SS Guidebook 18

Early Pennsylvanian Paleotopography and Depositional Environments, Rock Island County, Illinois

Richard L. Leary
C. Brian Trask

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Richard L. Leary
Illinois State Museum
Springfield, Illinois 62706

C. Brian Trask
Illinois State Geological Survey
Champaign, Illinois 61820

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Illinois State Geological Survey
Morris W. Leighton, Chief
Natural Resources Building
615 East Peabody Drive
Champaign, Illinois 61820

1985

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Moline Consumers
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Moline, IL 61265

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Mr. Richard DeShepper
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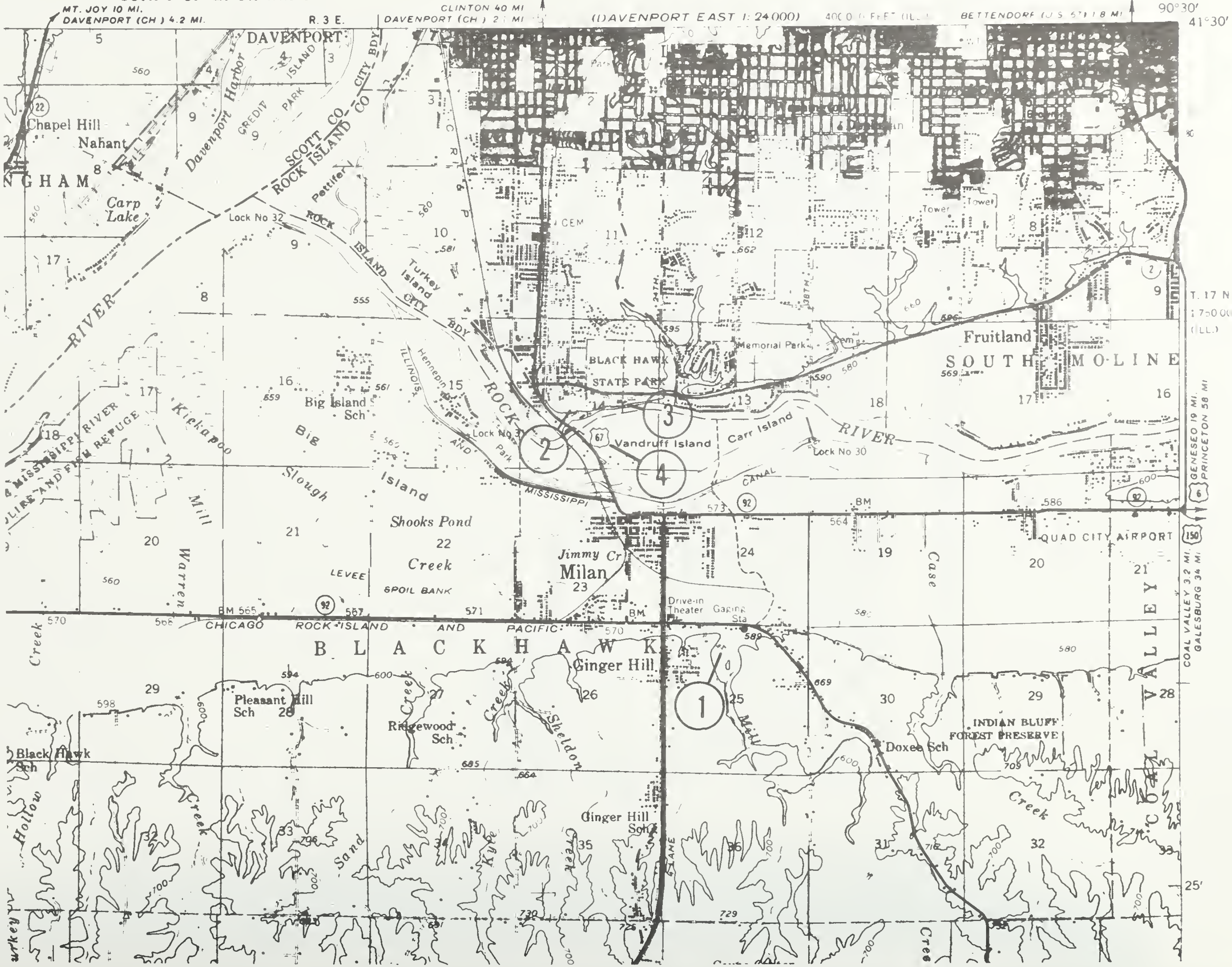


EARLY PENNSYLVANIAN PALEOTOPOGRAPHY AND DEPOSITIONAL ENVIRONMENTS, ROCK ISLAND COUNTY, ILLINOIS

INTRODUCTION

The Geological Society of America, North-Central Section, presents this one-day field trip to Rock Island County, Illinois, where you will have the opportunity to examine the pre-Pennsylvanian unconformity, overlying sediments, and an early Pennsylvanian upland compression flora. The itinerary repeats a trip originally offered during the Ninth International Congress of Carboniferous Stratigraphy and Geology (IX-ICC) in 1979.

In recent years the nature and significance of the Mississippian-Pennsylvanian boundary have received considerable attention. In Illinois, as in much of the continental United States, the boundary is marked by a major unconformity. Extensive topographic relief developed on underlying strata prior to initial Pennsylvanian deposition. In parts of Illinois, especially along the margins of the Illinois Basin, erosion removed great thicknesses of pre-Pennsylvanian rocks (although some formations may have been thinner than equivalent strata in the deep part of the basin, or in fact, may never have been deposited).

In the Rock Island County area, the Pennsylvanian System overlies rocks ranging in age from Silurian to Devonian. Pre-Pennsylvanian topography was characterized by deep valleys, high hills, and some karst features. Although much of this topography can be examined only by means of drilling records, some higher elevations are now exposed. Several of these features will be seen on this field trip.

In recent years the senior author has collected a large number of well preserved early Pennsylvanian plant fossils in the Rock Island area. The fossils occur in rocks immediately overlying the erosional surface developed on Devonian carbonate strata (Cedar Valley and Wapsipinicon Limestones: Middle Devonian Series). The composition of the fossil plant assemblage is distinct from the more commonly preserved "coal-swamp flora."

The distinctive character of the flora has been considered the result of the distinctive environment that produced the flora. All flora from Rock Island County, and one from Brown County to the south, have been referred to as an "upland" flora.

This field trip will give geologists and paleobotanists an opportunity to examine the stratigraphic and paleotopographic setting of this flora. It will also provide an opportunity to discuss the nature of the flora, its relationship to the setting, and the paleoecological and evolutionary implications.

The guidebook itself is a reprint of Leary (1979). Some revisions have been made to update the guidebook with new exposures, new data, and new references. The geology of the field-trip area has been discussed by Leary (1981). Additional information concerning *Labriscorpio alliedensis* is also available (Leary, 1980). Phillips and Peppers (1984) have summarized regional paleoenvironmental patterns of coal swamps and discussed the effect of climate on coal occurrence in Euramerican coal fields.

Figure 6 has been revised to reflect new data. Now this illustration better shows the pre-Pennsylvanian paleovalleys in the Rock Island County area. Figure 7 shows the full extent of the channel exposed in the Allied Stone Company quarry. It also indicates that most of the fossil-bearing strata have now been removed by quarrying. Figure 8 has been updated to show a current (1984) cross section of a channel.

Russel A. Peppers at the Illinois State Geological Survey has examined the spore content of the coal from Stop 2. He believes (1984, personal communication) that this coal is lower Westphalian A in age.

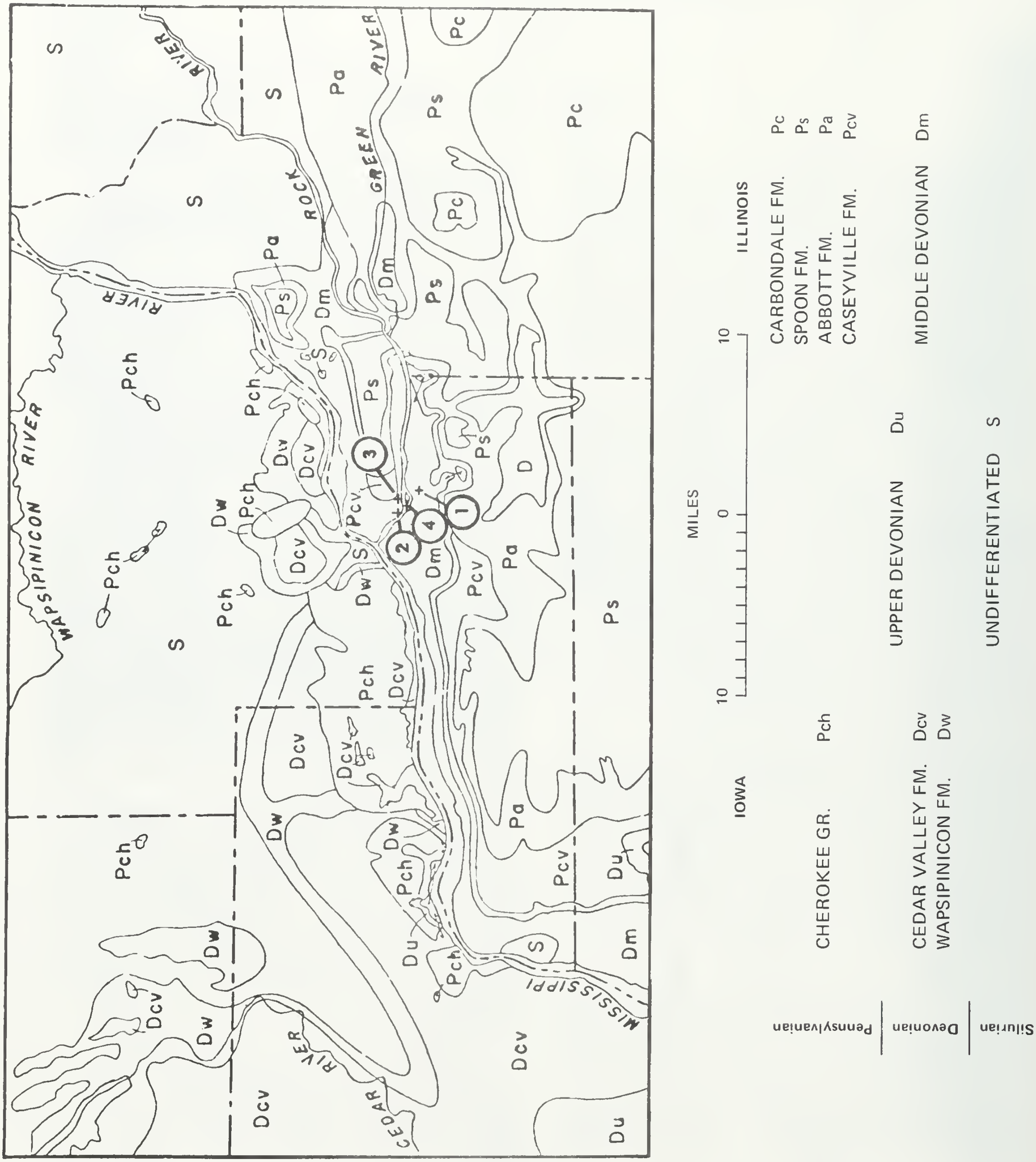


Figure 1. Geologic map of the Rock Island County area. Circled numbers are stops. Base map from Edmund and Anderson, 1967.

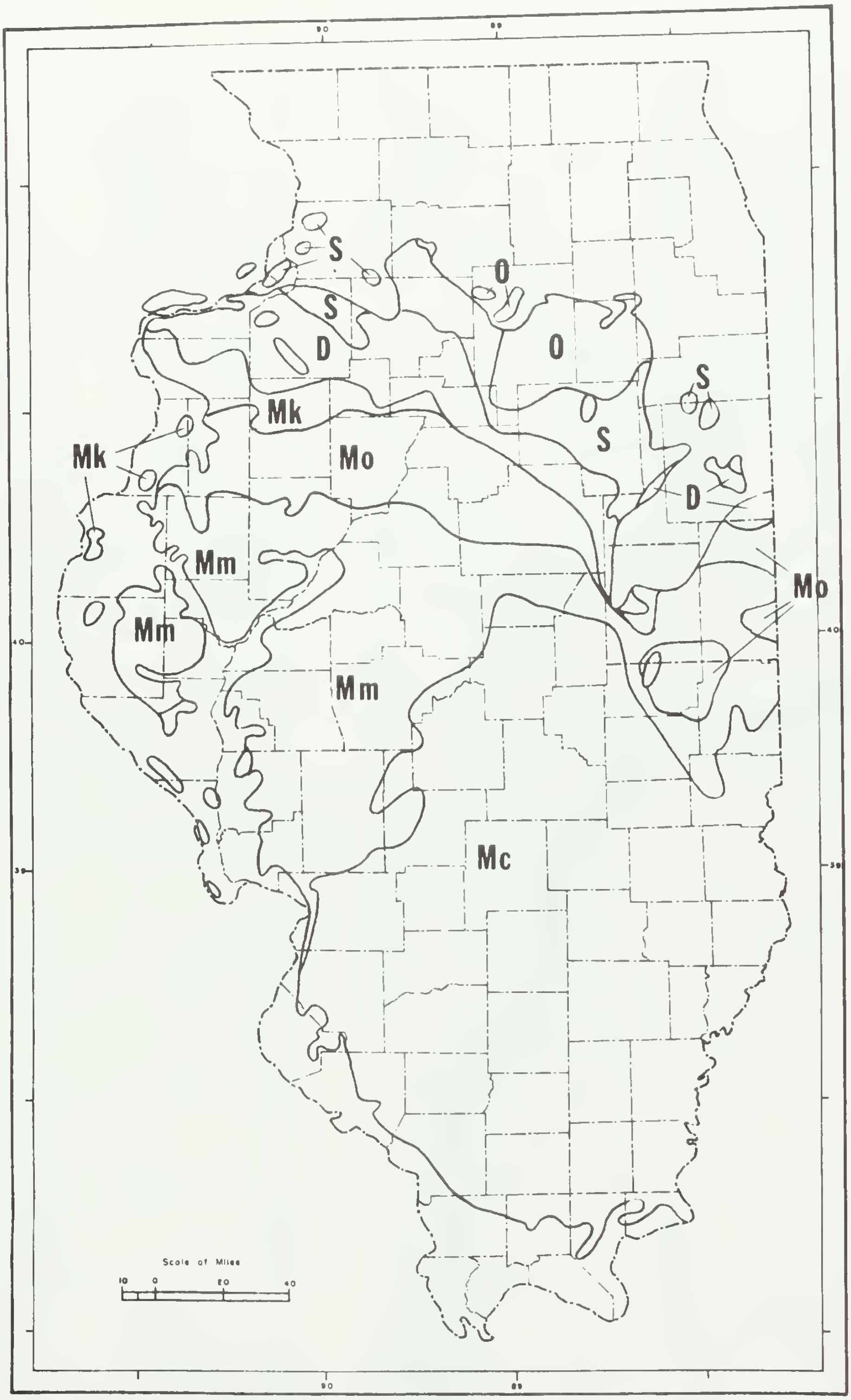
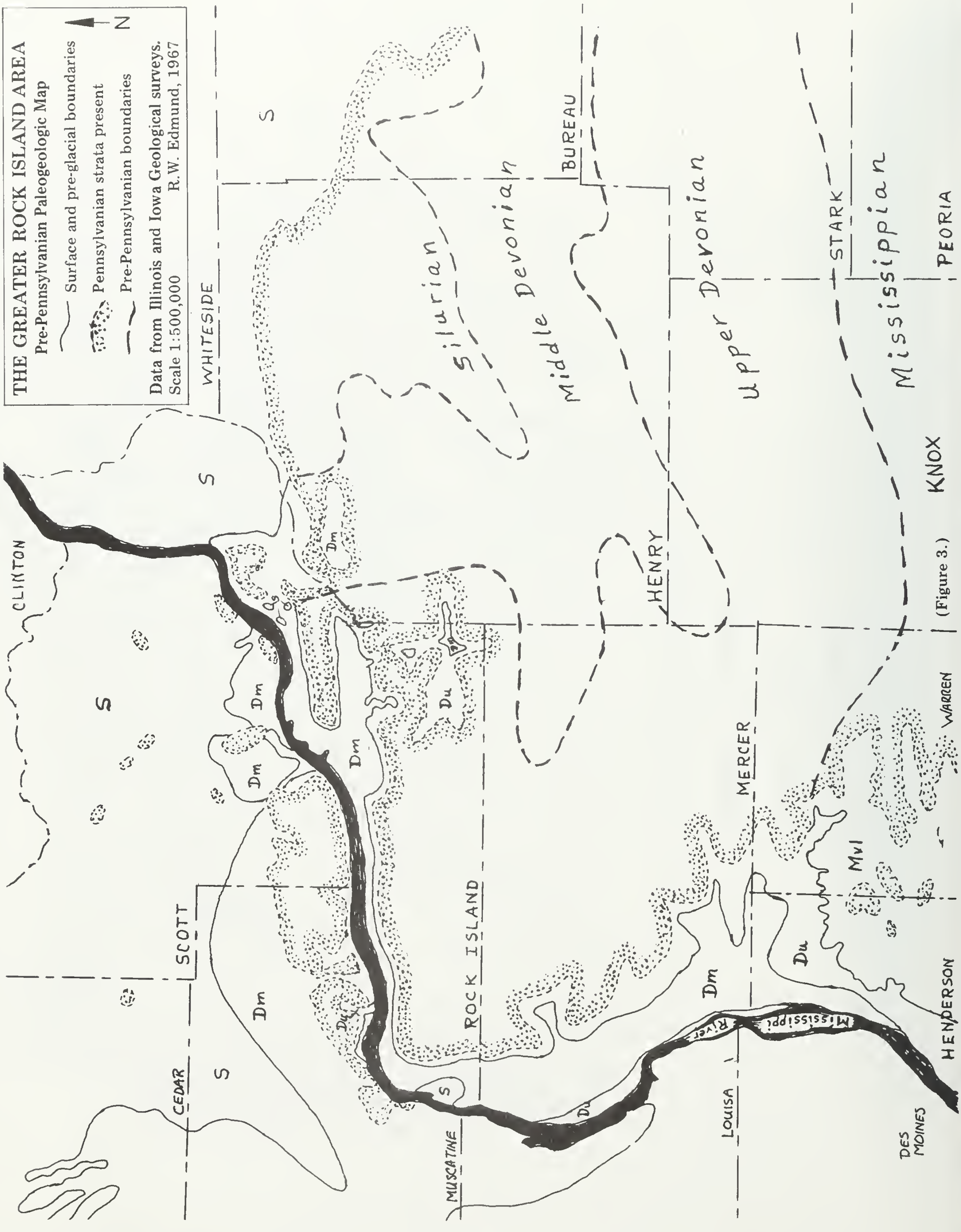


Figure 2. Generalized sub-Pennsylvanian geologic map of Illinois. (From Plate 2, Paleotectonic investigations of the Pennsylvanian System in the United States, McKee and Crosby, Coordinators, U.S.G.S. Prof. Paper 853.)


THE GREATER ROCK ISLAND AREA
Pre-Pennsylvanian Paleogeologic Map
Surface and pre-glacial boundaries
Pennsylvanian strata present
Pre-Pennsylvanian boundaries
N
Data from Illinois and Iowa Geological surveys.
Scale 1:500,000
R.W. Edmund, 1967
CLINTON
CEDAR
SCOTT
MUSCATINE
WHITESIDE
ROCK ISLAND
LOUISA
DES MOINES
MERCER
HENDERSON
HENRY
BUREAU
WARREN
KNOX
STARK
PEORIA
Silurian
Middle Devonian
Upper Devonian
Mississippian
Mississippi River
S
Dm
Du
Mvl

(Figure 3.)

Geological Background

Stratigraphy. In the Illinois Basin, Pennsylvanian strata overlie rocks ranging in age from Ordovician to Mississippian. The sub-Pennsylvanian strata are primarily carbonates and had been exposed to subaerial erosion. Along the western margin of the Basin, Pennsylvanian rocks overlie older Mississippian rocks in the central part and Devonian rocks in the northwest (Reinertsen *et al.*, 1974). Silurian and Ordovician strata underlie the Pennsylvanian along the northern margin (see geologic maps, Figs. 2, 3).

The relevant portion of the stratigraphic sequence in the Rock Island County area is illustrated in Figure 4. The major unconformity between the Devonian Cedar Valley Limestone and basal Pennsylvanian indicates a long period of erosion prior to earliest Pennsylvanian sedimentation. Because strata as young as the St. Louis Limestone (Valmeyeran = basal Visean) occur beneath the unconformity to the south, it is believed that the period of erosion came in Late Mississippian/Early Pennsylvanian (at the base of the European Namurian?).

Pre-Pennsylvanian topography. Major valleys are known to have drained eastward and southeastward across the pre-Pennsylvanian surface in the Illinois Basin (Smith, 1941; Horberg, 1950). Similar valleys up to 140 m deep and up to 32 km wide are known from other parts of the Illinois Basin (Bristol and Howard, 1971).

As can be seen in several quarries and natural exposures in this area, the unconformity surface in the Rock Island County area was relatively flat. A few years ago, one could walk on the unconformity, a rolling limestone surface with a maximum relief of 2 m that was exposed in the Allied Stone Company quarry; unfortunately, it was destroyed by quarrying operations between 1975 and 1977. The flat upper surface of Devonian limestone can still be seen along the north and south walls of the Allied Stone Company quarry (Stop 4).

There are small knolls or "hills" on the limestone surface. One such knoll can be seen across the Rock River, north of the Allied quarry (Fig. 5). This one is only 3 to 4 m high. Another one, a higher limestone hill, is exposed northeast of the bridge where US 67 crosses the Rock River north of Vandruff Island and the Allied quarry. This hill is about 10 m above the river level which is the approximate elevation of the major portion of the unconformity here. This hill will be seen at Stop 2.

Although extensive areas of relatively low relief are present, some deep valleys were also developed prior to earliest Pennsylvanian sedimentation. One such valley occurs in southeastern Rock Island County (see map, Fig. 6).

A system of steep-sided, flat-bottomed channels was developed on Devonian limestone in the Rock Island County area. Although now largely destroyed by quarrying operations, these were observed in both the Allied Stone Company quarry and the Cleveland quarry. The primary trend of these channels was east-west (Fig. 7), but the locations were apparently controlled by jointing in the limestone. The exact nature of these channels has not been determined.

These channels were 4 to 6 m deep and 8 to 20 m wide (Fig. 8). They were filled with shale, mudstone, and occasional lenses or thin, discontinuous layers of sandstone. Occasional thin layers and masses of pyrite are also present with a few pyritized plant axes. The shale and mudstone are almost exclusively gray except for the upper portion which is sometimes thinly laminated black shale.

Similar channels have been exposed in several other quarries in the Rock Island County area (Fig. 9). Plant fossils comparable to those of the Allied Stone Company quarry were observed in the quarry at Cleveland, Henry County, Illinois, but these were poorly preserved and recent quarrying operations have destroyed the fossil-bearing deposits.

Pre-Pennsylvanian karst topography. A karst topography apparently developed at the close of the Mississippian when the region was uplifted and exposed to subaerial erosion. At that time large areas of Silurian, Devonian, and Mississippian limestone strata were exposed on the western margin of the Illinois Basin. Caves, filled with Pennsylvanian mud, silt, and sand, are known in the area. Sinkholes have been reported from both surface and subsurface data (McGinnis and Heigold, 1974). It is not known whether the channels exposed in the Allied Stone Company quarry drained into caves via sinkholes or into nearby deep valleys.

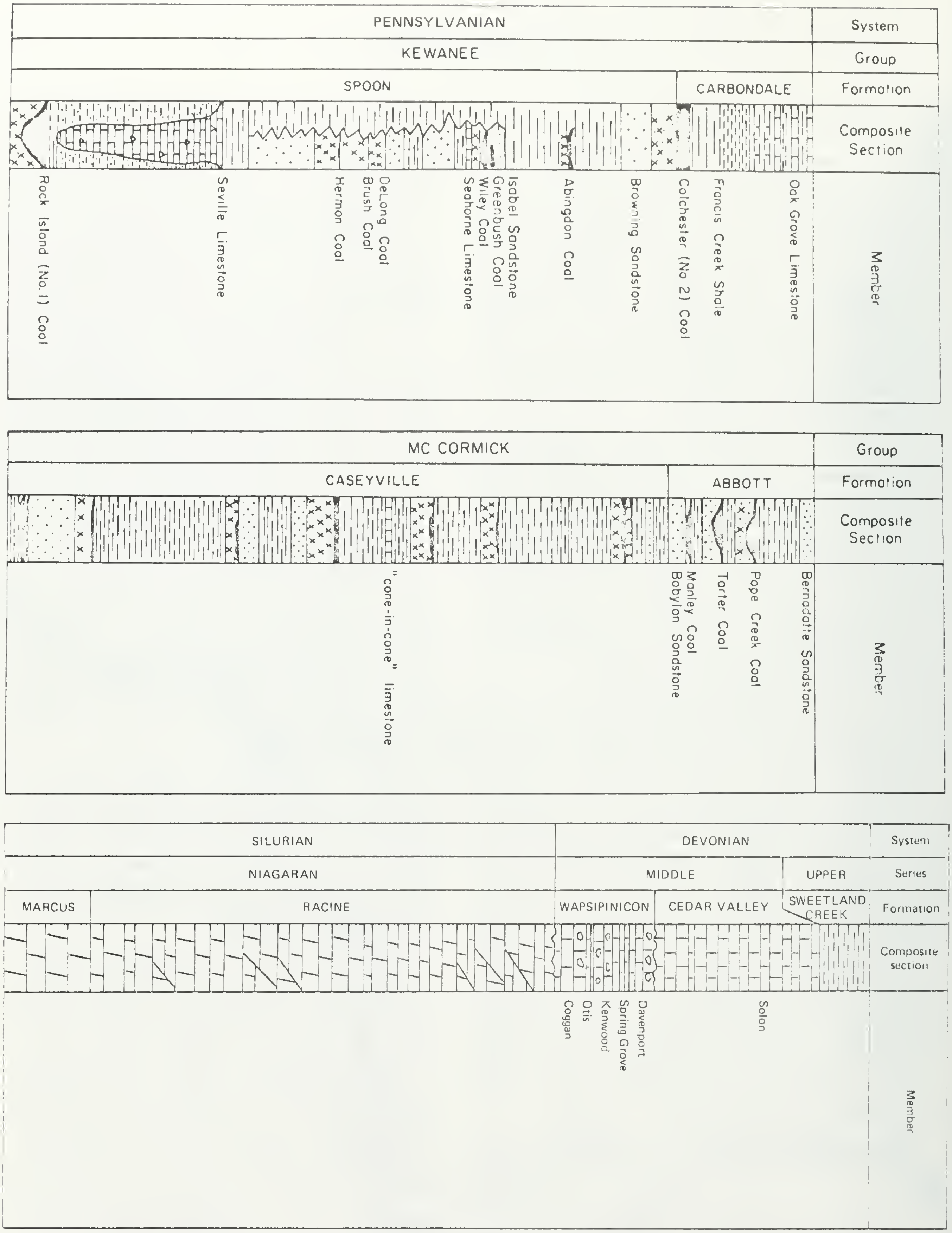


Figure 4. Composite section of Pennsylvanian, Devonian and Upper Silurian strata in the Rock Island County area. Pennsylvanian section from Searight and Smith, 1969.

Paleobotanical Background

Historical perspective. Several occurrences of Early Pennsylvanian (Late Namurian-Early Westphalian) plant fossils in western Illinois have been known since the late 1800's (Worthen, 1873). In 1907, David White (1908) examined fossils from several localities in this area and published a brief report with a list of 14 fossil plant genera. Since that time, only sporadic collecting has been done and no significant collections are known other than those at the Illinois State Museum. The above, and broader aspects of compression plant fossil studies in the area of the Illinois Basin, are reviewed by Phillips, Pfefferkorn, and Peppers (1973).

Description of significant "upland" taxa. The term "upland" has been used to designate distinctive nonswamp floras, but the actual paleoecology of such floras is not known. The "upland" plants grew on soils derived from limestone bedrock in western Illinois, and many were near stream banks and ultimately were deposited in stream channels with minimal transport.

Because the "upland" flora includes a number of genera which are unknown in coal swamps and are not well known, some general descriptions and illustrations are given.

Several species of *Megalopteris* occur in the floras of western Illinois. These range from large trilobed *M. dawsoni* (Hartt) Andrews (Pl. 1, Fig. 1) to smaller, pinnate (alethopteroid) forms such as *M. ovata* Andrews (Pl. 2, Fig. 1). Other specimens (Pl. 2, Fig. 2) probably belonging to the megalopteroid group, if not to the genus *Megalopteris*, are similar to published figures and descriptions of such genera as *Neriopteris* (Newberry, 1873), *Orthogoniopteris* (Andrews, 1875) and *Protoblechnum* (Andrews, 1875). Differences between these genera and their relationships are not clear from the literature.

Lesleya foliage is similar to *Megalopteris* pinnules but consists of simple leaves (Pl. 1, Fig. 2). These leaves are greater than 30 cm long and 10 cm wide. The midvein is broad, though not as broad as that of *Megalopteris;* the lateral veins are curved and divide once or twice. *Lesleya* and *Megalopteris* are also separated on the basis of epidermal structures (Florin, 1933).

Mesocalamites (Pl. 3, Fig. 1) is distinguished from *Calamites* on the basis of the continuity of ribs across the nodes. *Calamites* ribs alternate whereas some ribs of *Mesocalamites* alternate and some are continuous. *Mesocalamites* is largely restricted to the Namurian, rarely extending into the Westphalian. *Archaeocalamites,*

Figure 5. A limestone knoll exposed on the north side of the Rock River below the Watchtower, Black Hawk State Park. Sec. 14, T. 17 N., R. 2 W.

Figure 6. Paleotopographic map of Rock Island County, Illinois; 40-foot contours show relief of the Devonian-Pennsylvanian unconformity.

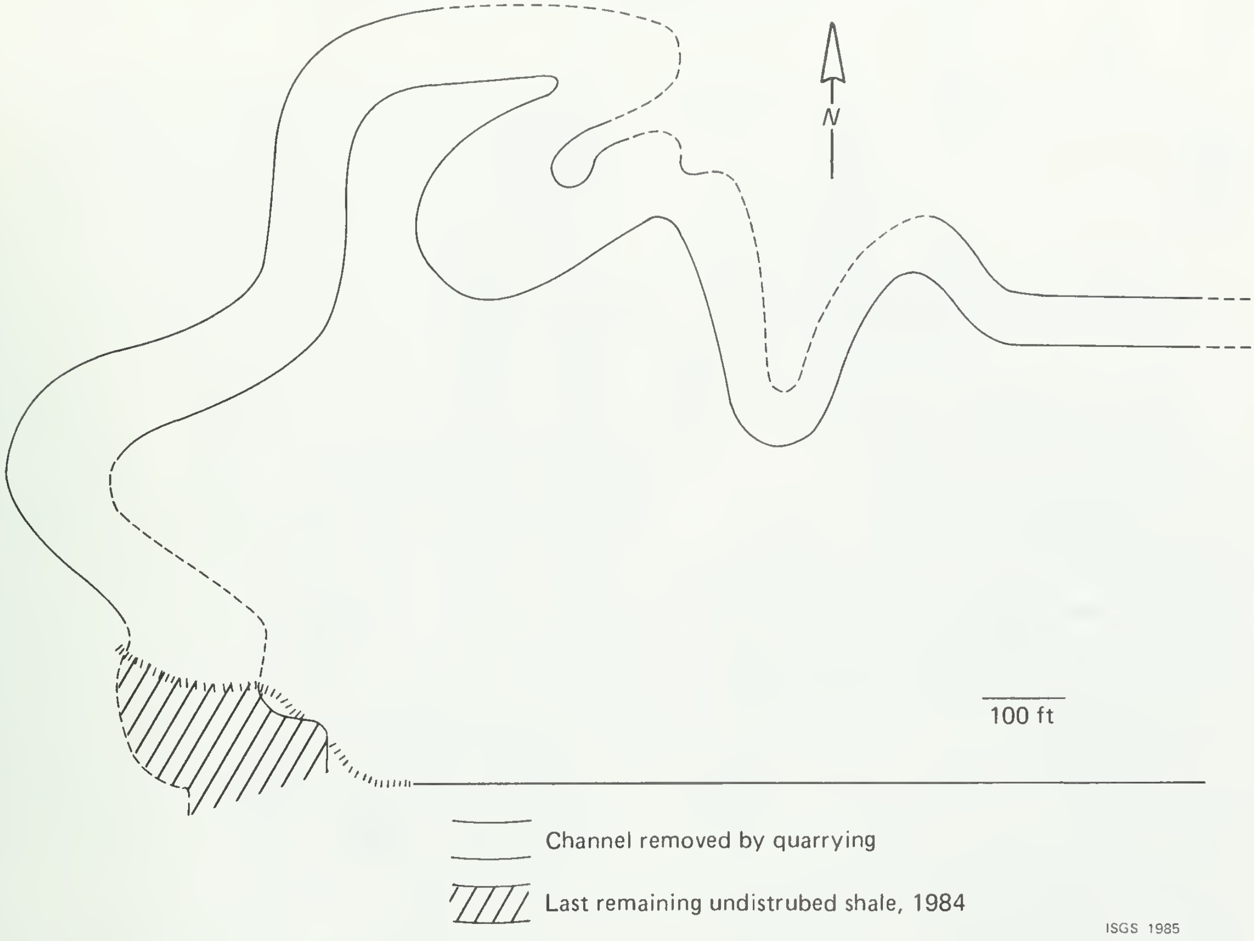


Figure 7. Channel filled with fossil-bearing shale, siltstone, and sandstone in the Allied Stone Company quarry.

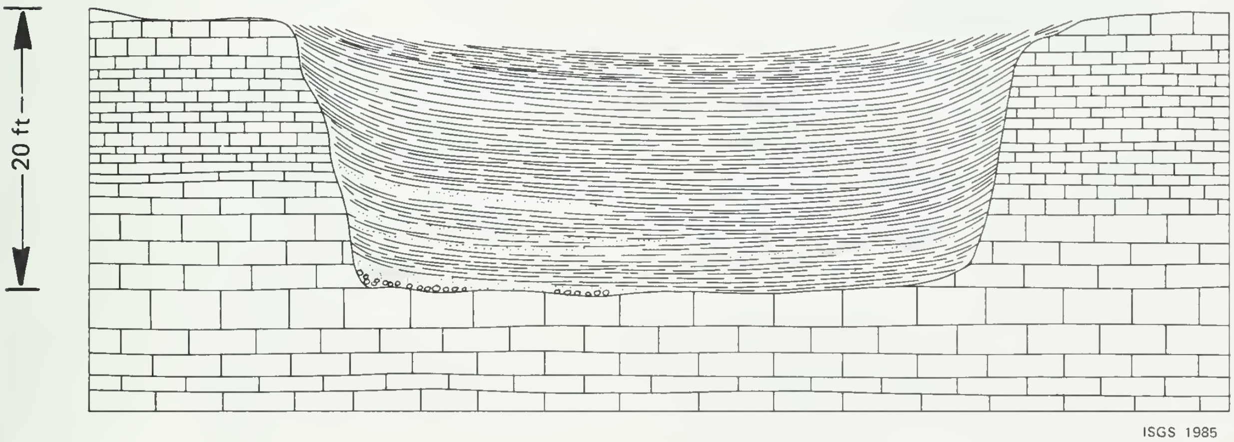


Figure 8. Cross section of a channel.

Figure 9. Map of Rock Island County showing locations of exposures of the Devonian-Pennsylvanian unconformity and lower Pennsylvanian strata.

an older form, has all ribs continuous across the nodes. The correlation of various species of *Mesocalamites/Calamites* to species of foliage, *Asterophyllites/Annularia*, and fructifications, *Calamostachys*, is still not complete.

Lacoea (Pl. 3, Fig. 5) is a cone consisting of semicircular sporophylls which alternate on a thick axis. *Lacoea* and similar, perhaps synonymous, forms are known from a few localities but in distant parts of the world: Holland (Hirmer, 1940, 1941); Belgium (Stockmans and Williere, 1962); Czechoslovakia (Feistmantle, 1879); Germany (Hirmer, 1940); and China (Stockmans and Mathieu, 1957). Although Read (1946) suggested that *Lacoea* might be a pteridosperm, specimens from Brown County, Illinois, have permitted a reinterpretation; *Lacoea* is now considered a member of the Noeggerathiales (Leary, 1973). However, the broader natural affinities of the Noeggerathiales are not known. This order has been treated as a separate group or loosely allied with either the Pteridopsida or Sphenopsida (Boureau, 1964). The Noeggerathiales are well represented in the "upland" floras of western Illinois.

Gulpenia (Pl. 3, Fig. 2), another member of the Noeggerathiales, is characterized by small, deeply lacerated leaves attached spirally to a thin axis. In compression, *Gulpenia* bears a superficial similarity to *Sphenophyllum* but the leaves clearly alternate.

Megalopteris is not known to occur outside North America (Arnold, 1934)* where it has been reported from the following localities:

St. John, New Brunswick
Dawson (1871), Stopes (1914)
Rushville, Ohio
Andrews (1875), Cross (1962)
Port Byron, Illinois
Lesquereux (1880)
Wyoming Hill, Iowa
Noe (1925)
Grand Ledge, Michigan
Arnold (1934)
Saginaw, Michigan
Arnold (1934)
Putnam County, Indiana
Arnold (collected 1936, oral comm.)
Pictou, Canada
Bell (1940)
West Virginia
White (1913)
Greene County, Indiana
Canright (1959), Wood (1963)
Brown County, Illinois
Leary and Pfefferkorn (1977)
Rock Island County, Illinois
Leary (1974b, 1976, this guidebooklet)

In almost half of these localities, *Megalopteris* occurs with a flora which is distinct from the common coal swamp flora. The *Megalopteris* floras appear to contain greater percentages of pteridosperms and *Cordaites* and smaller percentages of ferns and lycopods than do Early Pennsylvanian floras associated with coal seams ("swamp floras") (Phillips *et al.*, 1974). White (1931, p. 275-276) suggested that *Megalopteris* and *Lesleya* are unique to uplands developed on carbonates. Recent studies by Cross supports this concept (personal communication). The flora associated with *Megalopteris* apparently grew on drier uplands underlain by limestone.

Environmental changes indicated in the Allied flora. Studies of the paleoecological differences in Mississippian-Pennsylvanian floras have shown that several paleoenvironments can be recognized (Peppers and Pfefferkorn, 1970, for summary, also Remy and Remy, 1977). At the top of the sequence in several channel fills in the Allied quarry, the flora is characterized by an overwhelming abundance of *Mesocalamites* with *Lepidodendron* and *Psaronius;* little else is present. This change in composition apparently represents a change from drier "upland" to wet lowland, or swamp, conditions as stream channels were filled with sediment and the water table correspondingly rose to near ground level. Tenchov (1976) described floral changes within a Carboniferous floral sequence of western Bulgaria and related these to continuous uplift of the basin. Changes in the elevation of the western margin of the Illinois Basin, relative to the central area of the Basin, may have brought about changes in floral composition in this area.

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*A single fragment from Britain reported as *Megalopteris* (Arber, 1904) is now referred to *Lesleya* (Leary, in press).

Comparisons of "upland" floras. Recent studies of an Early Pennsylvanian flora from Brown County, Illinois (Fig. 10) (Leary, 1973, 1974a, 1974b, 1976; Leary and Pfefferkorn, 1977) have identified twenty-one genera of plants (Table 1). Among the most common are *Lacoea*, *Sphenopteris*, *Cordaites*, and *Alethopteris*. *Megalopteris* and *Lesleya* are also well represented. Thirty-two genera of foliage, fructifications, and stems have so far been identified from the Allied Stone Company quarry (Table 1). The most abundant taxa at this site are *Megalopteris*, *Lesleya*, *Samaropsis*, *Cordaites*, and *Cardiocarpus*.

The two floras (Table 1) have many genera in common; differences are in the relative abundance of certain genera and presence or absence of certain others. Arborescent lycopods are common in the nonswamp Rock Island flora but very rare in the Brown County flora; only one determinable specimen and two fragmentary specimens of *Lepidodendron* have been found at the latter site; *Lepidophloios* is absent from the Brown County locality and rare in the Allied quarry site. Lycopods are the dominant plants in most Lower and Middle Pennsylvanian coal swamp floras of the Illinois Basin (Phillips *et al.*, 1974). Sphenopsids and Cordaites are more abundant in parts of the Rock Island flora than in the Brown County flora; ferns are more common in the the Brown County flora.

Although the ages of the two floras are probably not exactly the same, the differences in generic composition probably reflect environmental differences rather than age differences. The presence of a permanent body of water in the channels apparently permitted the growth on the drier sites in Rock Island of genera (e.g., *Lepidodendron* and *Mesocalamites)* common to coal swamps.

Comparison with European Floras. The flora exposed in the Allied Stone Company quarry is one of very few Namurian-age floras known in North America and provides a rare opportunity for comparison with floras of similar age in Europe. Analysis of the Illinois "upland" floras enables us to make comparisons with the "flozformend" (seam-forming) and "flozfern" (distant from the seam) floras of the European Namurian (Havlena, 1961). Numerous similarities exist between these as well as significant differences.

The greatest similarity appears to be with the flora of the Ostrava-Karvina coal district of Czechoslovakia (Sustra, 1928; Purkynova, 1970). Here, Havlena (1970) recognized several microenvironments within the Namurian hygrophile environment in addition to a major separation of the hygrophile and mesophile environments. The mesophile ("upland") flora described by Havlena from the Ostrava-Karvina coal district was present only as fragments (Havlena, 1971, p. 245) whereas preservation of the plants in the Allied quarry is excellent.

TABLE 1

LIST OF GENERA PRESENT AT THE LOCALITIES IN BROWN AND ROCK ISLAND COUNTIES, ILLINOIS

GENERA	ABUNDANCE: BROWN COUNTY	ABUNDANCE: ROCK ISLAND COUNTY
Lycophytina		
Lepidodendron	vr	c
Lepidophloios		vr
Lepidophylloides		c
Lepidostrobus		c
Lepidostrobophyllum		c
Lepidocarpon		c
Stigmaria		vr
Sphenophytina		
Mesocalamites	c	c
Asterophyllites	c	c
Annularia	vr	
Calamostachys	c	c
Sphenophyllum		r
Filicophytina (Ferns)		
Alloiopteris	c	vr
Dactylotheca	r	
Pteriodospermales		
Alethopteris	c	r
Sphenopteris	a	c
Lagenospermum	vr	?
Telangium	c	r
Megalopteris	c	a
Lesleya	c	a
Samaropsis	c	a
?Neuropteris		vr
?Mariopteris	vr	vr
Whittleseya		vr
Aulacotheca		vr
Rhodea	r	vr
Rhodeopteridium	vr	?
Noeggerathiales		
Lacoea	a	c
Palaeopteridium	c	vr
Gulpenia	r	vr
Cordaitales		
Cordaites	c	a
Cardiocarpus	r	c
Cordaianthus		r
Artisia		vr

Approximate abundance indicated by the following:

vr = very rare (1, 2)

r = rare (3-5)

c = common (5-25

a = abundant (> 25)

Based upon 350 specimens from each locality.

1 St. Louis, Mo.

2 Golden Eagle

3 Brown County

4 Monmouth

5 Wyoming Hill, Iowa

6 Cleveland quarry

7 Midway quarry

8 Port Byron

9 La Salle County

10 Channahon

11 Kankakee

12 Putnam County, Ind.

13 Green County, Ind.

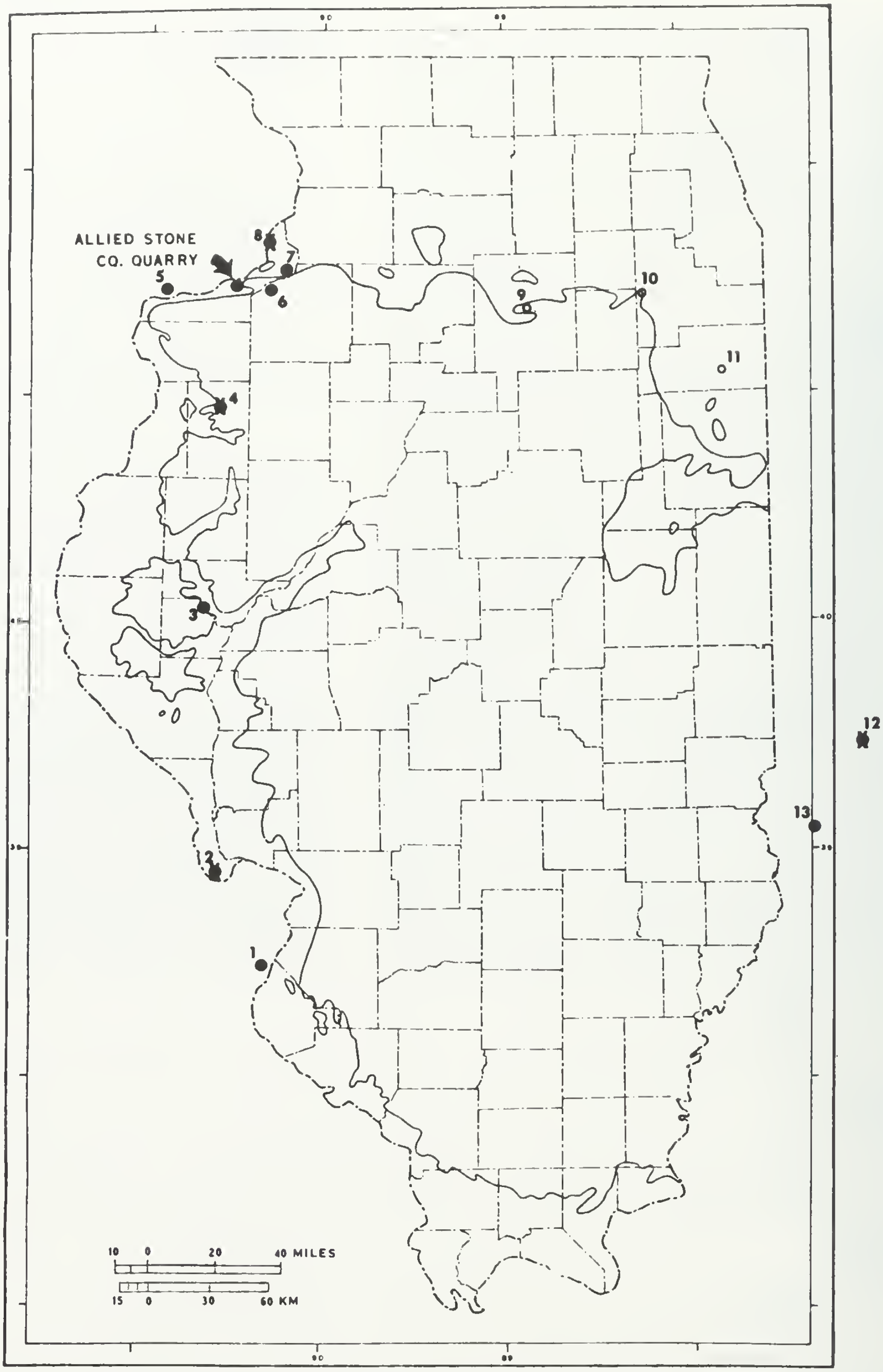

Figure 10. Map of reported localities of Early Pennsylvanian plant fossils on the margins of the Illinois (Eastern Interior) Basin.

Margin of Pennsylvanian strata *Existing locality*

Locality no longer accessible *Spores only*

Stop 1: Collinson Stone Company Quarry.

SE SE NE NW Sec. 25, T. 17 No., R. 2 W., Milan 7.5' Quadrangle.

Caution: Do not approach the edge of the main quarry. Look where you step and watch what is above you on the upper level.

Exposures of Pleistocene, Pennsylvanian, and Devonian strata can be seen in this quarry.

Strata exposed by quarrying operations here include slightly more than 30 m of middle Devonian limestones that are divided into about 10 m of Wapsipinicon Limestone in the deeper part of the quarry and about 18 m of overlying Cedar Valley Limestone (Fig. 11). The limestones composing these two formations accumulated in warm shallow seas that covered the midcontinent region about 370 to 395 million years ago. Although initially it would appear that conditions of deposition were fairly consistent for long periods so that thick limestones could accumulate, a closer examination of the Wapsipinicon shows that it contains a considerable amount of brecciation. The brecciation has been interpreted as being the result of the removal of soluble beds, such as gypsum or salt. Their removal then caused collapse of overlying limestone layers. Significantly, gypsum is currently being mined from the Spring Grove Dolomite Member of the Wapsipinicon at Mediapolis, Iowa, less than 80 km to the southwest. If removal of an evaporite bed were the actual cause of brecciation, it would appear that the formation accumulated in a restricted basin of deposition, such as a large lagoon. The water temperature and salinity may have been high because there was limited open circulation with the deeper oceans nearby and conditions were right for the deposition of evaporite materials. The scarcity of fossil forms indicates that the water did not support abundant life. Since brecciation and contorted bedding is restricted to the Wapsipinicon, removal of the soluble evaporite materials must have preceded the deposition of the overlying Cedar Valley.

The Cedar Valley Limestone must have been deposited under much different conditions. The absence of brecciation and contorted bedding and the presence of abundant fossil forms indicate that the seas were shallow, warm, and open to free circulation. (Fossil collecting is best from the bench upward.)

At the close of the Devonian Period, when seas withdrew from the midcontinent region, strata in this area were subjected to erosion before Mississippian seas advanced across the region. Although strata from this latter marine advance have not been identified from this vicinity, chert fragments from the overlying basal conglomerate of the Pennsylvanian Period contain fossil fragments indicative of the early and middle portions of the Mississippian time, indicating that Mississippian sedimentation did occur in this area. After Mississippian sedimentation ceased in this region, the land surface again stood above sea level and was so extensively eroded that all Mississippian rocks were removed, except for the relatively insoluble chert rubble. An uneven topography was developed; when shallow Early Pennsylvanian seas encroached upon the region, new sediments did not blanket all earlier strata. The higher hills and knobs of the older topography must have been low islands in the sea. Stream channels, sinkholes, and caves which developed on and in the old eroded surface were the first to receive earliest Pennsylvanian sediments consisting of sands, silts, and muds that later formed sandstone, siltstone, and shale. A description of the topography of this surface can be found under BACKGROUND, page 5.

Pennsylvanian deposits noted at this quarry seem to be only sinkhole fillings, although as the quarry is expanded farther south and west, more extensive Pennsylvanian strata should be encountered. Because of slumping, the exact relations are not always visible; so it is possible that the Pennsylvanian strata in the southwestern part of the quarry highwall could be located in a shallow stream channel on the old surface.

Overburden exposed along the southwestern part of the quarry reveals possible Kansan and Yarmouthian deposits beneath Illinois, Sangamonian, Wisconsinan, and Holocene materials.*

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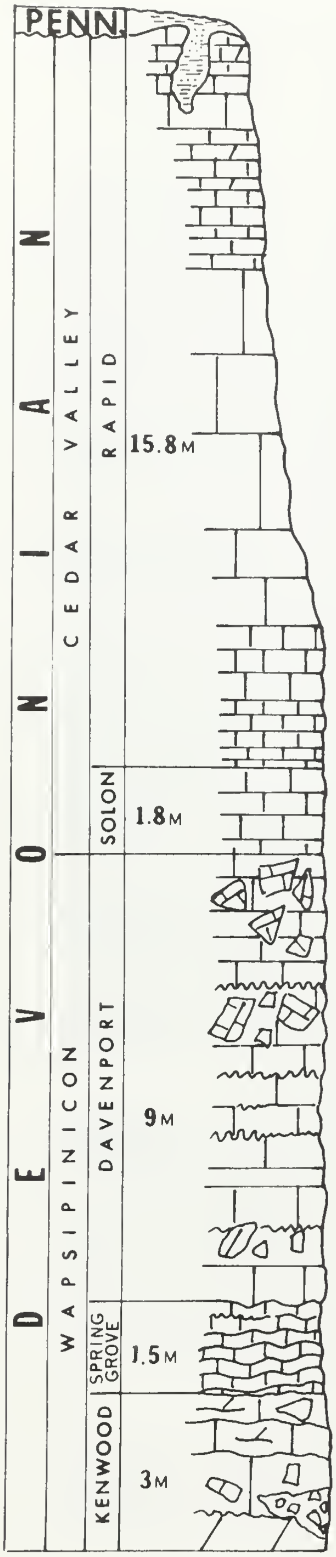
*Modified from the I.S.G.S. Milan Guidebook, 1974.



Sandstone, sandy greenish shale in solution cavities.

Limestone, gray to buff. *Cystodictya*, *Stropheodonta*, *Spirifer*. Bioherm with *Hexagonaria*, *Cystphyllum*, *Favosites*, *Cladopora*, and *Atrypa* common

Limestone, gray to buff, dolomitic, with abundant crinoids and some micro-conglomerate.

Many stromatoperoids and bryozoa with fossils listed above.

Limestone, greenish-gray to buffish-gray, fine grained, argillaceous, massive, weathers readily, oblique joints prominent.

Relatively few fossils.

Fossils present but not abundant.

Limestone, greenish-gray to grayish-brown, fine grained, argillaceous to shaley partings, weathers easily, fossiliferous. *Atrypa*, *Strophodonta*, *Leptostrophia*, *Chonetes*, *Spirifer*, *Schizophoria*, *Pentamerello*, *Heliophyllum*, *Cystiphyllum*, *Favosites*, *Productella*, also crinoidal.

Limestone, grayish-brown, sublithographic to fine grained, weathers with brown splotches, very fossiliferous. *Astreospongia*, Stromatoporoids, *Heliophyllum*, *Favosites*.

Limestone, very light gray, lithographic to sublithographic, brecciated, pyritic sandy streaks. Grades down to brownish-gray lithographic limestone.

Limestone, very light gray to light gray, lithographic to sublithographic, hard, brecciated to bedded.

Limestone, brown to brownish-gray, sublithographic with thin light-colored laminae.

Limestone, brownish-gray, sublithographic, fractures often calcite filled, some pyrite.

Limestone, gray, lithographic, contorted bedding, brecciated.

Limestone, light buff, very fine grained, dolomitic, wavy bedded, mostly thin bedded and slabby.

Limestone, blue-gray to brownish-gray, medium to coarse grained, thin dark wavy laminae at top, locally brecciated; dolomite in lower part. cavities numerous with crystals of pyrite, calcite, and quartz.

Figure 11. Stop 1. Collinson Stone Company quarry stratigraphic section. NW Sec. 24, T. 17 N., R. 2W., Rock Island County, Illinois. From 31st Tri-State guidebook, Edmund and Anderson, 1967.

Stop 2: Borrow pit east side of US 67.

SW NE SW Sec. 14, T. 17 N., R. 2 W., Milan 7.5' Quadrangle.

Devonian, Pennsylvanian, and Pleistocene strata are exposed in this locality.

The borrow pit exposes strata of Pennsylvanian age that are older than those seen at Stop 1. Above a gray underclay in the background is a 20 to 26 cm coal bed that is one of the oldest coals known in this part of the state. A gray silty shale lies above the coal. The shale is either locally nearly cut out by a sandstone channel that crosses the area or is replaced by a sandstone facies to the south (see Fig. 12). The large covered area near the center of the exposure obscures an important part of the section. The southern half of the east wall of the pit and the floor of the pit reveal Pennsylvanian strata dipping to the north and truncated to an even, nearly horizontal surface upon which Illinoian till was deposited. The till is overlain by Wisconsinan silts and thick loess. Along the southern part of the exposure, a Pleistocene channel was cut through Illinoian till to the bedrock surface and was later filled with Wisconsinan silts. Beneath this channel, bedrock strata have been considerably disturbed. Although a slight possibility exists that the Pleistocene channel had something to do with the disturbance, the location of the two features is coincidental.*

The Devonian-Pennsylvanian unconformity is exposed at several points along the north side of the Rock River for nearly 1 km east of Stop 2 (Section 14, T. 17 N., R. 2 W.). In addition to the exposure at this point, a second good exposure of basal Pennsylvanian sediments now exists on the bluff below the lodge in Black Hawk State Park (Stop 3, Fig. 13).

Although the Pennsylvanian-Devonian contact is approximately at river level, small knobs or "hills" of Devonian limestone are exposed in cross section along the Rock River. One of these is shown in Figure 5 and can be seen from Vandruff Island. It can be reached (though not easily) from Black Hawk State Park. The largest hill is exposed at Stop 2. The easternmost "hill" is approximately 3 m high and slightly irregular in form. The upper portion of the limestone is iron stained, with a sideridic top. Because the "hill" is essentially exposed only in cross section, the north-south extent is unknown.

The "hill" is overlain by 14 m of shale with some thin sandstone beds. Above the shale is a thick, cross-bedded sandstone. Both the shale and sandstone are unfossiliferous at this point.

About 100 m to the west is possibly another limestone "hill." This "hill" appears from the distance to be lower than the previously described one because the upper portion is weathered to a thin-bedded state resembling shale and thin-bedded sandstone. Less iron appears to be present here than at the eastern "hill." This second "hill" is also overlain by shale; but weathering, slumping, and vegetation obscure details of the section.

The top of the westernmost hill, 100 m east of US 67 (Stop 2), is approximately 10 m above the Rock River. It is heavily iron stained and in part replaced by iron. Because excavation has only exposed the top of this hill, its extent is not known.

Stop 3: (Lunch) Black Hawk State Park.

NE NW SE Sec. 14, T. 17 N., R. 2 W., Milan 7.5' Quadrangle.

Devonian and Pennsylvanian strata are exposed along the Rock River below and to the east of Watch Tower Inn.

(The following discussion is taken from the 31st Tri-State Geological Guidebook: The Mississippi River Arch, by R.W. Edmund and R.C. Anderson, Augustana College, 1967).

Black Hawk State Park preserves the most scenic portion of the lands once occupied by Saukenuk, the largest Indian village in the Upper Mississippi Valley. It was here that Chief Black Hawk and his band of Sauk and Fox came in conflict with the territorial claims of the white man in the years

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*Modified from the I.S.G.S. Milan Guidebook, 1974.

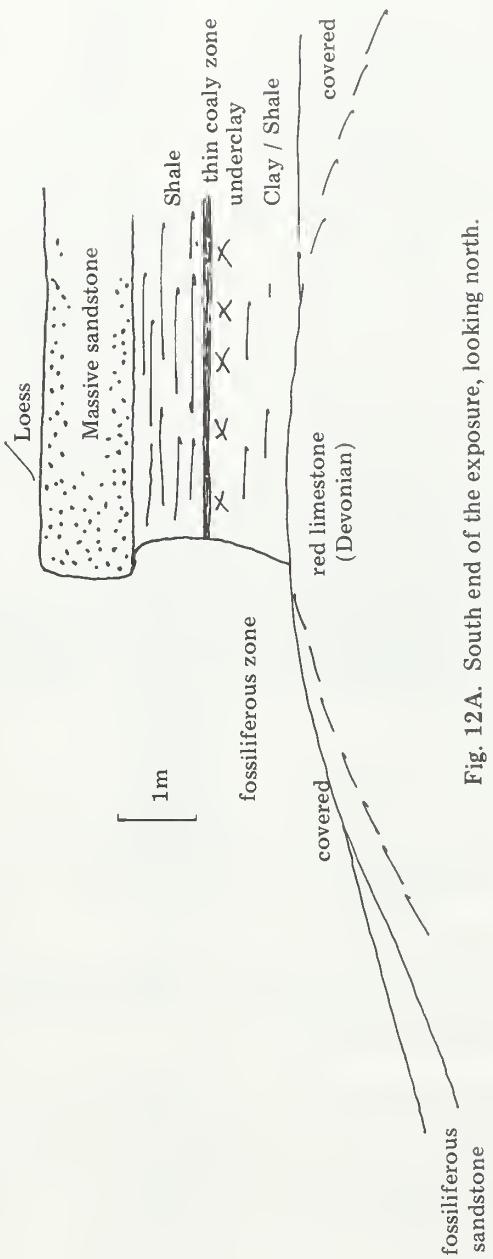


Fig. 12A. South end of the exposure, looking north.

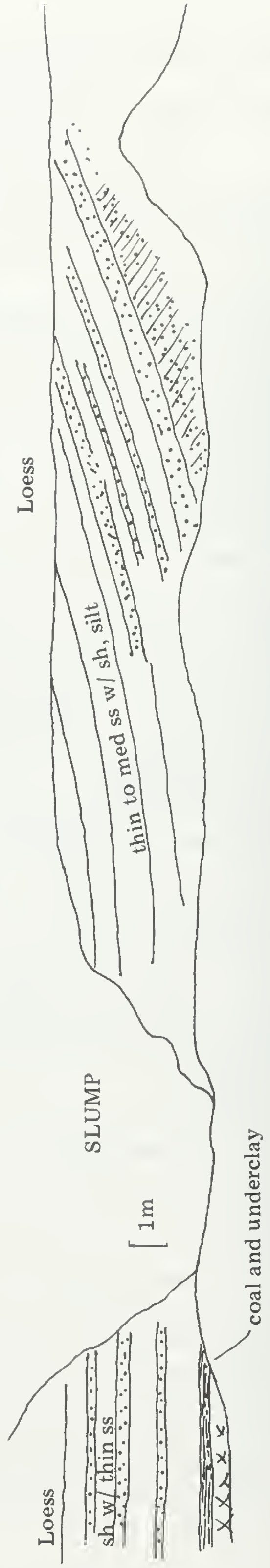


Fig. 12B. East side of the borrow pit.

Fig. 12. Stop 2. Borrow pit, east side of U.S. 67. SW NE SW Sec. 14, T. 17 N., R. 2 W., Milan quadrangle, Rock Island County, Illinois.

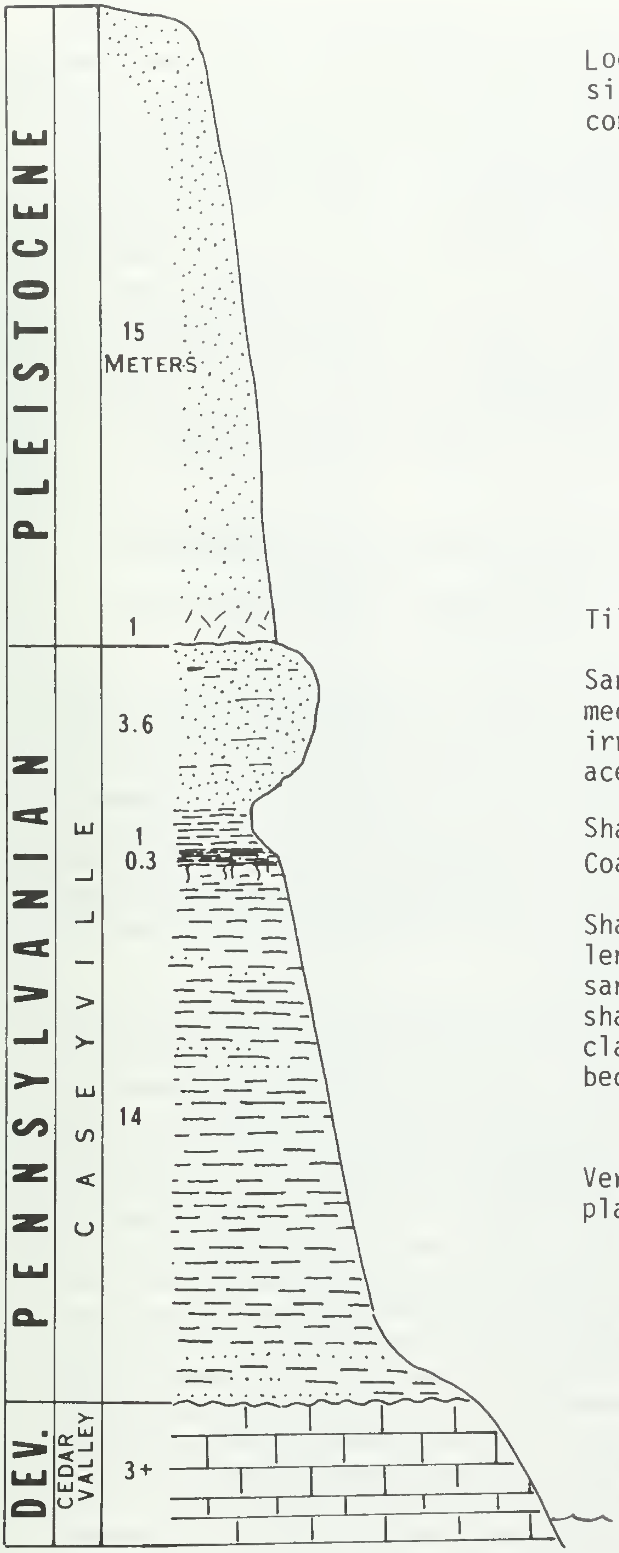


Figure 13. Stop 3. Stratigraphic section at Black Hawk State Park, Rock Island, Illinois.

preceding the Black Hawk War of 1832. The area is rich in Indian lore, and some of it can be savored in the Black Hawk Museum on the "Watch Tower."

From the Watch Tower, a high promontory on the north bluffs of the Rock River, many of the features of the landscape in the Rock Island area can be seen. This area is characterized by flat upland prairies greatly dissected along the major streams and by broad valleys bounded by steep bluffs and occupied by sizable streams such as the Rock River.

Chief Black Hawk is reported to have said, "At the Watch Tower, which was frequently visited by me alone I could sit and smoke my pipe and look with wonder and pleasure at the grand scenes that were presented by the sun's rays, even across the mighty water." The quarry on Vandruff's Island makes it impossible for us to view this scene with the same serenity as did Black Hawk, but it has provided some very fine exposures of the Devonian Cedar Valley limestone (and fossil-bearing basal Pennsylvanian, ed.). This will be our first stop upon leaving the park.

Within the confines of Black Hawk State Park the fossiliferous Cedar Valley limestone, Devonian, crops out along the north bank of the Rock River, exposing approximately ten feet of section above water level. The Devonian beds here are overlain by sandy carbonaceous shale and gray shale totaling approximately 40 feet of strata, Pennsylvanian in age. Fragments of plant fossils have been observed directly above the Devonian in fine silty sandstones and dark gray shales. The Pennsylvanian shales are overlain by about 50 feet of Pleistocene loess (Fig. 13).

The Pennsylvanian rocks at Black Hawk State Park are representative of the exposures found on the south side of Rock Island and Moline, adjacent to the Rock River.

Dr. Russel Peppers, paleobotanist at the Illinois State Geological Survey, has examined the spore flora in the coal in this section and determined that the coal is a unit in the Caseyville Formation of the McCormick Group, being older than the Reynoldsburg Coal Member and younger than the Gentry Coal Member. This particular coal has a number of spores not found in other Illinois coals. It seems likely that this coal is of limited extent and probably was deposited in a small, discontinous basin, as along an upper delta plain or abandoned stream channel. The overlying Rock Island (No. 1) Coal is likewise discontinuous and is thought to have been deposited in an estuary (Moody, unpublished thesis 1959; Wanless, 1975).

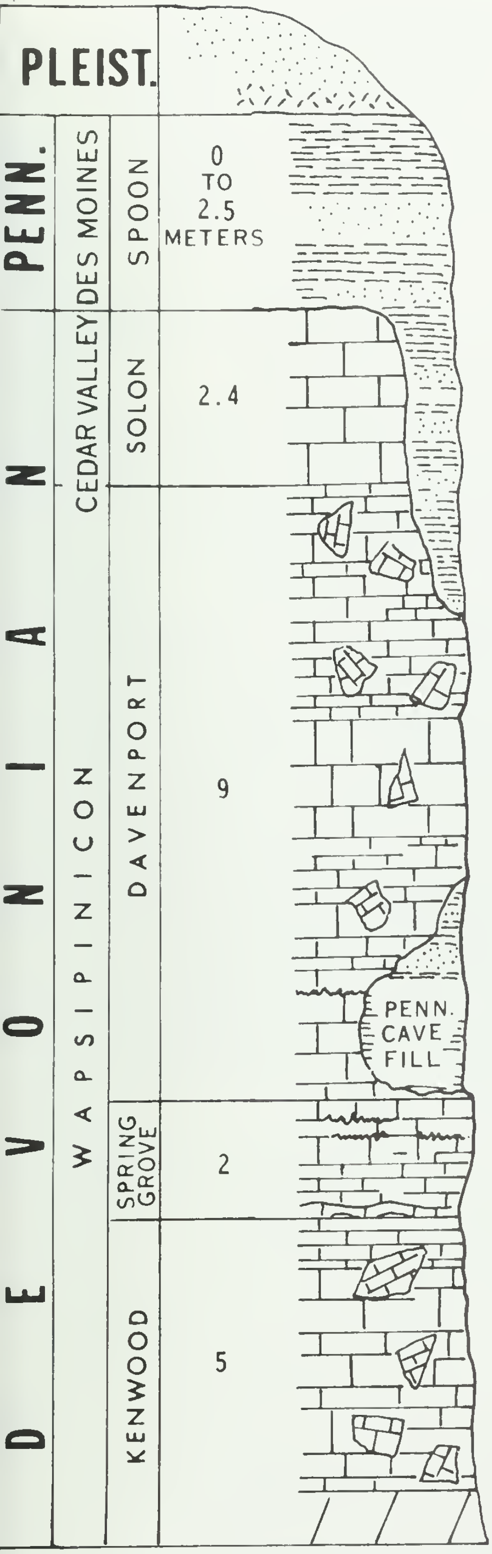
Stop 4. Allied Stone Company Quarry.

NW SW SE Sec. 14, T. 17 N., R. 2 W.,
Milan 7.5' Quadrangle.

Devonian, Pennsylvanian, and Pleistocene strata are exposed in this quarry (Fig. 14). This stop affords a better opportunity to study the lower part of the Wapsipinicon Limestone (Middle Devonian) than Stop 1. As noted previously, the Wapsipinicon contains only scattered fossils. The Solon Limestone Member is the only portion of the overlying Cedar Valley Limestone present here.

Here the Allied Stone Company is quarrying Cedar Valley and Wapsipinicon limestones of Middle Devonian age (Fig. 14) and crushing the stone for road and general construction stone. As we enter we will pass the field office, scales for weighing trucks loaded with crushed stone, piles of crushed stone of various sizes, the crushing plant, and maintenance shops. The quarry itself is nearly 1.6 km long, 0.5 km wide, and up to to 12 m deep. Because this is an active quarry, and the plant fossils occur within the overburden, locations of fossil-bearing strata change from year to year. Over large areas of the quarry the Devonian limestone was immediately overlain by outwash as a result of erosion and deposition during the Pleistocene. Few occurrences of Pennsylvanian strata can be observed.

Probably the most striking feature of this quarry is the presence of a number of channels and caves that developed in Devonian strata.



Loess and very thin glacial drift.

Shale, black to dark gray, fissile to blocky with interbedded thin sandstones. Grades down to greenish gray sandy shales and light colored pyritic sandstones.

Limestone, buff, fine to medium grained, numerous brachiopods.

Limestone, very light gray, sublithographic to lithographic, very brecciated, green clay and shale streaks, graded downward to greenish gray and light brownish gray limestone, hard and brittle, numerous wavy bands and irregular thin beds.

Cave fillings common with fine to medium angular sand interbedded with greenish clay and shale. Fragments of plants and much pyrite is common.

Limestone, very light gray to very light buff, dolomitic, lithographic to sublithographic, styolitic, weathers to thin slabs, some brecciation.

Limestone, brownish to bluish gray and dark colored, fine to coarsely crystalline with thin dark shale laminae, brecciated with shale and limestone matrix.

Dolomite, brownish-gray, fine grained.

Figure 14. Stop 4. Allied Stone Company quarry, stratigraphic section. SE¼, Sec. 14, T. 17 N., R. 2 W, Rock Island County, Illinois.

These features must have formed after the end of Mississippian deposition because they contain no sediments of Mississippian age. On the other hand, they must have existed before widespread Pennsylvanian sedimentation began in this area, for the sediments filling them are among some of the oldest-known Pennsylvanian strata in the state. These Pennsylvanian rocks occur stratigraphically lower than the Pennsylvanian layers at a neighboring borrow pit (Stop 2) and across the Rock River at Black Hawk State Park.

The solution features strongly suggest that this area was topographically high—part of the Mississippi River Arch—when they were formed. Four conditions contribute to the development of such large numbers of sinkholes: First, soluble rock, preferably limestone, must occur at or near the surface and should be flat-lying, or nearly so. Second, and one of the most important factors, the limestone should be dense, abundantly jointed, and preferably thinly bedded. The limestone should not be porous; if it is, rainwater will be absorbed, moving through the whole body of the rock rather than being concentrated along joints and bedding planes. Third, major valleys must be entrenched below the uplands, serving as outlets toward which the ground water can move in the subsurface. Fourth, there must be ample rainfall.

Sinkholes form in two ways. Collapse sinks, known as ponors, are caused by the collapse of the roofs of caves that lie near the surface. Caves were initially formed above the zone of saturation by ground water percolating downward (such water is called vadose water). Roof collapse followed uplift of the area and subsequent entrenchment of major drainage channels. Collapse sinks are generally deep and steep walled. A second type of sinkhole is called a doline, in which solution takes place along joints beneath the soil mantle so that the surface is gradually lowered without collapsing the rock mass. They do not require the presence of large subterranean cavities, most of them being shallow, saucer-shaped depressions. Their depth is controlled by the depth of the water table at the time of their formation. Both types of sinks are generally present in a sinkhole area, but dolines generally are more common.*

The basal Pennsylvanian deposits in this quarry have been the major source of plant fossils representing Early Pennsylvanian "upland" floras in Illinois. Although now largely removed by quarrying operations, some fossil-bearing channel deposits can be seen and plant fossils can be collected.

The plant fossils occur in the shale and mudstone which fill elongate depressions (channels) eroded in the Middle Devonian Cedar Valley Limestone. The channels are 4 to 6 m deep and 8 to 20 m wide. One channel can be seen in cross section at the top of the north wall at about mid-quarry. As of late 1978 they can best be seen at the west end of the quarry where several channels are visible in both cross section and horizontally (see diagram, Fig. 8). During the autumn of 1978 the best plant fossil collecting was in the channel nearest the large gravel pile (arrow on Fig. 7). The only Pennsylvanian animal fossils yet discovered here, a scorpion (Leary, in press) and a single fish scale, were found at this site in October, 1977.

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*Modified from the I.S.G.S. Milan Guidebook, 1974.

The following section on Mississippian deposition is taken from Illinois State Geological Survey Report of Investigations 216: *Classification of Genevievian and Chesterian . . . Rocks of Illinois* (1963) by D.H. Swann, pp. 11-16. The section on Pennsylvanian deposition is taken from Illinois State Geological Survey publications.

Mississippian Deposition

During the Mississippian Period, the Illinois Basin was a slowly subsiding region with a vague north-south structural axis. It was flanked by structurally neutral regions to the east and west, corresponding to the present Cincinnati and Ozark arches. These neighboring elements contributed insignificant amounts of sediment to the basin. Instead, the basin was filled by locally precipitated carbonate and by mud and sand eroded from highland areas far to the northeast in the eastern part of the Canadian Shield and perhaps the northeastward extension of the Appalachians. This sediment was brought to the Illinois region by a major river system, which it will be convenient to call the Michigan River (Fig. 15) because it crossed the present state of Michigan from north to south or northeast to southwest . . . .

The Michigan River delivered much sediment to the Illinois region during early Mississippian time. However, an advance of the sea midway in the Mississippian Period prevented sand and mud from reaching the area during deposition of the St. Louis Limestone. Genevievian time began with the lowering of sea level and the alternating deposition of shallow-water carbonate and clastic units in a pattern that persisted throughout the rest of the Mississippian. About a fourth of the fill of the basin during the late Mississippian was carbonate, another fourth was sand, and the remainder was mud carried down by the Michigan River.

Thickness, facies, and crossbedding . . . indicate the existence of a regional slope to the southwest, perpendicular to the prevailing north 65° west trend of the shorelines. The Illinois Basin, although developing structurally during this time, was not an embayment of the interior sea. Indeed, the mouth of the Michigan River generally extended out into the sea as a bird-foot delta, and the shoreline across the basin area may have been convex more often than concave.

. . . The shoreline was not static. Its position oscillated through a range of perhaps 600 to 1,000 or more miles (970-1,600 km). At times it was so far south that land conditions existed throughout the present area of the Illinois Basin. At other times it was so far north that there is no suggestion of near-shore environment in the sediments still preserved. This migration of the shoreline and of the accompanying sedimentation belts determined the composition and position of Genevievian and Chesterian rock bodies.

Lateral shifts in the course of the Michigan River also influenced the placement of the rock bodies. At times the river brought its load of sediment to the eastern edge of the basin, at times to the center, and at times to the western edge. This lateral shifting occurred within a range of about 200 miles (320 km). The Cincinnati and Ozark areas did not themselves provide sediments, but, rather, the Michigan River tended to avoid those relatively positive areas in favor of the down-warped basin axis.

Sedimentation belts during this time were not symmetrical with respect to the mouth of the Michigan River. They were distorted by the position of the river relative to the Ozark and Cincinnati shoal areas, but of greater importance was sea current or drift to the northwest. This carried off most of the mud contributed by the river, narrowing the shale belt east of the river mouth and broadening it west of the mouth. Facies and isopach maps of individual units show several times as much shale west of the locus of sand deposition as east of it. The facies maps of the entire Chesterian . . . show maximum sandstone deposition in a northeast-southwest belt that bisects the basin. The total thickness of limestone is greatest along the southern border of the basin and is relatively constant along that entire border. The proportion of limestone, however, is much higher at the eastern end than along the rest of the southern border, because little mud was carried southeastward against the prevailing sea current. Instead, the mud was carried to the northwest and the highest proportion of shale is found in the northwestern part of the basin.

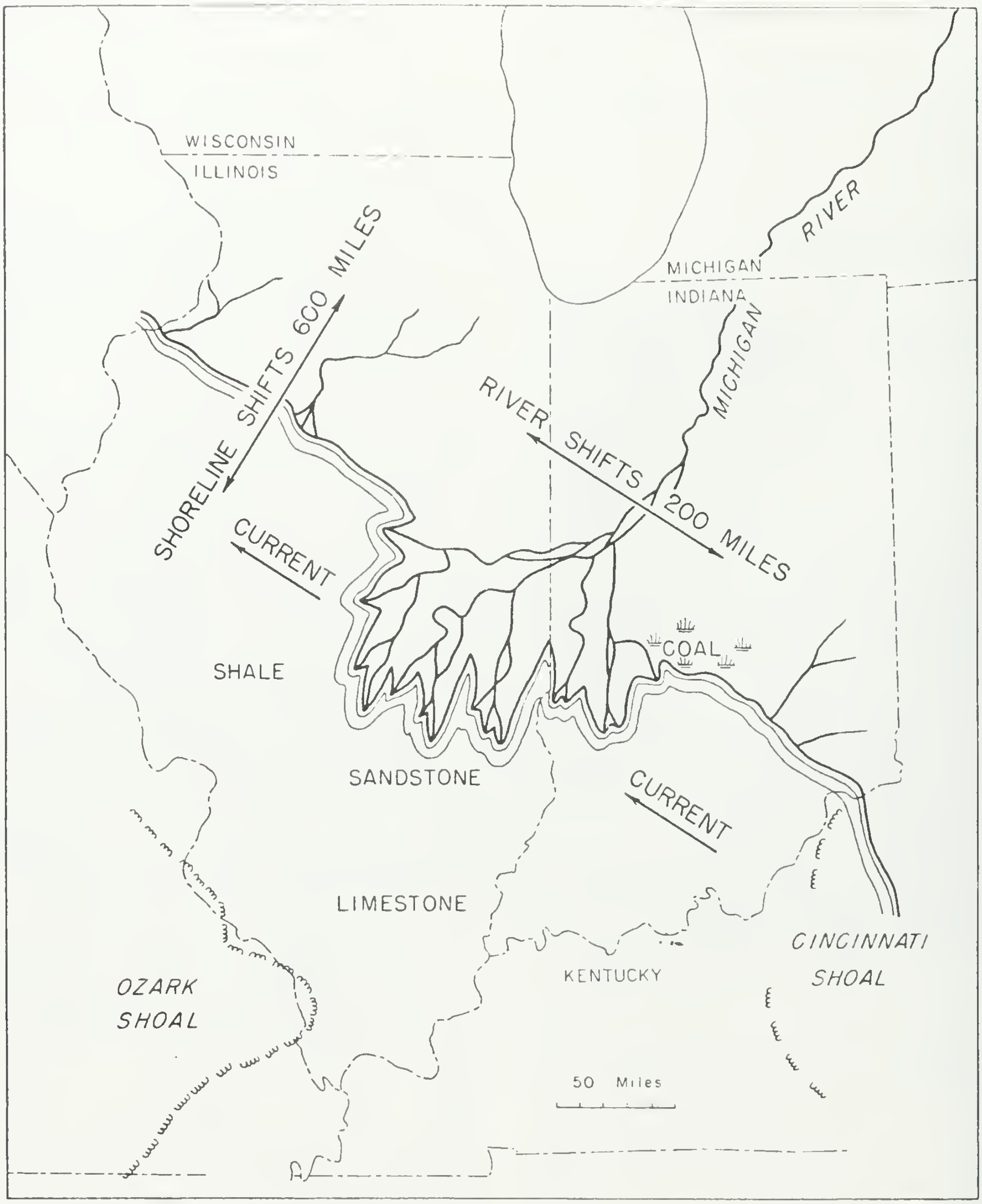

Figure 15. Paleogeography at an intermediate stage during Chesterian (Mississippian) sedimentation. From Swann, 1963.

Genevievian and Chesterian seas generally extended from the Illinois Basin eastward across the Cincinnati Shoal area and the Appalachian Basin. Little terrigenous sediment reached the Cincinnati Shoal area from either the west or the east, and the section consists of thin limestone units representing all or most of the major cycles. The proportion of inorganically precipitated limestone is relatively high and the waters over the shoal area were commonly hypersaline . . . . Erosion of the shoal area at times is indicated by the presence of conodonts erorded from the St. Louis Limestone and redeposited in the lower part of the Gasper Limestone at the southeast corner of the Illinois Basin . . . .

The shoal area included regions somewhat east of the present Cincinnati axis and extended from Ohio, and probably southeastern Indiana, through central and east-central Kentucky and Tennessee into Alabama . . . .

Toward the west, the seaway was commonly continuous between the Illinois Basin and Central Iowa, although only the record of Genevievian and earliest Chesterian is still preserved. The seas generally extended from the Illinois and Black Warrior regions into the Arkansas Valley region, and the presence of Chesterian outliers high in the Ozarks indicates that at times the Ozark area was covered. Although the sea was continuous into the Ouachita region, detailed correlation of the Illinois sediments with the geosynclinal deposits of this area is difficult.

Pennsylvanian Deposition

At the close of the Mississippian Period, about 310 million years ago, the Mississippian sea withdrew from the Midcontinent region. A long interval of erosion took place early in Pennsylvanian time and removed hundreds of feet of the pre-Pennsylvanian strata, completely stripping them away and cutting into older rocks over large areas of the Midwest. An ancient river system cut deep channels into the bedrock surface. Erosion was interrupted by the invasion of the Morrowan (early Pennsylvanian) sea.

Depositional conditions in the Illinois Basin during the Pennsylvanian Period were somewhat similar to those that existed during Chesterian (late Mississippian) time. A river system flowed southwestward across a swampy lowland, carrying mud and sand from highlands in the northeast. A great delta was built out into the shallow sea. As the lowland stood only a few feet above sea level, only slight changes in relative sea level caused great shifts in the position of the shoreline.

Throughout Pennsylvanian time the Illinois Basin continued to subside while the delta front shifted owing to worldwide sea level changes, intermittent subsidence of the basin, and variations in the amounts of sediment carried seaward from the land. These alternations between marine and nonmarine conditions were more frequent than those during pre-Pennsylvanian time, and they produced striking lithologic variations in the Pennsylvanian rocks.

Conditions at various places on the shallow sea floor favored the deposition of sandstone, limestone, or shale. Sandstone was deposited near the mouths of distributary channels. These sands were reworked by waves and spread as thin sheets near the shore. The shales were deposited in quiet-water areas—in delta bays between distributaries, in lagoons behind barrier bars, and in deeper water beyond the near-shore zone of sand deposition. Most sediments now recognized as limestones, which are formed from the accumulation of limey parts of plants and animals, were laid down in areas where only minor amounts of sand and mud were being deposited. Therefore, the areas of sandstone, shale, and limestone deposition continually changed as the position of the shoreline changed and as the delta distributaries extended seaward or shifted their positions laterally along the shore.

Nonmarine sandstones, shales, and limestones were deposited on the deltaic lowland bordering the sea. The nonmarine sandstones were deposited in distributary channels, in river channels, and on the broad floodplains of the rivers. Some sand bodies, 100 or more feet thick (30 m), were deposited in channels that cut through many of the underlying rock units. The shales were deposited mainly on floodplains. Freshwater limestones and some shales were deposited locally in freshwater lakes and swamps. The coals were formed by the accumulation of plant material, usually where it grew, beneath the quiet waters of extensive swamps that prevailed for long intervals on the emergent delta lowland. Lush forest vegetation, which thrived in the warm, moist Pennsylvanian climate, covered the region. The origin of the underclays beneath the coals is not precisely known, but they were probably deposited in the swamps as slackwater muds before the formation of the coals. Many underclays contain plant roots and rootlets that appear to be in their original places. The formation of coal marked the end of the nonmarine portion of the depositional cycle, for resubmergence of the borderlands by the sea interrupted nonmarine deposition, and marine sediments were then laid down over the coal.

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Plate 1

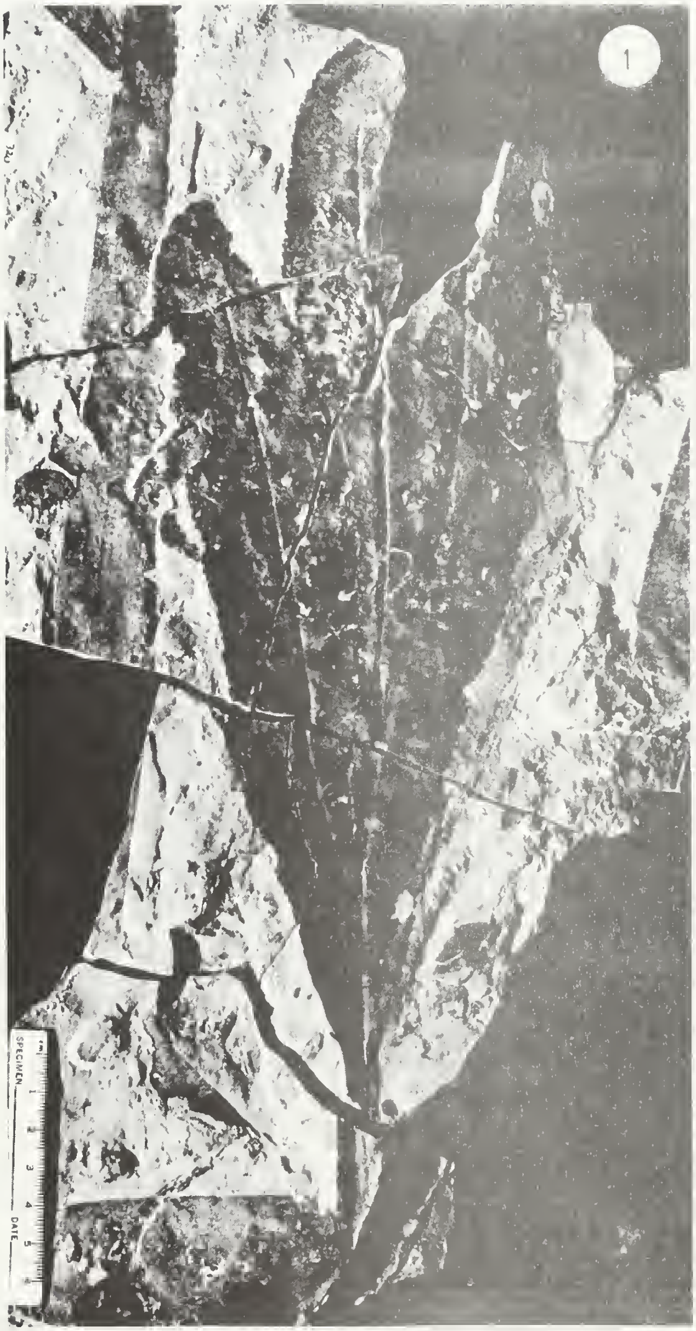


Fig. 1. *Megalopteris dawsoni* x ½

Fig. 2. *Lesleya cheimarosa* x ½

Plate 2

Fig. 1. *Megalopteris ovata* x1

Fig. 2. *Megalopteris ovata* ? x1

Plate 3

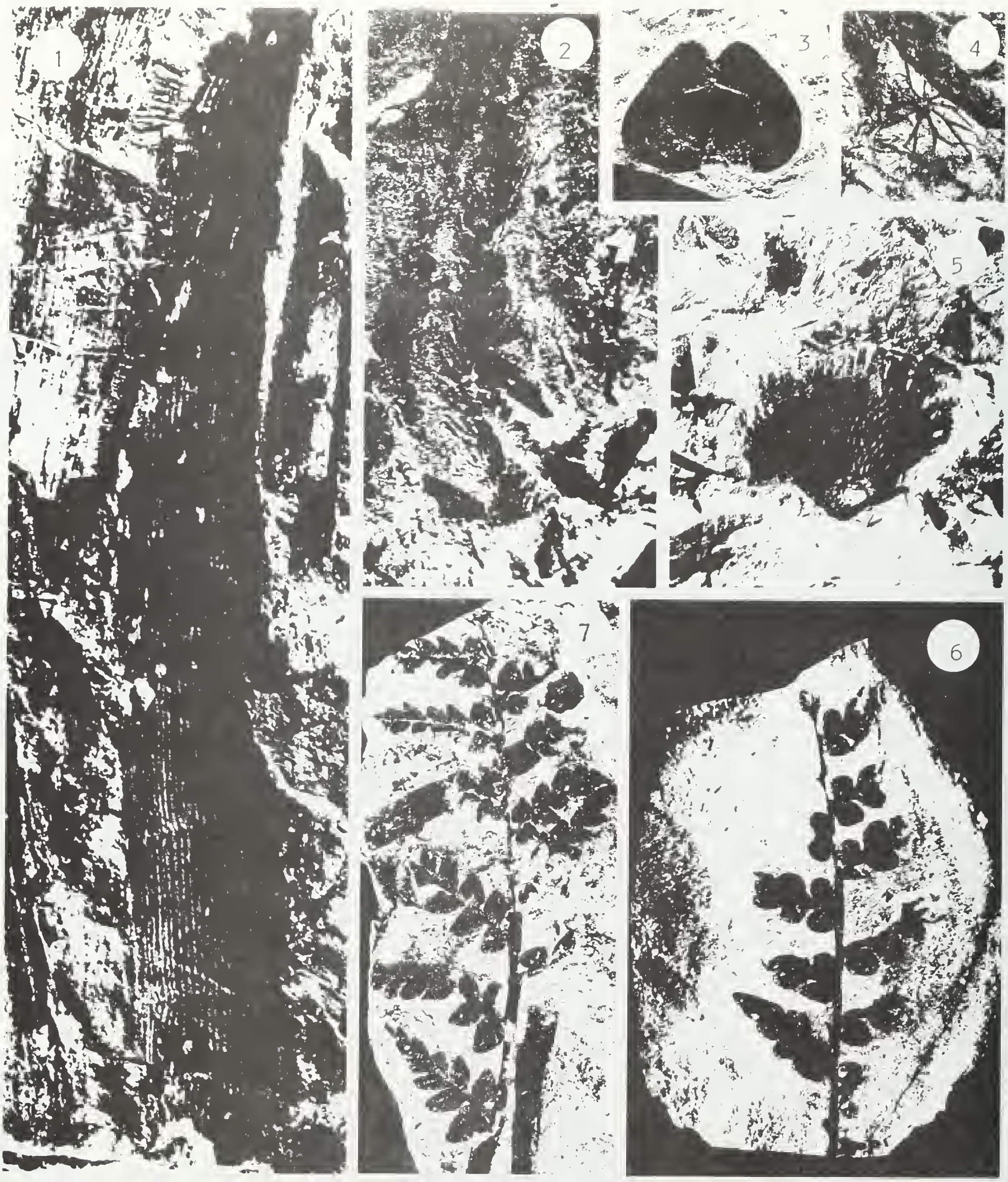


Fig. 1. *Mesocalamites* sp. x1

Fig. 2. *Gulpenia* sp. x2

Fig. 3. *Samaropsis newberryi* x1

Fig. 4. *Sphenophyllum tennerrimum* x1

Fig. 5. *Lacoea seriata* x1

Fig. 6. *Sphenopteris* sp. x1

Fig. 7. *Mariopteris* sp. x1

Plate 4

Fig. 1. *Palaeopteridium reussii* x2
Fig. 2. *Sphenopteris* sp. x1
Fig. 3. *Sphenopteris* sp. x1
Fig. 4. *Sphenophyllum cuneifolium* ? x2
Fig. 5. *Samaropsis newberryi* x1

Plate 5

Fig. 1. *Lepidostrobus* sp. x¾

Fig. 2. *Lepidodendron* sp. x1

Fig. 3. *Lepidocarpon* sp. x2

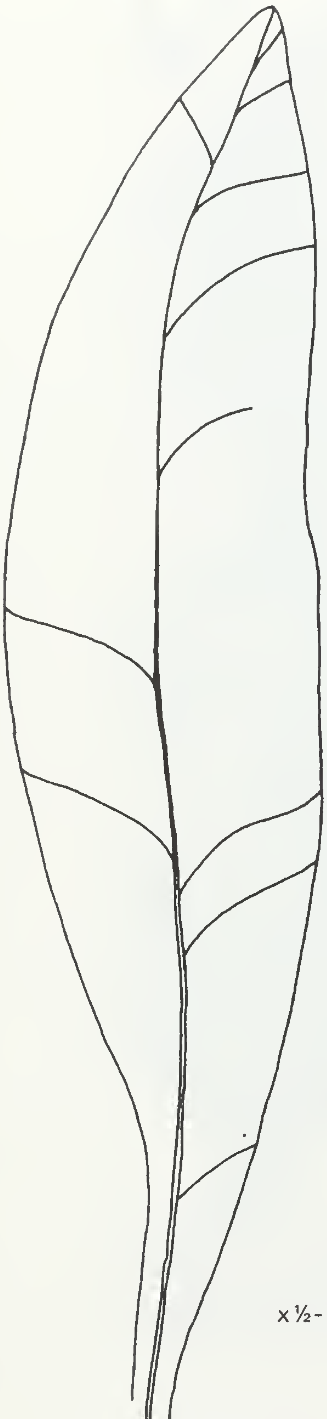
Fig. 4. *Lepidocarpon* sp. x2

Fig. 5. *Sphenophyllum* sp. x1

Fig. 6. *Triletes auritus* tetrad x5

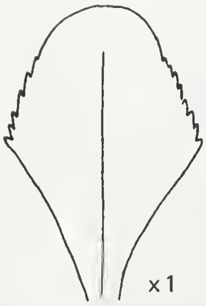
Fig. 7. *Triletes auritus* tetrad x15

SKETCHES OF LOWER PENNSYLVANIAN PLANT FOSSILS OF WESTERN ILLINOIS



x ½ - 1

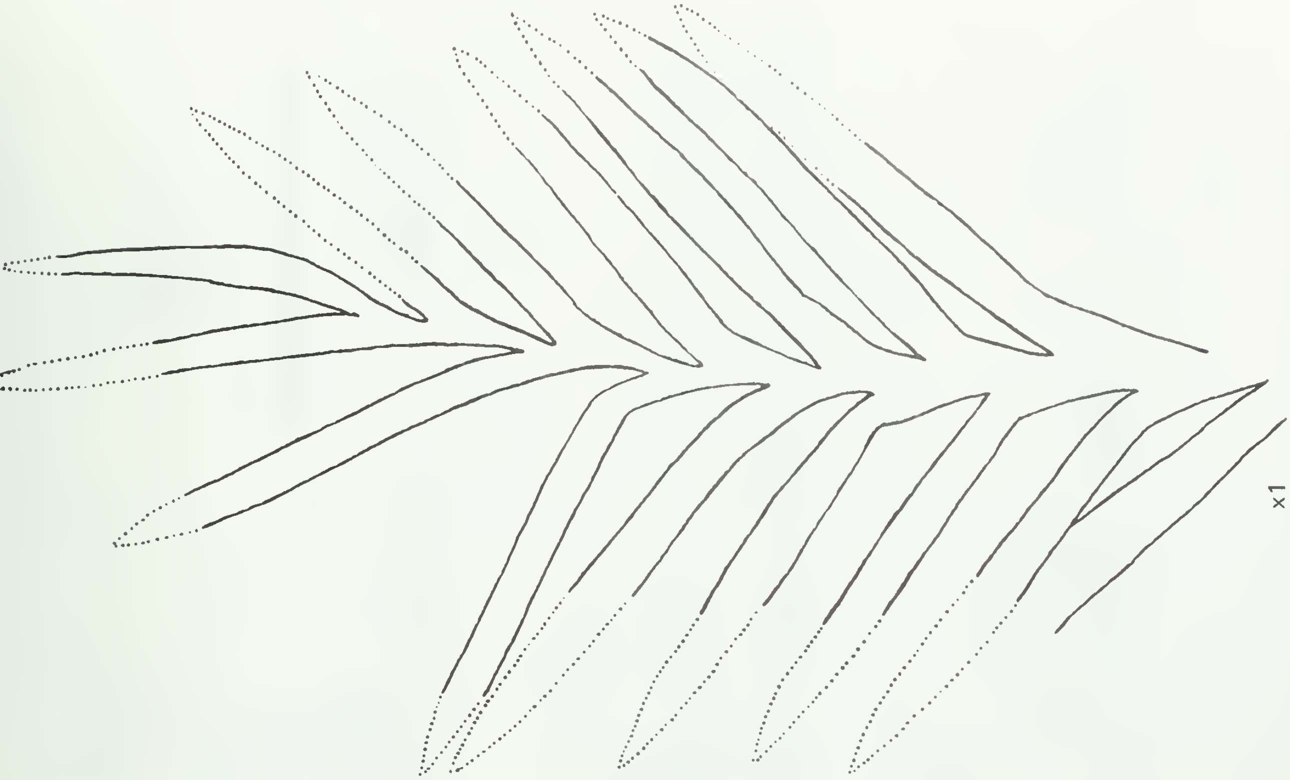
Lesleya



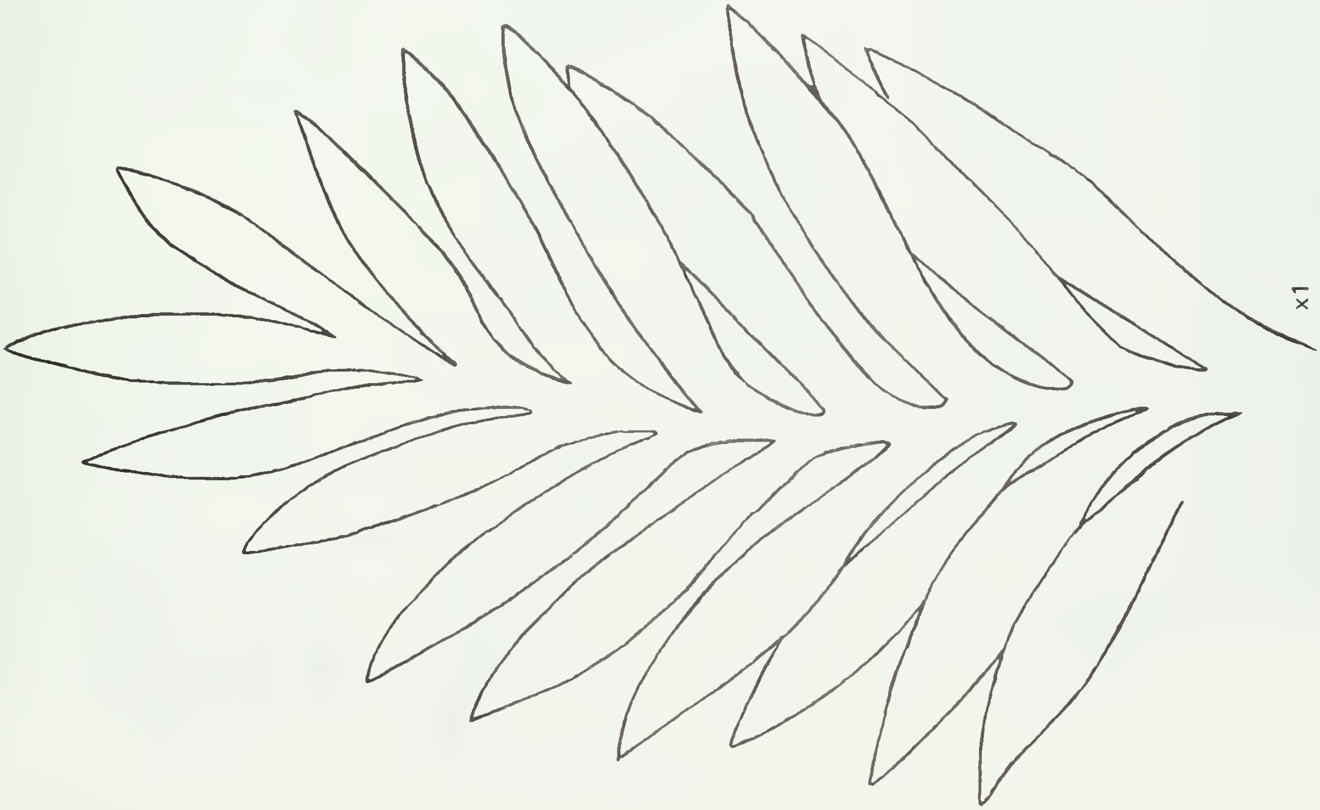
x 1

x ½

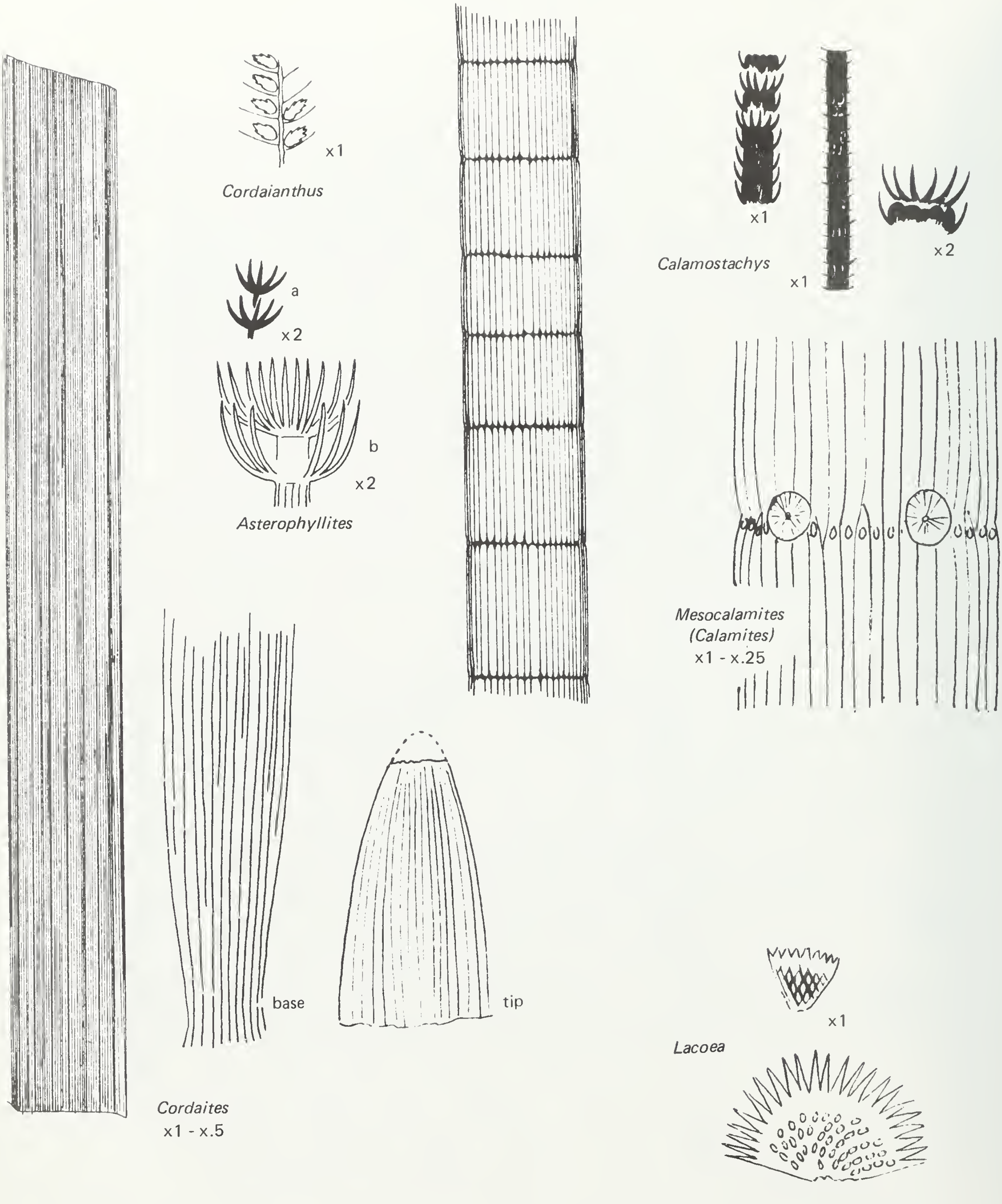
Megalopteris



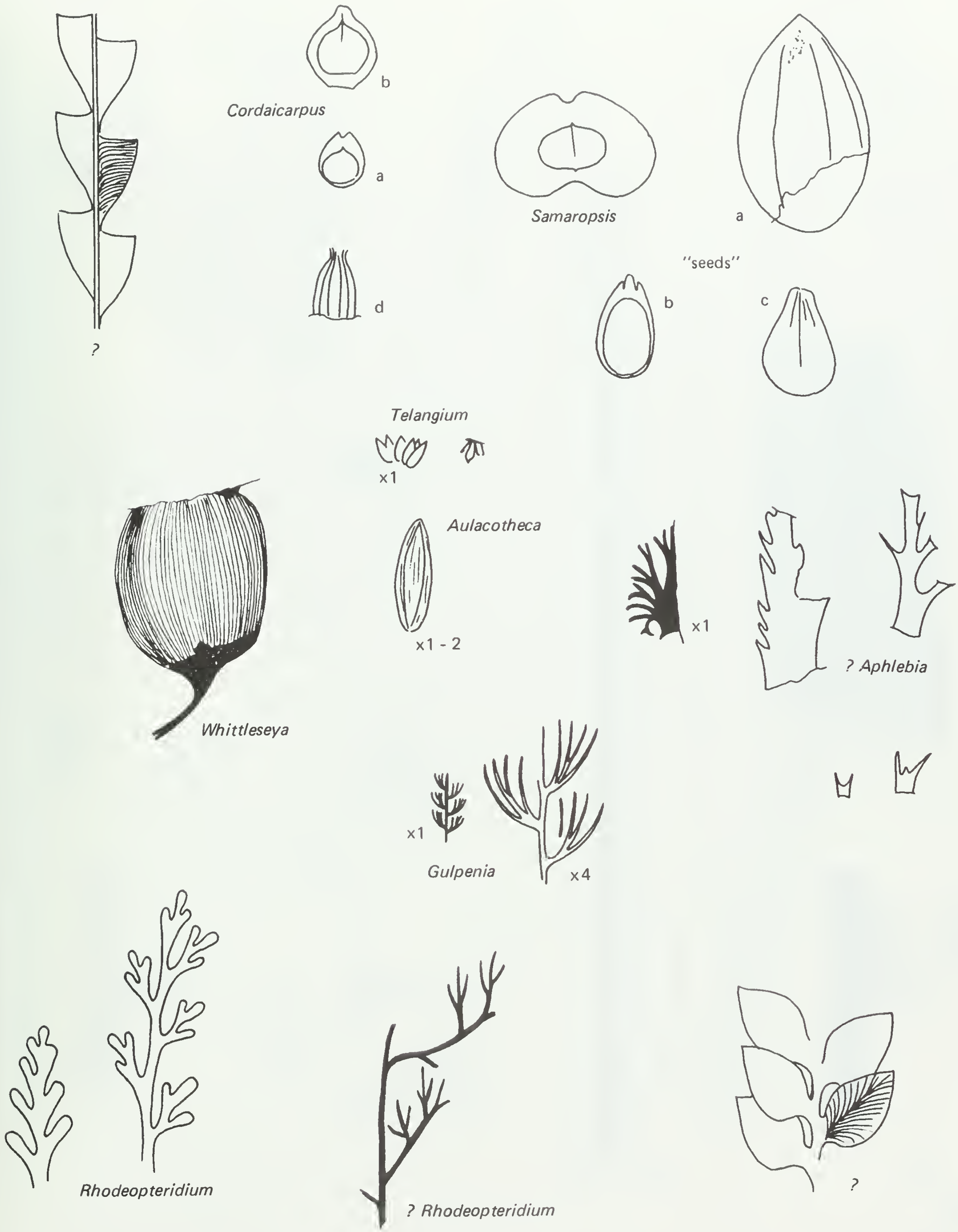
x1

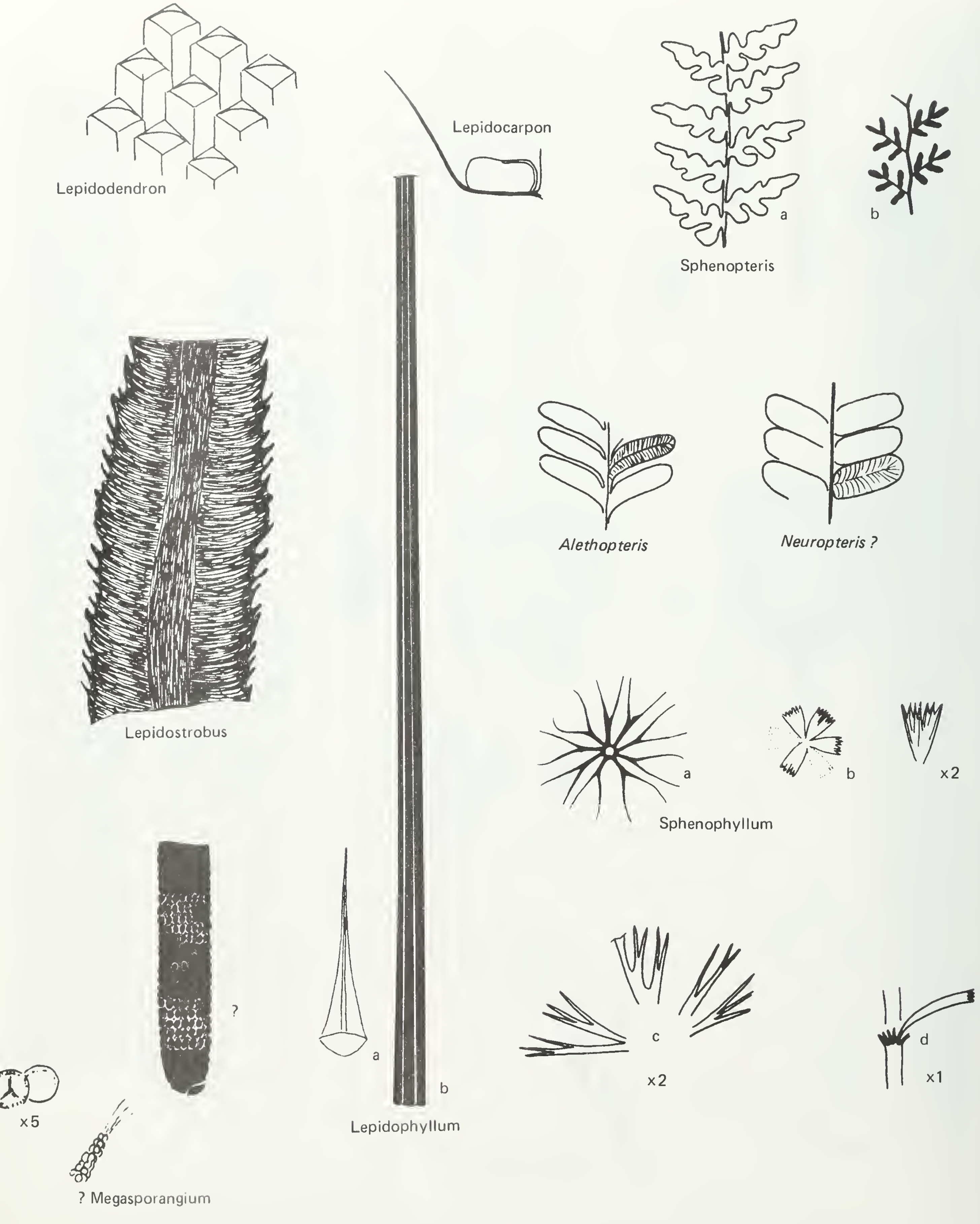


x1



x1
Cordaianthus
a
x2
b
x2
Asterophyllites
x1
x2
Calamostachys
x1
Mesocalamites
(Calamites)
x1 - x.25
base
tip
Cordaites
x1 - x.5
x1
Lacoea


?
Cordaicarpus
b
a
d
Samaropsis
a
"seeds"
b
c
Telangium
x1
Aulacotheca
x1 - 2
x1
? Aphlebia
Whittleseya
x1
Gulpenia
x4
Rhodeopteridium
? Rhodeopteridium
?

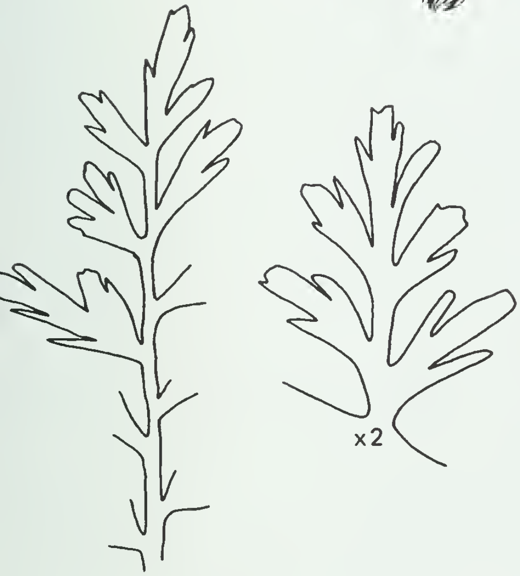

Lepidodendron
Lepidocarpon
a
b
Sphenopteris
Lepidostrobus
Alethopteris
Neuropteris ?
a
b
x2
Sphenophyllum
?
x5
? Megasporangium
a
b
Lepidophyllum
c
x2
d
x1

?

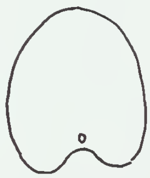
x1

Alloiopteris

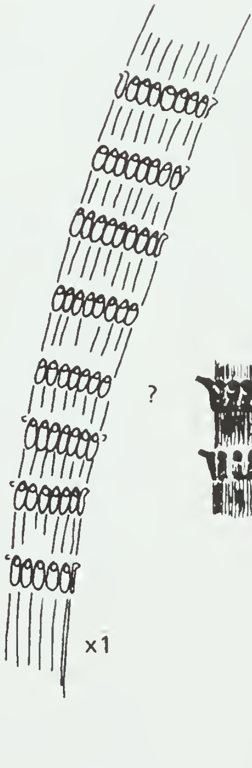
x2

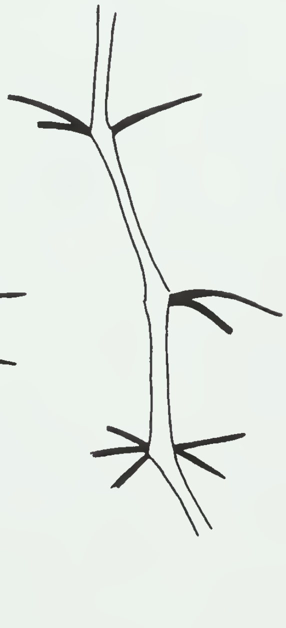


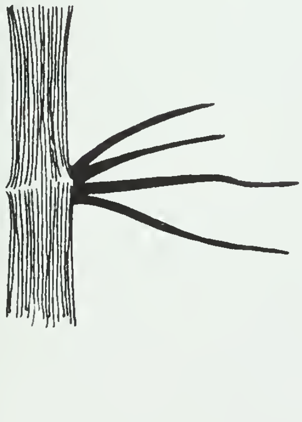
x2



Cyclopteris







?

x2

x1

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