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1986, pp. 203-214. https://doi.org/10.56577/FFC-37.203

in:

Truth or Consequences Region, Clemons, R. E.; King, W. E.; Mack, G. H.; Zidek, J.; [eds.], New Mexico Geological Society 37th Annual Fall Field Conference Guidebook, 317 p. https://doi.org/10.56577/FFC-37

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PALEONTOLOGY OF THE CABALLERO AND LAKE VALLEY FORMATIONS (LOWER MISSISSIPPIAN) WEST OF THE RIO GRANDE, SOUTH-CENTRAL NEW MEXICO

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Abstract—The late Kinderhookian to middle Osagean Caballero–Lake Valley (CLV) sequence near Lake Valley and in neighboring areas contains a diverse marine invertebrate fauna numbering more than 200 reported species. The Nunn Member of the Lake Valley Formation, the most highly fossiliferous unit in this sequence, is best known for its well-preserved crinoid fauna, but also contains large numbers of brachiopods and corals, and lesser numbers of many other groups. A review of this fauna based on the published literature and recently made collections indicates the presence of numerous undescribed or previously unreported species. Additional study of most major elements of the fauna would be very worthwhile. Comparison of reported taxa from western and eastern (mainly Sacramento Mountains) parts of the CLV outcrop area revealed significant differences. Two-thirds of the reported taxa from these formations are apparently restricted to either the eastern or western areas, with only one-third of the species having been reported from both areas. Possible ecological (greater heterogeneity of environments associated with "Waulsortian" mound development to the east) and paleobiogeographic (proximity of western exposures to restricted connections with the Western Interior faunal province) explanations are suggested, but incomplete knowledge of taxonomy and geographic distribution of many species is probably of equal importance. As presently known, the CLV faunas are very similar to, though less diverse than, those of the Burlington shelf (Missouri, Iowa), but apparent similarity will decrease as the CLV faunas become better studied.

INTRODUCTION

The gray shale and limestone exposures at Apache Hill, north of Lake Valley, were the first Mississippian rocks discovered in New Mexico. Soon after the first fossils were collected in the early 1880's, the richness of the Early Mississippian fauna preserved here was recognized, and the locality has achieved importance particularly for its diverse assemblages of well-preserved crinoids. Although more than 200 invertebrate species have been reported from the Caballero–Lake Valley sequence in the Lake Valley area, paleontological study of this fauna has been less than might be expected. Only a small percentage of the reported species has been described and illustrated over the past century, generally in short papers dealing with one or few of the species. In this paper the fauna of the Caballero and Lake Valley Formations in the Lake Valley area (parts of Sierra, Luna, and Grant Counties; Fig. 1) is summarized. This area, west of the Rio Grande, is essentially the western half of the Caballero–Lake Valley outcrop belt. Significant exposures of these formations also occur to the east, especially in the Sacramento, San Andres, and Caballo Mountains, but these are not discussed in detail here. Characteristic taxa are illustrated, some for the first time, and a list of all species reported from the Caballero and Lake Valley Formations west of the Rio Grande is included as an aid to future workers (Appendix I). A few species not previously reported from the Lake Valley area are also discussed. Species illustrated in this paper are in the University of New Mexico (UNM) Department of Geology paleontology collections.

HISTORY OF STUDIES

The earliest collections of fossils from the area under consideration here were made by members of the Wheeler Survey in 1873. Most of these fossils were early Paleozoic species, but Gilbert (1875: 515, 517) reported the coral *Zaphrentis* from Carboniferous rocks in the Burro Mountains and the brachiopods *Productus semireticulatus* and *Spirifer lineatus* from the Santa Rita Range. These names were applied to a wide variety of Carboniferous forms by early workers, and it is uncertain whether these fossils came from Mississippian or Pennsylvanian strata.

Silver was discovered in the Lake Valley area in August 1878. Word of the new strike spread quickly; a town sprang up, mining companies were organized, and the mineralized zones were rapidly explored and claimed (Eveleth in this guidebook).

Geologists were also attracted to Lake Valley. It was soon recognized that the ore deposits were concentrated in chambers, pockets, or pipes within a bluish-gray fossiliferous limestone. A small collection of invertebrate fossils from this limestone was sent in spring 1881 to the noted vertebrate paleontologist E.D. Cope, an early investor in the Lake Valley mines. He gave them to C.A. White, who identified a few species and determined that they were of "Middle Carboniferous" age (Anonymous 1881). Cope himself visited the Lake Valley area in late summer of 1881 and made a larger collection, which he turned over to S.A. Miller for study (Cope 1882b). In December 1881 Miller discussed the fauna, stated that it was of "Subcarboniferous age [belonging to] the Burlington or Keokuk Group, but most likely the former," and described 11 new species, mainly crinoids and brachiopods.

In the meantime, Cope (1881) briefly described the geology of the

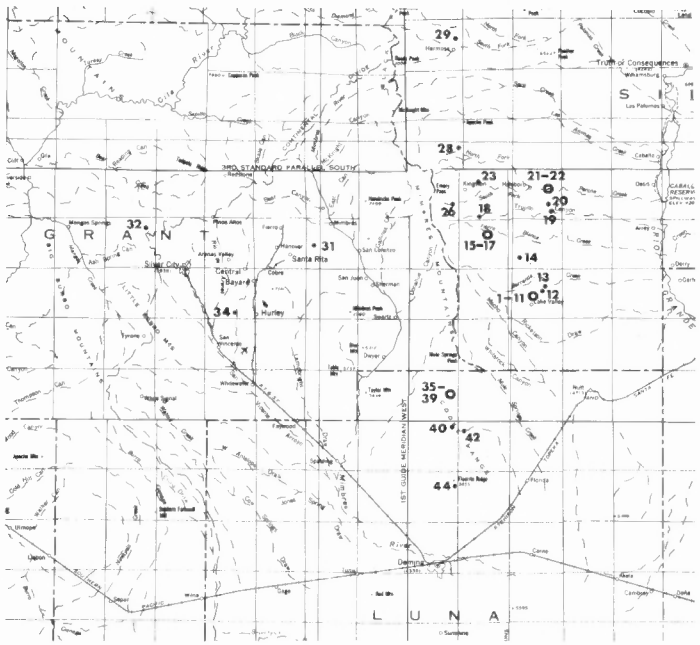


FIGURE 1—Lake Valley Formation localities west of the Rio Grande from which fossils have been reported. Numbers refer to localities listed in Appendix II.

Lake Valley area and published (Cope 1882a) a list of the taxa Miller had reported, noting that some of the fossils had been replaced by argentiferous iron. Benjamin Silliman (1882), who had also visited the Lake Valley mines in 1881, provided a more detailed discussion of the geology of the area and also concluded that the ore-bearing limestones were of Early Carboniferous age. Cope's experience in Lake Valley was an unhappy one. Short of funds needed to acquire the vertebrate fossils that were his main interest, "from being a naturalist he essayed to become a financier, a career for which he was totally unfit" (Osborn 1931: 272). Cope's investments in the Lake Valley mines and elsewhere were largely wiped out, leaving him with financial problems that plagued him for the rest of his life.

In 1882 Frank Springer, Las Vegas lawyer and crinoid specialist, visited Lake Valley and later (Springer 1884) briefly described the stratigraphy and paleontology of the fossiliferous Carboniferous limestones. Springer correlated these limestones with the lower Burlington Limestone of Iowa, of Early Carboniferous age. He reported a diverse fauna, including about 45 crinoid and 25 brachiopod species. Some of the crinoids were later described by Wachsmuth & Springer (1897) and mentioned in a few later papers (e.g. Springer 1911, 1920).

Shortly after the turn of the century, Keyes referred to the Mississippian limestones in the Lake Valley area as the Lake Valley Formation and Lake Valley Limestone, indicating that this unit consisted of 61 m of limestones underlying the Sandia Formation (Early Pennsylvanian) and overlying Devonian strata (Keyes 1904). It would appear that this is the earliest reference to the Lake Valley as a discrete formation. Laudon & Bowsher (1941) were perhaps too generous in crediting Cope (1882a) with the establishment of the name, for Cope merely referred informally to "the silver-bearing carboniferous limestone of Lake Valley" and provided no additional information to define the unit.

During the early twentieth century, the Mississippian units and faunas at Lake Valley were also recognized in neighboring areas. Gordon (1907, 1910), Darton & Burchard (1911), Paige (1916), and Darton (1916, 1917a, 1917b, 1928) reported numerous species from the Hillsboro, Kingston, and Silver City areas, and from several localities in the Cooke's Range. Most of these workers used the term Lake Valley Limestone for the entire Mississippian sequence. Paige (1916) considered the Mississippian and Pennsylvanian units in the Silver City area to be a single lithostratigraphic unit, the Fierro Limestone, a term that has since been abandoned.

Laudon & Bowsher (1941, 1949), in two landmark papers, studied the entire Mississippian sequence throughout southern New Mexico, provided numerous stratigraphic sections of the major exposures, and established the stratigraphic nomenclature in use today. In addition to defining a type section for the Lake Valley Formation, Laudon & Bowsher (1941) also established the underlying Kinderhookian Caballero Formation and ultimately (Laudon & Bowsher 1949) divided the Lake Valley Formation into six members. Only the lower four members (Andrecito, Alamogordo, Nunn, Tierra Blanca) are present west of the Rio Grande. The type sections for the Lake Valley Formation and Nunn and Tierra Blanca Members are near Lake Valley. Numerous species of fossils from each stratigraphic interval and locality were listed by Laudon & Bowsher (1941, 1949), adding significantly to the number of taxa known from the Caballero and Lake Valley Formations. Jicha (1954) also studied the geology of the Lake Valley area; his faunal lists for Mississippian units were derived from those of Laudon & Bowsher. Later studies of the geology of specific areas near Lake Valley (e.g. Jones et al. 1967, Pratt 1967) also added information about the stratigraphy and paleontology of Mississippian units. Since 1935 several authors (cited below) have described and illustrated some elements of the Caballero–Lake Valley faunas.

STRATIGRAPHY

Laudon & Bowsher (1949) established the stratigraphic nomenclature used throughout the Lake Valley area by refining an earlier set of names they had proposed in 1941. In the area discussed in this paper the Caballero Formation was reported by Laudon & Bowsher (1949) only at Lake Valley, although Cooper & Dutro (1982) later cited Kinderhookian conodonts from what they called the Caballero in the Kingston and Silver City areas. At Lake Valley the Caballero is about 15 m thick and consists of lower thin-bedded, brown, sandy limestones and an upper interval of light-gray nodular limestones interbedded with light-gray shales. The Caballero grades upward without significant change in lithology into the Andrecito Member of the Lake Valley Formation. The Andrecito varies considerably in thickness west of the Rio Grande, ranging from 22 m at Lake Valley to a maximum of 82 m southward in the Cooke's Range (Laudon & Bowsher 1949). Except at Lake Valley, where it rests on the Caballero, the Andrecito unconformably overlies the Upper Devonian Percha Shale. The Andrecito is sparsely fossiliferous except for fenestellid bryozoans. East of the Rio Grande it is also characterized by the trace fossil *Zoophycos* (= *Taonurus*) and was originally called the *Taonurus* siltstone facies by Laudon & Bowsher (1941).

The overlying Alamogordo Member is a relatively thin, massive, dark-gray, cherty limestone unit that forms a persistent 10 m thick cliff near the top of the west side of Apache Hill (Fig. 2). The Alamogordo Member is present with only moderate variation in thickness and lithology throughout the Lake Valley outcrop area. In the Sacramento Mountains it displays mound-shaped bioherms. The overlying Nunn Member consists of nodular, light-gray, crinoid-rich limestones interbedded with light-gray shales and argillaceous limestones. This member is profusely fossiliferous and has yielded typical Lake Valley crinoid faunas. Laudon & Bowsher (1949) considered the Nunn fauna to be early Osagean, somewhat older than that of the Burlington Limestone of the Midwest. More recently, study of conodonts by Lane (1974) and Lane & De Keyser (1980) demonstrated that the Nunn contains conodont faunal unit 3 and the lower part of unit 4, and is correlative with the lower part of the Burlington Limestone. The Nunn is about 20 m thick at Lake Valley and gradually thickens to the south (45 m in the Cooke's Range) and to the west, where it reaches 55–60 m near Santa Rita (Laudon & Bowsher 1949, Jones et al. 1967). The Nunn forms eroded slopes and ledges that are well exposed and fossiliferous on the eastern side of Apache Hill (Fig. 3).

The Tierra Blanca Member is the uppermost unit of the Lake Valley Formation present in the Lake Valley area. The Tierra Blanca gradationally overlies the Nunn and is composed of medium-bedded, gray to brown, coarse-grained, crinoid-rich limestones that typically contain abundant light-colored, nodular chert beds. In the Sacramento Mountains the Tierra Blanca includes the locally thick core and flank facies of the largest "Waulsortian" mounds. At Lake Valley the Tierra Blanca is about 15 m thick and does not vary greatly in thickness elsewhere in the area. The Tierra Blanca contains elements of conodont faunal units 4 to 5 (Lane & Ormiston 1982), of middle Osagean age and straddling the Tournaisian–Visean boundary. The upper members of the

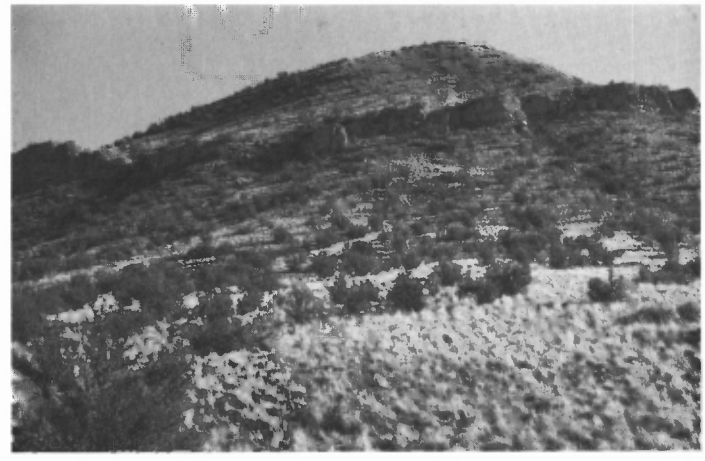


FIGURE 2—View of part of west side of Apache Hill, about 1.5 km north of Lake Valley townsite, from NM-27. Alamogordo Member of Lake Valley Formation forms persistent limestone cliff; underlying Caballero Formation and Andrecito Member of Lake Valley Formation are largely covered. Slope-forming unit above Alamogordo Member is Nunn Member.

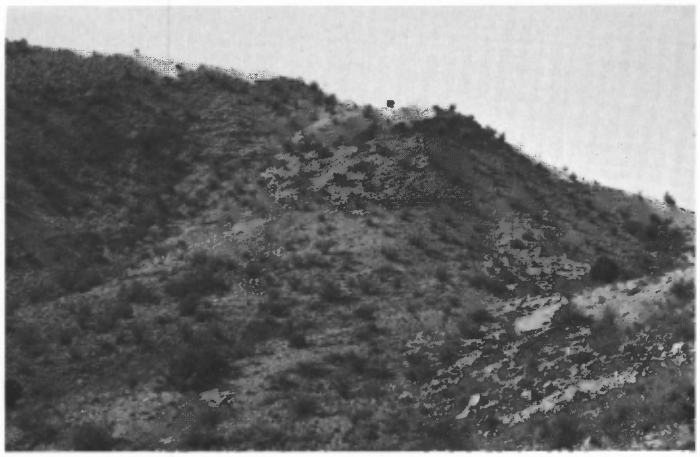


FIGURE 3—Eroded slopes of Nunn Member, Lake Valley Formation, on east side of Apache Hill. Most of the Nunn fossils discussed in this paper were collected from this area.

Lake Valley (Arcente and Doña Ana Members of Laudon & Bowsher 1949, and Table Top Member of Lane & Ormiston 1982) are of late Osagean age and were deposited between the topographically high "Waulsortian" mounds in the Sacramento Mountains. They are not present west of the Rio Grande. In this area the Tierra Blanca is generally overlain unconformably by Pennsylvanian units, with local thin remnants of the Kelly Formation reported by Laudon & Bowsher (1949).

Southwest of Lake Valley, in Hidalgo County of New Mexico and in southeastern Arizona, the Keating Formation is coeval with, and lithologically similar to, the Caballero–Lake Valley sequence, as discussed by Armstrong & Mamet (1978) and Armstrong et al. (1979, 1980). Many of the taxa identified from the Lake Valley area are also present in the Keating.

PALEONTOLOGY

The Caballero–Lake Valley sequence west of the Rio Grande contains a high diversity of late Kinderhookian to middle Osagean marine invertebrates—about 200 species have been reported (Tab. 1). Nearly two-thirds of the species in these formations are brachiopods and crinoids, with corals adding another 12%. All other groups together contribute only about 24% of the reported diversity. The large number of species reported from this sequence, however, is a deceptive measure of our knowledge of its paleontology. Surprisingly few studies have described, discussed, and illustrated Mississippian faunas from the Lake Valley area. Workers have typically investigated intensively only one or few species within any given group, e.g. corals (Grove 1935, Jeffords 1943, 1955, Bowsher 1961, Armstrong 1962), crinoids (Wachsmuth & Springer 1897, Bowsher 1955, Brower 1965, Lane et al. 1985), blastoids (Fay 1961, 1962), brachiopods (Muir-Wood & Cooper 1960), and trilobites (Hessler 1963, 1965). A significant number of species reported by early workers requires verification because they have not been reported by more recent workers, or are taxa that have since been subjected to extensive revision or reinterpretation.

TABLE 1—Summary of Caballero–Lake Valley taxa reported from exposures west of Rio Grande. Number of species includes apparently valid, named species and genera unidentified to species that represent the only report of a genus from this sequence.

GROUP	SPECIES	PERCENT OF TOTAL	NEW GENERA	NEW SPECIES
Calcareous algae	1	–	–	–
Foraminifera	1	–	–	–
Coelenterata	24	12	–	3
Brachiopoda	69	34	2	5
Bryozoa	12	6	–	1
Gastropoda	2	1	–	–
Bivalvia	1	–	–	–
Rostroconchia	1	–	–	–
Nautiloidea	2	1	–	1
Ammonoidea	1	–	–	–
Trilobita	9	4	–	1
Ostracoda	2	1	–	–
Blastoidea	5	2	2	3
Crinoidea	61	30	1	9
Conodonta	10	5	–	–
Chondrichthyes	2	1	–	–

A total of five new genera and 23 new species currently recognized as valid or possibly valid have been established on the basis of specimens from Lake Valley area (Tab. 1). However, Laudon & Bowsher (1949), discussing the Nunn Member fauna at Lake Valley, estimated that more than half the species in this fauna were undescribed. Progress has been made (some of the studies cited above), but the validity of Laudon & Bowsher's assessment is emphasized by two unpublished Master's theses completed at the University of Wisconsin under the direction of Laudon. Paape (1955) noted more than 20 species of platycrinitid crinoids from both eastern and western exposures of the Lake Valley that had not previously been reported, and recognized an additional seven species he believed to be new. Kilps (1956) reported 14 new species of actinocrinitid crinoids and numerous other specimens that might also represent additional new species.

Most intervals of the Caballero–Lake Valley sequence west of the Rio Grande are at least locally fossiliferous, but most of the species and specimens are concentrated in the Nunn Member. For several years the author and students have been sampling the Nunn fauna at Apache Hill. There, the Nunn Member forms slopes and ledges from which large numbers of fossils continuously erode. Subjective estimates of the abundance of various groups suggest that 75% or more of the total individual specimens in the Nunn are brachiopods and corals. Bryozoans and crinoids add perhaps another 15–20%; specimens of all other groups are uncommon to rare. The intention here is not to attempt a detailed discussion of the Nunn faunas; rather the emphasis is on observations that provide new information about this fauna and indicate what appear to be profitable lines of future research. A selection of common Nunn taxa is illustrated in Fig. 4.

Sponges and spirorbid worms, previously not reported from the Nunn Member west of the Rio Grande, are minor elements in the fauna at Apache Hill. At least two genera of sponges are present. Unidentified sponges have also been reported from the Lake Valley Formation in the Sacramento Mountains (Lane & Ormiston 1982). Spirorbid worms are moderately common as epizoans on brachiopods and platyceratid gastropods. There appear to be two species, one smooth and the other highly ornamented, but identification was not attempted. Northrop (in Kelley & Silver 1952) previously reported *Spirorbis* sp. from the Lake Valley Formation of the Caballo Mountains, and it is likely that these annelids are present throughout the Lake Valley outcrop area. Less common as epizoans are the small, slit-shaped holes of acrothoracic barnacles.

Lake Valley corals are reasonably well known through the studies of the workers cited above. Several species of solitary, conical rugose corals (*Amplexizaphrentis*) together with numerous fragments of the long, cylindrical *Caninia arcuata* (Fig. 4T) and small to medium-sized colonies of a tabulate coral resembling *Favosites* comprise the most conspicuous elements of the Nunn coral fauna at Apache Hill. The tabulate corals are elongate to nearly spherical colonies often encrusting crinoid stem segments, and appear to be the species first identified as *Favosites velmeyerensis* by Weller (1909) from the Burlington Limestone. This species (Fig. 4W) was reported from the Lake Valley Formation by several workers, including Laudon & Bowsher (1941), but Laudon & Bowsher (1949) did not mention it, possibly because its systematic status was unclear. The genus *Favosites* is not present in the

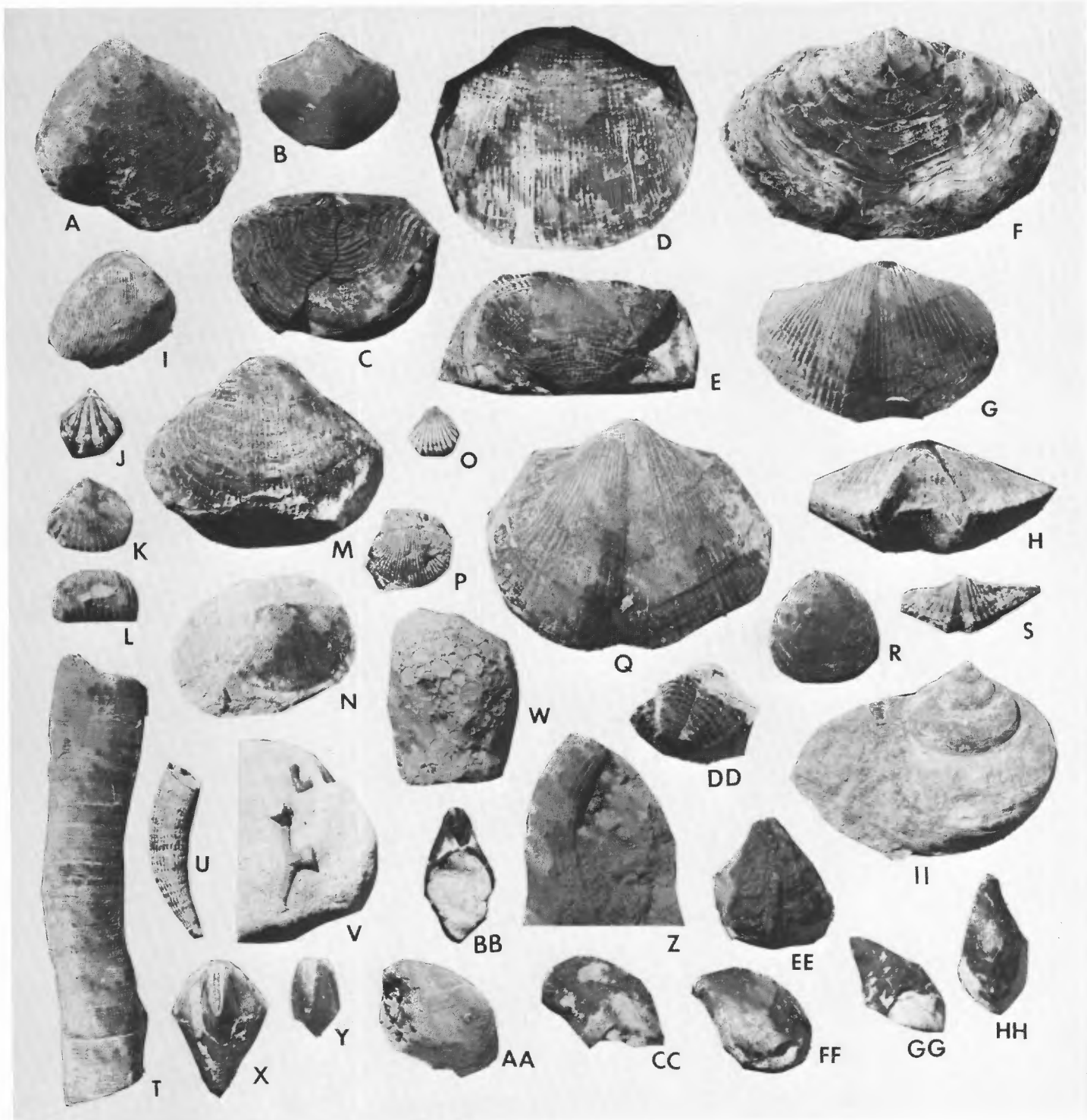


FIGURE 4—Invertebrates from the Nunn Member, Lake Valley Formation, at Apache Hill (all ×1 unless otherwise indicated). **A,** *Cleiothyridina obmaxima* (McChesney), incomplete pedicle valve, UNM 9380. **B,** *Cleiothyridina temeraria* (Miller), brachial valve, UNM 9381, ×1.5. **C,** *Leptaena analoga* (Phillips), brachial valve, UNM 9382. **D, E,** *Marginatia* sp., pedicle valve and posterior view, UNM 9383. **F,** *Athyris lamellosa* (L'Eveille), flattened pedicle valve, UNM 9384. **G, H,** *Unispirifer vernonensis* (Swallow), pedicle valve and front view, UNM 9385. **I,** *Ovatia "ovata"* (Hall), pedicle valve, UNM 9386. **J,** *"Ptychospira"* aff. *sexplicata* (White & Whitfield), brachial valve, UNM 9387, ×1.5. **K, L,** *Rhynchopora persinuata* (Winchell), pedicle valve, UNM 9388, and front view, UNM 9389. **M,** *Stegacanthia bowsheri* Muir-Wood & Cooper, pedicle valve, UNM 9390. **N,** *Rugosochonetes* aff. *burlingtonensis* (Weller), incomplete pedicle valve, UNM 9391, ×2. **O,** *Camarotoechia tuta* (Miller), pedicle valve, UNM 9393, ×2. **P,** *Plicochonetes ornatus* (Shumard), pedicle valve, UNM 9392, ×1.75. **Q,** *Spirifer rowleyi* Weller, pedicle valve, UNM 9394. **R,** *Rhipidomella dalyana* (Miller), pedicle valve, UNM 9395. **S,** *Amesopleura novamexicana* (Miller), pedicle valve, UNM 9396. **T,** *Caninia arcuata* Jeffords, incomplete specimen, UNM 9397. **U,** *Cyathaxonia tantilla* (Miller), UNM 9398, ×2. **V,** *Cladochonus* sp., UNM 9399, ×2. **W,** *"Favosites" valmeyerensis* Weller, colony grown around a crinoid-stem fragment, UNM 9400. **X,** *Orophocrinus*? sp., UNM 9401, ×2. **Y,** *Pentremites*? sp., UNM 9402, ×2. **Z,** *"Triboloceras" digonum* (Meek & Worthen), fragment of steinkern, UNM 9403. **AA–CC,** *Platyceras* (*Platyceras*) *nasutum* Miller; AA, oblique side view of UNM 9404; BB, CC, apertural and side views of UNM 9405. **DD,** *Phillipsia tuberculata* Meek & Worthen, pygidium, UNM 9406. **EE, FF,** *Platyceras* (*Orthonychia*) aff. *lodiensis* Meek, top and side views, UNM 9407, ×1.5. **GG, HH,** *Platyceras* (*Orthoynchia*) aff. *waverlyensis* Hyde, side (×1.5) and top (×2) views, UNM 9408. **II,** *Mourlonia* aff. *northfieldensis* Weller, oblique side view of a compressed steinkern, UNM 9409.

Mississippian (Hill 1981) and to my knowledge *"Favosites" valmeyerensis* has not been restudied or reassigned. The branching tabulate genus *Cladochonus* is sparsely present in the Nunn (Fig. 4V).

Numerous small, straight to gently arcuate, narrow, solitary rugose corals are also present in the Nunn Member (Fig. 4U). These specimens, which reach a maximum length of about 20 mm, are referred to *Cyathaxonia tantilla* (=*C. minor* of Weller 1909, fide Grove 1935). *Cyathaxonia tantilla* has not been previously reported from the Lake Valley Formation, although *C. minor* has been noted in the Caballero Formation of the Sacramento Mountains (Laudon & Bowsher 1941). A related species, *C. arcuata,* also occurs in the Andrecito and Nunn Members of the Lake Valley Formation (Laudon & Bowsher 1941, 1949), but is considerably larger and wider than *C. tantilla,* and tends to be more curved (Weller 1909). Only a few possible specimens of *C. arcuata* are present in the UNM collections.

The only study of any bryozoan from the Caballero–Lake Valley sequence in the Lake Valley area is Miller's (1881) description of *Fistulipora americana.* Bryozoans are abundant and well enough preserved in the Nunn and other members of the Lake Valley to make a comprehensive study of them feasible and worthwhile. This is true of several other Mississippian units in New Mexico, which are similarly rich in specimens of this largely ignored group.

Brachiopods are both abundant and diverse in the Nunn Member. Most of the reported species were originally described from Lower Mississippian units in the Midwest. Spiriferids dominate the brachiopod fauna both in abundance and diversity. The most conspicuous large species are *Spirifer rowleyi* (Fig. 4Q) and *Unispirifer vernonensis* (Fig. 4G, H). Some specimens of *U. vernonensis* reach slightly larger sizes and have several more costae on the lateral slopes than typical specimens from the Midwest and from the Keating Formation of southwestern New Mexico (Armstrong 1962). Small spiriferids, such as *Spirifer louisianensis, Amesopleura novamexicana* (Fig. 4S), and *Punctospirifer solidirostris,* are also relatively common in the Nunn. Several species of the athyrid genus *Cleiothyridina* are also present, including *C. obmaxima* (Fig. 4A), an unusually large species, and the abundant form described by Miller (1881) as *Spirifera temeraria* (Fig. 4B). This species is similar to *C. prouti* from the Midcontinent and further study is required to determine whether the two species are synonymous, as some (Weller 1909) have suggested. Athyrids are also represented by the distinctive *Athyris lamellosa* (Fig. 4F), which reaches a maximum width of about 60 mm and is abundant in the Nunn Member. Several small spiriferids appear to be undescribed species.

The small, strongly costate spiriferid reported as *Ptychospira sexplicata* from the Caballero and Lake Valley Formations of the Sacramento Mountains (Laudon & Bowsher 1941) is also present in the Nunn Member at Apache Hill (Fig. 4J). Generic assignment of this species is apparently in doubt. Cooper (1942) proposed the new name *Plectospira* to replace *Ptychospira,* a homonym that had previously been applied to a gastropod, but Boucot et al. (1965) indicated that *Plectospira* was limited to the Lower and Middle Devonian.

Productoids are less common, relative to spiriferids, than is the case in typical Pennsylvanian marine limestones in New Mexico. *Marginatia fernglenensis, M.* cf. *burlingtonensis,* and a large undescribed species (Fig. 4D, E; also see Muir-Wood & Cooper 1960), together with the spinose *Stegacanthia bowsheri* (Fig. 4M) and several smaller productoids, are moderately common in the Nunn Member at Apache Hill. About half a dozen chonetid species have been reported from the Caballero–Lake Valley sequence throughout its outcrop area, and my observations of the Nunn fauna at Apache Hill suggest the presence of additional forms, such as *Plicochonetes ornatus* (Fig. 4P) and *Rugosochonetes burlingtonensis* (Fig. 4N). Strophomenid brachipods are also represented by the distinctive and abundant species *Leptaena analoga* (Fig. 4C)—the *L. rhomboidalis* of early workers. Orthotetids and schuchertellids are rare.

Miller (1881) described two new species of rhynchonellids from the Lake Valley area: *Camarophoria occidentalis* [now considered a synonym of *Rhynchopora persinuata* (Fig. 4K, L) fide Weller 1914] and *Rhynchonella* (now *Camarotoechia*) *tuta* (Fig. 4O). Both species are moderately common in the Nunn Member at Apache Hill. Although Laudon & Bowsher (1949) did not cite *C. tuta* from the Caballero–Lake Valley sequence west of the Rio Grande, they noted its presence in the Caballero of the Sacramento Mountains, and it has been documented in the lower member of the Keating Formation in Hidalgo County (Armstrong 1962). Of the orthids, species of *Rhipidomella* and *Schizophoria* are moderately common. Most specimens of *Rhipidomella* in the UNM collections are finely lirate forms with a short hinge line (Fig. 4R), the *Orthis dalyana* of Miller (1881). However, *Rhipidomella dalyana* was not cited by Laudon & Bowsher (1941, 1949), although they did report *R. missouriensis* and *R. oweni* from the Lake Valley Formation at Apache Hill. Inarticulate brachiopods are very rare in the Nunn Member at Apache Hill. Only a single specimen of *Lingula gorbyi* has been collected.

It is perhaps clear from these brief comments that the brachiopod fauna of the Nunn Member, and the entire Caballero–Lake Valley sequence, deserves much additional study. Future studies will result in the description of new species, the addition of species from other areas to the known Lake Valley fauna, and a more accurate assessment of the status of Midcontinent species that have been reported from the Lake Valley Formation.

Among the gastropods only platyceratids are moderately common, as might be expected from the fact that these coprophagous forms typically lived attached to crinoid calyxes. Several species of *Platyceras* have been reported from the Lake Valley Formation through its outcrop area, but only *P.* (*Orthonychia*) *equilaterum* has previously been identified from the Lake Valley area. Species of *Platyceras* are often highly variable; shell form, apertural shape, and other features are strongly influenced by the topography of the substrate on which they lived. A collection of about 70 *Platyceras* specimens from the Nunn Member on Apache Hill includes three forms which are briefly characterized here.

About 90% of the specimens are medium-sized (20–35 mm long), nearly planispiral shells with a disjunct but strongly curved narrow apex that expands rapidly to produce a mature shell of about one to one and half complete whorls. The body whorl is strongly to moderately arched across its midline and typically possesses a single broad, low to obscure radial ridge on each lateral slope. Growth lines are deflected forward across this ridge, then backward across a depression between the ridge and the summit of the shell, and then forward again across the summit. These specimens agree in their essential features with forms often in the past assigned to *Platyceras paralium* (e.g. Keyes 1894, Hyde 1953). However, Rollins (1975) pointed out that *P. paralium* sensu stricto possesses a whorl surface with several pronounced plications and referred shells of similar shape but lacking these plications to *P.* (*Platyceras*) *nasutum.* Most of the Nunn specimens are considered here to be *P.* (*P.*) *nasutum* (Fig. 4AA–CC). Laudon & Bowsher (1941) and others have reported *P. paralium* from several members of the Lake Valley Formation in the Sacramento Mountains. At least some of their specimens may be *P.* (*P.*) *nasutum.*

A second type of *Platyceras* observed in the Nunn Member has a broad, symmetrical, capuliform shell with an uncoiled or slightly coiled apex, and a prominent midline ridge that extends from the apex to the aperture (Fig. 4EE–FF). Among Lower Mississippian platyceratids, this form is most similar to *P.* (*Orthonychia*) *lodiensis* in general shape and presence of the ridge. However, the Lake Valley specimens have a higher and more inflated shell, and may represent an undescribed species.

A third species has a narrow, elongate, conical shell with no trace of initial coiling at the apex (Fig. 4GG–HH). A rather uneven, low, midline carina begins about midway between the apex and the aperture. The shape of this shell is similar to that of *P.* (*Orthonychia*) *waverlyensis* from the Logan Formation of Ohio (Hyde 1953). This species, however, is known only from steinkerns that are about twice the size of the Lake Valley specimens.

Several non-platyceratid gastropods are also present in the Nunn Member at Apache Hill. One large (height about 35 mm), distorted steinkern of a turbiniform pleurotomariacean preserves a slightly raised selenizone situated a short distance above the lower suture, and traces of fine spiral lirae (3/mm) crossed by prosoclinally inclined transverse

lirae of equal size on the whorl surface above the selenizone (Fig. 4II). Although the nature of preservation prevents positive identification, this specimen appears to be very similar to *Mourlonia northviewensis*, described by Weller (1899) from the Kinderhookian of Missouri.

Bivalves have seldom been reported from the Lake Valley Formation, but about eight genera have been obtained from the Nunn Member at Apache Hill during recent collecting. All are either fragmentary or preserved as steinkerns, and even tentative identification is not justified here because of poor preservation. One unidentified rostroconch was also collected. The bivalves are mainly confined to light-gray calcareous-shale intervals. Because they are fragile and do not survive exposure and erosion, adequate sampling of the Nunn bivalve fauna can only be accomplished by splitting the shale rather than surface collecting. Additional collection and study of the bivalves and rostroconchs would add a worthwhile facet to our knowledge of the Nunn fauna.

Aside from fragments of orthoconic nautiloids and the ammonoid *Goniatites*, the only cephalopod reported from the Lake Valley Formation west of the Rio Grande is *"Trematoceras" rockymontanus* (Miller 1881). Several other species were described by Miller & Youngquist (1947) from the Caballero Formation of the Sacramento Mountains. The only cephalopod remains in the UNM collections from the Nunn Member at Apache Hill are a few small fragments with prominent longitudinal ridges (Fig. 4Z) that are similar to specimens identified as *Triboloceras digonum subcirculare* by Miller & Youngquist (1947).

Trilobites are uncommon in the Nunn Member at Apache Hill and are represented predominantly by isolated pygidia. Hessler (1963, 1965), in a detailed study of Lower Mississippian trilobites, described and illustrated most of the species that are present in the Lake Valley Formation. *Phillipsia tuberculatus* (Fig. 4DD) is the most abundant trilobite in the Nunn Member and is easily distinguished by its large size (pygidia are up to 25 mm wide) and strongly tuberculate ornamentation. A few small pygidia are unusual in having very subdued segmentation. In these specimens axial segments are faint, flat, and separated by very shallow furrows, and the pleural areas are smooth, showing little or no evidence of segmentation. Pygidia of this type characterize *Breviphillipsia swallowi* and an undescribed species of *Griffithides* reported by Hessler (1965) from the Lake Valley Formation in Sierra County.

Blastoids are a minor element of Nunn faunas at Apache Hill, although their usual small size (most are 7 mm or less in height) makes them easy to overlook. The three named species known from Apache Hill were all described as new species by Fay (1961, 1962), but blastoid diversity is greater than is indicated in published reports. UNM collections contain 16 specimens representing six species—*Hadroblastus convexus, Monadoblastus granulosus*, cf. *Tanaoblastus haynesi, Pentremites*? sp. (Fig. 4Y), *Orophocrinus*? sp. (Fig. 4X), and a well-preserved specimen that has not been identified. Intensive searching for blastoids will probably yield even more species.

The Lake Valley Formation is probably best known to paleontologists for its crinoid fauna. About 60 species of crinoids have been reported from western exposures of the Lake Valley, the great majority of them from the Nunn Member, and numerous undescribed species are also present (Paape 1955, Kilps 1956). The crinoids are typically well preserved and are represented mainly by partial to complete calyxes. The tegmen is preserved on some specimens, but complete crowns including the arms are rare. Many of the calyxes are silicified. Most of the reported crinoid species are forms originally described from Lower Mississippian units in Iowa and Missouri, but nine species have been established on the basis of specimens collected from the Lake Valley area (Tab. 1). The majority of species, although not necessarily Lake Valley specimens, were described and illustrated by Wachsmuth & Springer (1897). Because ample information about Lake Valley crinoids is available, and some are actively being studied, no further discussion is presented here.

Few microfossils have been reported from the Caballero–Lake Valley sequence west of the Rio Grande. Several conodont species were noted from the basal Mississippian of the Silver City–Kingston area by Cooper & Dutro (1982). The paucity of foraminifers in these formations is in striking contrast to the profuse faunas documented in other New Mexico Mississippian limestones (especially the Osagean–Meramecian Arroyo Peñasco Group) by Armstrong and Mamet in several papers. Mamet (written comm. 1986) has observed only sparse Earlandiidae, Tournayellidae (mostly *Septaglomospiranella*), and *Latiendothyra* in the Lake Valley Formation. Toomey (in Lane 1974) suggested that the very low number of foraminifers and calcareous algae in the Lake Valley of the Sacramento Mountains was due to a relatively deep-water environment. Similarly, both Armstrong (written comm. 1986) and Mamet (written comm. 1986) attribute the rarity of calcareous foraminifers and algae to the fact that many Lake Valley units represent crinoid- and bryozoan-rich facies that occurred in somewhat deeper water than the shallow, well-oxygenated environment in which endothyrids thrived. Mamet also noted that significant migration of endothyrids from the Tethyan realm, where they originated, to North America became possible only in mid- to late Tournaisian time, when Caballero–Lake Valley deposition was well underway.

PALEOBIOGEOGRAPHICAL OBSERVATIONS

There appear to be considerable geographic differences in the composition of Caballero–Lake Valley faunas. Comparison of brachiopod, crinoid, and coral species reported from equivalent stratigraphic intervals (Caballero Formation through Tierra Blanca Member of Lake Valley Formation) west and east of the Rio Grande (Tab. 2) indicates that only about one-third of the species occur in both areas. The remainder is either limited to eastern (especially Sacramento Mountains) or western (mainly near Lake Valley) outcrops. Predominantly restricted geographic ranges are also characteristic of blastoids, cephalopods, and conodonts.

The significance of these pronounced apparent geographic variations in Caballero–Lake Valley faunas is difficult to assess precisely, but several factors are almost certainly involved. First, because many elements of these faunas have not been systematically or completely studied, our knowledge of true taxonomic diversity and geographic distribution of most groups is incomplete. Secondly, some groups have been collected and/or studied more intensively in restricted areas than across the entire Caballero–Lake Valley outcrop belt. Most of the cephalopods, for example, were described from a few localities in a small area of the Sacramento Mountains (Miller & Youngquist 1947). Moreover, much attention has recently been focused on the stratigraphy and paleoecology of the Lake Valley Formation in the Sacramento Mountains as a consequence of interest in the "Waulsortian" bioherms that are well developed there (Pray 1975, Bolton et al. 1982). A detailed conodont zonation is available for units in the Sacramento Mountains (Lane 1974, Lane & Ormiston 1982), whereas Mississippian conodonts west of the Rio Grande have been little studied. Intensity of collection and study obviously affects the taxonomic data base available for a formation from place to place. As the fauna of the Caballero–Lake Valley sequence continues to be studied, the apparent geographic differences between eastern and western faunas will undoubtedly decrease.

A more important question is whether these differences reflect real variations in the distribution of taxa across the approximately 250 km wide area in which Caballero and Lake Valley sediments were deposited. During Kinderhookian and Osagean time, marine environments spread across southern New Mexico and extended into central and northern New Mexico by the end of the Osagean (Armstrong et al. 1979). Deposition of Caballero–Lake Valley sediments occurred on a

TABLE 2—Comparison of number of species of Caballero–Lake Valley (Andrecito to Tierra Blanca Members) brachiopods, crinoids, and corals east and west of Rio Grande. Percent is percentage of total species of a group reported from given area.

GROUP	EAST ONLY	PERCENT	EAST AND WEST	PERCENT	WEST ONLY	PERCENT	TOTAL SPECIES
Brachiopods	35	35	36	36	29	29	100
Crinoids	29	33	27	31	31	36	87
Corals	12	44	9	33	6	22	27
TOTAL SPECIES	76		72		66		214

shallow-marine carbonate shelf called the Lake Valley shelf by Lane & De Keyser (1980). These sediments wedged out to the south into a low-energy, probably deeper-water, starved basin (Wilson 1975, Armstrong et al. 1979, Lane & De Keyser 1980). Northward, in central New Mexico, the Lake Valley shelf was bounded by the Transcontinental arch, a cratonic axis that was intermittently exposed (Pedernal and Zuni highlands) during the Mississippian. This structure functioned as a barrier between Western Interior and Southeastern zoogeographic provinces (Sando et al. 1975, Lane & De Keyser 1980). The only open, unrestricted connection between these two provinces was across the Lake Valley shelf and adjacent deeper-marine environments to the south. Judging from coral similarity indices (Sando et al. 1975), considerable faunal interchange between the two provinces occurred during Kinderhookian and Osagean time through southern New Mexico and southeastern Arizona.

This broad paleogeographic scenario, encompassing continuous, shallow-shelf environments from the present Sacramento Mountains to the Lake Valley area, might lead to an expectation of greater similarity between eastern and western faunas than has actually been documented. However, Lake Valley lithofacies in the Sacramento Mountains are considerably more heterogeneous than those to the west, due to the presence of numerous "Waulsortian" mounds. The structure and stratigraphy of these large (up to 100+ m high and 1 km+ wide) bioherms have been much studied (e.g. Laudon & Bowsher 1941, Pray 1958, 1975, Bolton et al. 1982) and will not be discussed here in detail. Lane & Ormiston (1982) have shown that growth of these mounds produced abrupt litho- and biofacies changes not only across the shallow shelf on which they grew, but also along the slope break into the deeper basins to the south. De Keyser et al. (1985) recognized a windward shelf/reef ecofacies depositional system in the Sacramento Mountains that is not present to the west in the San Andres Mountains, although these two portions of the Lake Valley shelf are otherwise very similar. The eastern area of mound or reef development thus included a greater variety of ecological conditions than were present on the shelf to the west, where no mounds formed. The areas of mound development that are so well preserved in the Sacramento Mountains may also have formed isolated, subaqueous "islands" on and around which species not otherwise indigenous to the area could live, much as modern coral reefs do today. However, this does not completely explain why there are nearly as many species restricted to the western Caballero–Lake Valley exposures as there are species that are only present in the Sacramento Mountains. Possibly there is a component of immigrant species from the Western Interior province in the western Caballero–Lake Valley sequence that never reached the Sacramento Mountains area. Ecological differences may partly explain the geographic variations in these faunas, but incomplete knowledge of the taxonomy and geographic distribution of many species is probably equally important.

The reported faunas of the Caballero and Lake Valley Formations throughout their entire outcrop area in southern New Mexico are remarkably similar to those of contemporaneous units (e.g. Burlington and Fern Glen Formations) in Iowa and Missouri—a fact recognized from the very beginning of paleontological studies in the Lake Valley area (e.g. Miller 1881, Springer 1884). For example, virtually every species of crinoid reported from the Lake Valley Formation west of the Rio Grande, except species originally described from this area, was listed as occurring in the Burlington Limestone (Bassler & Moodey 1943). Likewise, most Lake Valley brachiopod species were reported from the Lower Mississippian of the Midcontinent by Weller (1914). The taxonomic similarities are undoubtedly not as close as an uncritical comparison of species would indicate, given the significant number of undescribed species known to be present in the Lake Valley, but they do suggest the existence of a continuous marine connection between the Lake Valley shelf through Texas and Oklahoma to the Burlington shelf. The faunas of the Burlington shelf during the Early Mississippian were much more diverse than those of the Lake Valley shelf; Bassler & Moodey (1943), for example, listed about 400 crinoid species from the Burlington Limestone, compared to less than 100 known species from the Caballero and Lake Valley Formations. This is not surprising, considering that the areal extent of the Burlington shelf was an order of magnitude greater than that of the Lake Valley shelf, and Burlington faunas have been more intensively studied.

The nearest contemporaneous shelf carbonate to the east of the Caballero–Lake Valley outcrop area is the Chappel Limestone of the Llano region of central Texas. Carter (1967: 258) studied the brachiopods of this formation and noted that they are "most similar to and correlative with [the brachiopod fauna of] the Caballero Formation of New Mexico." Of the 52 named species discussed by Carter, 13 (25%) are also found in the Caballero, whereas 14 previously named species (27%) are not. Nearly half (25) of the Chappel brachiopod species (48%) were new species that are not known from other areas. Carter's study is important from the point of view of assessing Caballero–Lake Valley faunas for several reasons. The large number of new species in the Chappel fauna demonstrates the well-known dramatic effect a monographic study can have on the known diversity of a fauna and suggests that a similar study of Caballero–Lake Valley brachiopods might yield similar results. Secondly, it provides additional evidence of wide geographic ranges for the Caballero species that are present in the Chappel. Many of these species, and some of those present in the Chappel but not in the Caballero, also range into Kinderhookian strata in the Midwest, indicating a significant degree of faunal interchange from the Midwest to Texas and New Mexico. And finally, all the new species reported from the Chappel suggest a strong endemic character to the fauna as a whole. Study of the Caballero brachiopods obviously must precede any final conclusions about the similarity of Caballero and Chappel brachiopod faunas. However, in view of Carter's study and some of the evidence presented above, it would not be surprising to find a similar pattern of faunal diversity—significant numbers of geographically widespread species mixed with many endemics—in the Caballero and Lake Valley faunas when they have been thoroughly studied.

CONCLUDING REMARKS

This brief review suggests that much additional paleontological study remains to be done on faunas of the Caballero–Lake Valley sequence west of the Rio Grande. At least two extensive collections, only partly studied to date, include large numbers of specimens from the Lake Valley area. The Laudon collection at the University of Wisconsin contains many excellent specimens. From 1947 to 1952, Arthur Bowsher and William Allen spent several months each year collecting from the Paleozoic of New Mexico, with special emphasis on the Mississippian, for the Smithsonian Institution. These collections are accessioned in the U.S. National Museum, Washington, DC. A set of notebooks prepared in conjunction with the field work was filed with the Department of Invertebrate Paleontology and Paleobotany at the U.S. National Museum (Bowsher written comm. 1986). Because the richly fossiliferous Caballero–Lake Valley sequence near Lake Valley has long been known to paleontologists, substantial collections doubtless also exist at other institutions.

The need for additional taxonomic studies of virtually every invertebrate group that occurs in the Mississippian of the Lake Valley area has been noted previously. Petrographic, microfacies, and paleoecological studies similar to some completed or in progress in the Sacramento and San Andres Mountains would also add to our knowledge of faunas and environments that existed in the western portion of the Lake Valley shelf. Studies of this nature would aid in comparing Early Mississippian communities across the shelf and in isolating local or regional environmental variations that affected the growth of bioherms.

ACKNOWLEDGMENTS

I am grateful to Arthur L. Bowsher, Yates Petroleum Corporation, and Augustus K. Armstrong, U.S. Geological Survey, for reviewing an earlier version of this paper and offering helpful information and suggestions. I also thank Bernard Mamet, University of Montreal, for providing unpublished observations on Lake Valley microfossils.

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APPENDIX I: FAUNAL LIST

The following faunal list includes all taxa reported from the Caballero and Lake Valley Formations west of the Rio Grande, except for those that appear only in unpublished reports and in papers in this guidebook. Taxa are listed under the name by which they are currently known, insofar as that could be determined, followed by the stratigraphic unit(s) from which they have been reported. In addition, other names used by earlier workers appear in the list, with a reference to the current name. A reasonable attempt has been made to assign all reported taxa to presently recognized genera and species, but not all of the literature dealing with Mississippian invertebrates has been surveyed and it is possible that nomenclatural changes have been made of which I am unaware. Several monographs and bibliographic compilations proved especially useful in assembling this faunal list, including Weller (1898)—invertebrates; Bassler (1950)—coelenterates; Schuchert (1897), Weller (1914), and Carter & Carter (1970)—brachiopods; Muir-Wood & Cooper (1960)—productoid brachiopods; Yochelson & Saunders (1967)—gastropods; Bassler & Moodey (1943)—echinoderms; and Webster (1973)—crinoids. Many species reported only by 19th and early 20th century workers appear to be valid and stratigraphically reasonable, but require verification. Species that were only questionably identified or qualified with a "cf." or "aff." have generally been grouped, although it is recognized that these reports may refer to more than one taxon. Species that were originally established on the basis of specimens from the Caballero and Lake Valley Formations west of the Rio Grande, and are presently considered valid, are indicated with an asterisk. New genera are indicated with two asterisks.

This list is derived from an annotated faunal catalogue compiled by me, which for each taxon includes information on stratigraphic occurrence, localities, nomenclatural history and other data reported by each author who has cited the taxon from the area and units considered in this paper.

Calcareous algae

Asphaltina sp., Tierra Blanca Mbr.

Foraminifera

Endothyra sp., Lake Valley Fm.

Coelenterata

Amplexizaphrentis centralis (Milne-Edwards & Haime), Nunn Mbr.
A. cliffordana (Milne-Edwards & Haime), Andrecito Mbr.
**A. hespere* (Grove), Alamogordo and Nunn Mbrs.
A.? sp., Lake Valley Fm.
Amplexus fragilis White & St. John, Lake Valley Fm.
A. sp., Lake Valley Fm.
**Caninia arcuata* Jeffords, Nunn Mbr.
C. cornucopiae Michelin, Nunn Mbr.
C. sp., Nunn Mbr.
Cladochonus sp., Nunn Mbr.
Cleistopora typa typa (Winchell), Andrecito Mbr.
Cyathaxonia arcuata Weller, Andrecito Mbr.
C.? sp., Lake Valley Fm.
Cyathophyllum subcaespitosum—see *Caninia arcuata*
"Favosites" aff. *valmeyerensis* Weller, Lake Valley Fm.
"F." sp., Lake Valley Fm.
**Hapsiphyllum nunnensis* Armstrong, Nunn Mbr.
Homalophyllites circularis Easton, Andrecito Mbr.
Lithostrotion sp., Alamogordo Mbr.
Lithostrotionella confluens—see *Stelechophyllum microstylum*
L. lochmanae—see *Stelechophyllum lochmanae*
L. microstyla—see *Stelechophyllum microstylum*
Lonsdaleia sp., Lake Valley Fm.
Menophyllum sp., Lake Valley Fm.
Michelinia? sp., Lake Valley Fm.
Microcyclus blairi Miller, Caballero Fm.
Stelechophyllum lochmanae (Armstrong), Andrecito and Alamogordo Mbrs.
S. microstylum (White), Andrecito Mbr.
Syringopora aculeata Girty, Alamogordo Mbr.
S. surcularia Girty, Andrecito and Alamogordo Mbrs.
Triplophyllites cliffordanus hesperis—see *Amplexizaphrentis hespere*
Triplophyllum cliffordanum var. *hespere*—see *Amplexizaphrentis hespere*
Triplophyllum sp.—see *Amplexizaphrentis*? sp.
Vesiculophyllum? sp., Andrecito Mbr.
Zaphrentis centralis—see *Amplexizaphrentis centralis*
Z. cliffordana—see *Amplexizaphrentis cliffordana*
Z. sp.—see *Amplexizaphrentis*? sp.
Zaphrentites sp., Andrecito and Alamogordo Mbrs.

Brachiopoda

Ambocoelia minuta—see *Crurithyris*? *minuta*
***Amesopleura novamexicana* (Miller), Nunn Mbr.
A.? sp., Caballero and Lake Valley Fms.
Athyris incrassatus—see *Cleiothyridina incrassata*
A. lamellosa (L'Eveille), Andrecito through Tierra Blanca Mbrs.
A. parvirostris—see *Cleiothyridina*? *parvirostris*
A. planosulcatus—see *Cleiothyridina roissyi*
A. sp., Lake Valley Fm.
Brachythyris aff. *peculiaris* (Shumard), Lake Valley Fm.
B. suborbicularis (Hall), Nunn Mbr.
Buxtonia? sp., Lake Valley Fm.
Camarophoria occidentalis—see *Rhynchopora persinuata*
Camarotoechia metallica (White), Lake Valley Fm.
C. occidentalis—see *Rhynchopora persinuata*
**C. tuta* (Miller), Lake Valley Fm.
C. sp., Caballero Fm.
Chonetes glenparkensis—see *Pliocochonetes glenparkensis*
Chonetes aff. *logani* Norwood & Pratten, Lake Valley Fm.
Cleiothyridina glenparkensis (Weller), Nunn Mbr.
C. incrassata (Hall), Lake Valley Fm.
C. obmaxima (McChesney), Nunn and Tierra Blanca Mbrs.
C.? *parvirostris* (Meek & Worthen), Lake Valley Fm.
C. roissyi (L'Eveille), Lake Valley Fm.
**C. temeraria* (Miller), Lake Valley Fm.
C. tenuilineata (Rowley), Caballero Fm. and Nunn Mbr.
C. sp., Nunn Mbr.
Cleiothyris roissyi—see *Cleiothyridina roissyi*

C. sp.—see *Cleiothyridina* sp.
Cliothyridina glenparkensis—see *Cleiothryidina glenparkensis*
C. incrassata—see *Cleiothyridina incrassata*
C. obmaxima—see *Cleiothyridina obmaxima*
C. temeraria—see *Cleiothyridina temeraria*
C. tenuilineata—see *Cleiothyridina tenuilineata*
C. sp.—see *Cleiothyridina* sp.
Composita humilis (Girty), Lake Valley Fm.
C.? sp., Lake Valley Fm.
Crania aff. *missouriensis* Weller, Lake Valley Fm.
C. sp., Lake Valley Fm.
Crurithyris? *minuta* (Weller), Caballero Fm.
Cyrtina sp., Lake Valley Fm.
Delthyris novamexicana—see *Amesopleura novamexicana*
D.? sp.—see *Amesopleura*? sp.
Dictyoclostus fernglenensis—see *Marginatia fernglenensis*
Dielasma burlingtonensis (White), Lake Valley Fm.
D. utah (Hall & Whitfield), Lake Valley Fm.
D. sp., Caballero and Lake Valley Fms.
Echinoconchus alternatus (Norwood & Pratten), Lake Valley Fm.
Eumetria? *tuta*—see *Camarotoechia tuta*
E. sp., Lake Valley Fm.
Hemipronites crenistria—see *Orthotetes* sp.
Imbrexia aff. *forbesi* (Norwood & Pratten), Alamogordo Mbr.
I. aff. *imbrex* (Hall), Lake Valley Fm.
Labriproductus aff. *wortheni* (Hall), Lake Valley Fm.
Leptaena analoga (Phillips), Nunn Mbr.
L. rhomboidalis—see *Leptaena analoga*
Marginatia cf. *burlingtonensis* (Hall), Nunn Mbr.
M. fernglenensis (Weller), Andrecito through Tierra Blanca Mbrs.
M. n.sp., Nunn Mbr.
M.? sp., Alamogordo Mbr.
Martinia sp., Lake Valley Fm.
Nucleospira rowleyi Weller, Caballero Fm.
Orbinaria sp., Lake Valley Fm.
O.? sp., Alamogordo Mbr.
Orthis dalyana—see *Rhipidomella dalyana*
O. michelini—see *Rhipidomella oweni*
O. resupinata—see *Schizophoria resupinata*
O. resupmoides—see *Schizophoria resupinata*
O.? sp.—see *Rhipidomella*? sp.
Orthotetes sp., Lake Valley Fm.
Ovatia laevicosta (White), Lake Valley Fm.
O. ovata (Hall), Lake Valley Fm.
Plicochonetes glenparkensis (Weller), Caballero Fm.
Productina sampsoni (Weller), Caballero and Lake Valley Fms.
Productus aff. *arcuatus*—see *Spinulicosta*? aff. *arcuata*
P. burlingtonensis—see *Marginatia* cf. *burlingtonensis*
P. laevicosta—see *Ovatia laevicosta*
"P." mesialis Hall, Lake Valley Fm.
P. ovatus—see *Ovatia ovata*
P. sampsoni—see *Productina sampsoni*
P. scabriculus—see *Buxtonia*? sp.
P. semireticulatus—see *Setigerites* sp.
P. shumardianus—see *Orbinaria* sp.
P. vittatus—see *Echinoconchus alternatus*
P. wortheni—see *Labriproductus* aff. *wortheni*
"P." sp., Lake Valley Fm.
Pseudosyrinx aff. *gigas* Weller, Lake Valley Fm.
Punctospirifer aff. *solidirostris* (White), Lake Valley Fm.
P. sp., Nunn Mbr.
Pustula sp.—see *Stegacanthia* sp.
Reticularia cooperensis (Swallow), Lake Valley Fm.
R. temeraria—see *Cleiothyridina temeraria*
Reticulariina aff. *spinosa* (Norwood & Pratten), Lake Valley Fm.
Retzia sp.—see *Eumetria* sp.
**Rhipidomella dalyana* (Miller), Lake Valley Fm.
R. michelini—see *R. oweni*
R. missouriensis (Swallow), Caballero Fm., Andrecito Mbr.
R. oweni (Hall & Clarke), Nunn Mbr.
R. pulchella? (Herrick), Lake Valley Fm.
R.? sp., Lake Valley Fm.
Rhynchonella missouriensis—see *Rhynchopora missouriensis*
R. prolutosa—see *Rhynchopora pustulosa*
R. pustulosa—see *Rhynchopora pustulosa*
R. tuta—see *Camarotoechia tuta*
Rhynchopora hamburgensis Weller, Caballero Fm.
R. occidentalis—see *Rhynchopora persinuata*
R. persinuata (Winchell), Nunn Mbr.
R. pustulosa (White), Lake Valley Fm.
Schizophoria chouteauensis Weller, Caballero Fm.
S. poststriatula Weller, Nunn Mbr.
S. resupinata (Martin), Lake Valley Fm.
S. aff. *swallovi* (Hall), Lake Valley Fm.
Schuchertella chemungensis (Conrad), Lake Valley Fm.
S. sp., Lake Valley Fm.
Setigerites sp., Lake Valley Fm.
Shumardella missouriensis (Shumard), Lake Valley Fm.
Spinulicosta? aff. *arcuata* (Hall), Lake Valley Fm.
Spirifer centronatus (Winchell), Lake Valley Fm.
S. extenuatus—see *Syringothyris extenuata*
S. aff. *forbesi*—see *Imbrexia* aff. *forbesi*
S. gregeri Weller, Caballero Fm.
S. aff. *grimesi* Hall, Lake Valley Fm.
S. imbrex—see *Imbrexia* aff. *imbrex*
S. louisianensis Rowley, Caballero Fm. to Nunn Mbr.
S. novamexicana—see *Amesopleura novamexicana*
S. aff. *peculiaris*—see *Brachythyris* aff. *peculiaris*
S. platynotus Weller, Caballero Fm.
S. rowleyi Weller, Alamogordo through Tierra Blanca Mbrs.
S. aff. *solidirostris*—see *Punctospirifer* aff. *solidirostris*
S. striatiformis (Meek), Lake Valley Fm.
S. suborbicularis—see *Brachythyris suborbicularis*
S. vernonensis—see *Unispirifer vernonensis*
S. sp., Andrecito and Alamogordo Mbrs.
Spirifera novamexicana—see *Amesopleura novamexicana*
S. rockymontanus—see *Spirifer* sp.
S. striata—see *Spirifer* sp.
S. temeraria—see *Cleiothyridina temeraria*
Spiriferina aff. *spinosa*—see *Reticulariina* aff. *spinosa*
"S." sp., Lake Valley Fm.
***Stegacanthia bowsheri* Muir-Wood & Cooper, Lake Valley Fm.
S. sp., Lake Valley Fm.
Strophomena rhomboidalis—see *Leptaena analoga*
Syringothyris extenuata (Hall), Lake Valley Fm.
S. texta (Hall), Nunn Mbr.
S. sp., Lake Valley Fm.
Terebratula burlingtonensis—see *Dielasma burlingtonensis*
T. utah—see *Dielasma utah*
Tylothyris novamexicana—see *Amesopleura novamexicana*
Unispirifer balki Armstrong, Andrecito Mbr.
U. vernonensis (Swallow), Andrecito and Tierra Blanca Mbrs.

Bryozoa

Cheilotrypa sp., Lake Valley Fm.
Cystodictya aff. *pustulosa* Ulrich, Lake Valley Fm.
C.? sp., Nunn Mbr.
Fenestella sp., Andrecito through Nunn Mbrs.
**Fistulipora americana* (Miller), Lake Valley Fm.
Hernodia sp., Andrecito Mbr.
Leioclema sp., Andrecito Mbr.
Lichenotrypa sp., Andrecito Mbr.
Lioclema? sp.—see *Leioclema* sp.
Penniretepora sp., Andrecito and Alamogordo Mbrs.
Pinnatopora sp.—see *Penniretepora* sp.
Polypora sp., Alamogordo and Nunn Mbrs.
Ptylopora sp., Alamogordo Mbr.
Rhombopora sp., Andrecito Mbr.
Thamniscus sp., Andrecito Mbr.
Trematopora americana—see *Fistulipora americana*
Trematopora vesiculosa—see *Fistulipora americana*

Mollusca: Gastropoda

"Chemnitzia" sp., Lake Valley Fm.
Orthonychia sp.—see *Platyceras* (*Orthonychia*) sp.
Platyceras (*Orthonychia*) *equilaterum* Hall, Lake Valley Fm.
P. oequilaterale—see *Platyceras* (*Orthonychia*) *equilaterum*
P. peculiare—see *Platycrinites peculiaris* (crinoid)
P. pileiforme—see *Platycrinites pileiformis* (crinoid)
P. (*Orthonychia*) sp., Lake Valley Fm.
P. sp., Lake Valley Fm.

Mollusca: Bivalvia

Allorisma aff. *hannibalensis*—see *Wilkingia*? aff. *hannibalensis*
Wilkingia? aff. *hannibalensis* (Shumard), Lake Valley Fm.

Mollusca: Rostroconchia

Conocardium sp., Lake Valley Fm.

Mollusca: Nautiloidea

"Actinoceras" sp., Lake Valley Fm.
Michelinoceras? sp., Lake Valley Fm.
Nautilus (Euomphalus) rockymontanus—see *"Trematoceras" rockymontaus*
Orthoceras sp.—see *Michelinoceras*? sp.
**"Trematoceras" rockymontanus* (Miller), Lake Valley Fm.
Trematodiscus rockymontanus—see *"Trematoceras" rockymontanus*

Mollusca: Ammonoidea

Goniatites sp., Lake Valley Fm.

Trilobita

Brachymetopus sp., Lake Valley Fm.
Breviphillipsia sampsoni (Vogdes), Nunn Mbr.
**B. semiteretis* Hessler, Nunn Mbr.
Griffithdella doris (Hall), Lake Valley Fm.
Griffithides sp., Lake Valley Fm.
Phillipsia aff. *loganensis*—see *Richterella* aff. *loganensis*
P. obesa—see *Proetus (Pudoproetus) missouriensis*
P. peroccidens—see *Phillipsia tuberculata*
P. sampsoni—see *Breviphillipsia sampsoni*
P. tuberculata Meek & Worthen, Nunn Mbr.
P. sp., Lake Valley Fm.
Proetus (Pudoproetus) fernglenensis Weller, Nunn Mbr.
P. aff. *loganensis*—see *Richterella* aff. *loganensis*
Proetus (Pudoproetus) missouriensis Shumard, Nunn Mbr.
P. peroccidens—see *Phillipsia tuberculata*
P. proceidens—see *Phillipsia tuberculata*
P. sp., Lake Valley Fm.
Richterella aff. *loganensis* (Hall & Whitfield), Lake Valley Fm.

Ostracoda

Bairdia sp., Lake Valley Fm.
Paraparchites sp., Lake Valley Fm.

Blastoidea

Codaster sp.—see *Hadroblastus* sp.
Cryptoblastus pisum—see *Monadoblastus granulosus*
Granatocrinus sp.—see *Monadoblastus granulosus*
***Hadroblastus convexus* Fay, Nunn Mbr.
H. sp., Lake Valley Fm.
***Monadoblastus granulosus* Fay, Nunn Mbr.
Phaenoblastus conicus—see *Phaenoschisma conicum*
P.? sp., Lake Valley Fm.
**Phaenoschisma conicum* (Fay), Nunn Mbr.
P. sp., Lake Valley Fm.
Troostocrinus sp.—see *Phaenoblastus*? sp.

Crinoidea

Abatocrinus curiosus (Miller & Gurley), Nunn Mbr.
Actinocrinites rubra—see *Nunnacrinus rubra*
A. tenuisculptus—see *Cusacrinus chloris*
A. spp., Lake Valley Fm.
Actinocrinus coelatus—see *Cusacrinus coelatus*
A. copei—see *Physetocrinus copei*
A. dalyanus—see *Nunnacrinus dalyanus*
A. lineatus—see *Dorycrinus unicornis*
A. multibrachiatus—see *Cactocrinus multibrachiatus*
A. opusculus—see *Cactocrinus opusculus*
A. proboscidialis—see *Nunnacrinus dalyanus & N. mammillatus*
A. tenuisculptus—see *Cusacrinus chloris*
A. spp.—see *Actinocrinites* spp.
Agaricocrinus planoconvexus Hall, Lake Valley Fm.
Agaricocrinus pyramidatus (Hall), Lake Valley Fm.
Amphipsalidocrinus alamogordoensis (Strimple & Koenig), Nunn Mbr.
Amphoracrinus divergens (Hall), Nunn and Tierra Blanca Mbrs.
A. spinobrachiatus (Hall), Lake Valley Fm.
A. sp., Nunn Mbr.
Aryballocrinus whitei (Hall), Nunn Mbr.
Barycrinus cornutus (Owen & Shumard), Lake Valley Fm.
B. rhombiferus (Owen & Shumard), Lake Valley Fm.
B. wachsmuthi (Meek & Worthen), Lake Valley Fm.
Batocrinus curiosus—see *Abatocrinus curiosus*
Cactocrinus coelatus—see *Cusacrinus coelatus*
C.? cf. *extensus* Wachsmuth & Springer, Nunn Mbr.
C. multibrachiatus (Hall), Nunn Mbr.
C. opusculus (Hall), Lake Valley Fm.
C. proboscidialis—see *Nunnacrinus dalyanus* and *N. mammillatus*
C. sp., Nunn Mbr.
Coeliocrinus dilatatus (Hall), Lake Valley Fm.
C. ventricosus (Hall), Lake Valley Fm.
**Cribanocrinus urceolatus* (Wachsmuth & Springer), Nunn Mbr.
C. wachsmuthi (Hall), Lake Valley Fm.
C. wortheni (Hall), Nunn Mbr.
Cusacrinus chloris (Hall), Lake Valley Fm.
C. coelatus (Hall), Nunn Mbr.
Cyathocrinites enormis (Meek & Worthen), Lake Valley Fm.
C. iowensis (Owen & Shumard), Lake Valley Fm.
Cyathocrinus enormis—see *Cyathocrinites enormis*
C. iowensis—see *Cyathocrinites iowensis*
Dichocrinus pisum Meek & Worthen, Lake Valley Fm.
Dorycrinus lineatus—see *Dorycrinus unicornis*
D. unicornis (Owen & Shumard), Nunn Mbr.
D. sp., Lake Valley Fm.
Eretmocrinus corbulis (Hall), Lake Valley Fm.
Eucladocrinus pleuroviminus (White), Nunn Mbr.
E. sp., Nunn Mbr.
Forbesiocrinus sp., Lake Valley Fm.
Macrocrinus carica (Hall), Nunn Mbr.
Megistocrinus evansii (Owen & Shumard), Lake Valley Fm.
Nunnacrinus dalyanus (Miller), Lake Valley Fm.
***N. mammillatus* Bowsher, Nunn Mbr.
N. rubra (Weller), Nunn Mbr.
Periechocrinus whitei—see *Aryballocrinus whitei*
**Physetocrinus copei* (Miller), Lake Valley Fm.
**P. lobatus* Wachsmuth & Springer, Alamogordo, Nunn, and Tierra Blanca Mbrs.
P. ornatus (Hall), Lake Valley Fm.
P. planus—see *Platycrinites planus*
P. sp., Nunn Mbr.
Platycerinus sp.—see *Platycrinites* sp.
Platycrinites burlingtonensis (Owen & Shumard), Nunn and Tierra Blanca Mbrs.
P. discoideus (Owen & Shumard), Lake Valley Fm.
P. halli (Shumard), Nunn Mbr.
P. nodostriatus (Wachsmuth & Springer), Nunn Mbr.
P. parvinodus (Hall), Lake Valley Fm.
**P. peculiaris* (Wachsmuth & Springer), Nunn Mbr.
P. pileiformis (Hall), Nunn Mbr.
P. planus (Owen & Shumard), Lake Valley Fm.
P. pocilliformis (Hall), Nunn Mbr.
**P. poculum* (Miller), Lake Valley Fm.
P. regalis (Hall), Lake Valley Fm.
P. sculptus (Hall), Nunn and Tierra Blanca Mbrs.
P. springeri (Weller), Nunn Mbr.
P. subspinosus—see *Plemnocrinus subspinosus*
P. verrucosus (White), Lake Valley Fm.
P. spp., Andrecito and Nunn Mbrs.
Platycrinus spp.—most species are now assigned to *Platycrinites*
P. subspinosus—see *Plemnocrinus subspinosus*
Plemnocrinus subspinosus (Hall), Nunn Mbr.
Poteriocrinites macropleurus (Hall), Lake Valley Fm.
Poteriocrinus macropleurus—see *Poteriocrinites macropleurus*
**Rhodocrinites tuberculatus* (Wachsmuth & Springer), Lake Valley Fm.
R. wortheni—see *Cribanocrinus wortheni*
R. wortheni urceolatus—see *Cribanocrinus urceolatus*
R. sp., Nunn Mbr.
Rhodocrinus tuberculatus—see *Rhodocrinites tuberculatus*
R. wachsmuthi—see *Cribanocrinus wachsmuthi*
R. wortheni—see *Cribanocrinus wortheni*
R. wortheni urceolatus—see *Cribanocrinus urceolatus*
R. sp.—see *Rhodocrinites* sp.
**Steganocrinus altus* Brower, Nunn Mbr.

S. araneolus—see *Steganocrinus pentagonus*
S. pentagonus (Hall), Nunn and Tierra Blanca Mbrs.
S. sculptus (Hall), Lake Valley Fm.
S. sp., Nunn Mbr.
Synbathocrinus sp., Lake Valley Fm.
Taxocrinus thiemei—see *Wachsmuthicrinus thiemei*
Vasocrinus macropleurus—see *Poteriocrinites macropleurus*
Wachsmuthicrinus spinifer (Hall), Lake Valley Fm.
W. thiemei (Hall), Lake Valley Fm.

Conodonta

Hindeodella sp., Caballero Fm.
Neoprinoniodus sp., Caballero Fm.
Polygnathus inornatus Branson, Caballero Fm.
P. longiposticus Branson & Mehl, Caballero Fm.
P. scobiniformis Branson, Caballero Fm.
P. symmetricus Branson, Caballero Fm.
Pseudopolygnathus primus Branson & Mehl, Caballero Fm.
Siphonodella cooperi Hass, Caballero Fm.
S. obsoleta Hass, Caballero Fm.
Spathognathodus aculeatus (Branson & Mehl), Caballero Fm.

Vertebrata: Chondrichthyes

Chomatodus sp., Lake Valley Fm.
Petalorhynchus sp., Lake Valley Fm.

APPENDIX II: LOCALITIES

This list includes reasonably definite localities west of the Rio Grande from which Caballero–Lake Valley fossils have been reported in the published literature. Locality numbers are keyed to the locality map (Fig. 1). Many localities given by early authors were relatively imprecise (e.g. "Lake Valley") and may encompass several more accurately identified localities. In a few cases errors are present in the information provided by the original authors; these have been noted and clarified when possible. A reference has been given for each locality, but this is not necessarily the only reference that cites the locality.

1. NE¼NW¼ sec. 21, T18S, R7W, near Lake Valley, Sierra County; type section for Lake Valley Formation (Laudon & Bowsher 1949).
2. Apache Hill, Lake Valley (essentially the W½ sec. 21, T18S, R7W), Sierra County (Laudon & Bowsher 1941).
3. Lake Valley, Sierra County (Gordon 1907).
4. E½ sec. 21, T18S, R7W, flat to E of Apache Hill, Sierra County (Lane et al. 1985).
5. About NW¼SE¼ sec. 21, T18S, R7W, Sierra County (Hessler 1963).
6. About SE¼NW¼ sec. 21, T18S, R7W, slopes and scarps on Apache Hill, 1 mi N of Lake Valley, Sierra County (Bowsher 1955).
7. About SW¼ sec. 21, T18S, R7W, scarp south of Apache Hill, just NE of Lake Valley, Sierra County (Bowsher 1955).
8. Center sec. 28, T18S, R17W (actually R7W), N side of Apache Hill, near Lake Valley, Sierra County (Jeffords 1955)
9. SE¼NW¼ sec. 28, T18S, R7W, Apache Hill, N of Lake Valley, Sierra County (Jeffords 1943).
10. SW¼NW¼ sec. 20, T18S, R7W, near Lake Valley, Sierra County (Jicha 1954). Note: Jicha's map does not show Mississippian exposures at this locality.
11. Saddle 0.25 mi E of road (NM-27), 1.7 mi NW of Lake Valley, Sierra County (about S½ sec, 16, T18S, R7W) (Muir-Wood & Cooper 1960).
12. SE¼NE¼SW¼ sec. 10, T18S, R7W, 3 mi N of Lake Valley, Sierra County (Bowsher 1961).
13. NW¼NE¼ sec. 11, T18S, R7W, W-facing scarp on N side of Berenda Creek, about 0.5 mi NE of Wilson Ranch house, Sierra County (Wilson's Ranch section of Laudon & Bowsher 1949).
14. Center of W line sec. 29, T17S, R7W, Berenda Canyon, Sierra County (Berenda Canyon section of Laudon & Bowsher 1949).
15. SW¼NW¼ sec. 10, T17S, R8W, Tierra Blanca Canyon just upstream from Pryor Nunn Ranch, Sierra County (Tierra Blanca section of Laudon & Bowsher 1949).
16. About SE¼NW¼ sec. 10, T17S, R8W, SW side of scarp approximately 0.7 mi NW of Pryor Nunn Ranch on Tierra Blanca Creek, Sierra County (Bowsher 1955).
17. Pryor Nunn Ranch, vicinity of Lake Valley, Sierra County (probably at or near localities 15 and 16) (Brower 1965).
18. Center sec. 33, T16S, R8W, Trujillo Canyon, N bank of Trujillo Creek, Sierra County (Trujillo Canyon section of Laudon & Bowsher 1949).
19. SW¼SE¼ sec. 26, T16S, R7W, about 6 mi (actually closer to 4 mi) SE of Hillsboro (Jeffords 1943).
20. Center N line sec. 26, T16S, R7W, N of Trujillo Creek on W-facing scarp along canyon running N from Trujillo Creek, approximately 3.3 mi S50°E of Hillsboro, Sierra County (Bowsher 1955).
21. SE¼ sec. 14, T16S, R7W, hills on south side of Percha Creek, Sierra County (Percha Creek, Lower Canyon section of Laudon & Bowsher 1949).
22. Two miles E of Hillsboro, Sierra County (at or near locality 21) (Gordon 1907).
23. SE¼ sec. 9, T16S, R8W, along both walls of Percha Creek, just downstream from the fork in Percha Creek, 2.5 mi downstream from Kingston, Sierra County (Percha Creek Fork section of Laudon & Bowsher 1949).
24. A short distance E of Kingston, Sierra County, probably near locality 23 (Darton 1917b).
25. Kingston, Sierra County (Gordon 1907).
26. About SW¼ sec. 24, T16S, R9W, 200 yds N of house on North Percha Creek at the junction of North Percha Creek trail and ranger trail, Sierra County (Bowsher 1955).
27. Percha Creek, vicinity of Lake Valley, Sierra County (Brower 1965).
28. SW¼ sec. 24, T15S, R9W, bold escarpments along several tributaries of North Percha Creek, Sierra County (North Percha Creek section of Laudon & Bowsher 1949).
29. SW¼ sec. 13, T13S, R9W, both sides of Palomas Creek, a short distance downstream from Hermosa, Sierra County (Hermosa section of Laudon & Bowsher 1949).
30. Near center SW¼E¼ sec. 14, T16S, R27W, Kingston 15′ quad. (Cooper and Dutro 1982). Note: R27W is too far W to be in New Mexico, and Kingston is in the Hillsboro 15′ quad. This locality is described as being in the Kingston–Silver City area, but its location is uncertain.
31. NE¼ sec. 20, T17S, R11W, along N side of Santa Rita–Hillsboro Highway (NM-90), a few miles east of Santa Rita, Grant County (Santa Rita section of Laudon & Bowsher 1949).
32. SE¼ sec. 11, T17S, R15W, SW-facing scarp that runs from the SW suburbs of Silver City NW to Bear Mountain, Grant County (Bear Mountain section of Laudon & Bowsher 1949).
33. Bear Mountain, Grant County, probably in sec. 13, T17S, R15W (Cooper & Dutro 1982).
34. SW¼SE¼SE¼ sec. 27 and N½NE¼NE¼ sec. 34, T18S, R13W, cliff and slopes on E side of Cameron Creek, near Lone Mountain, Grant County (Pratt 1967).
35. SW¼NE¼ sec. 24, T20S, R9W, E side of Cooke's Range, near N end, Luna County (North Cooke's Range section of Laudon & Bowsher 1949).
36. S center sec. 24, T20S, R9W, along bed of a small creek which cuts into E side of Cooke's Range, Luna County (Middle Cooke's Range section of Laudon & Bowsher 1949).
37. SE¼ sec. 14, T20S, R9E, N end of Cooke's Range, Luna County (Jeffords 1955).
38. N side of Cooke's Peak (probably sec. 25, T20S, R9W), Luna County (Gordon 1907).
39. Near top of Cooke's Peak, 1.5 mi NW of Cooke's Post Office, Luna County (Darton 1916).
40. SW¼ sec. 1, T21S, R9W, along walls of a small creek which cuts into E side of the Cooke's Range, Luna County (South Cooke's Range section of Laudon & Bowsher 1949).
41. Cooke's Peak region, Luna County (Darton 1917b).
42. Cliffs 4 mi NW of Fort Cummings (probably along Rattlesnake Canyon, Cooke's Range), Luna County (Darton 1916).
43. Fluorite Ridge (an elongate line of hills W of the Cooke's Range), Luna County (Darton & Burchard 1911).
44. 0.5 mi W by S of Fluorite Camp, SE end of Fluorite Ridge, Luna County (Darton 1916).