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UPPER TRIASSIC DOCKUM FLORA OF EASTERN NEW MEXICO AND TEXAS

by

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INTRODUCTION

Study of the Dockum flora is in its infancy even though the flora has been known to exist for many years. Only a few members of the flora have been identified or described. As a consequence it is rather poorly known in comparison to the more or less contemporaneous and closely related flora in the Chinle Formation of western New Mexico and adjacent areas in Arizona and Utah. The Chinle has been the subject of numerous reports (see Ash, 1972) in contrast to the Dockum flora. The purpose of the present report is to bring together references for the published data that are available on the plant remains in the Dockum, and the information I have gathered about them during the past several years.

My investigation of the Dockum Flora has been expedited by a number of people to whom I am grateful. They include, but are not limited to, Mr. Fred Trauger and Mr. C. B. Read of the U.S. Geological Survey in Albuquerque, Mr. Warren Finch of the U.S. Geological Survey in Denver, and the Drs. Jack T. Hughes, Robert C. Burton, and Gerald E. Schultz of West Texas State University in Canyon. Field work was partially financed by the Geological Society of America and the Society of the Sigma Xi. Preparation of this report was supported by National Science Foundation Grant GA-25620.

PREVIOUS INVESTIGATIONS

Apparently plant fossils were first reported in the Dockum Group by the geologist W. F. Cummins (1889, 1890) who mentioned the occurrence of petrified wood in the unit near the settlement of Dockum, Texas. Since then petrified wood and other plant material has been reported from a number of localities in the Dockum of eastern New Mexico and Texas (Drake, 1892; Case, 1914; Nye, 1932). The famous botanist R. E. Torrey (1923) collected some petrified wood from the Dockum Group near Spur, Texas and later described it as representing a new genus and species he called *Voltzioxylon dockumense*. Torrey's report contains the first published description of a Dockum plant fossil and thus is of some significance although his findings have been discounted by Turkel (1968). In 1936 a rich deposit of the leaves of the cycadeoid *Otozamites powelli* was discovered in the Santa Rosa Sandstone by members of the WPA (Federal Works Progress Administration) while they were laying a sidewalk in Santa Rosa, New Mexico (S. A. Northrop, written communication). Subsequently, several specimens showing nice examples of the leaves were given to the University of New Mexico. They were carefully cleaned by Dr. Northrop and placed on exhibit in the geology museum where they have been studied by students in the ensuing years.

The most significant contribution to our knowledge of the Dockum flora was made by L. H. Daugherty when he reported (1914) the occurrence of several typical Chinle gymnosperms in the Dockum Group. They included the wood of the two conifers *Araucarioxylon arizonicum* and *Woodworthia arizonica* and the leaves of *O. powelli* and of the Cordaite now called *Pelourdea poleoensis*. The fossils were collected from localities near Alanreed and Canyon, Texas and Tucumcari, New Mexico.

At various times since 1960 I have collected plant fossils from the Dockum at localities in eastern New Mexico and Texas. Although I have obtained considerable material little of it has been described as yet. However, I did report (Ash, 1970) the occurrence of the leafy shoot and possible fertile structure of the enigmatic gymnosperm *Dinophyton spinosus* near Kalgary, Texas. Recently I submitted a manuscript reporting the occurrence of the remains of the perplexing plant *Sanmiguelia lewisi* in Texas to the Texas Journal of Science. Another manuscript describing other members of the Dockum flora is in advance stages of preparation.

Only one report on the spores and pollen that occur in the Dockum has appeared (Dunay and Traverse, 1971) although they are being studied by several people. In their report Dunay and Traverse note they have obtained microfossils from two localities in the valley of the Canadian River in the Panhandle of Texas. Several of the more distinctive forms are illustrated by them and identified to the generic level.

COMPOSITION OF THE FLORA

Thy Dockum Group is known to contain eight species based on megafossils, including the remains of three ferns, four gymnosperms, and one of uncertain affinities. Two of the eight species are based on petrified wood and the others are based on either impressions or compressions of leaves and other structures. About 70 species identified on the basis of spores and pollen have been reported in the Dockum by Dunay and Traverse (1971).

Ferns

Leaves of ferns have never been reported from the Dockum prior to this time. They are not common or diverse and only three species have been identified at just two localities. Those that have been identified are:

Cynepteris lasiophora Ash
Phlebopteris smithii (Daughterty) Arnold
Clathropteris walkeri Daughterty, em. Ash

All three originally were described from the Chinle Formation in which they are common (Ash, 1972). Recently the first two

species in the list were also reported from a new locality in the Upper Triassic Newark Series in North Carolina (Hope and Patterson, 1969).

Cynepteris lasiophora has a large bipinnate leaf which may be as much as a meter in length. The oblong decurent pinnules of this species contain reticulate venation making it easy to identify (see figs. 1F, 1G). Only a few small fragments of *C. lasiophora* have been collected from the Dockum Group. They were found a few months ago in the Santa Rosa Sandstone near Santa Rosa, New Mexico by R. A. Scott of the U.S. Geological Survey (see fig. 2B).

The leaf of *P. smithii* is palmately divided and as much as 30 cm in diameter. It usually has 10-14 pinnae that are deeply divided into many linear pinnules containing simple forking veins (figs. 1A, 1B). A number of small but nearly complete leaves of the species have been obtained from the Tecovas Shale of the Dockum northwest of Amarillo, Texas (fig. 2C). Modern relatives of *P. smithii* now live in the Indo-Malaysian region.

The third fern *Clathropteris walkeri,* also has a palmate leaf but it is much more robust than that of *P. smithii* although it isn't as large (20 cm in diameter). In addition the pinnae are not divided into definite pinnules as in *P. smithii* and the pinnae margins are toothed. The venation in the pinnae is reticulate with blind vein endings (see figs. 1D, 1E). Just a few small fragments of the species have been collected from the Tecovas Shale Member of the Dockum near Amarillo but they are large enough to show its characteristic venation and the marginal teeth of the pinnae (fig. 2H). Most of the living relatives of this genus are found in the tropics and subtropics of eastern Asia.

Dunay and Traverse report (1971) that spores of the Cryptogams (which include the ferns) are "fairly well represented" in the Dockum microfloras they are working on. In the report they illustrate specimens of *Concavisporites* sp. and *Retusotriletes* sp. which are referred to the ferns and are common in the two Dockum microfloras. Both spores are quite small (30 cm in diameter) and show strong trilete marks. The specimens of *Concavisporites* illustrated by Dunay and Traverse are triangular and smooth. In contrast the specimen

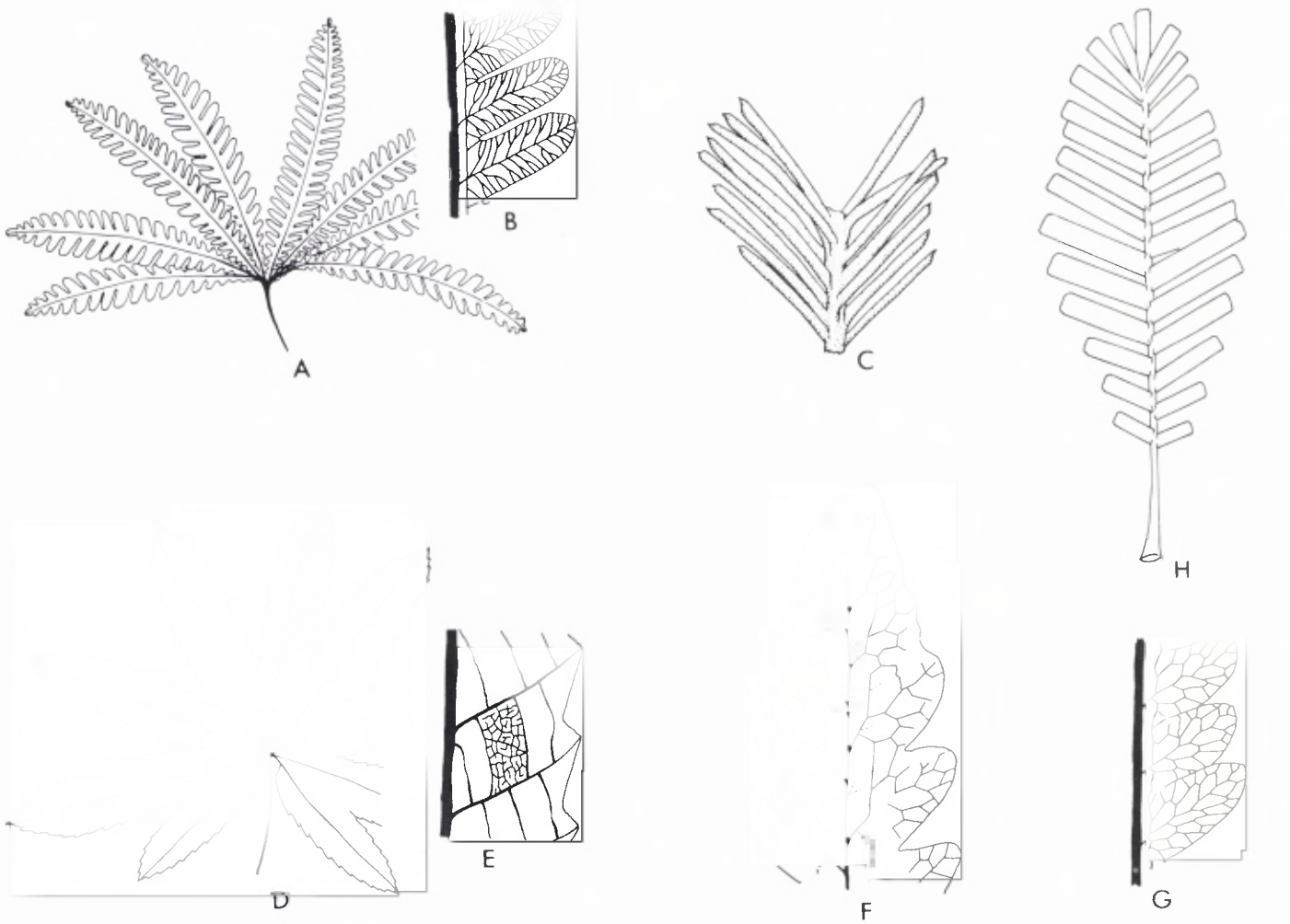

Figure 1. Sketches of some of the fossil plants found in the Dockum Group. A, general view of a leaf of Phlebopteris smithii, *X½. B, details of the forking venation in the pinnules of* P. smithii, *X2. C, portion of the leafy shoot of* Dinophyton spinosus, *X2. D, general view of the leaf of* Clathropteris walkeri, *X½. E, details of the reticulate venation in a pinna of* C. walkeri, *X2. F, apical region of a pinna of* Cynepteris lasiophora *showing the characteristic reticulate venation of the species, X5. G, typical pinnules of* C. lasiophora, *X2. H, entire leaf of* Otozamites powelli, *X½. A-E, G-H, adapted from Ash, 1972; F adapted from Ash, 1970.*

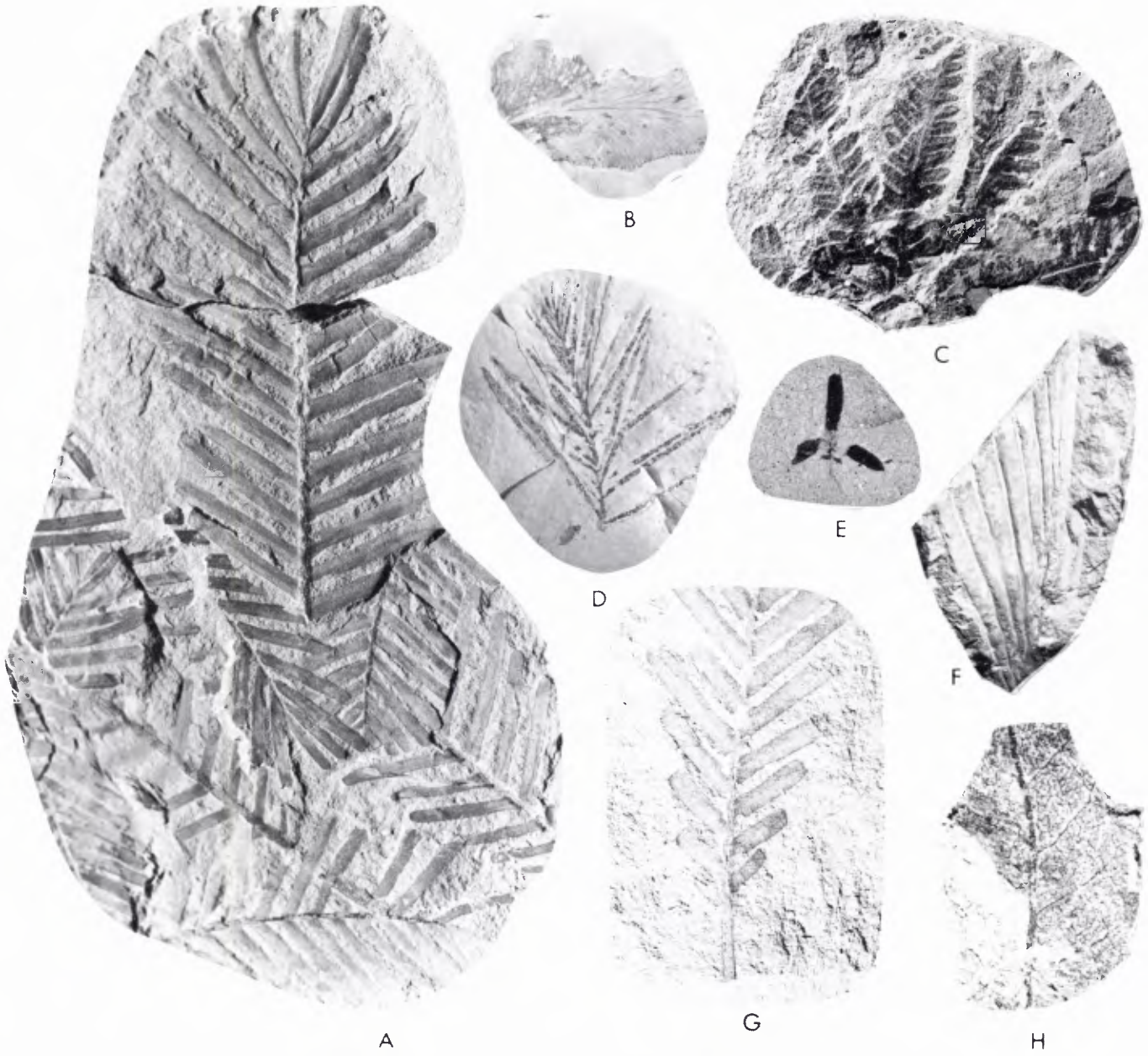

Figure 2. Photographs of some of the plant fossils found in the Dockum Group. A, several examples of **Otozamites powelli**, *the most common leaf fossil in the Dockum, X½. B, fragment of a pinnule of* **Cynepteris lasiophora**, *X1. C, a nearly complete example of the palmate leaf of* **Phlebopteris smithii**, *X1. D, portion of the leafy shoot of* **Dinophyton spinosus**, *X1. E, pinwheel organ attributed to* **D. spinosus**, *X1. F, basal portion of the palmlike leaf of* **Sanmiguelia lewisi**, *X¼. G, basal part of the leaf of* **O. powelli**, *X1. H, fragment of a pinna of* **Clathropteris walkeri** *showing the characteristic reticulate venation of the species.*

of *Retusotriletes* is rounded and finely reticulate and thus is remarkably like the spores produced by the fern *Cynepteris lasiophora* (cf. Dunay and Traverse, 1971, pl. 1, fig. 7 with Ash, 1970, pl. 3).

Gymnosperms

The gymnosperms which include the conifers, ginkgophytes, cycads, and several extinct groups are represented on the Dockum group by five species based on megafossils and numerous undescribed microfossils. The species based on megafossils are *Pelourdea poleoensis* (Daugherty) Arnold, *Araucarioxylon arizonicum* Knowlton, *Woodworthia arizonica* Jeffery, *Otozamites powelli* (Fontaine) Berry, and *Dinophyton spinosus* Ash. All these species were originally described from the Chinle Formation in which they occur in abundance. Both *A. arizonicum* and *O. powelli* have been reported also from the Newark Series of the eastern United States (Hope and Patterson, 1969). *Pelourdea poleoensis* has been reported from the Triassic Dolores Formation in southwestern Colorado by Arnold (1964).

Pelourdea poleoensis is based on linear, straplike leaves containing narrow parallel veins. The apices of the leaves are rounded but the bases and form of the attachment are un-

known. Specimens vary from 2 to 5 cm in width and may be as long as 65 cm. Daugherty reported impressions of what is now called *P. poleoensis* from the Dockum Group near Canyon, Texas and I have collected similar fossils at several places elsewhere in the Dockum. Presumably they are all referrable to the same species although none has been studied in detail.

Petrified wood is probably the most common plant fossil found in the Dockum Group. Some of the specimens are several feet in diameter and apparently represent trees that were at least 40 or 50 feet tall. Generally the wood is straight grained and is usually gray or light brown. Nearly all the specimens of Dockum wood that have been investigated, including the material called *Voltzioxylon dockumense* by Torrey, are now referred to *Araucarioxylon arizonicum*. Turkel (1968) has shown that the specimens on which *V. dockumense* was based are actually poorly preserved remains of *A. arizonicum*. It is generally accepted that *A. arizonicum* is closely related to the araucarians, such as the Norfolk Island Pine, that now live in the tropics. *A. arizonicum* seems to occur in all members of the Dockum.

Woodworthia arizonica is based on a few rather small petrified stems which bear small circular scars on their external surfaces. The scars are interpreted to be the remains of persistent short shoots. Jeffery and Daugherty agree that this species, like the previous one, appears to be closest to the living araucarians. Daugherty, who reported the occurrence of this species in the Dockum, does not indicate where the specimens come from.

Otozamites powelli is the most common leaf fossil found in the Dockum Group (and the Chinle as well). It has a pinnate leaf which may be as long as 30 cm and up to 10 cm wide. The pinnules are linear with generally parallel margins and distinctly truncate apicies (fig. 1H). Pinnule margins are expanded slightly near the pinnule bases but because of their small size they are not always visible to the unaided eye. The veins are typically parallel and end in the apical margins. *O. powelli* has been collected from the Tecovas Shale, Trujillo Sandstone, Santa Rosa Sandstone and Chinle Shale formations of the Dockum Group at localities throughout eastern New Mexico and Texas (figs. 2A, 2G). This species is assigned to the cycadeoids without question. What appear to be the closest relatives of the cycadeoids now live in the humid tropics and subtropics.

One of the more common species in the Dockum Flora is *Dinophyton spinosus*. It is represented by leafy shoots that resemble superficially those of certain living conifers (figs. 1C, 2D). However, detailed studies have shown that they cannot be assigned to the conifers or to any other group of plants with much assurance. Tentatively these fossils have been assigned to the gymnosperms. Closely associated with the shoots are some small structures that resemble pinwheels with four arms or the leaf whorls of the Paleozoic fossil plant *Annularia* (fig. 2E). Cuticular studies indicate that these structures were parts of the plants that bore the leafy shoots mentioned above but we cannot be sure of their function. It has been suggested that they may be the seed-bearing organs of the plants. *Dinophyton spinosus* has been recognized in the Tecovas Shale and Santa Rosa Sandstone of the Dockum.

Incertae Sedis

The palmlike leaves of the controversial plant *Sanmiguelia lewisi* have recently been recognized in the Trujillo Sandstone Member of the Dockum Group at two localities near Canyon, Texas (Ash, in press). *S. lewisi* was first described from the Triassic Dolores Formation in southwestern Colorado by Roland Brown (1956) who suggested that the fossils might represent the leaves of a palm. Many paleobotanists dispute Brown and believe that *Sanmiguelias* belongs to some other group, such as the cycads, conifers or some otherwise unknown group of extinct plants. Three nearly complete leaves of *S. lewisi* together with some small fragments have been collected from the Dockum in Texas. The best preserved example is shown in fig. 2F). All specimens are parts of large, pleated eliptical leaves which range in size from about 10-12 cm. in width and up to 28 cm. in length. Some carbonaceous residue is preserved on some of the specimens and shows fine parallel venation. Although the new specimens do not indicate whether *Sanmiguelia* is a palm or not they are important because they extend the geographic and stratigraphic range of this interesting fossil.

CORRELATION

All but one of the species based on plant megafossils in the Dockum Group of Texas and Eastern New Mexico also occur in the Chinle Formation west of the Rio Grande and it is clear that the two floras correlate closely. The Dolores Formation of Late Triassic age in southwestern Colorado and the Dockum also contain two of the same species suggesting that they probably correlate. Correlation with the flora in the Upper Triassic Newark of the eastern United States is less certain as that unit contains so few Dockum species. At this time it appears that none of the species in the Dockum flora occurs outside of the United States and it is difficult to correlate the flora with Triassic flora elsewhere in the world on that level. On the other hand, some of the Dockum genera do occur elsewhere and they do suggest a Late Triassic age for the flora.

PALEOCLIMATIC INTERPRETATIONS

Of all the lines of evidence used to interpret ancient climates that offered by plant fossils seems to be the most reliable (Dorf, 1970). The basis of this supposition is the knowledge that modern plants strongly reflect the climatic conditions under which they grow and it is assumed that fossil plants likewise reflect the climate under which they grew. Both the taxonomic relationships and morphologic characteristics of fossil plants are useful in this type of work.

The plant remains found in the Dockum Group suggest that the climate was moist and warm (tropical to subtropical) when the unit was deposited. This interpretation is suggested by the fact that, as noted above, the closest probable relatives of *P. smithii, C. walkeri, A. arizonicum. W. arizonica,* and *O. powelli* now live in tropical to subtropical parts of the world. In addition the mere presence of ferns in the Dockum flora suggests that it developed in an area where the climate was warm and moist. The large specimens of *A. arizonicum* suggest an abundant water supply. Although the epidermises and cuticles are not preserved on the Dockum leaves that have been collected they often are in examples of the same species in the contemporaneous Chinle Formation of nearby areas. As has been indicated elsewhere (Ash, 1972; Dorf, 1970) the morphology of the Chinle plants suggests that the climate was moist and warm when the Chinle was being deposited and it seems reasonable to assume the climate was also fairly similar in adjacent areas where the Dockum was being deposited.

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