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THE BENNETTITALEAN LEAF *"ZAMITES" POWELLII* FROM THE MIDDLE TRIASSIC MOENKOPI FORMATION, EAST-CENTRAL NEW MEXICO

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Abstract—Two localities in Middle Triassic (lower Anisian) strata of the Moenkopi Formation (Anton Chico Member) in east-central New Mexico yield numerous fossils of the bennettitalean *"Zamites" powellii* Fontaine. This record extends the temporal distribution of *"Z." powellii* from the late Carnian to the early Anisian, eliminating its use as a late Carnian index taxon. It also indicates that at least one Triassic bennettitalean taxon has a longer temporal range than previously known, and that the diversity of Middle Triassic bennettitaleans is not well documented.

INTRODUCTION

In the western United States, an extensive paleofora of Late Triassic age has long been known from nonmarine red beds of the Chinle Group (e.g., Ash, 1989; Lucas, 1995). However, the underlying Lower-Middle Triassic red beds of the Moenkopi Formation have to date yielded plants from only one locality in Arizona (Ash and Morales, 1993). This locality, in the lower Anisian Holbrook Member of the Moenkopi Formation, yielded the fungus *Polyporites*, the sphenophyte *Neocalamites*, the conifer *Araucarioxylon* and a new tree fern. With the exception of the new tree fern, these taxa are known from the Upper Triassic Chinle Group (Ash and Morales, 1993). Here, I describe a second Moenkopi Formation fossil plant occurrence that also yields a taxon well known from the Chinle Group, the bennettitalean leaf *"Zamites" powellii*. In this article, NMMNH = New Mexico Museum of Natural History, Albuquerque.

PROVENANCE

Alex Velásquez discovered numerous fossil leaves of *"Zamites" powellii* at two localities just northeast of Anton Chico in Guadalupe County, New Mexico (Fig. 1). Both localities are at the same stratigraphic level in the Anton Chico Member of the Moenkopi Formation of Lucas and Hunt (1987). These sites are NMMNH localities 3643 and 3644. The plant-bearing horizon is a 2-m thick, grayish red, ripple-laminated sandstone in approximately the middle of the Moenkopi section (Fig. 1). Nearby vertebrate-fossil localities that are stratigraphically higher in the Moenkopi Formation yield the temnospondyl *Eocyclotosaurus* (Lucas and Morales, 1985; Lucas and Hunt, 1987; Morales, 1987). This taxon is an index fossil of the Perovkan land-vertebrate faunachron of Lucas (1998), and this establishes the early Anisian age of the *Zamites powellii* localities. Indeed, the Anton Chico Member of the Moenkopi Formation in east-central New Mexico is a correlative of the early Anisian Holbrook Member of the Moenkopi Formation in eastern Arizona (Morales, 1987).

IDENTIFICATION

The NMMNH collection contains about 30 leaves from NMMNH localities 3643 and 3644 preserved as oxidized impressions. These fossils are catalogued as NMMNH P-20310, 33254 and 33279 through 33291. These leaves (Fig. 2) belong to a single taxon and are pinnate, ranging in length from 9 to 21 cm, and from 5 to 8 cm wide. The linear pinnae (leaflets) have essentially parallel margins and truncated apices (they are rectangular) and parallel veins that end at the pinna apices. The bases of at least some of the pinnae are contracted (e.g., Fig. 2F). In all features, these leaves closely resemble previously described specimens of *"Zamites" powellii* Fontaine (cf. Ash, 1975), to which they are assigned.

The name *Zamites* is placed here in quotation marks because of taxonomic problems that surround *Zamites powellii sensu* Ash (1975) that cannot be resolved here. Thus, *Zamites* has long been used as a broadly defined form genus, and not all species assigned to it, including *"Z." powellii* of Ash (1975), necessarily belong here. Indeed, not all taxa assigned to *Zamites* are necessarily benettitalean (J. Knaus , written commun., 2001). Recently, Weber and Zamudio-Varela (1995) proposed a new benettitalean genus, *Laurozamites*, for specimens from the Carnian of Sonora, Mexico. They reassigned *"Z." powellii sensu* Ash to *Laurozamites*. However, this reassignment may not be justified (B. Axsmith, written commun., 2000). Clearly, more systematic study is needed to resolve the taxonomic status of *"Z." powellii*. What is important here is that a plant morphotype previously thought characteristic of Chinle paleofloras is now known from the much older Moenkopi Formation.

DISCUSSION

"Zamites" powellii is one of the most common fossil plants found in the lower part of the Upper Triassic Chinle Group in the Western Unites States (Ash, 1975, 1989; Lucas, 1995). Ash (1980) indicated that this taxon is found in both his *Eoginkgoites* and *Dinophyton* Zones, which are of late Carnian age. *"Zamites" powellii* is also present in correlative strata of the Newark Supergroup—the Pekin Formation in North Carolina (Ash, 1975) and the Stockton Formation in Pennsylvania (Axsmith and Kroehler, 1989). The record of *"Z." powellii* in the Moenkopi Formation of east-central New Mexico thus represents a considerable extension of the temporal range of this taxon, back to the early Anisian. The use of *"Z." powellii* as an indicator of late Carnian time thus needs to be abandoned.

Ash (1975, 1980) noted that *"Zamites" powellii* is abundant in strata of the Chinle Group and apparently was one of the domi-

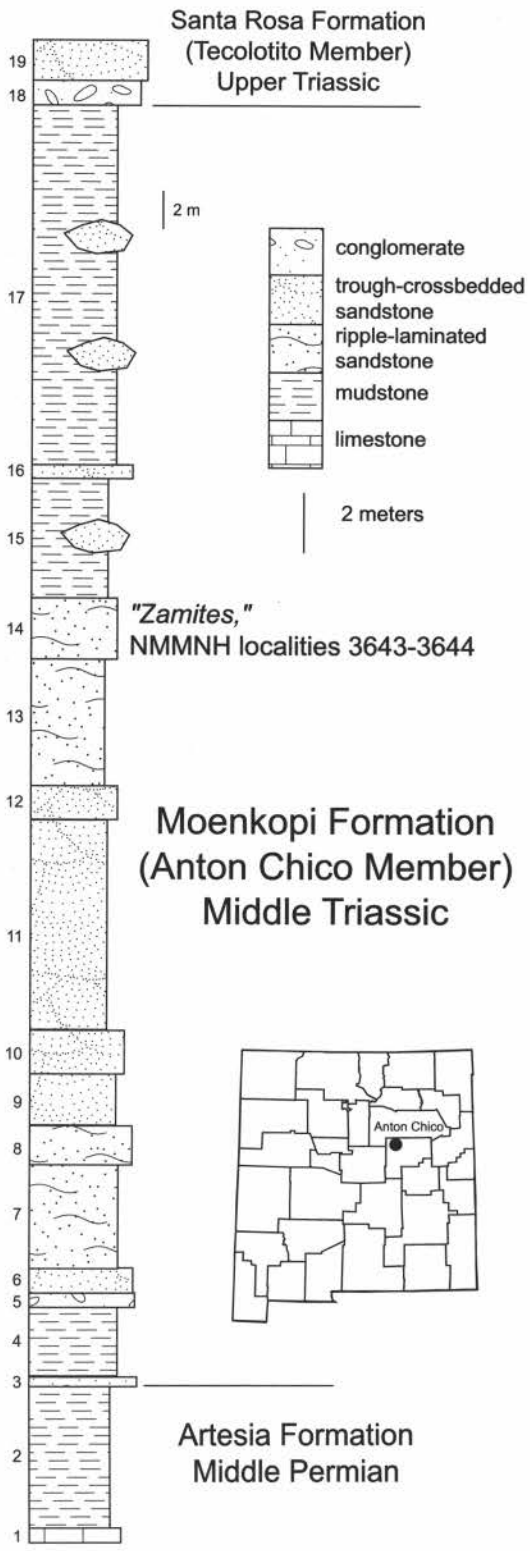

FIGURE 1. Stratigraphic section and location of the Moenkopi Formation "*Zamites*" locality near Anton Chico. See Appendix for description of measured section.

nants of the Chinle paleoflora. Its abundance near Anton Chico may also mean that it too was a dominant of the Moenkopi paleoflora. Indeed, the fossil plants from the Holbrook Member of the Moenkopi Formation in Arizona (Ash and Morales, 1993) and the correlative Anton Chico Member in New Mexico are mostly taxa known from the Chinle Group. This may suggest a long-lived (Anisian-Carnian) chronoflora probably was present near riverine environments in the western United States during the Middle-Late Triassic.

Crane (1986) and Axsmith et al. (1995) drew attention to the diversity and unusual morphology of some Late Triassic bennettitaleans, implying a much earlier origination of the group. The Middle Triassic record of "*Zamites*" indicates a much greater longevity of one Late Triassic bennettitatlean than previously reported. Indeed, the morphology of some Late Triassic bennettitaleans may not be so unusual if they are understood as members of a bennettitalean diversification whose roots are much older, in the Early or Middle Triassic.

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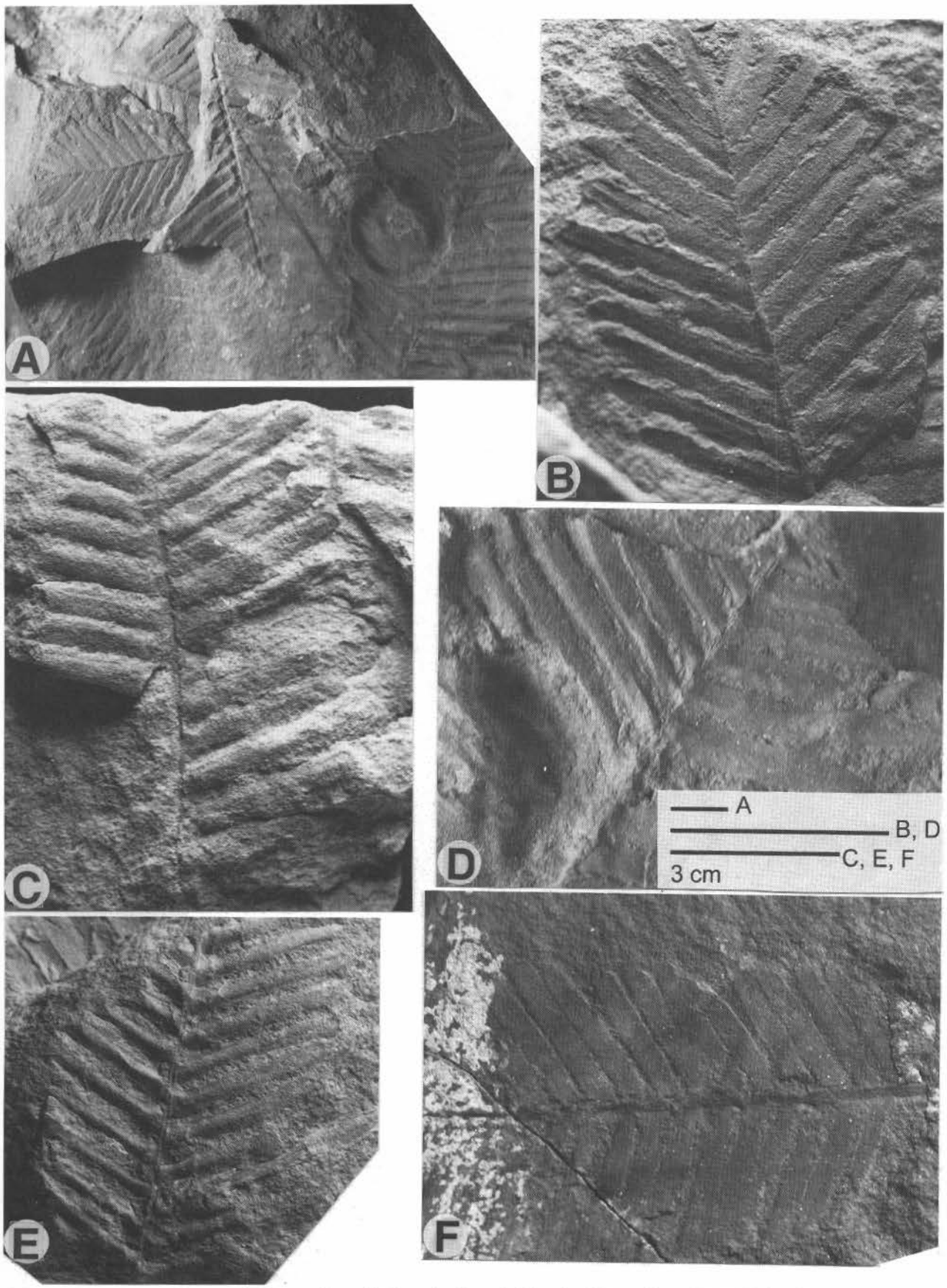

FIGURE 2. Selected specimens of leaves of "*Zamites*" *powellii* Fontaine from the Moenkopi Formation at NMMNH locality 3643. A, B, D, NMMNH P-33288. C, NMMNH P-33282. E, NMMNH P-33280. F, NMMNH P-33281.

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APPENDIX-MEASURED STRATIGRAPHIC SECTION

Section measured at NMMNH locality 3643. Strata are essentially flat-lying, though some local slumping produces dips up to 14° to the N.

unit lithology **thickness (m)**

Santa Rosa Formation: Tecolotito Member:

19. Sandstone; yellowish gray (5Y7/2) with grayish orange (10YR7/4) mottles; medium to coarse grained; micaceous litharenite; some clay pebbles; calcareous; trough crossbedded. **2.0+**
18. Conglomerate; mottled pale yellowish brown (10YR6/2), pale red (10R6/2) and light greenish gray (5GY8/1); clasts are mostly rip-ups of Moenkopi siltstone and calcrete and Paleozoic limestone up to 15 cm in diameter; matrix is medium-to coarse-grained litharenite; calcareous; massive; scour base. **0.3-0.6**

Tr-3 unconformity

Moenkopi Formation: Anton Chico Member:

17. Mudstone and sandy mudstone; variegated pale reddish brown (10R5/4) and light olive gray (5Y6/1); contains a few lenses of grayish red (10R4/2) fine-grained, micaceous sandstone; some calcrete nodules; forms a slope. **18.2**
16. Sandstone; light greenish gray (5GY8/1); fine grained; micaceous litharenite; calcareous; low angle trough crossbeds; top bioturbated; forms a well indurated cuesta. **0.5**
15. Mudstone; pale reddish brown (10R5/4); slightly sandy; calcareous; contains a few lenses of grayish red (10R4/2) fine-grained, micaceous sandstone. **6.2**
14. Sandstone; grayish red (10R4/2); fine grained; micaceous litharenite; calcareous; ripple laminated; "*Zamites*" fossils (NMMNH localities 3643-3644). **3.0**
13. Sandstone; pinkish gray (5YR8/1); fine to medium grained; micaceous litharenite; calcareous; ripple laminated. **6.5**
12. Sandstone; pinkish gray (5YR8/1); fine grained; micaceous litharenite; calcareous; trough crossbedded; forms a bench. **1.6**
11. Sandstone; same color and lithotype as unit 9. **11.1**
10. Sandstone; pale reddish brown (10R5/4); very fine grained to fine grained; micaceous litharenite; trough crossbedded; forms a bench. **1.8**
9. Sandstone; pale red (10R6/2); fine grained; micaceous litharenite; calcareous; ripple laminated and small trough crossbedded; slope. **2.5**
8. Sandstone; yellowish gray (5Y8/1); fine to medium grained; micaceous litharenite; not calcareous; ripple laminated; forms an indurated bench. **1.8**
7. Sandstone; light greenish gray (5GY8/1); very fine grained; micaceous litharenite; calcareous; ripple laminated; forms a friable slope. **5.1**
6. Sandstone; yellowish gray (5Y8/1); fine grained; micaceous litharenite; calcareous; trough crossbedded. **1.3**
5. Conglomerate; mottled light brownish gray (5YR6/1); light olive gray (5Y6/1) and moderate yellowish brown (10YR5/4); clast supported; clasts are limestone pebbles up to 1 cm in diameter; massive. **0.4**
4. Siltstone; grayish red purple (5RP4/2); sandy; calcareous. **3.3**
3. Conglomerate; mottled grayish red (10R4/2), grayish orange (10YR7/4) and very pale orange (10YR8/2); clasts are siltstone chert and calcrete up to 6 mm in diameter; clast supported; calcareous. **0.2**

Tr-1 unconformity

Artesia Formation:

2. Shale; pale reddish brown (10R5/4); calcareous; calcrete nodules are pale reddish brown (10R5/4) to moderate reddish orange (10R6/6). **7.2**
1. Limestone; light bluish gray (5B7/1) ledge. **0.4**