, will enlighten phylogenetic relationships of Triassic floral assemblages.

The plant remains was first encountered by open pit mining for materials in the manufacture of clay products. As the mining operation is current, first attempts in the preparation of this report were to sample as representatively, and as quickly as possible so these fossils would not be lost. It was largely through the kindness of Boren Clay

Products and their associate Pomona Pipe Products that this was possible. The fossil bearing formation has now been almost completely mined and the fossils here described are the first of some 1500 to 2000 recovered.

Stratigraphy

Triassic rocks of the Sanford Basin, assigned to the Upper Newark Group are clastics derived from the pre-Triassic metamorphic and igneous rocks. They are claystones, shales, siltstones, sandstones and conglomerates characterized by abrupt lateral changes in texture and composition. These deposits are divided into three formations: a lower called the Pekin, a middle the Cumnock and an upper the Sanford (Campbell and Kimball, 1923).

With the exception of Neocalamites virginiensis (Fontaine) Berry (Plate II, fig. 3), all the fossils described in this report are from the Pekin Formation. The exception came from the Cumnock Formation which lies conformably on the Pekin with a distinctly different lithology. Thickness of the Cumnock Formation ranges from a few inches to 800 feet and contains sandstones and shales ranging in color from a light tan to dark gray and black. There are in addition two beds of coal. The Cumnock Formation is similar in faunal and floral assemblages to the Lockatong Formation in northern New Jersey and eastern Pennsylvania and has been paleontologically correlated also with the Chinle B. horizon of Arizona (Colbert, 1965). The Chinle B. horizon has been designated the Owl Rock Member of the Chinle (Stewart, 1959).

The Sanford Formation is conformable on the Cumnock and contains predominately red claystones, sandstones, shales and conglomerates.

No fossils have been recognized from the Sanford Formation.

The Pekin Formation at the collecting site represents an unweathered surface of siltstone which ranges in color from a gray and light tan to reddish brown. The plant fossils are fairly well distributed throughout the formation and are extremely well preserved. The preservation indicates possible collection of the plants in a lagoon or perhaps along a flood plain associated with a meandering stream. There are places where the plant materials are macerated and associated with minor cross-bedding. This indicates some movement by current, however, almost all the evidence indicates a relatively undisturbed environment.

The proximity to the Indian Creek fault gives a series of conflicting dips but in general the trend is N. 65° W. with an average dip of 20° to the southwest. The thickness is approximately 30 feet and the formation at the collecting locality is stratigraphically some 400 feet above the base of the Triassic. It has been stated that the Indian Creek fault is a normal fault with a displacement of 800-1000 feet (Reinemund, 1955). This fault has displaced the western end of the fossil bearing strata approximately 1100 feet to the north. Evidence for displacement can be seen in a road cut on highway U.S. 421, one mile north of Gulf. In this road cut fossils are fragmentary but appear to be the same as at the collecting site.

Similarities in faunal remains indicate paleontological correlation of the Pekin Formation with the Monitor Butte Member of the Chinle Formation in Arizona (Stewart, 1959;) (Baird and Patterson, 1967); further plants described in this paper, specifically Otozamites powelli (Fontaine) Berry, Neocalamites virginiensis (Fontaine) Berry,

Lonchopteris virginiensis Fontaine, Cladophlebis microphylla Fontaine and Phlebopteris smithii (Daugherty) Arnold appear to support this conclusion.

Previous Work

The study of North Carolina Triassic flora began in 1856 when Ebenezer Emmons described a number of new genera and species. Fontaine (1883) and Ward (1899) reviewed Emmon's classification and with very little change used his nomenclature. Campbell and Kimball (1923) made a brief reference to plant fossils and this as a short review from Emmons (1856). Reinemund (1955) notes that plant fossils have been found associated with the coal measures and refers back to Emmons (1856).

Systematic Descriptions

Division	TRACHEOPHYTA
Subdivision	SPHENOPSIDA
Order	EQUISETACLES
Family	EQUISETACEAE
Genus	NEOCALAMITES Halle 1908

Neocalamites virginiensis (Fontaine) Berry

(Plate II, Fig. 3)

Neocalamites virginiensis (Fontaine) Berry, Bot. Gaz, Vol. 53, P. 176, 1912

Schizoneura virginiensis Fontaine, U.S. Geol. Surv. Monogr. 6, P. 17, Pl. 1, Figs 4-6, 1883

Material. Several pith casts of which this specimen is representative. All are from the Cumnock Formation. Specimen here measures approximately

14 cm. in length and near 6 cm. in width. There are three nodes separated by internodes of about 4 1/2 cm. Careful observation at one point shows the system of ridges and furrows continuous across the nodes; however, this is not clear over most of the specimen. The distance separating the ridges is approximately 5 mm. There are three short branch apices in whorled arrangement, one in each nodal area.

(Plate III, Fig. 5)

Material. One compression specimen from the Pekin Formation, 8 cm. in length and 1 3/4 cm. in width. There are 6 ridges and associated furrows 2 mm apart. Furrows cross the single node point.

(Plate III, Figs 1, 2, 3, 4, and 6)

Material. These specimens are representative of abundant and well preserved compressional materials. The leaves average 2 mm in width; the number for each node being 6 (Plate III, fig. 1 and 2). Internodal distance is 1 1/2 cm. Venation is parallel. Some of the leaves seem to be rounded at the tips mainly in a truncate manner.

Neocalamites knowltoni Berry

(Plate IV, Figs 1-6)

Neocalamites knowltoni Berry, Bot. Gaz., Vol. 53, P. 177-180, 1912

Material. Six described specimens with figs. 1, 3, and 5 showing preservation of main axis. Three node points are preserved in figs. 1 and 3 while four nodes are seen in fig. 5. The leaf arrangement is whorled. A variable number of leaves ranging from five or six to as high as

eight at a node have been observed. The internodal distance is about 1 1/2 cm. Each leaf has a single midrib. This midrib probably became prominent only after fossilization.

Subdivision PTEROPSIDA
Class PTEROPHYTA
Order FILICALES
Family OSMUNDACEAE
Genus Lonchopteris Brongniart

Lonchopteris virginiensis Fontaine

(Plate V, Figs. 1, 2,3,4)

Lonchopteris virginiensis Fontaine, U.S. Geol. Surv. Monogr. 6, P. 53, Pl. 28, Figs. 1, 2; Pl. 29, Figs. 1-4, 1883

Material. Three described specimens with others available for reference. Fontaine first described this species from material collected at Manakin and Clover Hill, Virginia. The pinnules vary in shape from being sickle-shaped varying from obtuse to acute mainly acutely oriented. The venation anastomoses to form elongate ellipital meshes fig. 3 the principal nerve attaches strongly and united at base where the ultimate pinnae are opposite or subopposite.

Cladophlebis Brongniart 1849
Cladophlebis microphylla Fontaine.

(Plate VI, Figs 1, 2, 3, 4)
(Plate VII, Figs. 1, 2)

Cladophlebis microphylla Fontaine, U.S. Geol. Surv. Monogr. 6, P. 51, Pl. 27, Figs. 2, 2a, 1883.

Material. Five specimens taken from abundant materials for description. First described by Fontaine at Clover Hill, Virginia. The pinnae are

alternate becoming sub-opposite toward the end of the principle rachis. Frond bipinnate. Strong nerves branch dichotomously once and occasionally twice in lobed linear - lanceolate pinnules.

Family MATONIACEAE

Phlebopteris smithii (Daugherty) Arnold

Plate VII, Figs 3, 4

Plate VIII, Figs. 1, 2, 3, and 4

Laccopteris smithii Daugherty, Carn. Inst. Wash. Pub. 526, Pl. 7; Pl. 8, Figs. 1-3, Pl. 9, Fig. 1, 1921.

Material. Five specimens of which four are shown in Plates VII and VIII. The specimen not shown is fragmented but of the same nature as Fig. 4 showing sori with clusters of sporangia. With the exception of Plate VII, fig. 3 all the other material representing this species are fertile fronds. The pinnules are pinnate and opposite, and sickle shaped, acutely but slightly shortened toward the proximal end. The pinnae are attached pedately to the principal rachis as shown by one specimen in Plate VIII, Fig. 1. Venation as shown in Plate VIII, fig. 2 is a dichotomous pattern with a strong midnerve of which the twice branching veins occasionally anastomose toward the margins of the ultimate pinnules. The average width of the pinnules is 1-1.5 mm. much less than originally described (Arnold, 1956). The sori are arranged in a single row on each side of the midrib. The sporangia seem to have been attached to a central stalk like structure because of their impressed position. There is no observed evidence of indusia.

Class CYCADOPHYTA
Order CYCADEOIDALES
Genus OTOZAMITES BRAUN

Otozamites powelli (Fontaine) Berry

(Plate IX, Figs. 1-4)

Otozamites powelli (Fontaine) Berry, Jour. Washington Acad. Sci., Vol. 17, Pl. 305, text-figs. 1-5, 1927.
Zamites powelli Fontaine, in Fontaine and Knowlton, Proc. U.S. Nat. Mus., Vol. 13, P. 284, Pl. 25, Fig. 5; Pl. 26, Figs. 6, 7, 1890.

Material. Abundant showing great variation; however, these specimens are representative on the basis of a leaf description. The pinnules are alternate except toward the distal end where they become sub-opposite. They diverge from a stout rachis acutely, with some specimens almost perpendicular; also truncate at the ends, are coriaceous, linear and contract at the base. Further, the pinnules constrict and are attached to the upper surface of the frond rachis. There are from 18-20 parallel veins that radiate from the point of attachment. These leaves are common and represent one of the most abundant fossils in the collection. Fossils which measure larger than 14 cms. and 10 cms. in width are not uncommon.

Otozamites hespera Wieland

(Plate X, Figs. 1-4)

Otozamites hespera Wieland, Mexico Inst. Geol. Bull. 31, pp. 1-165.

Material. Six specimens ranging from 20 cms. in length to 12 cms. in width. These were selected as representative of abundant material. There is a stout punctuate rachis averaging 3 mms. in width. The broad thin leaflets are coriaceous and diverge from slightly acute to almost per-

pendicular. The pinnules are constricted at the base and are attached to the upper surface of the frond rachis. In general there is a spatulate shape to each leaflet and some indication of areas of unequal lamina.

Conclusions

Correlation of the Pekin Formation is shown by the plant assemblages with the Monitor Butte Member of the Chinle Formation. In addition to a paleontological correlation a similarity of plant environment is shown: a similarity which relates to the climate of two widely separated areas during Triassic times.

References Cited

Arnold, Chester A., 1956, Fossil ferns of the Matoniaceae from North America: Jour. Paleontological Soc. India, Inaugural No. vol. 1, p. 119-120, Lucknow.

Baird, D. and Patterson, O.F., 1967, Dicynodont-Archosaur fauna in the Pekin Formation (Upper Triassic) of North Carolina: Geol. Soc. America Annual Meetings, Abstract, New Orleans.

Berry, E.W., 1912, American Triassic Neocalamites: Bot. Gaz. vol. 53, p. 174-180.

_____, 1927, Cycads in the Shinarump conglomerate of southern Utah: Jour. Wash. Acad. Sci. Vol. 17, p. 305, p. 306, Figs. 1-5.

Campbell, M.R. and Kimball, K.W., 1923, The Deep River coal field of North Carolina: N.C. Geol. and Econ. Survey Bull. 33, Raleigh.

Colbert, E.H., 1965, A Phytosaur from North Bergen, New Jersey: Am. Mus. Nat. History, New York.

Daugherty, L.H., 1941, The Upper Triassic flora of Arizona: Carnegie Inst. Pub. 526. Washington.

Emmons, E., 1856, Geological report of the midland counties of North Carolina: North Carolina Geol. Survey, Henry D. Turner, Raleigh, 351 p.

_____, and Fontaine, W.M., 1857, Am. Geol., p. 120, Fig. 88.

Fontaine, W.M., 1883, The Older Mesozoic flora of North Carolina: U.S. Geol. Surv. Monogr. 6.

_____, 1883, Contribution to the knowledge of the older Mesozoic flora of Virginia: U.S. Geol. Surv. Monogr. 6.

_____, and Knowlton, F.H., 1890, Notes on Triassic plants from New Mexico: Proc. U.S. Nat. Mus. vol. 13, p. 281-285.

Reinemund, J.A., 1955, Geology of the Deep River coal field North Carolina: U.S. Geol. Surv. Prof. Paper No. 246. Washington.

Stewart, John N., et. al., 1959, Stratigraphy of Triassic and associated formations in part of the Colorado Plateau Region: U.S. Geol. Surv. Bull. 1046-Q.

References (Cont'd)

Ward, L.F., 1898-99, Status of Mesozoic floras of the United States: U.S. Geol. Surv. 20th Annual Report, pt. 2.

Wieland, G.R. 1914, La Flora liasica de la Mixteca Alta: Mexico Inst. Geol. Bull. 31, pp-1-165.

Plate I

Figure 1. Geographical location of Deep River Triassic Basin.

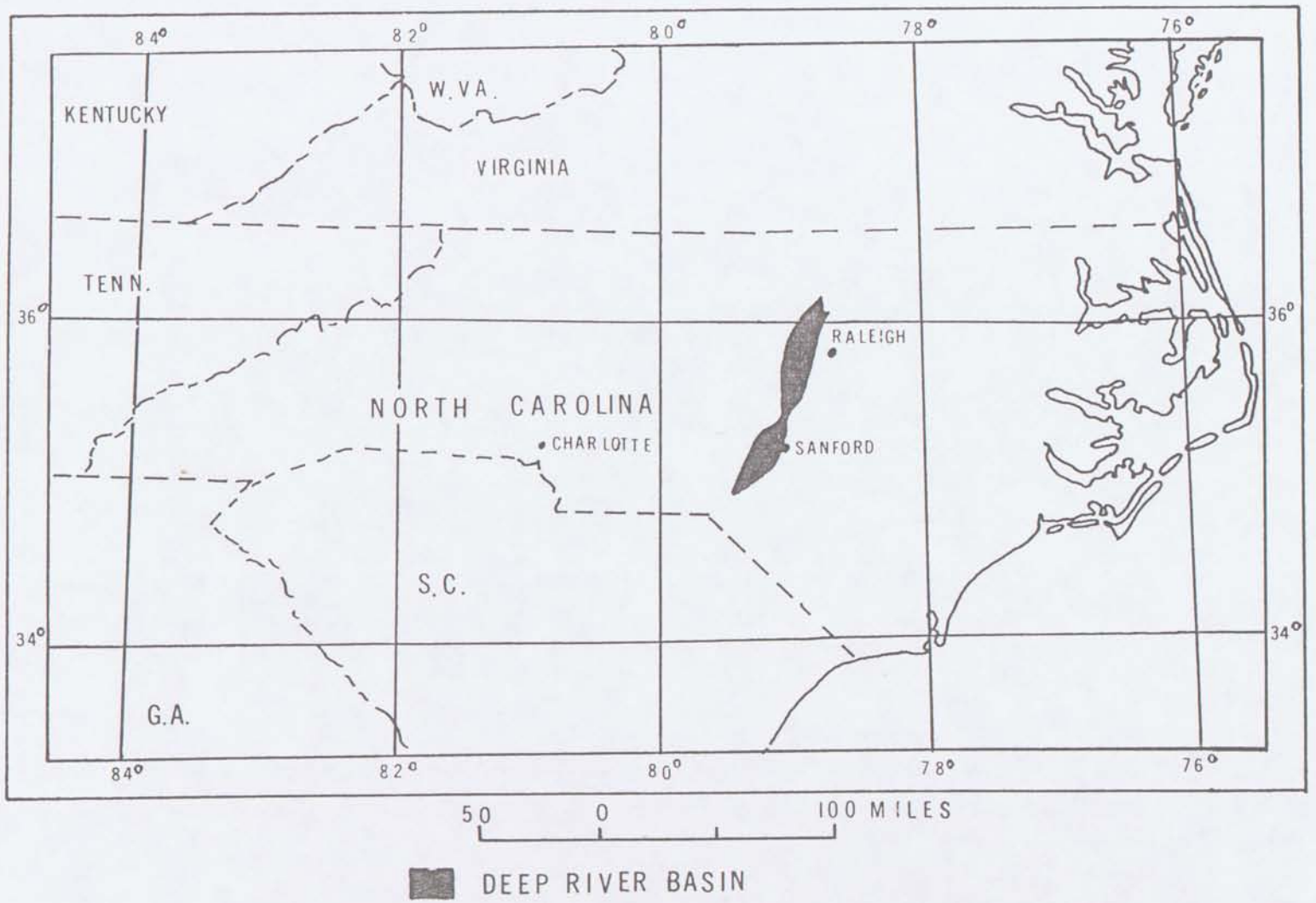

84°
82°
80°
78°
76°
KENTUCKY
W. VA.
VIRGINIA
TENN.
36°
NORTH CAROLINA
RALEIGH
CHARLOTTE
SANFORD
S.C.
34°
G.A.
50 0 100 MILES
DEEP RIVER BASIN

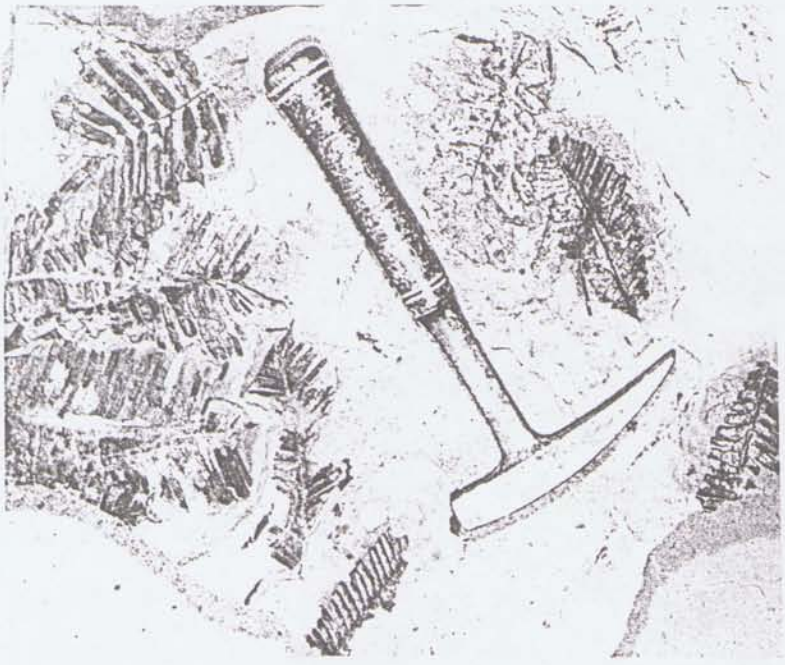
PLATE I

Plate II

Figure 1. Principal collecting site.
Figure 2. Typical floral assemblage.
Figure 3. Neocalamites virginiensis (Fontaine) Berry indicating pith cast, X 0.75.

PLATE II

1



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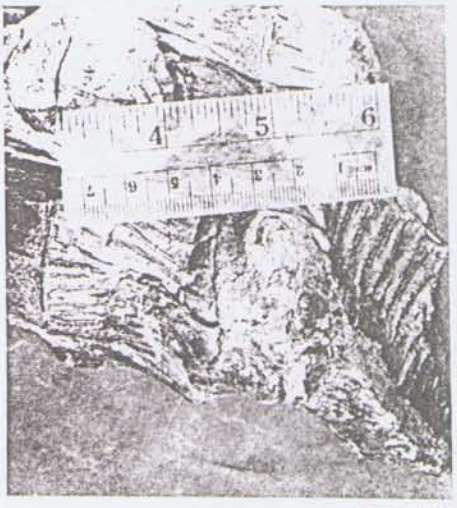

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Plate III

Figures 1-4, 6. Neocalamites virginiensis (Fontaine) Berry foliage 1, 3,4, X 0.75; 2 X 0.75; 6, X 1.

Figure 5. Neocalamites virginiensis (Fontaine) Berry. Stem compression, X 0.5.

PLATE III

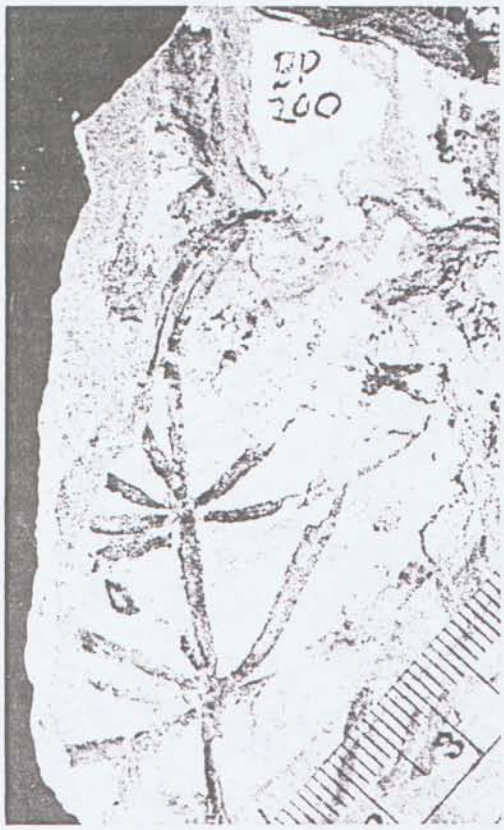

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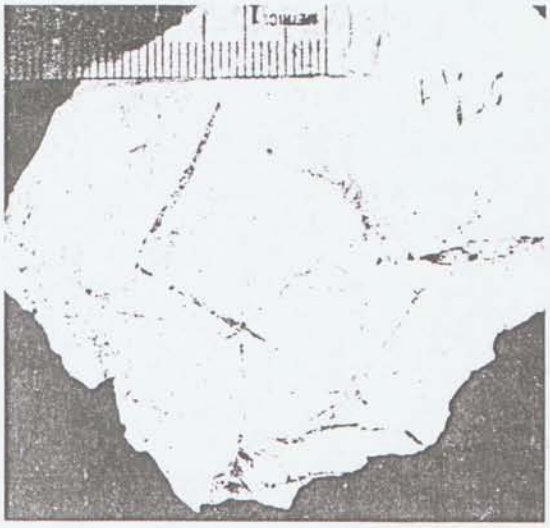
Plate IV

Figure 1-6. Neocalamites knowltoni Berry indicating foliage. 1, 6, X 1; 2, X 1.5; 3, 4, 5, X 0.75.

PLATE IV



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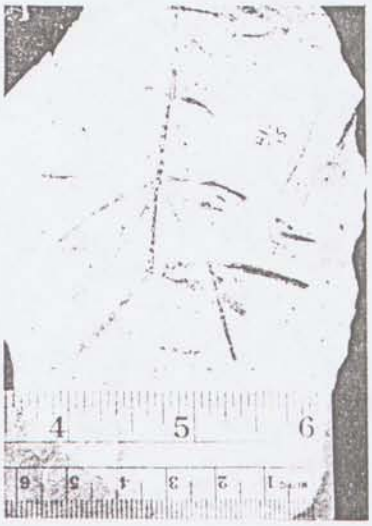

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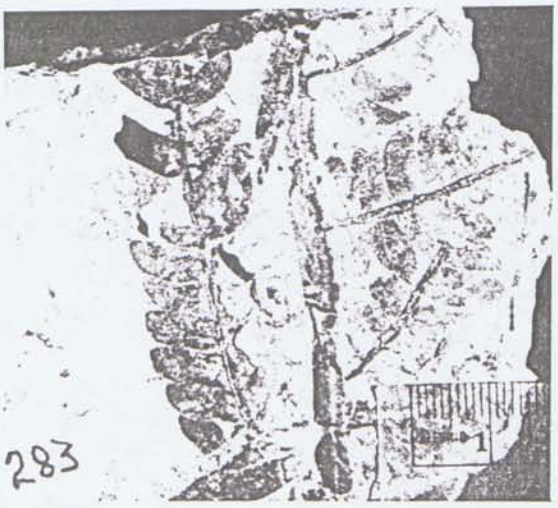
6

Plate V

Figure 1, 2,4. Lonchopteris virginiensis Fontaine indicating parts of fronds, X 0.75 parts showing venation.

Figure 3. Lonchopteris virginiensis Fontaine indicating netted venation X 10.

PLATE V



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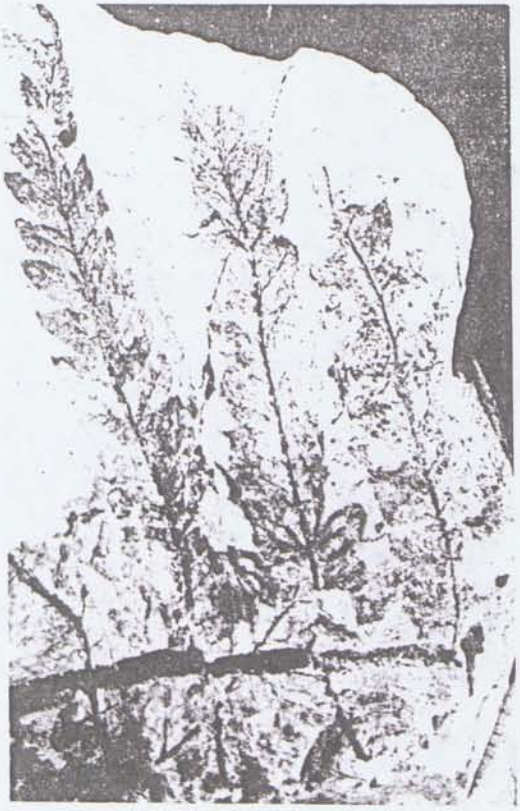

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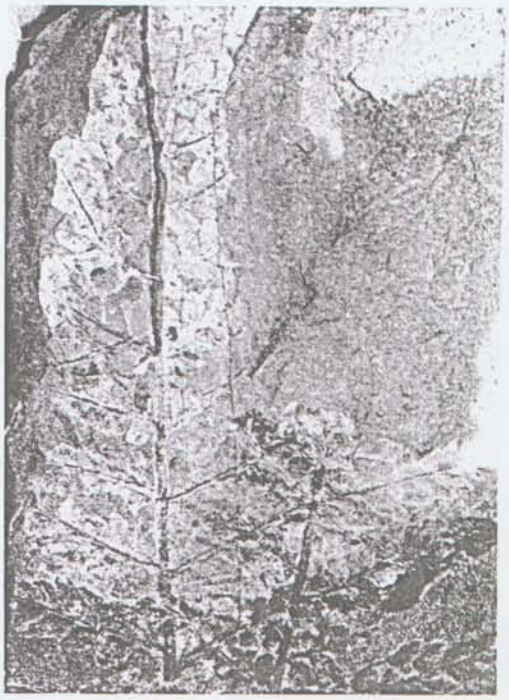
Plate VI

Figures 1, 2, 3. Cladophlebis microphylla Fontaine, indicating bipinnate fronds. X 0.75.

Figure 4. Cladophlebis microphylla Fontaine, indicating venation, X 2.

1



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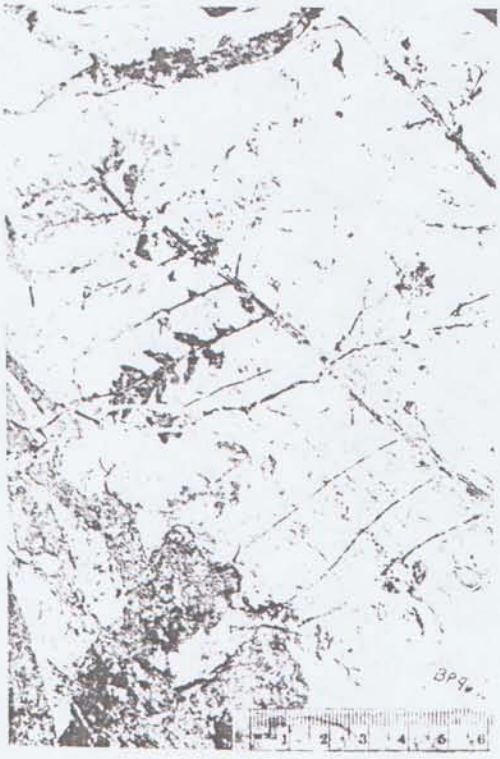

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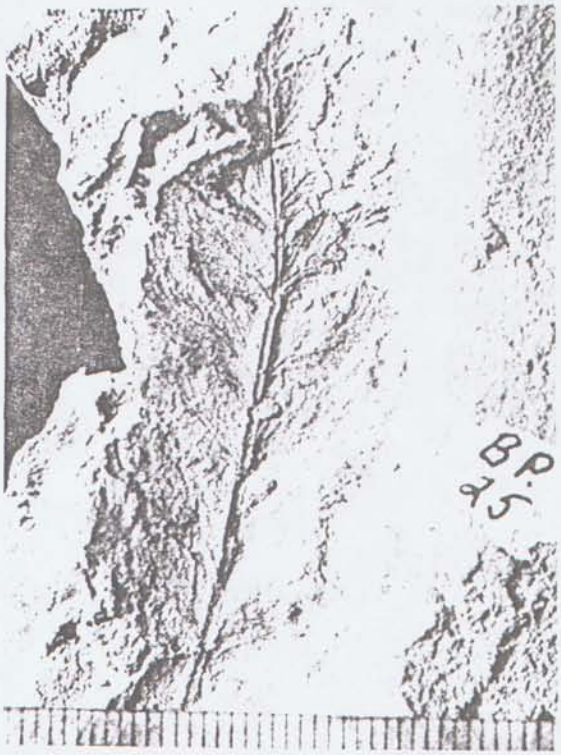

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Plate VII

Figures 1, 2. Cladophlebis microphylla Fontaine. 1 indicates dichotomous nerve branching, X 10; 2 indicating a bipinnate frond, X 1.

Figures 3, 4. Phlebopteris smithii (Daugherty) Arnold. 3 indicating pedate structure, X 1; 4 indicating matoniaceous sori, X 10.

PLATE VII

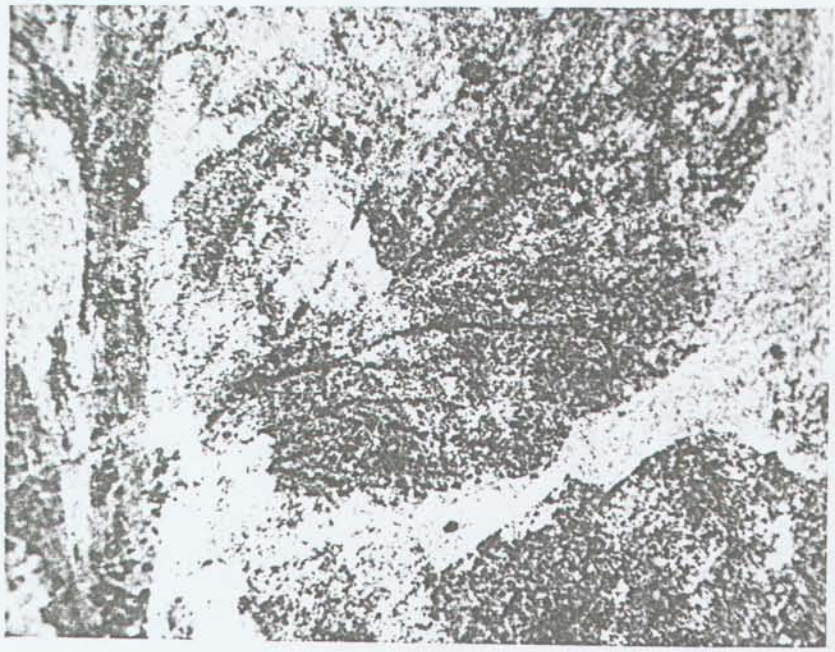

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Plate VIII

Figures 1-4 Phlebopteris smithii (Daugherty) Arnold. 1, indicating pedate structure X 2; 2, indicating venation and sori arrangement X 10; 3, indicating sori, X 10; 4, indicating a fertile frond, X 0.5.

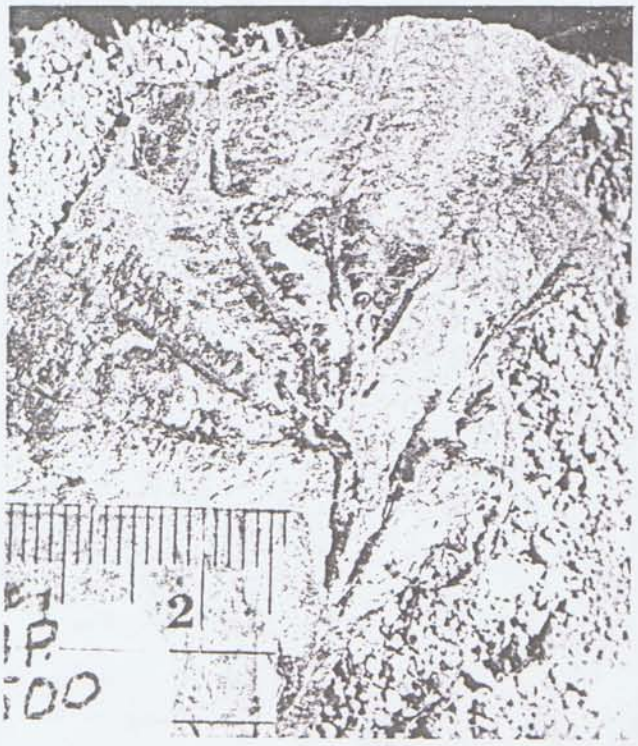

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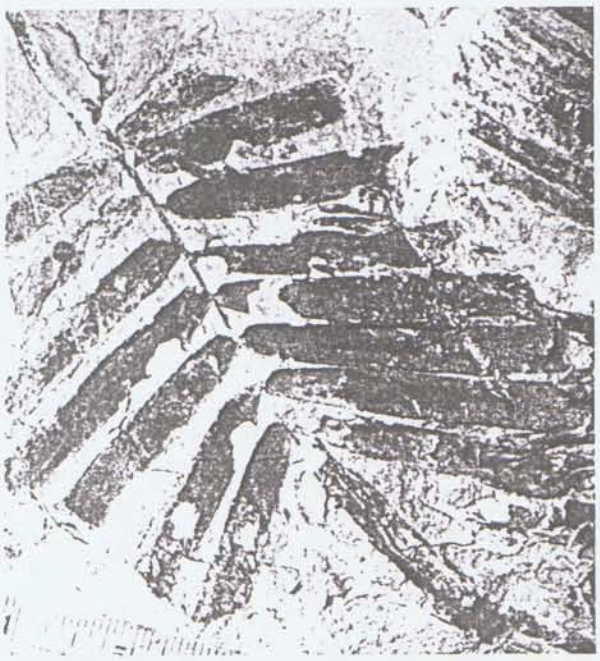
Plate IX

Figures 1-4. Otozamites powelli (Fontaine) Berry, 1,3, 4, indicating pinnules, 1, 3, X 0.5; 4, X 1; 2, indicating venation, X 3.



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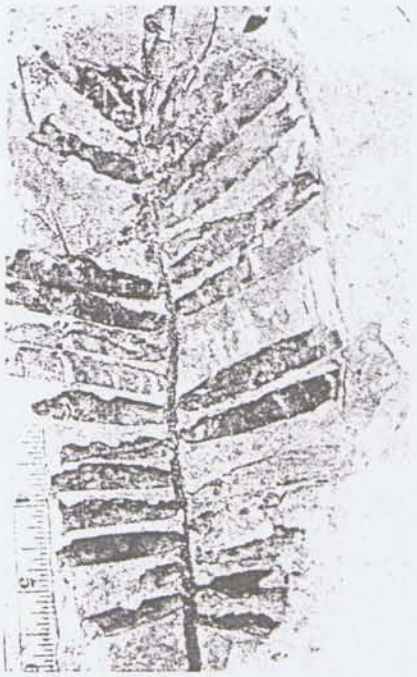

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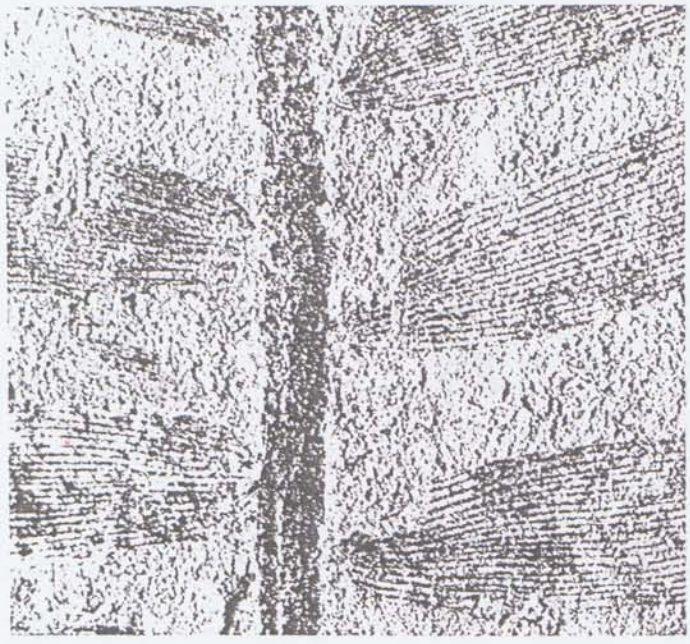

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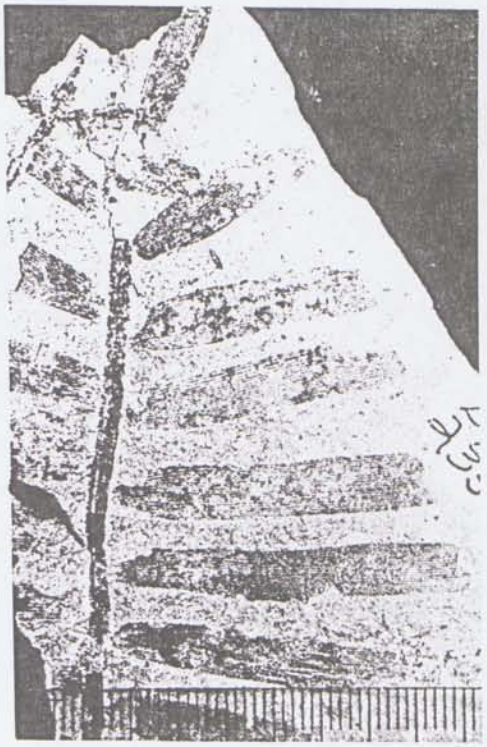

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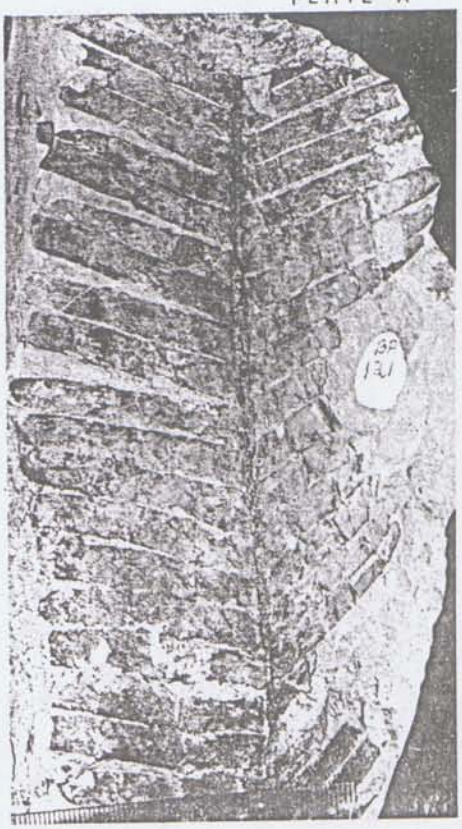
Plate X

Figures 1-4 Otozamites hespera Wieland 1-4, indicating coriaceous pinnae, X 0.75.

PLATE X

1



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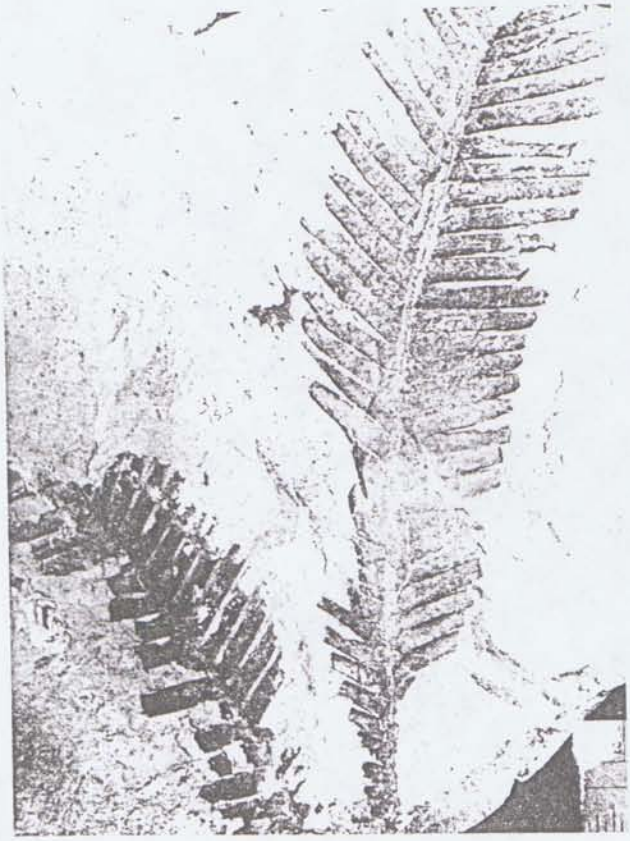

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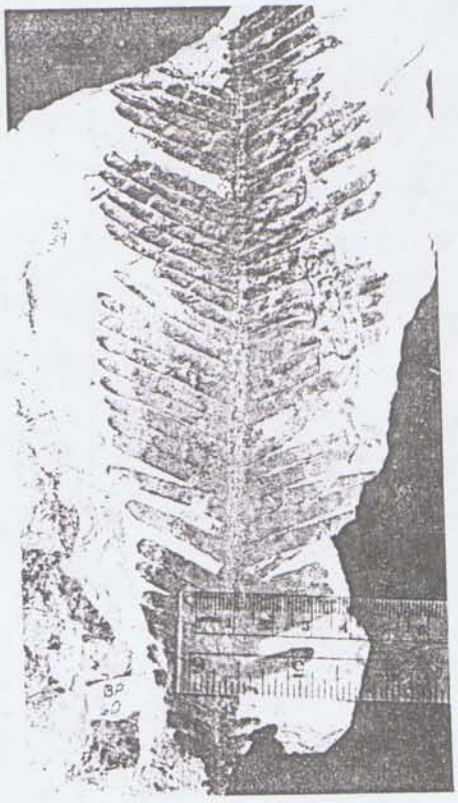

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