The paleoflora of the lower Cutler Formation (Pennsylvanian, Desmoinesian?) in El Cobre Canyon, New Mexico, and it's biochronological significance

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THE PALEOFLORA OF THE LOWER CUTLER FORMATION (PENNSYLVANIAN, DESMOINESIAN?) IN EL COBRE CANYON, NEW MEXICO, AND ITS BIOCHRONOLOGICAL SIGNIFICANCE

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Abstract——Two new megafossil plant localities have been discovered in megasequence one of the Cutler Formation in El Cobre Canyon. Megasequence one also contains putative Late Pennsylvanian vertebrates. Plant taxa present at NMMNH localities 2575 and 2576 in megasequence one are *Neuropteris scheuchzeri, Alethopteris serlii, A. ambigua, Sigillaria rugosa, Cyperites bicarinatus, Cyathocarpus* cf. *P. arborescens* and indeterminate seeds. These taxa suggest an age possibly as old as Middle Pennsylvanian (Desmoinesian) for megasequence one and its tetrapod fauna.

INTRODUCTION

El Cobre Canyon is a large box canyon in north-central New Mexico (Fig. 1) most readily reached by traversing several kilometers of the rocky bed of Arroyo del Cobre. Despite its remoteness, El Cobre Canyon has been the focus of much paleontological interest for more than a century. The main portion of the canyon is a U-shaped valley with extensive exposures of the Cutler Formation, which have yielded a significant vertebrate fauna, including *Limnoscelis,* long considered the oldest reptile. Other exposures of the Cutler Formation in north-central New Mexico have also yielded significant vertebrate faunas that are unequivocally Early Permian in age. However, the El Cobre Canyon fauna has generally been considered older and possibly Pennsylvanian in age (e.g., Williston and Case, 1912; Fracasso, 1980). Plant megafossils from El Cobre Canyon have been used as evidence for a Late Pennsylvanian age for some of the Cutler strata in El Cobre Canyon (Fracasso, 1980), but these plant fossils have not been described. We have collected fossil plants from the locality mentioned by Fracasso (1980). Here, we describe the paleoflora from this and other localities and discuss its biochronological significance. In this article, NMMNH refers to New Mexico Museum of Natural History, Albuquerque.

GEOLOGICAL SETTING

El Cobre Canyon (Fig. 1) is at the core of a breached anticline. The majority of the steep walls, which reach 300 m in height, and the entire bottom of the canyon are composed of red beds assigned to the Cutler Formation (Smith et al., 1961). The upper portions of the canyon walls are composed of the lower part of the Upper Triassic Chinle Group (Lucas and Hunt, this volume). Smith et al. (1961) mapped the canyon, and Fracasso (1987) undertook a preliminary sedimentological analysis of the Cutler strata exposed there. However, the most thorough studies of the stratigraphy and sedimentology of the Cutler Formation in El Cobre Canyon and surrounding areas have been by Eberth (1987; Eberth and Berman, 1983; Eberth and Miall, 1991).

Eberth (1987) divided the Cutler Formation in north-central New Mexico into three megasequences of fluvial origin. The oldest of these is megasequence one. This is only exposed in El Cobre Canyon and is the source of the putative Late Pennsylvanian tetrapods and of the megafossil plants described here. We believe that this megasequence is a mappable unit that can be distinguished lithologically from the overlying portion of the Cutler Formation and should be distinguished either as a member of the Cutler Formation or as a distinct formation.

Megasequence one is distinguished from the other megasequences by its drab colored strata, an abundance of laterally offset, multistoried sandstone sheets, numerous, thick intervals of interlaminated and shaly sandstone-siltstone-claystone units, few major sandstone ribbons, an absence of U-shaped mixed-fill units and extensively bioturbated interchannel deposits (Eberth, 1987; Eberth and Miall, 1991). Fluvial
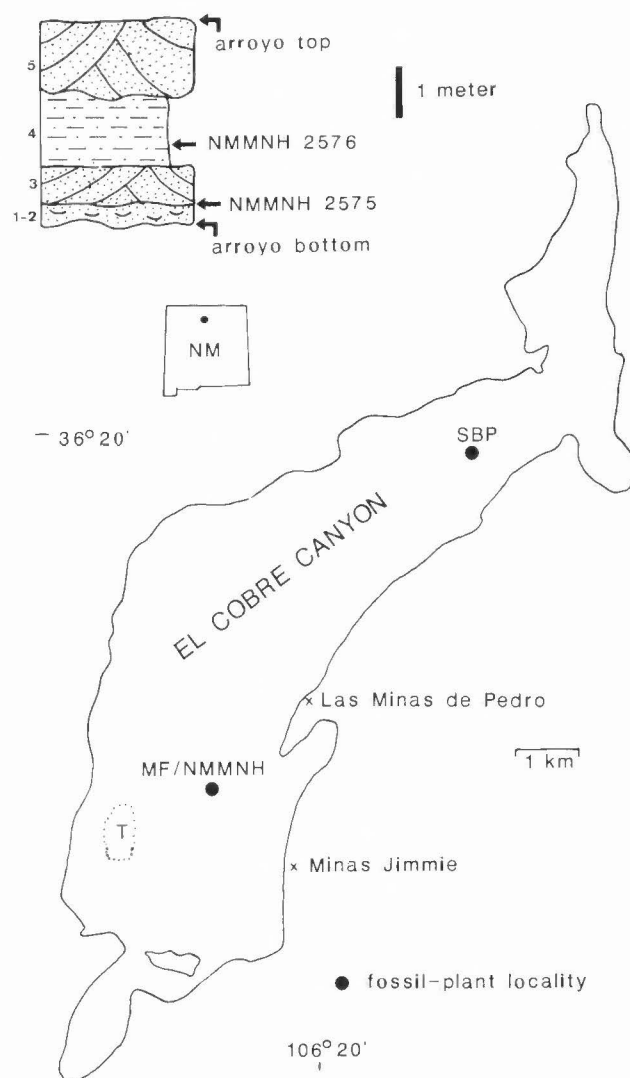
FIGURE 1. Map of El Cobre Canyon outlined by the contact between the Cutler Formation (within canyon) and younger strata, and measured stratigraphic section at NMMNH localities (see Appendix for description of numbered lithologic units). Abbreviations are: MF/NMMNH, plant localities reported by Fracasso (MF-4: Fracasso, 1980) and NMMNH localities 2575 and 2576; SBP, plant locality reported by Smith et al. (1961); T, collecting area for tetrapods in megasequence one.

style during deposition of this unit was characterized by poorly confined, shallow braided channels (Eberth, 1987; Eberth and Miall, 1991). In-channel flow was probably seasonal, but the floodplain probably remained wet for extended periods of time (Eberth, 1987; Eberth and Miall, 1991).

During the deposition of megasequence one, the climate was semi-arid, but floodbasin ponds were common (Eberth, 1987; Eberth and Miall, 1991). The plant fossils described below occur at two localities in fissile mudstone, siltstone and fine-grained sandstone rich in organic debris, which we interpret to represent floodbasin ponds.

Both new plant localities occur in the wall of a major tributary of Arroyo del Cobre (Fig. 1). The section here consists of 4.0+ m of the lower part of the Cutler Formation (Appendix). The principal locality is NMMNH locality 2576 (UTM 4016450N, 378750E, zone 13), which is in a sandy siltstone (Fig. 2). Megafossil plants are common but not as well preserved at NMMNH locality 2575 (same map coordinates as NMMNH locality 2576), which occurs in a sandstone. These localities are apparently approximately 8–10 m below the tetrapod-bearing beds. There is no doubt that the plant locality described by Smith et al. (1961) occurs adjacent to a fault plane. Eberth (1987, fig. 3) showed the area of Fracasso's locality (and NMMNH localities 2575 and 2576) transected by a fault. However, the exact location of NMMNH localities 2575 and 2576 is about 0.5 km northwest from this fault.

Eberth (1987) also noted the presence of normal faults in the area where the tetrapods were collected. However, we disagree with Eberth (1987) in considering that there might be significant displacement between the plant and vertebrate localities, or at least the majority of them. NMMNH localities 2575 and 2576 lie at the northwestern corner of the outcrop mapped by Eberth as being the area collected by Fracasso. This is on the same side of the main southwest-northeast fault as the majority of the vertebrate localities. Eberth (1987) mapped the plant beds as crossing this supposed major fault with no offset. Also, we noted no major offset along the faults mapped by Smith et al. (1961, pl. 6) or Eberth (1987, fig. 3) through the vertebrate collecting localities. Thus, we conclude that there is negligible fault offset between NMMNH localities 2575 and 2576 and the vertebrate localities.

Brief reconnaissance suggests that plant-bearing, carbonaceous beds, such as those reported here and by Smith et al. (1961) and Fracasso (1980), are restricted to the lowest exposures of the Cutler Formation in El Cobre Canyon. Higher stratigraphic intervals are dominated by more oxidized sediments. This is in broad agreement with Eberth's (1987; Eberth and Miall, 1991) conclusion that Cutler sediments document increasingly arid environments upward through the formation.

PREVIOUS STUDIES

Four megafossil-plant localities have been reported from the Cutler Formation of El Cobre Canyon (Fontaine, 1890; Smith et al., 1961;

FIGURE 2. Photograph of NMMNH locality 2576 (asterisk) and numbered units (Fig. 1; Appendix) from the measured section at this locality.

Fracasso, 1980; Eberth, 1987). Fontaine described two pith casts as the new species *Equisetum abiquiense* and *E. knowltoni*. Fontaine (1890) and Knowlton (1890) believed that these fossils were Triassic in age. There are Late Triassic plant fossils from El Cobre Canyon which derive from two copper mines in the Agua Zarca Formation (Lucas and Hunt, this guidebook). These mines are the Las Minas de Pedro and Las Minas Jimmie (Fig. 1; Ash, 1974). However, the fossils described by Fontaine are from the:

> new copper mines, which were opened during the spring of 1889, are in the northwestern part of the basin. They are located in a white very coarse-grained sandstone which, as there exposed, forms the floor of the basin and is consequently several hundred feet lower than the old [Agua Zarca] mines (Knowlton, 1890, p. 282).

As noted by Ash (1972, 1974), this location is clearly at the base of the canyon where only the Cutler Formation is exposed. Ash (1974) was unable to locate the new mines or the holotypes of Fontaine's taxa. We were able to identify adits fitting this description in megasequence one. They are in the vicinity of the vertebrate localities at the base of the west wall of the canyon. These adits are located in a white bench-forming sandstone. However, these adits are not shown in the 1953 Canjilon SE USGS 7.5-minute topographic map of the area and appear to be relatively new excavations. Thus, we conclude that they are not the mines referred to by Fontaine and Knowlton.

Smith et al. (1961, p. 5) reported a small exposure of carbonaceous, gypsiferous and micaceous siltstone that yielded fossil plants in the floor of the northern part of the canyon (Fig. 1). C. B. Read identified this flora as being dominated by *Alethopteris serlii* (Smith et al., 1961). Smith et al. (1961) subsequently mapped a small area of Pennsylvanian strata, distinct from the Cutler Formation, around this fossil locality.

Fracasso (1980) reported the discovery of a third plant locality in megasequence one. S. Mamay identified *Alethopteris serlii* and *Neuropteris scheuchzeri* from this locality. The localities reported here (NMMNH localities 2575 and 2576) are at Fracasso's locality.

Eberth (1987, fig. 77) noted the presence of common plant fossils within channel lag deposits in El Cobre Canyon and illustrated a *?Calamites* stem from an undetermined locality in megasequence one.

SYSTEMATIC PALEOBOTANY

Kingdom **Plantae**
Division **Lycopodiophyta**
Class **Lycopsida**
Order **Lepidodendrales**
Family **Sigillariaceae**
Genus *Sigillaria* Brongniart, 1822
Sigillaria rugosa Brongniart, 1822
Fig. 3F

Referred specimens—NMMNH P-18255–18257 (NMMNH locality 2575).

Description—Ribs slightly convex and undulate and about 10 mm wide; rib divided by a central ridge, and on either side are longitudinal striae; narrow and slightly undulatory furrows lie between the ribs; leaf scars relatively poorly preserved, oblong, about 4 mm long and 2 mm wide and spaced about 25 mm apart.

Discussion—These specimens represent *Sigillaria* because of the close similarity of these specimens to others referred to this genus (e.g., Tidwell et al., 1970, fig. 11n; Tidwell, 1988, fig. 3B). The El Cobre specimens are very similar to specimens from the Pennsylvanian of Pennsylvania assigned to this taxon by Oleksyshyn (1982, fig. 8G–H). There are no lateral or parichnos scars, which is probably due to poor preservation. Species with elongate leaf scars include *S. rugosa, S. candollei, S. schlotheimiana* and *S. elongata* (Tidwell, written comm. 1992).

Genus *Cyperites* Lindley and Hutton, 1832
Cyperites bicarinatus Lindley and Hutton, 1832
Fig. 3C

Referred specimens—NMMNH P-18263–18265 (NMMNH locality 2575); NMMNH P-18253–18254 (NMMNH locality 2576).

Description—Long "grass-like" leaves, 3 mm wide; single median vein; stomatal grooves on either side of vein and lie midway between vein and margins; leaf margin entire.

Discussion—This taxon is very distinct and easily recognizable even in fragmentary specimens. NMMNH P-18263 (Fig. 3C) is similar to specimens from Pennsylvania assigned to this taxon (Oleksyshyn, 1982, fig. 9B). Various authors have suggested that *Cyperites* was borne on species of *Sigillaria* and *Lepidodendrum* (Cridwell, 1966; Tidwell et al., 1974). At NMMNH localities 2575 and 2576 *Cyperites* occurs with *Sigillaria*.

Division **Pteridospermophyta**
Order **Medullosales**
Family **Alethopteridaceae**
Genus *Alethopteris* Sternberg, 1825
Alethopteris ambigua Lesquereux, 1880
Fig. 3A

Referred specimens—NMMNH P-18261 (in part) (NMMNH locality 2575); NMMNH P-18197–18199, 18202, 18205, 18207, 18209, 18211, 18219–18220, 18244, 18247–18248, 18249 (NMMNH locality 2576).
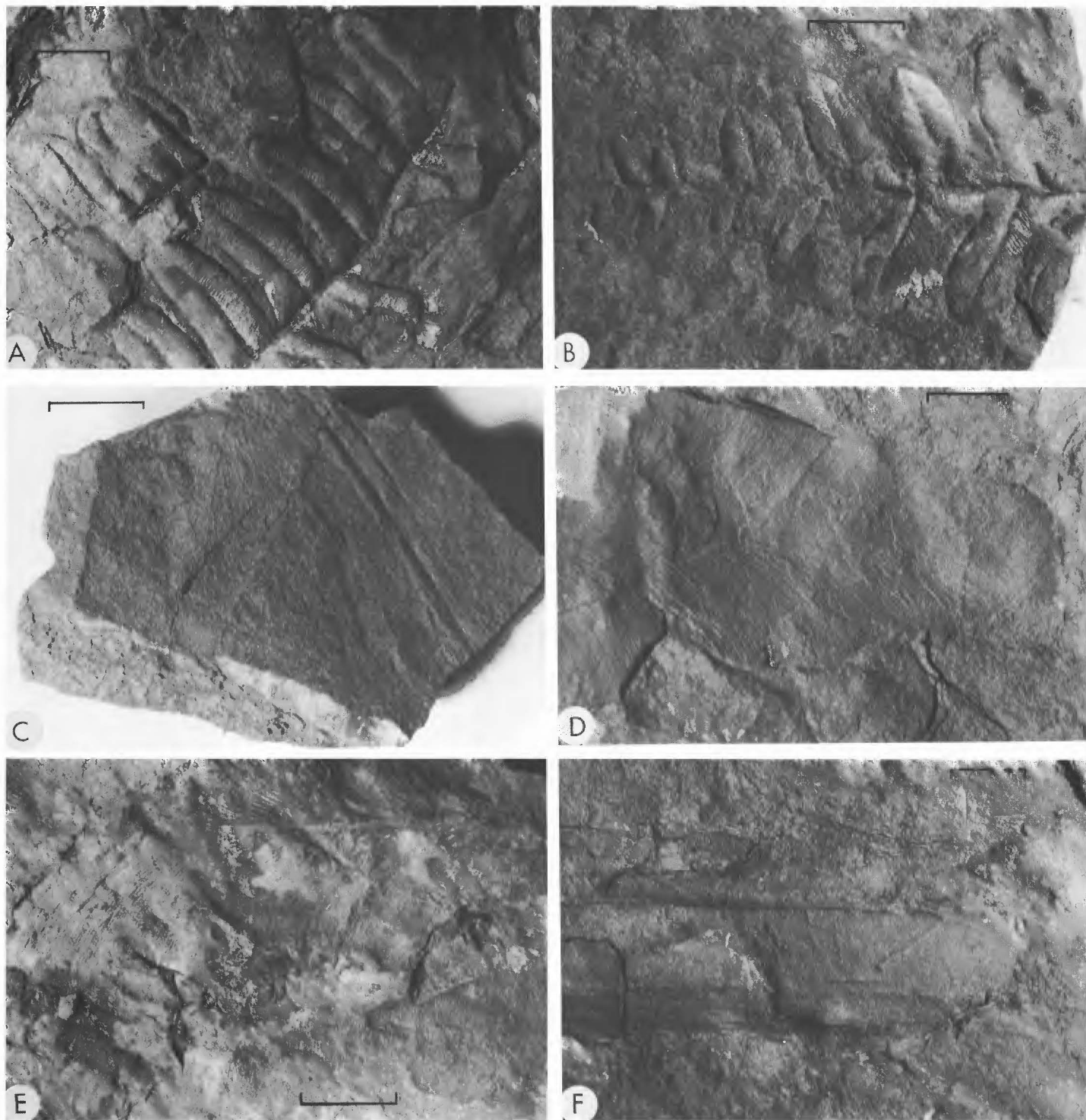

FIGURE 3. Middle Pennsylvanian plants from El Cobre Canyon. A, *Alethopteris ambigua*, NMMNH P-18249. B, *Alethopteris serlii*, NMMNH P-18216. C, *Cyperites bicarinatus*, NMMNH P-18263. D–E, *Neuropteris scheuchzeri*, NMMNH P-18244, and NMMNH P-18252, respectively. F, *Sigillaria rugosa*, NMMNH P-18257. Scale bars are 1 cm.

Description—Pinnules decurrent, with complete basal attachment and midveins extending almost to apex; midvein thick; lateral veins dominantly simple (rarely forking once), open and rising obliquely meeting pinnule margin at nearly a right angle; pinnules oblong and alternate or subopposite and obliquely attached to narrow rachis; pinnules parallel sided and obtusely pointed at apex.

Discussion—These specimens represent *Alethopteris* because they possess decurrent pinnules with complete basal attachments and a midvein that extends almost to the apex of the pinnule (Tidwell et al., 1970; Tidwell, written comm. 1992). Furthermore, they represent *A. ambigua* because the pinnules are parallel sided and obliquely pointed at the apex and because the midrib is thick (Tidwell et al., 1970; Oleksyshyn, 1982). *Alethopteris ambigua* is one of the most common taxa at NMMNH locality 2576.

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Alethopteris serlii (Brongniart) Goeppert, 1836
Fig. 3B

</center>

Referred specimens—NMMNH P-18200, 18203–18204, 18214, 18216, 18217–18218 (NMMNH locality 2576).

Description—Same as for *A. ambigua*, except pinnules widest in the middle and obtusely pointed at apex.

Discussion—These specimens are quite similar to *Alethopteris ambigua*, but are assigned to *A. serlii* because the pinnules are enlarged in the middle rather than being parallel sided and because most veinlets are simple (Tidwell et al., 1970; Oleksyshyn, 1982). *Alethopteris serlii* composes about one-third of the *Alethopteris* specimens from NMMNH locality 2576.

<center>

Family **Neuropteridaceae**
Genus *Neuropteris* Brongniart, 1822
Neuropteris scheuchzeri Hoffman, 1826
Figs. 3D, E

</center>

Referred specimens—NMMNH P-18261 (in part), -18264 (NMMNH locality 2575); NMMNH P-18221–18252 (NMMNH locality 2576).

Description—Large elongate pinnules as much as 100 mm long and 40 mm wide; pinnules apparently have a single point attachment, taper to a bluntly pointed apex and some are slightly constricted near the base; margins of the pinnules entire and not undulate; midvein extends almost to apex of pinnule and gives rise to many lateral veins that divide from three to five times; first dichotomy is near the midvein, second and third are midway across to the margin and fourth and fifth are near the margin; small rigid hairs about 2 mm in length scattered on lower surface of at least three large pinnules.

Discussion—These specimens represent *Neuropteris* because they have pinnules that have midveins which extend three-quarters of the way to the apex, single point attachment and lack net venation (Tidwell et al., 1970). Furthermore, they represent *N. scheuchzeri* because the veinlets bifurcate three to five times and because of the presence of a villose pinnule surface (Tiwell et al., 1970). This is the most common taxon at NMMNH locality 2576.

<center>

Division **Pterophyta**
Class **Pteropsida**
Order **Marattiales**
Family **Pecopteridaceae**
Genus *Cyathocarpus* Weiss,1869
Cyathocarpus cf. *P. arborescens* (Brongniart) Weiss, 1869
Fig. 4A

</center>

Referred specimen—NMMNH P-18258 (NMMNH locality 2575).

Description—Specimen is a poorly preserved large frond; the pinnae touch at their margins; pinnules small (3 mm long and 1.5 mm wide), alternate and of the same length.

Discussion—NMMNH P-18258 is assigned to *Cyathocarpus* cf. *C. arborescens* because of its overall similarity to this taxon (Lyons and Darrah, 1978, fig. 3A–C; Oleksyshyn, 1982, fig. 14G–H; Tidwell, 1988, figs. 40–42) and because the pinnules match the form and size described for this taxon (Oleksyshyn, 1982).
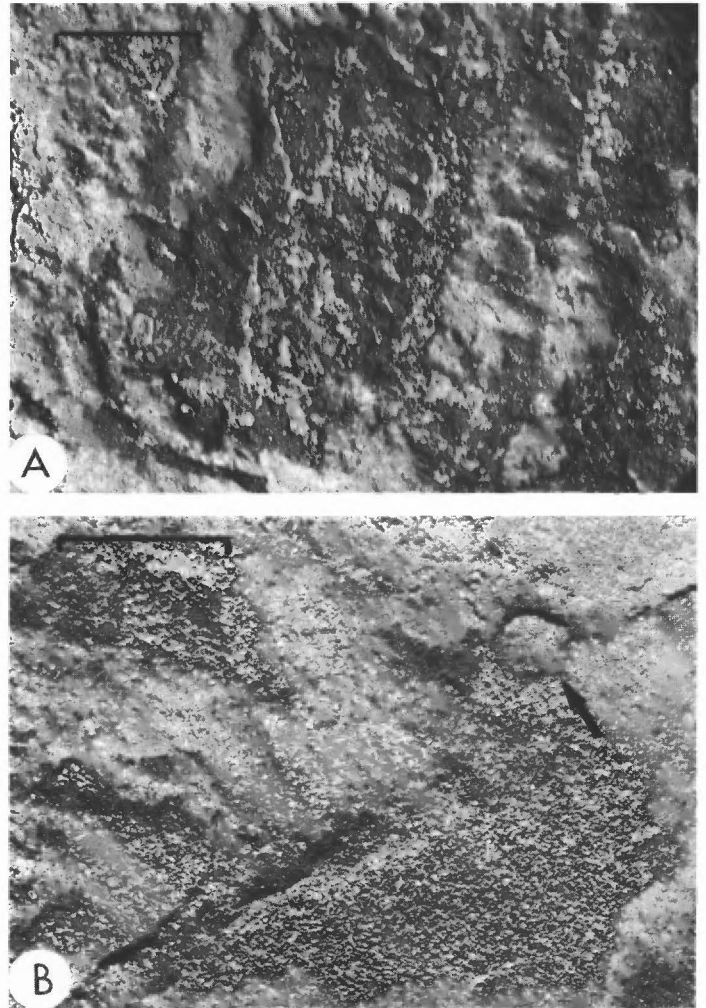

FIGURE 4. Middle Pennsylvanian plants from El Cobre Canyon. A, *Cyathocarpus arborescens*, NMMNH P-18258. B, unidentified seed indicated by arrow, NMMNH P-18259. Scale bars are 1 cm.

<center>

Class **Incertae sedis**
Seeds
Fig. 4B

</center>

Referred specimens—NMMNH P-18259, 18260, 18266 (NMMNH locality 2575).

Description—Compressions; flattened and round to subround in shape; thick vascular envelope and diameters ranging from 3–5 mm; one specimen has two ovoid bodies that fill the interior.

Discussion—These specimens undoubtedly represent seeds (cf. White, 1929, plate 49, fig. 4, plate 50, figs. 3–4). However, because of poor preservation, their exact affinities are difficult to determine. They probably represent medullosans or other seed ferns, as there are no indications in the flora of other gymnosperms such as cordaites. Seeds are very common in the sandier portions of NMMNH locality 2575.

<center>

PALEOECOLOGY

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The flora of NMMNH locality 2576 consists of the following taxa with the approximate percentages of number of individual elements in parentheses: *Neuropteris scheuchzeri* (70), *Alethopteris ambigua* (18), *Alethopteris serlii* (7), *Sigillaria rugosa* (4), *Cyperites bicarinatus* (2). The flora of NMMNH locality 2575 consists of the following taxa whose abundance is so low that percentages are not calculated: *Pecopteris* cf. *P. arborescens*, *Alethopteris serlii*, *Neuropteris scheuchzeri*, *Cyperites bicarinatus* (more common than in the stratigraphically higher locality), seeds (very common in coarser grain-sized portions of locality).

Both floras are of relatively low diversity. Locality 2576 is dominated by the seed ferns *Neuropteris* and *Alethopteris,* which probably superficially resembled tree ferns (Thomas and Spicer, 1987). Less common are the arborescent lycopod leaves *Sigillaria* and *Cyperites.* Locality 2575 also contains representatives of *Pecopteris* (some species bear seeds and others are true ferns; Tidwell, written comm. 1992) and possible seed-fern seeds.

Fontaine's (1890) specimens of *Calamites* (which he called *Equisetum*) came from a fluvial, channel sandstone, and their absence in the new localities in pond deposits is presumably a taphonomic artifact. The large *Calamites* fragments are preserved in a high energy channel, whereas the more delicate plant specimens from NMMNH localities 2575 and 2576 are preserved in low energy ponds. It is also possible that Fontaine's locality was sampling a different community. The abundance of *Neuropteris* and *Alethopteris* at NMMNH localities 2575 and 2576 suggests that they represent the same flora reported by Smith et al. (1961) and Fracasso (1980).

Overall, the paleoflora indicates a warm, moist environment. However, the low diversity of the two floras and the presence of weakly developed calcretes (suggesting seasonal aridity) in megasequence one (Eberth and Miall, 1991) indicate a somewhat stressed environment relative to the very diverse floras of contemporary coal swamps.

It is interesting that the two new floras contain taxa most commonly found in coal swamp environments. Megasequence one has also yielded several undescribed specimens of embolomere amphibians, which are characteristic of coal swamps and are almost unknown in red-bed sequences (Eberth, 1987). Megasequence two has yielded a more typical red-bed flora in the Rio Puerco Valley (Langston, 1953; Eberth, 1987). Thus, it appears that there may have been a major environmental change between megasequences one and two.

BIOCHRONOLOGICAL SIGNIFICANCE OF THE FLORA

Williston and Case (1912) suggested that megasequence one in El Cobre Canyon is of Late Pennsylvanian age on the basis of the presence of a brachiopod *Anthracospirifer rockymountanus.* However, this brachiopod was not found *in situ* and was obviously derived from a marine unit. Langston (1953) observed that the Cutler in El Cobre Canyon is totally of fluvial origin, and thus the brachiopod is clearly an extraformational clast and of little biochronological utility.

The vertebrate fauna of megasequence one contains six endemic tetrapod taxa—*Anconastes vesperus, Diasparactus zenos, Chamasaurus dolichognathus, Baldwinonus trux, Nitosaurus jacksonorum, Ruthiromia elcobriensis* (Fracasso, 1980; Eberth, 1987, written comm. 1992). The other eight described taxa of tetrapods are known from Early Permian (Wolfcampian) strata in New Mexico and/or other states. Thus, the tetrapod evidence for the age of megasequence one is inconclusive and has given rise to age estimates of either Wolfcampian (Langston, 1953; Vaughn, 1963) or Late Pennsylvanian (Williston and Case, 1912; Fracasso, 1980). Eberth (1987) noted that the classic vertebrate localities occur through a stratigraphic interval of 20 m, and thus he concluded that a specific age for this horizon is problematic. However, we think it likely that a 20-m-thick sequence contains only one fauna for which a precise age can be determined. Eberth (1987) produced a stratigraphic/sedimentological model for the Cutler Formation of north-central New Mexico that incorporates lithostratigraphic, tectonostratigraphic and biostratigraphic data. He concluded that megasequence one in El Cobre Canyon is of Late Pennsylvanian (Virgilian) age (e.g., Eberth, 1987, fig. 21; Berman et al., 1987, fig. 3; Eberth and Miall, 1991, fig. 3).

Lesquereux (e.g., 1884) was the first to use plant megafossils for biochronological purposes in the Pennsylvanian of North America (Pfefferkorn and Gillespie, 1980). Subsequently, White and Read developed more refined biostratigraphies, with Read (1947) and Read and Mamay (1964) recognizing nine floral zones in the Pennsylvanian. These zones are a combination of acme and assemblage zones (Pfefferkorn and Gillespie, 1980). Given the refinement of this biostratigraphy and the extensive literature on Pennsylvanian plant megafossils in North America, the paleoflora in El Cobre Canyon is potentially of great biochronological utility.

Age determinations based on previous analysis of the paleoflora of megasequence one in El Cobre Canyon have been: (1) "not older than Rhetic [*sic*]" (Fontaine, 1890, p. 285), principally based on the Late Triassic taxa from the Agua Zarca Formation; (2) "Desmoinesian or Missourian in age, probably Desmoinesian" (Read in Smith et al., 1961, p. 5) based on a flora dominated by *Alethopteris serlii;* and (3) "clearly of Pennsylvanian age, and there is nothing in it [the paleoflora] that would indicate Permian age or contradict a Desmoinesian or Missourian assignment. The combination of the species *Neuropteris scheuchzeri* and *Alethopteris serlii* is common in the Des Moines and Missouri, but I have reason to believe it is more characteristic of the Des Moines" (Mamay in Fracasso, 1980, p. 1242). Fracasso (1980) utilized evidence from both the tetrapod fauna, which includes taxa thought to range from Missourian to Wolfcampian, and Mamay's identification of Desmoinesian-Missourian plant megafossils to somewhat arbitrarily decide that both the flora and fauna were of Missourian age.

The ranges and acme ranges of the taxa recovered from NMMNH localities 2575 and 2576 are shown in Fig. 5. The abundance of *Neuropteris scheuchzeri, Alethopteris serlii* and *A. ambigua* at locality 2576 suggests that its age could be as old as Desmoinesian, although the taxonomic composition of the flora is also consistent with a Missourian age. A Desmoinesian age agrees with the views of Read (in Smith et al., 1961) and Mamay (in Fracasso, 1980), who had analyzed earlier floral samples from megasequence one. The ranges of the other taxa, which are not common at the new localities, are consistent with either a Desmoinesian or Missourian assignment. Thus, the flora from megasequence one, which is the most robust biochronological evidence available, indicates a possible Desmoinesian age for these strata and their included tetrapod fauna.

A Desmoinesian age for the flora and fauna discussed here could have great importance for ideas concerning the early evolution of terrestrial tetrapods, as the El Cobre fauna has always been considered at least Missourian (e.g., Late Pennsylvanian) in age or younger. This would mean that the El Cobre tetrapods are some of the oldest tetrapods in New Mexico and among the oldest North American tetrapods (Lucas

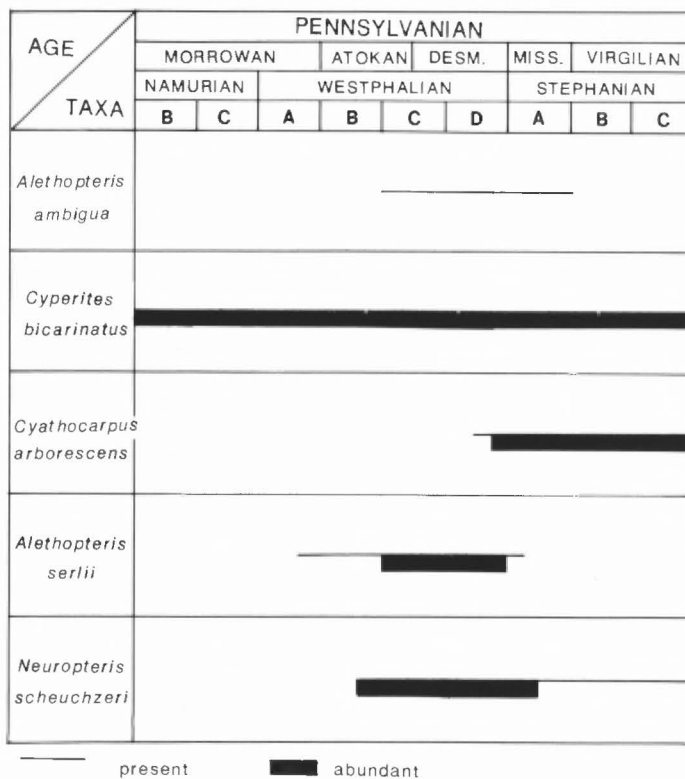| AGE / TAXA	PENNSYLVANIAN								
	MORROWAN		ATOKAN	DESM.			MISS.	VIRGILIAN	
	NAMURIAN		WESTPHALIAN				STEPHANIAN		
	B	C	A	B	C	D	A	B	C
Alethopteris ambigua									
Cyperites bicarinatus									
Cyathocarpus arborescens									
Alethopteris serlii									
Neuropteris scheuchzeri									

present ▬▬ abundant

FIGURE 5. Temporal ranges and acmes of plant taxa from NMMNH localities 2575 and 2576. Based on Oleksyshyn (1982, fig. 27) and Tidwell (written comm. 1992).

and Hunt, 1991; Hunt et al., 1992). This fauna would be very unusual for its age for not coming from a coal swamp environment. If the El Cobre fauna is Desmoinesian in age and the fauna and flora of mega-sequence two is of Wolfcampian (Early Permian) age, as all recent workers agree (e.g., Fracasso, 1980; Hunt, 1983; Eberth and Miall, 1991), then it suggests the presence of an unconformity between mega-sequences one and two. This is supported by the major floral change between the two megasequences noted above.

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APPENDIX—MEASURED STRATIGRAPHIC SECTION

The measured stratigraphic section (Fig. 1) of part of the Cutler Formation at NMMNH localities 2575 and 2576 (UTM 4016450N, 378750E, zone 13) is described here. Rock colors are those of Goddard et al. (1984).

unit	lithology	thickness (m)
	Cutler Formation:	
5	Sandstone; grayish red (10 R 4/2) and dark reddish brown (10 R 3/4); micaceous litharenite; fine to very coarse grained; poorly sorted; subrounded; calcareous; trough crossbedded; top of arroyo bank.	1.5
4	Sandy siltstone; same color as unit 5; slightly calcareous; thinly laminated; 40 cm above the base of unit is NMMNH locality 2576.	1.4
3	Sandstone; same color as unit 1; micaceous litharenite; very fine grained; well sorted; subrounded; slightly calcareous; trough crossbedded.	0.7
2	Sandstone; same color and lithology as unit 1; ripple laminar; some fossil plants at top of unit (NMMNH locality 2575).	0.1
1	Sandstone; grayish red (10 R 6/2) and pale red (10 R 6/2); micaceous litharenite; very fine–fine grained; moderately sorted; subrounded-subangular; calcareous; ripple laminar; arroyo bottom.	