SYSTEMATIC PALEONTOLOGY AND PALEOENVIRONMENTAL ANALYSIS OF THE UPPER HUECO FORMATION, ROBLEDO AND DONA ANA MOUNTAINS, DONA ANA COUNTY, NEW MEXICO

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By

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SYSTEMATIC PALEONTOLOGY AND PALEOENVIRONMENTAL ANALYSIS OF THE UPPER HUECO FORMATION, ROBLEDO AND DONA ANA MOUNTAINS, DONA ANA COUNTY, NEW MEXICO

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ABSTRACT

A detailed megafaunal and paleoenvironmental analysis of the cyclic Abo and Upper Hueco Limestone Members of the Hueco Formation has been developed from measured sections in the western Dona Ana and southern Robledo Mountains of south-central Dona Ana County, New Mexico.

The Abo and Upper Hueco Limestone Members appear to be faunally related to the Talpa Formation of north-central Texas, the lower part of the Colina Formation of southeastern Arizona and southwestern New Mexico, and the Hueco Group of the Franklin and Hueco Mountains of west Texas. A Wolfcampian age is confirmed for the Permian rocks of the Dona Ana and Robledo Mountains. No definitive fossils of Leonard age have been recovered from the Dona Ana or Robledo Mountains. An Upper Wolfcampian age for the Abo and Upper Hueco Limestone Members is substantiated on the basis of the flora and fauna recovered.

The upper part of the Hueco Formation (Abo and Upper Hueco Limestone Members) in the Robledo and Dona Ana Mountains contains a brachiopod-mollusk dominated fauna which consists of 61 genera of invertebrates, of which 10 are assigned to the Brachiopoda and 39 to the Mollusca.

Stevens' (1963, 1966) concept of Wolfcampian megafaunal communities has been utilized in the paleoenvironmental analysis of the Abo and Upper Hueco Limestone Members in the Dona Ana and Robledo Mountains. These communities, as well as two others, are recognized with special variations. They are defined as deltaic-tidal flat, ostracod, euphemitid, nuculanid, Costellarina, chonetid, productoid-Composita, phylloid algae and coral (gastropod), fusulinid, and palaeotextulariid. The chonetid, fusulinid, and palaeotextulariid communities are not recognized in the Abo or Upper

Hueco Limestone Members of the Robledo and Dona Ana Mountains, but their presence has been confirmed in the Hueco Group of the Franklin and Hueco Mountains of west Texas.

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INTRODUCTION

Location of Study Area

The areas studied are located in the southern Robledo and western Dona Ana Mountains in central Dona Ana County, south-central New Mexico (Fig. 1). The Robledo Mountains (southern half T. 21 S., R. 1 W. and T. 22 S., R. 1 W., western half T. 22 S., R. 1 E.) are approximately 15 miles (24 kilometers) northwest of Las Cruces and the Dona Ana Mountains (T. 21 S., eastern half R. 1 E. and western half R. 2 E.) are approximately 10 miles (16 kilometers) north of Las Cruces.

The Robledo Mountains are a wedge-shaped horst block of Paleozoic sedimentary rocks (Lower Ordovician-Lower Permian) and Cenozoic clastic, volcanic, and intrusive rocks that are tilted about 10 to 15 degrees to the south. The low cuestas in the southern and central portion of the range expose the upper part of the Hueco Formation of Wolfcampian age.

The Dona Ana Mountains are composed of tilted Upper Paleozoic sedimentary rocks (Lower Permian) and Cenozoic clastics, volcanic, and intrusive rocks that have a dip of 10 to 15 degrees to the west. The low cuestas in the northwestern part of the range expose the upper part of the Hueco Formation.

Previous Work

Little work has been done on the Permian rocks in the Dona Ana and Robledo Mountains until recently. The first worker to comment on the Permian in the Robledo Mountains was Bogart (1953) in his study on the geology of the Florida and Tres Hermanas Mountains. Bogart (1953) made a

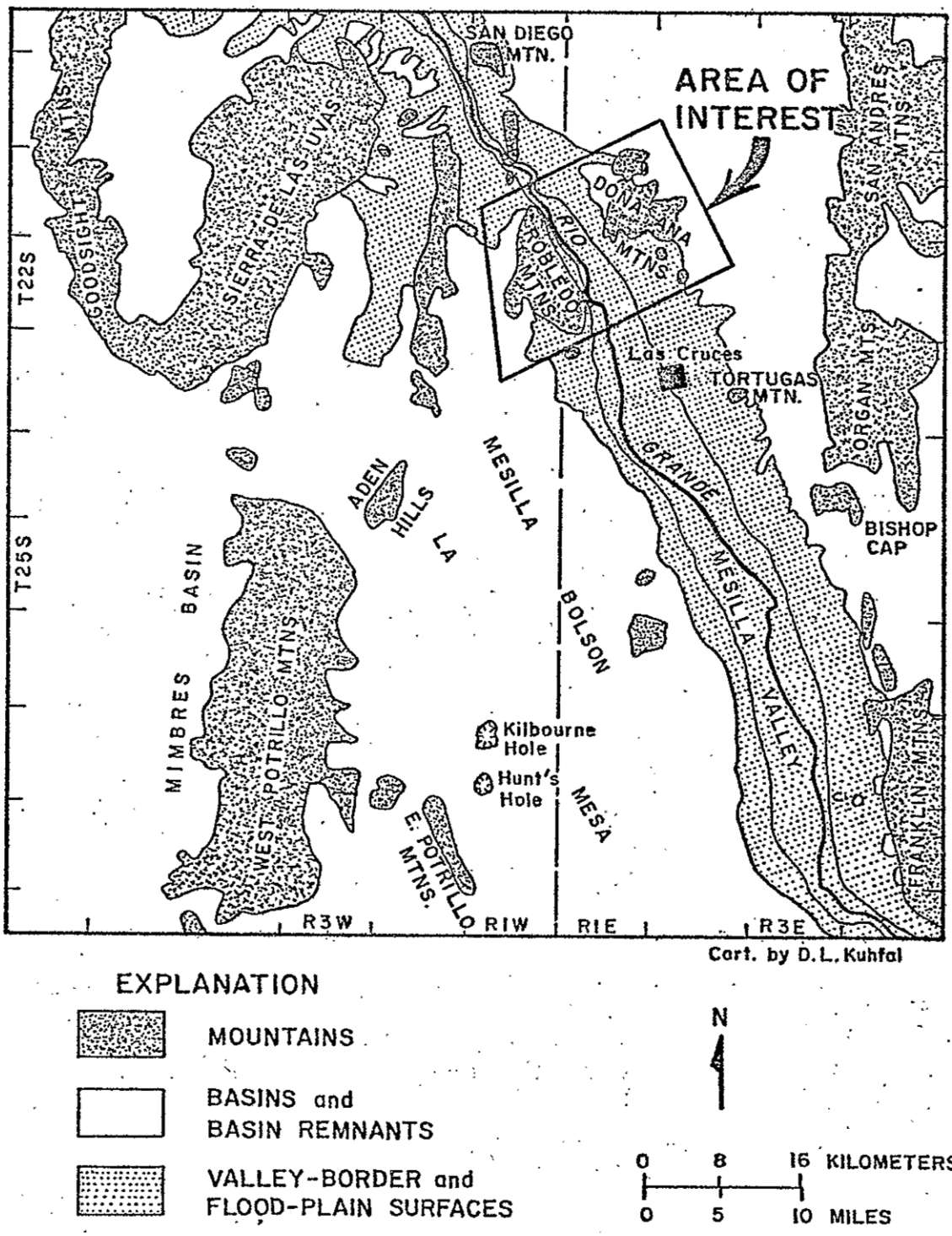


Figure 1. Location Map of Study Area Dona Ana County, New Mexico (After King, 1971).

brief reconnaissance to determine if similar rocks were present in the Robledo Mountains. The reconnaissance was made in the vicinity of the Shalem Colony section. Bogart (1953) concluded that the sequence studied was equivalent to the Hueco Formation present in the Florida Mountains.

Thompson (1954) collected and identified Lower Permian (Wolfcampian) fusulinids from the "Bursum" and Lower Hueco Formations of the Robledo Mountains. Kottlowski mapped the regional general geology and measured the stratigraphic column in his Las Cruces Quadrangle study (1960). Jordan (1971) completed a microfacies analysis of the complete section in the eastern Robledo Mountains.

LeMone, Klement, and King (1967) discovered an exceptional silicified phylloid algal bank in the Upper Hueco Limestone Member at the Shalem Colony section (Sec. 19, T. 22 S., R. 1 E.). This study was followed by a megafaunal and microfacies analysis of the Shalem Colony section (LeMone, Klement, and King, 1971). Seager has completed the detailed general geology of the Dona Ana and Robledo Mountains (Seager, personal communication, 1974). LeMone, Simpson, and Klement (1975a and 1975b) have completed a paleoenvironmental analysis of the Abo and Upper Hueco Limestone Members in the Robledo Mountains.

Purpose and Objectives of Study

The purpose of this study was to make a detailed megafaunal analysis of the Abo and Upper Hueco Limestone Members of the Hueco Formation present in the Dona Ana and Robledo Mountains of south-central New Mexico. One stratigraphic section was measured in the western Dona Ana Mountains and three stratigraphic sections were measured in the southern Robledo Mountains. Fossils and rock samples were collected and studied

from each of the sections measured. The determination of the stratigraphic sequence, age, megafaunal content, and paleoenvironmental conditions for the Abo and Upper Hueco Limestone Members has been attempted from the examination of these sections and collections.

GEOLOGICAL SETTING OF AREA STUDIED

Stratigraphy of Permian Rocks

Hueco Formation

In the Robledo Mountains, three stratigraphic sections (Pls. I and III) of the upper part of the Hueco Formation have been measured. The first, the Shalem Colony section, is located in Sec. 19, T. 22 S., R. 1 E. The second, the Corralitos Ranch Faulted section (Pl. IV), is located in Secs. 15 and 22, T. 22 S., R. 1 W. The third, the Hawkins East Tank section, is located in Sec. 28, T. 22 S., R. 1 W. In the Dona Ana Mountains, one stratigraphic section (Pls. II and III) of the upper part of the Hueco Formation was measured. This, the Dona Ana Mountains section, is located in Sec. 8, T. 21 S., R. 1 E.

The Hueco Formation consists of approximately 1,905 feet (595 meters) of alternating beds of gray to brownish limestone, reddish brown sandstone, siltstone, mudstone, and a few beds of light colored calcareous marl in the Dona Ana and Robledo Mountains.

The Hueco Formation can be divided into recognizable members on the basis of lithology. The Hueco Formation, as currently defined in this area, consists of four members (from oldest to youngest): Lower Hueco Limestone Member, Middle Hueco Limestone Member, Abo Member, and Upper Hueco Limestone Member. The Abo and Upper Hueco Limestone Members are the only

members to be considered in detail in this study.

Abo Member

The Abo Member in the Robledo Mountains comprises approximately 425 to 475 feet (133 to 149 meters) of gray to yellowish brown, thin bedded, fossiliferous limestones; reddish brown, slightly to very calcareous mudstones, claystones, siltstones, very fine grained sandstones, and a few light colored calcareous marls. In the Dona Ana Mountains the top of the Abo Member is not exposed; the thickness measured there is 329 feet (103 meters). The Abo Member in the Shalem Colony area has yielded invertebrate and lower vertebrate tracks and trackways, megafloral remains, ripple marks, and mud cracks in the red beds. These remains are located in the NE 1/4, SW 1/4 of Sec. 30, T. 22 S., R. 1 E. The identified invertebrate trackway is Paleohelcura tridactyla Gilmore. Identified lower vertebrate tracks and trackways are assignable to the following: Ammobatrachus, Dromillopus, and Stenichus. The megafloral remains consist of Callipteris conferta (Sternberg) Brongniart, Walchia piniformis (Schlotheim) Sternberg, and Brachyphyllum?. Megafloral remains also occur in a fine grained sandstone approximately 180 feet (56 meters) above the base of the Abo Member in the Dona Ana Mountains. These remains consist of the stems and leaves of Cordaites and Walchia piniformis (Schlotheim) Sternberg (Pl. VI). The limestone of the Abo Member contain marine, brackish-euryhaline invertebrate faunas. The Abo Member is interpreted as a prograding, largely subaerial deltaic-tidal flat complex intertonguing with shallow marine shelf carbonates.

Upper Hueco Limestone Member

The Upper Hueco Limestone Member consists of gray to yellowish brown, thin to medium bedded, highly fossiliferous limestones containing silicified fossils and with lenses and nodules of chert. Thicknesses range from 55 to 350 feet (17 to 109 meters) in the Robledo Mountains. In the Dona Ana Mountains the Upper Hueco Limestone Member is not present. The complete thickness is not known in the Robledo Mountains due to post-Wolfcamp erosion. Silicified phylloid algal banks occur in the Upper Hueco Limestone Member at the Shalem Colony (LeMone, Klement, and King, 1971), Corralitos Ranch Faulted, and Hawkins East Tank sections in the Robledo Mountains. Jordan (1971) reported the presence of fusulinid remains but no specific identifications were given.

Correlation of Abo and Upper Hueco Limestone Members

General Information

Correlation of the Abo and Upper Hueco Limestone Members with other Permian sections in the southwestern United States is based on lithologic and faunal evidence (Pl. V). The environments under which the Abo and Upper Hueco Limestone Members were deposited were widespread, as evidenced by similar lithologic characteristics and faunas present in other locales in the southwestern United States.

Lithologic Correlation

Lithologically and presumably environmentally, the Abo and Upper Hueco Limestone Members are comparable to the Permian sequences of south-central and southeast Arizona (Refer to Pl. V). The Abo and Upper Hueco

Limestone Members are comparable to the Big A Butte Member of the Supai Formation of south-central Arizona (Winters, 1963). The red beds of the Abo Member are also comparable to the upper red beds present in the Earp Formation (Sabins, 1957). The Upper Hueco Limestone Member seems lithologically and stratigraphically similar to the lower part of the Colina Formation of southeastern Arizona (Sabins, 1957). Lower Permian rocks in these regions are all characterized by cyclic deposits of red beds, light colored claystones, and limestones (Winters, 1963).

Cyclicity of Abo Member

Alternation between nonmarine red beds and marine carbonates within the Abo Member in the Robledo and Dona Ana Mountains are suggestive of cyclic deposition which was first recognized by Jordan (1971). The cycles of deposition may, in general, be classified as symmetrical and asymmetrical (Figs. 2 and 3).

A generalized description of an Abo cycle from bottom to top is as follows:

1. Siltstone and/or mudstone, nonmarine, reddish brown, calcareous or noncalcareous.
2. Mudstone and/or claystone, nonmarine or marine, light gray to yellow, calcareous.
3. Limestone, mudstone, and claystone, marine, light gray to brownish gray, very calcareous.

Winters (1963) believed that the alternations of these rock types indicated periodic inundations by a Permian sea from the south. The red beds of a broad flood plain or delta were first covered by fine clastic material and then by limestone. Following withdrawal of the seas, red beds

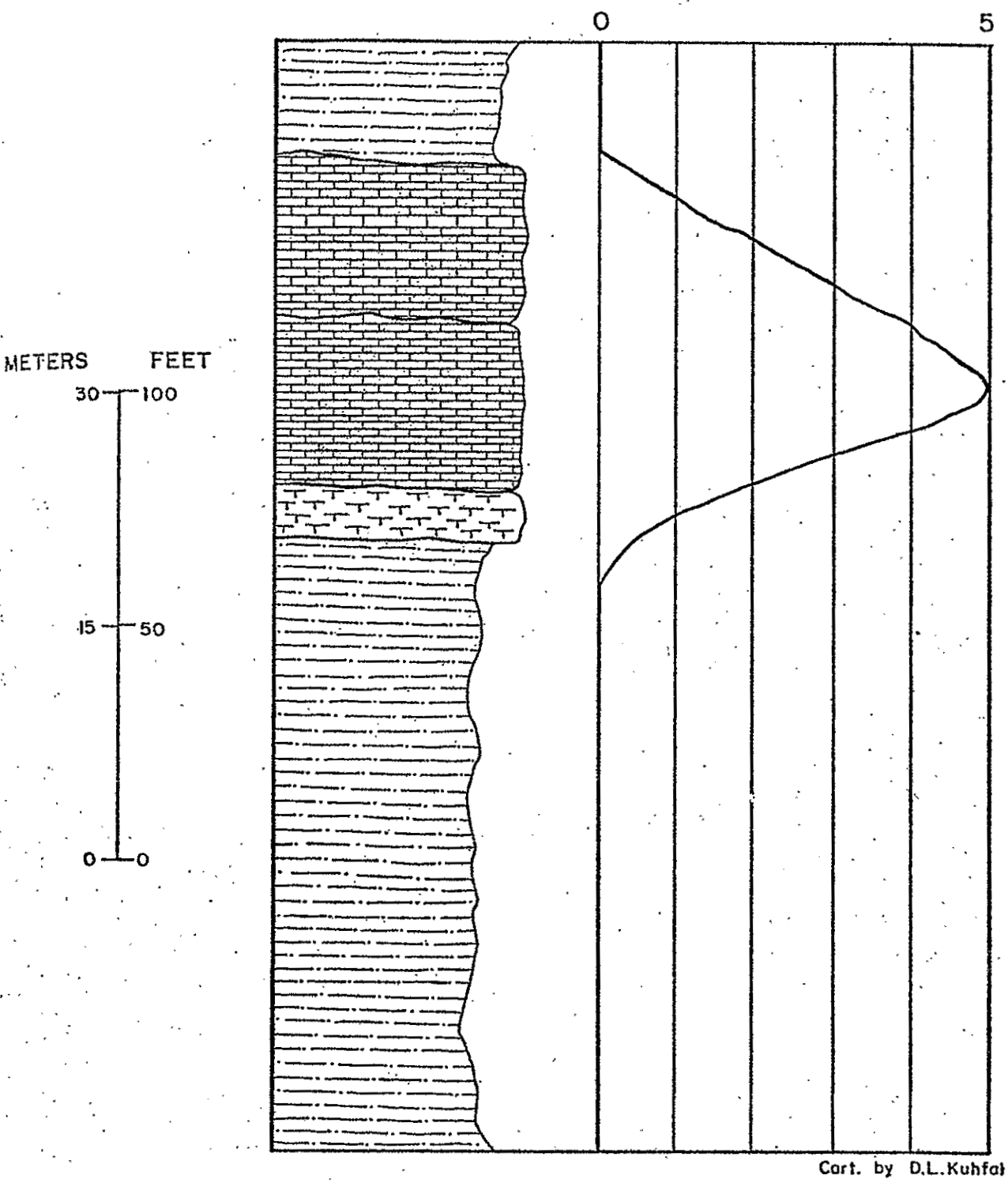


Figure 2. Diagrammatic Section of Abo Cycle in Hawkins East Tank Section

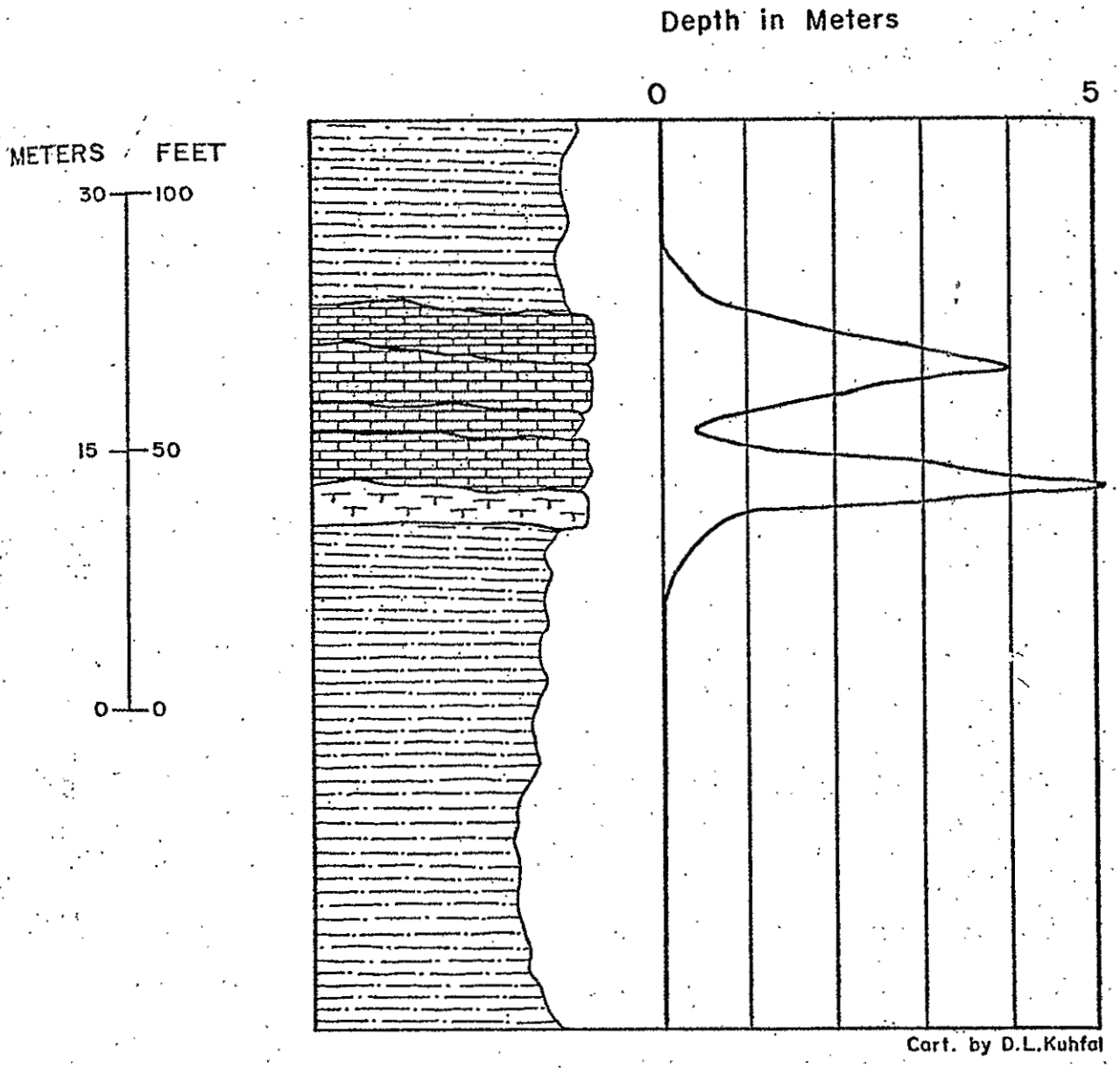


Figure 3. Diagrammatic Section of Abo Cycle in Corralitos Ranch Section

were once again deposited.

Faunal Correlation

Faunally, the Abo and Upper Hueco Limestone Members appear to be more closely related to the Talpa Formation of north-central Texas, lower Colina Formation of southeastern Arizona and extreme southwestern New Mexico, and the Hueco Group of the Franklin and Hueco Mountains of west Texas than to the standard section in the Glass Mountains, Texas.

Collection of fauna and direct comparison between the Abo and Upper Hueco Limestone Members and the Talpa Formation has been made. Fourteen species are common to the Abo and Upper Hueco Limestone Members and the Talpa Formation: Wewokella (Talpaspongia) clavata, Costellarina costellata, Squamaria moorei, Pteronites peracuta, Schizodus texanus, Wilkingia terminale, Chaenomya leavenworthensis, Euphemitopsis multinodosa, Straparollus (Euomphalus) cornudanus, Omphalotrochus obtusispira, Plagioglypta canna, Spirorbis sp., Rogerella sp., and Archaeocidaris trudifer.

Information concerning the Colina Formation is based on published faunal lists (Gilluly, Cooper, and Williams, 1954). Seven species are common to the Abo and Upper Hueco Limestone Members and the Colina Formation: Cancrinella cf. C. altissimia, Pontisia franklinensis, Composita mexicana, Euphemitopsis multinodosa, Straparollus (Euomphalus) cornudanus, Plagioglypta canna, and Archaeocidaris trudifer.

The Hueco Group of the Franklin and Hueco Mountains has been divided into the following formations (in ascending order) by Williams (1963, 1966), Jordan and Wilson (1971), and Jordan (1971): Hueco Canyon, Cerro Alto, and Alacran Mountain Formations. No detailed megafaunal

analyses have been made in the Franklin or Hueco Mountains. Information is derived from published faunal lists by Harbour (1972); King, King, and Knight (1945); and Williams (1963). Information on brachiopods is from King (1931) and Cooper and Grant (1973, 1974, 1975, 1976). Information on gastropods is from Batten (1958) and Yochelson (1956, 1960). This information has been supplemented by observation and partial collection from these formations.

Fourteen species are common to the Abo and Upper Hueco Limestone Members and the Hueco Canyon Formation of the Franklin Mountains: Wewokella (Talpaspongia) clavata, Linoproductus cora, Crurithyris guadalupensis, Beecheria bovidens, Pontisia franklinensis, Composita mexicana, Straparollus (Euomphalus) cornudanus, Omphalotrochus obtusispira, Amaurotoma zappa, Glyptospira n. sp., Septimyalina burmai, Bakevellia (Bakevellia) sulcata, Aviculopecten girtyi, and Astartella subquadrata.

Nineteen species are common to the Abo and Upper Hueco Limestone Members and the Cerro Alto Formation of the Franklin Mountains: Wewokella (Talpaspongia) clavata, Squamaria moorei, Cancrinella altissimia, Linoproductus cora, Pontisia franklinensis, Composita mexicana, Beecheria bovidens, Knightites (Retispira) eximia, Straparollus (Euomphalus) cornudanus, Omphalotrochus obtusispira, Amaurotoma zappa, Glyptospira n. sp., Nuculopsis levatiformis, Pteronites peracuta, Septimyalina burmai, Schizodus texanus, Permophorus albequus, Astartella subquadrata, and Wilkingia terminale.

Fourteen species are common to the Abo and Upper Hueco Limestone Members and the Alacran Mountain Formation of the Franklin Mountains: Costellarina costellata, Linoproductus cora, Pontisia franklinensis, Composita mexicana, Crurithyris guadalupensis, Beecheria bovidens,

Euphemitopsis multinodosa, Knightites (Knightites) bransoni, Knightites (Retispira) eximia, Straparollus (Euomphalus) cornudanus, Omphalotrochus obtusispira, Goniasma terebra, Properrinites denhami, Akmilleria huecoensis, and Rogerella sp.

Ten species are common to the Abo and Upper Hueco Limestone Members and the Cerro Alto Formation of the Hueco Mountains: Linoproductus cora, Cancrinella altissimia, Pontisia franklinensis, Composita mexicana, Crurithyris guadalupensis, Knightites (Retispira) eximia, Straparollus (Euomphalus) cornudanus, Omphalotrochus obtusispira, Meekospira knighti, and Pentagonocyclopa cf. P. dispar.

Two species are common to the Abo and Upper Hueco Limestone Members and the Alacran Mountain Formation of the Hueco Mountains: Pontisia franklinensis and Composita mexicana.

Age of Abo and Upper Hueco Limestone Members

Age determinations in the Pennsylvanian and Permian carbonate rocks have been, axiomatically, the prerogative of fusulinid specialists. Both the Abo and Upper Hueco Limestone Members lack significant fusulinid faunas. A single fusulinid was found in the Upper Hueco Limestone Member of the Robledo Mountains (LeMone, Klement, and King, 1967), but it clearly shows transport and redeposition. Jordan (1971) reported only one occurrence of fusulinids in the Upper Hueco Limestone Member. No fusulinids were recovered in the Abo Member of the Robledo or Dona Ana Mountains in this study.

A Wolfcampian age is indicated for the Permian rocks of the Dona Ana and Robledo Mountains on the basis of the flora and fauna recovered.

No definitive fossils of Leonard age have been recovered from the Permian rocks of the Dona Ana or Robledo Mountains. Confirmation of an Upper Wolfcampian age for the Abo and Upper Hueco Limestone Members in the Dona Ana and Robledo Mountains is given by the presence of the following invertebrates:

Porifera: Wewokella (Talpaspongia) clavata (R. H. King)

Brachiopoda: Linoproductus cora (d'Orbigny)
Cancrinella altissimia R. H. King
Squamaria moorei Muir-Wood and Cooper
Costellarina costellata (Muir-Wood and Cooper)
Pontisia franklinensis Cooper and Grant
Beecheria bovidens (Morton)

Gastropoda: Euphemitopsis multinodosa Yochelson
Straparollus (Euomphalus) cornudanus (Shumard)
Omphalotrochus obtusispira (Shumard)

Cephalopoda: Properrinites denhami Miller and Furnish
Akmilleria huecoensis (Miller and Furnish)

Scaphopoda: Plagioglypta cf. P. canna (White)

Bivalvia: Pteronites peracuta (Shumard)
Septimyalina burmai Newell
Wilkingia terminale (Hall)

Systematic Paleontology

General Characteristics

This study represents the first systematic description of the megafauna of the Upper Hueco Formation (Abo and Upper Hueco Limestone Members)

of the Dona Ana and Robledo Mountains. Fossils from the Shalem Colony section in the Robledo Mountains were first listed by LeMone, Klement, and King (1971).

The upper part of the Hueco Formation contains a brachiopod-mollusk fauna, dominated primarily by gastropods and bivalves. Approximately 61 genera of invertebrates are represented, of which 10 are in the Brachiopoda and 39 in the Mollusca.

The breakdown numerically of the invertebrate fauna of the upper part of the Hueco Formation includes approximately 63 species assigned to 61 genera. The Porifera is represented by one genus and species. In the Anthozoa only one genus and species has been recovered. The Bryozoa is represented by 4 genera and species. The Brachiopoda contains 10 genera and species. In the Mollusca 17 genera and 17 species of gastropods are present. The bivalves recorded include 12 genera and 14 species. There is only one genus and species of scaphopod. The cephalopods include 9 genera and species, of which two genera and species are ammonoids. The Polychaeta is represented by one genus and species. The Arthropoda includes one genus and species of acrothoracic cirripedians and ostracodes. The Echinodermata is composed of two genera and species of crinoids and one genus and species of echinoid.

Fauna of the Upper Hueco Formation, Abo and Upper Hueco Limestone Members, of the Dona Ana and Robledo Mountains, Dona Ana County, New Mexico

Phyllum Porifera

Class Calcispongia

Wewokella (Talpaspongia) clavata (R. H. King)

Phylum Coelenterata

Class Anthozoa

Lophophyllidium sp.

Phylum Bryozoa

Class Gymnolaemata

Tabulipora sp.

Fenestella sp.

Polypora sp.

Septopora sp.

Phylum Brachiopoda

Class Articulata

Meekella mexicana Girty

Derbyia carteri Cooper and Grant

Costellarina costellata (Muir-Wood and Cooper)

Squamaria moorei Muir-Wood and Cooper

Linoproductus cora (d'Orbigny)

Cancrinella altissimia R. H. King

Pontisia franklinensis Cooper and Grant

Composita mexicana (Hall)

Crurithyris guadalupensis (Girty)

Beecheria bovidens (Morton)

Phylum Mollusca

Class Gastropoda

Euphemites sp.

Euphemitopsis multinodosa Yochelson

Bellerophon (*Bellerophon*) sp.

Knightites (*Knightites*) *bransoni* Yochelson

Knightites (*Retispira*) *eximia* Yochelson

Straparollus (*Euomphalus*) *cornudanus* (Shumard)

Omphalotrochus obtusispira (Shumard)

Colpites sp.

Peruvispira sp.

Amaurotoma zappa Plas

Glyptospira n. sp.

Naticopsis cf. *N. apachensis* Winters

Trachydomia sp.

Goniasma terebra (White)

Palaeostylus (*Pseudozygopleura*) sp.

Soleniscus aff. *S. altonensis* (Worthen)

Meekospira knighti Winters

Class Cephalopoda

Mooreoceras sp.

Metacoceras sp.

Stearoceras sp.

Stenopoceras sp.

New Genus new species Flower

Liroceras sp.

Ephippioceras sp.

Akmilleria huecoensis (Miller and Furnish)

Properrinites denhami Miller and Furnish

Class Scaphopoda

Plagioglypta cf. *P. canna* (White)

Class Bivalvia

Nuculopsis levatiformis (Walcott)

Paleyoldia subscitula (Meek and Hayden)

Pteronites peracuta (Shumard)

Septimyalina burmai Newell

Bakevellia (*Bakevellia*) *sulcata* Geinitz

Aviculopecten girtyi Newell

Aviculopecten? *coreyanus* White

Limipecten sp.

Schizodus texanus Clifton

Permophorus albequus (Beede)

Permophorus mexicanus (Girty)

Astartella subquadrata Girty

Chaenomya leavenworthensis (Meek and Hayden)

Wilkingia terminale (Hall)

Phylum Annelida

Class Polychaeta

Spirorbis sp.

Phylum Arthropoda

Class Crustacea

Rogerella sp.

Ostracodes

Phylum Echinodermata

Class Crinoidea

Pentagonocyclopa cf. *P. dispar* Moore

Round stems and columnals

Class Echinoidea

Archaeocidaris trudifer White

Collecting Localities

Localities in measured sections are indicated by two numbers separated by a hyphen, *i. e.*, 2-7. The first number (2) indicates the measured section, and the second (7) indicates the unit within that measured section from which the sample came. An additional letter may follow, *i. e.*, 2-7a: "a" indicates that the sample is from bed a in unit 7.

1-5 Shalem Colony Section, unit 5, Abo Member, Hueco Formation, Robledo Mountains, Dona Ana County, New Mexico.

1-5c Shalem Colony Section, unit 5, bed c, Abo Member, Hueco Formation, Robledo Mountains, Dona Ana County, New Mexico.

1-7 Shalem Colony Section, unit 7, Upper Hueco Limestone Member, Hueco Formation, Robledo Mountains, Dona Ana County, New Mexico.

2-7c Corralitos Ranch Faulted Section, unit 7, bed c, Upper Hueco Limestone Member, Hueco Formation, Robledo Mountains, Dona Ana County, New Mexico.

2-16a Corralitos Ranch Faulted Section, unit 16, bed a, Upper Hueco Limestone Member, Hueco Formation, Robledo Mountains,

Dona Ana County, New Mexico.

2-16f Corralitos Ranch Faulted Section, unit 16, bed f, Upper Hueco Limestone Member, Hueco Formation, Robledo Mountains, Dona Ana County, New Mexico.

3-6h Hawkins East Tank Section, unit 6, bed h, Abo Member, Hueco Formation, Robledo Mountains, Dona Ana County, New Mexico.

3-8b Hawkins East Tank Section, unit 8, bed b, Upper Hueco Limestone Member, Hueco Formation, Robledo Mountains, Dona Ana County, New Mexico.

3-8f Hawkins East Tank Section, unit 8, bed f, Upper Hueco Limestone Member, Hueco Formation, Robledo Mountains, Dona Ana County, New Mexico.

4-5 Dona Ana Mountains Section, unit 5, Abo Member, Hueco Formation, Dona Ana Mountains, Dona Ana County, New Mexico. Plant bearing unit.

Phylum PORIFERA Grant, 1872

Class HYALOSPONGEA Vosmaer, 1886

Order HETERACTINIDA DeLaubenfels, 1955

Family WEWOKELLIDAE King, 1943

Genus Wewokella (Talpaspongia) King, 1943

Wewokella (Talpaspongia) clavata (R. H. King)

1943 Talpaspongia clavata R. H. King, Kansas Geol. Survey, Bull. 47, p. 28-30, pl. 1, fig. 6; pl. 3, fig. 1, 8.

1955 Talpaspongia clavata: DeLaubenfels, in Moore, Treatise, Pt. E, p. 93-94, fig. 78.

1959 Talpaspongia clavata: Rigby and Moyle, Jour. Paleontology, v. 33, n. 3, p. 401, pl. 56, fig. 5.

1964 Talpaspongia clavata: Lokke, Jour. Paleontology, v. 38, n. 4, p. 778-781, fig. 1-3.

Diagnosis.---- Large straight, or branching cylindrical; thick-walled: penetrated by a large, deep central cloaca and small scattered radial canals. Small clumps scattered within cloaca represent buds. Canals arranged in irregular anastomosing pattern: open to the exterior through pores, and into the cloaca through small round openings. Spicules consist of calcareous diact monaxons and triact triaxons. Body surface smooth; perforated by small pores; weathered body surface rough, revealing portions of spicules.

Dimensions (in mm.).----

	length	diameter	wall thickness
Loc. 1-5			
W-1a	17.85	14.50	5.10
W-1d	----	19.90	5.55
W-1e	55.53	49.75	16.07
Loc. 1-5c			
W-55	73.75	16.65 20.70	4.72 10.35
Loc. 2-7			
W-78h	35.75	25.40	9
W-78k	44.67	24.50	10.35
Loc. 2-16			
W-98a	36.62	23.62	6.32
W-98b	39.65	14.78	5.75
W-98c	44.72	36.28	10.55
Loc. 3-6			
W-127a	97.69	43.92	9.12
W-127b	37.95	52	14

Occurrence.----Section 1, units 5 and 7; Section 2, units 7 and 16; Section 3, units 6 and 8; and Section 4, unit 3.

Stratigraphic and Geographic Range.----Upper Mississippian-Wolfcampian. In Utah Wewokella (Talpaspongia) clavata occurs in the Mississippian Manning Canyon Formation of the Oquirrah Mountains. In Texas it occurs in the Talpa Formation of the north-central portion of the state; the Hueco Formation of the Sierra Diablo region; and the Hueco Canyon and Cerro Alto Formations

of the Franklin Mountains. In New Mexico it occurs in the Abo and Upper Hueco Limestone Members, Hueco Formation of the Robledo Mountains and Abo Member, Hueco Formation of the Dona Ana Mountains.

Phylum COELENTERATA Frey and Leuckart, 1847

Class ANTHOZOA Ehrenberg, 1834

Subclass ZOANTHARIA van Beneden, 1898

Order RUGOSA Milne-Edwards and Haime, 1850

Suborder STREPTELASMATINA Wedekind, 1927

Superfamily CYATHAXONIICAE Milne-Edwards and Haime, 1850

Family LOPHOPHYLLIIDAE Moore and Jeffords, 1945

Genus Lophophyllidium Grabau, 1928

Lophophyllidium sp. indet.

Diagnosis.---- Very small, immature lophophyllid corals; three specimens attached to the pedicle valve of the brachiopod Squamaria moorei. Because of their small size, determination as to species is impossible. The specimens show characters which place them in the genus Lophophyllidium.

Dimensions (in mm.).----

	length	diameter
Loc. 1-5		
W-2-1	7.65	3.85
W-2-2	5.95	3.60

Occurrence.---- Section 1, unit 5.

Phylum BRYOZOA Ehrenberg, 1831

Subphylum ECTOPROCTA Nitsche, 1869

Class GYMNOLAEMATA Allman, 1856

Order TREPOSOMATA Ulrich, 1882

Suborder AMALGAMATA Ulrich and Bassler, 1904

Family STENOPORIIDAE Waagen and Wentzel, 1886

Genus Tabulipora Young, 1883

Tabuliopora sp.

Diagnosis.---- Ramose or incrusting with thick-walled zooecia. Acanthopores low, slightly projecting; monilae indistinct. Zooecial pores are 0.5 to 1 mm wide.

Occurrence.---- Section 1, unit 5 and Section 2, unit 16.

Order CRYPTOSTOMATA Vine, 1883

Family FENESTELLIDAE King, 1850

Genus Fenestella Lonsdale, 1839

Fenestella sp.

Diagnosis.----Regular, fenestellid with fan-shaped zoarium. Each branch in the zoarium contains two rows of zooecia. Dissepiments occur approximately every millimeter. Six apertures occur in each row between the dissepiments. Fenestrules have a length and width of 0.5 mm.

Occurrence.---- Section 1; unit 5: Section 2, units 7 and 16: and Section 3, unit 6.

Genus Polypora M'Coy, 1844

Polypora sp.

Diagnosis.---- Regular, fenestellid with fan-shaped zoarium. Each branch in the zoarium contains four irregular rows of zooecia. Dissepiments occur approximately every 2 mm. Fifteen to thirty apertures occur in each row between the dissepiments. Fenestrules have a length and width of 1 mm., approximately four to five apertures occur on the fenestrules.

Occurrence.---- Section 1, unit 5 and Section 2, units 7 and 16.

Family ACANTHOCLADIIDAE Zittel, 1880

Genus Septopora Prout, 1859

Septopora sp.

Diagnosis.---- Irregular, acanthoclad with fan-shaped zoarium. Thick primary and heavy, arched secondary branches. Each primary branch in the zoarium contains two rows of zooecia separated by distinct median carina. Dissepiments occur approximately every millimeter. Four to six apertures occur in each row between the dissepiments. Fenestrules have a length of 2 mm. and a width of 0.5 mm., approximately two to eight apertures occur on the fenestrules.

Occurrence.---- Section 1, unit 5 and Section 2, units 7 and 16.

Phylum BRACHIOPODA Dumeril, 1806

Class ARTICULATA Huxley, 1869

Order STROPHOMENIDA Opik, 1934

Superfamily DAVIDSONIACEA King, 1850

Family MEEKELLIDAE Stehli, 1954

Subfamily MEEKELLINAE Stehli, 1954

Genus Meekella White and St. John, 1867

Meekella mexicana Girty

1909 Meekella mexicana Girty, U.S. Geol. Survey, Bull. 389, p. 53-54, pl. 6, fig. 1-5.

Diagnosis.---- Medium-sized, biconvex, maximum width at about midvalve; outline semicircular; hinge straight, width equal to about 4/5 of shell width. Plications numbering 17 on pedicle valve and 16 on brachial valve, rounded on crests, uneven and irregular, interrupted by growth lines, bifurcating. Costellae strong (increasing in number anteriorly by insertion); growth lines strong; commissure coarsely plicate.

Pedicle valve slightly convex, flattened or depressed posteriorly, interarea wide, high; beak short, blunt; pseudodeltidium delimited sharply or vaguely from lateral portions of interarea.

Brachial valve strongly convex, short interarea; beak slightly overhanging pedicle interarea. Interiors of valves were not observable, because of the lack of free valves with interior details visiable.

Dimensions (in mm.).----

	pedicle valve length	brachial valve length	maximum width	hinge width	inter-area length	thick-ness
Loc. 1-5						
W-8	21.42	20.10	23.30	14	4.28	14.45

Occurrence.---- Section 1, unit 5.

Stratigraphic and Geographic Range.---- Wolfcampian-Leonardian. In New Mexico Meekella mexicana occurs in the Abo Member, Hueco Formation of the Robledo Mountains: Yeso Formation of the San Andres Mountains; and San Andres Formation of the Caballo Mountains.

Family ORTHOTETIDAE Waagen, 1884

Subfamily DERBYIINAE Stehli, 1954

Genus Derbyia Waagen, 1884

Derbyia carteri Cooper and Grant

1931 Derbyia buchi: R.E. King, Univ. Texas, Bull. 3042, p. 59, pl. 8 fig. 4-6.

1974 Derbyia carteri Cooper and Grant, Smithsonian Contri. Paleo., n. 15, p. 293-294, pl. 30, fig. 2-6; pl. 65, fig. 1-15; pl. 66, fig. 1-47.

Diagnosis.---- Medium to large, wider than long, transversely rectangular in outline; hinge wide; cardinal extremities variable. Sides slightly oblique to gently rounded. Anterior commisure deformed. Surface multicostellate, costellae increasing by intercalation, 12-14 costellae in 5 mm. at 10 mm. anterior to beak in both valves and 8-9 in 5 mm. at anterior margin of adult. Surface concentrically wrinkled and with strong growth lamellae.

Pedicle valve slightly convex in umbonal region, anteriorly flattening and becoming concave; beak erect and pointed; anteriorly geniculated in profile; anterior profile broadly and moderately convex; interarea short; pseudodeltidium broad, strongly convex.

Brachial valve moderately and evenly convex; broadly domed, with flattened top and steep sides. Interarea and chilidium obscured; umbonal region flattened; median region with poor to well defined sulcus extending from swollen anteroumbonal region to margin.

Pedicle valve interior not observed. The following details are from Cooper and Grant (1974):

> Pedicle valve interior with uniseptum not usually reaching mid-valve: septum thin and delicate even in thick-shelled specimens: septal crest variable, usually near the middle, septum and dental ridges forming small chamber in some specimens. Muscle area moderate in size, rim thickened.

Brachial valve interior not observed. The following details are from Cooper and Grant (1974):

> Brachial valve interior with modified bilobed chilidium and moderately long, narrowly forked myophore, dentifers short and blunt; supporting plates elongated and wrapping around the outside of muscle field.

Dimensions (in mm.).----

Loc. 1-5c	pedicle valve length	brachial valve length	maximum width	hinge width	inter-area length	thick-ness
W-57a	38.50	32-33	54	40?	6	17

Occurrence.---- Section 1, unit 5.

Stratigraphic and Geographic Range.---- Wolfcampian. In Texas Derbyia carteri occurs in the Uddenites Shale Member, Gaptank and Neal Ranch Formations of the Glass Mountains. In New Mexico it occurs in the Abo Member, Hueco Formation of the Robledo Mountains.

Remarks.---- Derbyia carteri is best compared with D. crenulata Girty from which it differs by being more finely and evenly costellate. D. crenulata reaches a larger size than D. carteri.

Suborder PRODUCTIDINA Waagen, 1883

Superfamily STROPHALOSIACEA Schuchert, 1913

Family AULOSTEGIDAE Muir-Wood and Cooper, 1960

Subfamily COSTELLARIINAE Muir-Wood and Cooper, 1960

Genus Costellarina Muir-Wood and Cooper, 1967

Costellarina costellata (Muir-Wood and Cooper)

1960 Costellaria costellata Muir-Wood and Cooper, Geol. Soc. America, Mem. 81, p. 123-124, pl. 56, fig. 1-12.

1965 Costellaria costellata: Muir-Wood, in Moore, Treastise, Pt. H, p. 459, fig. 321:1a-d.

1967 Costellarina costellata: Muir-Wood and Cooper, Jour. Paleontology, v. 41, n. 3, p. 808.

1967 Costellaria costellata: Mayou, Brigham Young Univ., Geol. Studies, v. 14, p. 109-110, pl. 1, fig. 4, 6, 7, 9.

Diagnosis.---- Small, spiney, attached; pedicle valve evenly convex; brachial valve evenly concave; cicatrix truncates umbo. Pedicle valve convex in profile: ornamented by fine costellae and rugae, reticulated: spines of two types (1) long slender, suberrect on venter and trail, (2) rhizoid around ears and umbonal slopes. Umbo truncated by cicatrix, comprising one-fourth to one-half the width of the shell. Brachial valve concave in profile; ornamented by costellae and rugae, reticulated: non-spinose. Umbo has smooth swollen region which corresponds to cicatrix on pedicle valve.

Interior of pedicle and brachial valves not observed.

Probably as described by Muir-Wood and Cooper (1960):

> Interior of pedicle valve without teeth. Interior of brachial valve with short, strongly bilobed cardinal process, hollowed anteriorly; lateral ridges curving, short; breviseptum low and delicate; anterior surface with large endospines; adductor scars and brachial ridges obscure.

Based on information from Muir-Wood and Cooper (1960), Muir-Wood (1965), Mayou (1967), and observation.

Dimensions (in mm.).----

	pedicle valve length	brachial valve length	hinge length	height	thickness
Loc. 1-5					
W-9a	5	----	6.95	3.98	----
W-9b	3.50	----	4.35	2.57	----
Loc. 2-16					
W-102a	10.82	9.53	10.58	4.63	0.58
W-102b	6.63	----	8	3.61	----
W-103c	7.93	6.37	8.77	3.25	0.67
Loc. 3-6					
W-130	5.48	----	4.37	3.98	----

Occurrence.---- Section 1, units 5 and 7; Section 2; unit 16; and Section 3, units 6 and 8.

Stratigraphic and Geographic Range.---- Upper Wolfcampian-Leonardian. In Texas Costellarina costellata occurs in the Talpa Formation of the north-central portion of the state, and the Alacran Mountain Formation of the Franklin Mountains. In New Mexico it occurs in the Abo and Upper Hueco Limestone Members, Hueco Formation of the Robledo Mountains. In Nevada it occurs in the Leonard portion of the Loray Formation of the Butte Mountains.

Superfamily PRODUCTACEA Gray, 1840

Family DICTYOCLOSTIDAE Stehli, 1954

Subfamily DICTYOCLOSTINAE Stehli, 1954

Genus Squamaria Muir-Wood and Cooper, 1960

Squamaria moorei Muir-Wood and Cooper

1960 Squamaria moorei Muir-Wood and Cooper, Geol. Soc. America, Mem. 81, p. 289, pl. 106, fig. 1-7; 9-11.

1965 Squamaria moorei: Muir-Wood, in Moore, Treatise, Pt. H, p. 497, fig. 370:1a-g.

Diagnosis.---- Large, subquadrate in outline, pedicle valve strongly convex; greatest width along hinge; prominent ears, moderately sulcate medially; steep flanks; broadly rounded margins. Convex visceral disc; tapering umbo, slightly projecting beyond margin of hinge. Ornamented by fine costae, unequal in size; abundant and strong rugae, crossing visceral disc and intersecting with costae to produce fine reticulation on posterior one-third of valve; spines erect or suberect, clustered on ears, in one to three rows on posterior, and small spines scattered on visceral disc and trail, those on trail slightly larger. Numerous squamae on anterior portion of trail.

Brachial valve with nearly flat to slightly concave visceral disc; sulcate umbo; midvalve swollen slightly producing small fold. Ornamentation slightly stronger than that on pedicle valve; finely reticulate; costae on trail nearly uniform in size. Spines clustered on shallow, concave ears and scattered over visceral disc and trail; small, slender spines on trail.

Pedicle valve interiors not observed in specimens. The following details are from Muir-Wood and Cooper (1960):

> Interior of pedicle valve with long narrow dendritic adductors set on low ridge; diductors broad, extending anteriorly beyond adductors, finely ridged, spreading laterally and filling most of umbonal cavity.

Brachial valve interiors with cardinal process sessilely trilobate, anteriorly bilobate, dorsally bent at low angle, broad medially lobed myophore and sulcate diverging lateral lobes, converging without uniting on external trilobate face: short lateral ridges, diverging from hinge; cardinal process supported by medial septum, extending three-quarters length of visceral disc, narrow and more elevated anteriorly; dendritic, rounded trigonal adductor field, terminating in smooth node: horizontal brachial ridges: visceral disc end with numerous rows of prostrate endospines, elsewhere surface granular or pitted. Based on information from Muir-Wood and Cooper (1960) and observation.

Dimensions (in mm.).----

	pedicle valve length	brachial valve length	hinge width	height	thickness
Loc. 1-5					
W-10a	42.67	29.28	47.84	28.75	2.94
W-10b	43.05	31.96	39.90	24.96	2.94
W-10c	29.52	22.34	31.34	23.72	5.41
W-10d	39.02	27	36.72	25.22	2.52
W-10e	35.57	27.70	39.04	23.90	2.26
Loc. 1-5c					
W-58a	36.15	23.47	43.22	21.42	3.82
W-58b	38.48	29	39.40	26.17	3.44

W-58c	37.48	25.43	36.10	23.20	2.42
W-58d	29.85	23.42	34.74	19	2.72
W-58e	30.72	22	33.50	17.57	2.30
Loc. 2-7					
W-81a	36.95	---	41.66	24.57	---
W-81b	29.62	20.97	34	16.12	4.93
W-81c	30.02	21.57	35.90	16.87	6.30
Loc. 2-16					
W-103a	28.27	19.95	31.74	15.57	5.37
W-103b	25.12	18.95	28.10	14.65	4.60
W-103c	40.62	25.63	46.18	32.25	3.90
W-103d	32.08	24.70	35.60	23.97	---
W-103e	33.43	26.70	30.26	23.98	---
Loc. 3-6					
W-131a	43.20	31.47	41.44	27.17	3.32
W-131b	29.32	22.49	27.20	15.12	2.50
W-131c	39.17	30.32	41.40	26.95	2.20
W-131d	28.36	21.67	31.44	17.72	4.02
W-131e	22.50	18.75	28.20	12.92	5.52

Occurrence.---- Section 1, units 5 and 7; Section 2, units 7 and 16; and Section 3, units 2, 6, and 8.

Stratigraphic and Geographic Range.---- Upper Wolfcampian-Lower Leonardian? In Texas Squamaria moorei occurs in the Wildcat Creek Shale Member, Admiral; Bead Mountain; Grape Creek; Talpa; and Arroya Formations of the north-central portion of the state and Cerro Alto Formation of the Franklin Mountains. In New Mexico it occurs in the Abo Member, Hueco Formation of the Robledo Mountains.

Family LINOPRODUCTIDAE Stehli, 1954

Subfamily LINOPRODUCTINAE Stehli, 1954

Genus *Linoproductus* Chao, 1927

Linoproductus cora (d'Orbigny)

1842 *Productus cora* d'Orbigny, Voy. dans l'Amerique Meridionale, Pal., p. 55, pl. 5, fig. 8-10.

1847 *Productus cora*: de Koninck, Soc. Roy. Sci. Liege, Mem., v. 4, p. 148, pl. 4, fig. 4; pl. 5, fig. 2.

1847 *Productus cora*: de Koninck, Recherches sur les Animaux Fossiles, pt. 1, p. 50, pl. 4, fig. 4; pl. 5, fig. 2.

1859 *Productus prattenianus*: Meek and Hayden, Acad. Nat. Sci. Philadelphia, Proc ., p. 26.

1866 *Productus flemingi*: Geinitz, Carb. und Dyas in Nebraska, p. 52, tab. 4, fig. 1-4.

1866 *Productus koninckiauns*?: Geinitz, Carb. und Dyas in Nebraska, p. 53, tab. 4, fig. 5.

1866 *Productus calhounianus*: Geinitz, Carb. und Dyas in Nebraska, p. 53.

1866 *Productus cora*: Geinitz, Carb. und Dyas in Nebraska, p. 50.

1869 *Productus* cf. *P. cora*: Toula, Kais. Akad. der Wissensch, Sien, Sitzb., v. 59, 1st Abth., p. 441.

1874 Productus cora?: Derby, Cornell Univ. Sci., Bull., v. 1, n. 2, p. 49, pl. 2, fig. 6, fig. 17.

1876 Productus cora: Derby, Mus. Comp. Zool, Bull., v. 3, p. 281.

1884 Productus cora: Waagen, Palaeontologica Indica, ser. 13, f. 1, p. 677, pl. 66, fig. 3: pl. 67, fig. 1-2.

1900 Productus cora: Beede, Kansas Geol. Survey, Rept., v. 6, p. 75, pl. 11, fig. 1.

1900 Productus cora: Herrick and Bendrat, Am. Geol., v. 25, n. 4, p. 240.

1909 Productus cora: Girty, U. S. Geol. Survey, Bull. 389, p. 58-61.

1916 Productus cora: Broili, Paleo. von Timor, lief. 7, 13, p. 19-22.

1927 Linoproductus cora: Chao, Paleo. Sinica, ser. B, v. 5, fas. 2, p. 132-134, pl. 13, fig. 17-18; pl. 14, fig. 1-4.

1931 Linoproductus cora: R. E. King, Univ. Texas, Bull. 3042, p. 75-76, pl. 16, fig. 6-7.

1953 Linoproductus cora: Chronic, in Newell, et. al., Geol. Soc. America, Mem. 58, p. 88-89, pl. 7, fig. 7-9.

1959 Linoproductus aff. cora: Kashirtsev, Field Atlas Permian fauna of eastern Russia, p. 44-45, tab. 18, fig. 1-2.

1960 Linoproductus cora: Muir-Wood and Cooper, Geol. Soc. America, Mem. 81, p. 296-298, pl. 111, fig. 3-6.

1965 Linoproductus cora: Muir-Wood, in Moore, Treatise, Pt. H, p. 500, fig. 373:2a-d.

1965 Linoproductus cora: Gauri, Jahr. Geol. Bund., Sb. 11, p. 75, pl. 14, fig. 1-5.

Diagnosis.---- Large, subtrigonal in outline, pedicle valve strongly convex; greatest width at mid-length; ears prominent, broad, trigonal convex, highly wrinkled; trail long, medially convex; flanks steep; broadly rounded margins. Convex visceral disc; umbo tapering, incurved beyond hinge. Ornamented with fine, closely spaced, irregular, sinuous costellae; few rugae, producing broad wrinkles on flanks and ears; spines prostrate or suberect, irregularly spaced on umbo and anterior slopes, with one or two rows along hinge.

Brachial valve nearly flat to slightly concave on visceral disc, strongly geniculated frontal and lateral margins, short trail. Ornamentation of fine costellae; numerous rugae, crossing visceral disc; numerous growth lines; spines rare.

Pedicle valve interiors not observed. The following details are from Muir-Wood and Cooper (1960):

> Interior of pedicle valve with broad, longitudinally striated diductor scars; adductors elongated, parallel to median line with longitudinal markings.

Brachial valve interiors not observed. The following details are from Muir-Wood and Cooper (1960):

> Brachial valve with trilobate or quadrilobate sessile cardinal process, with broad sulcate median lobe, two lateral lobes curving dorsally, uniting with median lobe; alveolus shallow, posterior to cardinal process with external opening

at base of three conjunct lobes of process: breviseptum extending from alveolus anteriorly almost to end of visceral disc; adductors large, dendritic, rounded-trigonal in outline, and posteriorly placed just below lateral ridges: brachial impressions usually obscure, anterior part of ridge distinguishable almost at anterior end of visceral disc; lateral ridges diverging from hinge margin and not extending around ears, bearing transverse incision near cardinal process; second pair of ridges shorter and more oblique, arising at this point and bounding posterior part of adductors.

Based on information derived from Chronic (1953), Muir-Wood and Cooper (1960), and observation.

Dimensions (in mm.).----

	pedicle valve length	brachial valve length	hinge width	height	thickness
Loc. 1-5					
W-12a	29	22.23	35.30	17.32	4.70
W-12b	26.17	22.65	22.34	13.27	2.20
W-121	26.62	23.90	24.44	15.32	3.19
Loc. 2-16					
W-104a	12.95	11.62	13.40	4.40	1.30
W-104b	13.60	11.80	13.35	7.90	3.50
W-104c	28.02	21.52	23	16.65	2.52
W-104d	32.77	24.08	26	17.25	2.66
Loc. 3-6					
W-132a	27.80	21.95	27.64	13.55	1.90
W-132b	17.25	14.02	16.02	7.17	4.27

Occurrence.---- Section 1, units 5 and 7: Section 2, units 7 and 16; and Section 3, units 2, 6, and 8.

Stratigraphic and Geographic Range.---- Middle Pennsylvanian-Leonardian. In Texas Linoproductus cora occurs in the Uddenites Shale Member, Gaptank and Neal Ranch Formations of the Glass Mountains: Powwow Member, Hueco and Hueco Formations of the Sierra Diablo region; Hueco Canyon, Cerro Alto, and Alacran Mountain Formations of the Franklin Mountains. In New Mexico it occurs in the Abo Member, Hueco Formation of the Robledo Mountains; and the Abo Formation of the Chupadera Mesa and the Manzano and Sandia Mountains. In Arizona it occurs in the Kaibab Formation. In Peru it occurs in the Tarma Group, and the Copacabana Group of Bolivia and Peru. In Europe it occurs in the Upper Carboniferous of the Carnic Alps and the Lower Permian of Russia.

Genus Cancrinella Frederiks, 1928

Cancrinella altissimia R. H. King

1931 Linoproductus (Cancrinella) villiersi: R. E. King, Univ. Texas, Bull. 3042, p. 78, pl. 17, fig. 1-2.

1938 Cancrinella altissimia R. H. King, Jour. Paleontology, v. 12, n. 3, p. 275-276, pl. 39, fig. 27-28.

1954 Cancrinella altissimia: Stehli, Am. Mus. Nat. History, Bull., v. 105, art. 3, p. 321, pl. 22, fig. 1-5.

1960 Cancrinella altissimia: Muir-Wood and Cooper, Geol. Soc. America, Mem. 81, p. 417, pl. 112, fig. 1-7.

1965 Cancrinella altissimia: Muir-Wood, in Moore Treatise, Pt. H, p. 501, fig. 373: 1a-c.

1973 Cancrinella altissimia: Grunt and Dmitriev, Acad. Sci. USSR, Palaeontological Inst., Trans., v. 136, p. 106, pl. 8, fig. 1-2.

Diagnosis.---- Small, suborbicular in outline: greatest width near midvalve: pedicle valve convex; brachial valve concave. Pedicle valve evenly convex in profile, venter rounded: steep or spreading flanks: umbo strongly recurved: ears small, flattened; somewhat geniculated, posterior slope more so. Ornamented by costellae; rugae crossing venter or on flanks and ears: spines fine, long, sloping or erect scattered over the valve and in group on ears.

Brachial valve strongly concave: geniculated, ears same as for pedicle valve. Ornamented by costellae, with rugae on ears and lateral slopes; no spines.

Interior of pedicle and brachial valves not observed. Probably as described by Muir-Wood and Cooper (1960).

Interior of pedicle valve with dendritic adductor scars posteriorly placed, broad and striated, diductors extending farther anteriorly. Interior of brachial valve with small sessile, bilobate cardinal process with two flattened diverging, medianly depressed, pear-shaped lobes having raised rim, sometimes uniting posteriorly, and external face trilobate; short breviseptum; lateral ridges slightly curved; adductors obscurely dendritic, brachial ridges not observed.

Occurrence.---- Section 1, unit 5; Section 2, unit 16; and Section 3, unit 6.

Stratigraphic and Geographic Range.---- Cancrinella altissimia ranges from Desmoinesian-Leonardian. In Texas it occurs in the Graham, Thrifty, and Harpersville Formations of the north-central portion of the state; Uddenites Shale Member, Gaptank, Neal Ranch, and Lenox Hills Formations of the Glass Mountains; Bone Spring Formation of the Sierra Diablo region; Cerro Alto Formation of the Hueco Mountains; and Cerro Alto Formation of the Franklin Mountains. In New Mexico it occurs in the Abo Member, Hueco Formation of the Robledo Mountains. In Nevada it occurs in the Pequop Formation of Moorman Ranch Mountain. It also occurs in the Lower Permian of the Pamir Mountains of Russia.

Order RHYNCHONELLIDA Kuhn, 1949

Superfamily RHYNCHONELLACEA Gray, 1848

Family PONTISIDAE Cooper and Grant, 1976

Genus Pontisia Cooper and Grant, 1969

Pontisia franklinensis Cooper and Grant

1976 Pontisia franklinensis Cooper and Grant, Smithsonian Contri Paleo., n. 21, p. 2020-2021, pl. 529, fig. 64-70.

Diagnosis.---- Small, biconvex; subtrigonal profile; transversely subovate to subtrigonal in outline, sides diverging between 90 and 120 degrees; commissure uniplicate; low fold; shallow sulcus. Low, short costae, crests blunt, numbering 3 on fold, 2 in sulcus, 2-3 on flanks. Shell smooth, no concentric ornamentation or growth lines observed.

Pedicle valve with gently convex, smooth umbonal area, non-reflexed flanks; short blunt beak ridges; narrow or absent lateral pseudointerareas; valves overlap slightly. Triangular delthyrium, small deltidal plates. Brachial valve with nearly flat umbonal area; blunt beak.

Pedicle valve interior not observed in specimens. The following details are from Cooper and Grant (1976):

> Pedicle valve interior with sides of delthyrium widely diverging, teeth supported by vertical dental plates reaching floor of valve. Muscle area triangular, anteriorly expanding, slightly excavate, scars of separate muscles not observed.

Brachial valve interior not observed. Probably as described by Cooper and Grant (1976):

Brachial valve interior with undivided triangular hinge plate, bounded laterally by elongate, deep, anteriorly widening, hinge sockets; crura diverging anteriorly from forward edge of hinge plate, strongly curving ventrally, twisted, dorsal edges carinate; median ridge low, rounded. Muscle area not observed; probably subdivided into posterior and anterior adductor scars as in other species of genus.

Dimensions (in mm.).----

	pedicle valve length	brachial valve length	width	thickness
Loc. 1-5				
W-14a	6.75	5.92	7.92	4.27
W-14b	8.32	7.20	8.70	4.50
W-14c	6.57	6.77	7.72	6.09
W-14d	6.15	6.10	6.92	4.87
Loc. 1-5c				
W-60a	7	6.63	7.20	4.47
W-60b	7.43	6.40	8.22	4.97
W-60c	7.21	6.55	8.14	5.31
W-60d	8.52	7.40	8.95	5.90
W-60e	8.17	7.23	9.25	6.17

Occurrence.---- Section 1, units 5 and 7; and Section 2, unit 16-G.

Stratigraphic and Geographic Range.---- Wolfcampian. In Texas Pontisia franklinensis occurs in the Hueco Canyon and Alacran Mountain Formations of the Hueco Mountains; Hueco Canyon, Cerro Alto, and Alacran Mountain Formations of the Franklin Mountains. In New Mexico it occurs in the Hueco Formation of the Jarilla Mountains; Middle Hueco Limestone Member of the Dona Ana Mountains; Abo and Upper Hueco Limestone Members of the Robledo Mountains; and the Hueco Formation of the Florida Mountains.

Order SPIRIFERIDA Waagen, 1883

Suborder ATHYRIDIDINA Boucot, Johnson, and Staton, 1964

Superfamily ATHYRIDIDACEA M'Coy, 1844

Family ATHYRIDIDAE M'Coy, 1844

Subfamily ATHYRIDINAE M'Coy, 1844

Genus Composita Brown, 1849

Composita mexicana (Hall)

1857 Terebratula mexicana Hall, in Emory, U. S. and Mexican Boundary Survey, Rept., v. 1, pt. 2, pl. 20, fig. 2.

1907 Dielasma schucherti: Beede, Univ. Kansas, Sci. Bull., v. 4, n. 3, pl. 5, fig. 1k.

1908 Composita mexicana: Girty, U. S. Geol. Survey, Prof. Pap. 58, p. 389-390.

1908 Composita mexicana var. guadalupensis: Girty, U. S. Geol. Survey, Prof. Pap. 58, p. 390, pl. 24, fig. 11-13.

1909 Composita mexicana: Girty, U. S. Geol. Survey, Bull. 389, p. 68, pl. 8, fig. 1.

1931 Composita mexicana: R. E. King, Univ. Texas, Bull. 3042, p. 128-129, pl. 43, fig. 1-11.

1940 Composita mexicana: Brill, Geol. Soc. America, Bull., v. 51, p. 318-319, pl. 10, fig. 13-14.

1941 Composita guadalupensis: Stainbrook and Madera, Jour. Paleontology, v. 15, n. 4, p. 381, pl. 55, fig. 19-21.

1941 Composita mexicana: Stainbrook and Madera, Jour. Paleontology, v. 15, n. 4, p. 381, pl. 55, fig. 23.

1942 Composita mexicana: Clifton, Jour. Paleontology, v. 16, n. 11, p. 890, pl. 102, fig. 16-17.

1953 Composita cf. C. guadalupensis: Walter, Jour. Paleontology v. 27, n. 5, p. 690-691, pl. 71, fig. 9-11, 13.

1960 Composita mexicana: Coker, M. S. Thesis, Rice Inst., p. 45-46, pl. 3, fig. 4-6.

Diagnosis.---- Shell small, biconvex, subpentagonal in outline. Greatest width about two-fifths anteriorly from umbo; width about equal to length. Convexity variable, and length may exceed width. Shell smooth with concentric growth lines.

Pedicle valve with large inflated beak, incurved over brachial beak, terminating in circular foramen; strongly convex umbonal area. Strongly developed sulcus beginning posteriorly on umbo, broadening anteriorly producing strong forward and upward deflection of anterior margin; subpentagonal in outline.

Brachial valve strongly convex: small beak; pronounced narrow fold anteriorly. Fold is accentuated by strong depression on each side; subovate in outline.

Dimensions (in mm.).----

Loc. 1-5	pedicle valve length	brachial valve length	width	thickness
W-15a	7.70	6.35	6.98	4.92

W-15b	9.37	8.07	9.26	5.82
W-15c	9.42	7.73	9.56	6.18
W-15d	9.88	8.15	10.35	6.12
W-15e	11.81	10.37	12.41	7.58
Loc. 1-5c				
W-59a	6.68	5.42	5.38	4.32
W-59b	7.94	6.62	6.81	4.87
W-59c	8.30	7.25	7.91	5.22
W-59d	8.53	6.87	7.77	5.82
W-59e	10.25	8.75	9.72	6.72
Loc. 3-6				
W-133	10.58	9.56	11.36	7.11

Occurrence.---- Section 1, units 5 and 7 and Section 3, unit 6.

Stratigraphic and Geographic Range.---- Wolfcampian-Guadalupian. Composita mexicana occurs in the Lower Permian of Kansas. In Texas it occurs in the Coleman Junction Formation of the north-central portion of the state; Hess and Delaware Mountain Formations of the Glass Mountains; Hueco and Victorio Peak Formations of the Sierra Diablo region; Hueco Canyon, Cerro Alto, and Alacran Mountain Formations of the Hueco and Franklin Mountains; Black Limestone Member, Briggs Formation of the Malone Mountains: Rustler Formation of the Rustler Hills; and the Whitehorse Formation of the northern portion of the state. In New Mexico it occurs in the Abo Member, Hueco Formation of the Robledo Mountains; Hueco Formation of the Florida Mountains: Yeso Formation of the Chupadera Mesa: San Andres Formation of the San Andres Mountains: and the Bone Spring Formation, Getaway Member, Cherry Canyon Formation, and Rader and McCombs

Members, Bell Canyon Formation of the Guadalupe Mountains. In Arizona it occurs in the Colina Formation of the southeastern portion of the state and the Kaibab Formation of the northern portion of the state.

Remarks.---- The amount of development of the fold and sulcus in Composita mexicana varies greatly, with some shells having hardly any at all, making them indistinguishable from some small specimens of C. subtilita. Composita mexicana is much smaller with a more strongly marked fold and sulcus than that of C. subtilita.

Suborder SPIRIFERIDINA Waagen, 1883

Superfamily CYRTIACEA Frederiks, 1919 (1924)

Family AMBOCOELIIDAE George, 1931

Genus Crurithyris George, 1931

Crurithyris guadalupensis (Girty)

1908 Ambocoelia planiconvexa var. guadalupensis Girty, U. S. Geol. Survey, Prof. Pap. 58, p. 370-371, pl. 14, fig. 12-14.

1910 Ambocoelia arcuata Girty, U. S. Geol. Survey, Bull. 436, p. 35, pl. 6, fig. 15-17.

1931 Ambocoelia guadalupensis: R. E. King, Univ. Texas, Bull. 3042, p. 119-120, pl. 41, fig. 1-5.

Diagnosis.---- Large for genus, subovate in outline, greatest width at mid-length. Pedicle valve strongly convex: beak high, recurved. Cardinal area with high, triangular delthyrium bearing narrow deltidial plates.

Brachial valve transverse, gently convex: beak small, slightly recurved over small, triangular cardinal area; hinge line straight. Medial sulcus not present. Surfaces of both valves marked by fine concentric growth lines.

Dimensions (in mm.).----

Loc. 1-5	pedicle valve length	brachial valve length	width	thickness
W-17a	5.67	4.87	6.25	3.90

W-17b	6.30	5.55	7.47	4.41
W-17c	7.40	5.76	7.60	4.72
W-17d	7.17	6.30	7.97	4.97
W-17e	9.02	7.77	9.52	6.07
Loc. 2-16				
W-105a	4.42	3.97	4.95	2.80
W-105b	6.47	5.52	6.86	4.04
W-105c	6.57	5.67	6.52	5.06
W-105d	7.33	6.20	8.85	6.22
W-105e	9.55	8.25	9.95	6.74

Occurrence.---- Section 1, units 5 and 7; and Section 2, units 7 and 16.

Stratigraphic and Geographic Range.---- Upper Wolfcampian-Guadalupian. In Texas Crurithyris guadalupensis occurs in the Hueco Formation of the Sierra Diablo region: Black Limestone Member, Briggs Formation of the Sierra Blanca region; Cerro Alto Formation of the Hueco Mountains; Cerro Alto and Alacran Mountain Formations of the Franklin Mountains; "Leonard" and Word Formations of the Glass Mountains; "Leonard" Formation of the Shafter district: and the Delaware Mountains. In New Mexico it occurs in the Abo and Upper Hueco Limestone Members, Hueco Formation of the Robledo Mountains; and Bone Spring Formation and Lamar Member, Bell Canyon Formations and Bone Canyon Member, Capitan Formation of the Guadalupe Mountains. In Wyoming it occurs in the Park City Formation of the Sublette Mountains and Thomas Fork area. In Idaho it occurs in the Park City Formation of the Montpelier area.

Order TEREBRATULIDA Waagen, 1883

Suborder TEREBRATULIDINA Waagen, 1883

Superfamily DIELASMATACEA Schuchert, 1913

Family HETERELASMINIDAE Likharev, 1956

Genus Beecheria Hall and Clarke, 1893

Beecheria bovidens (Morton)

1836 Terebratula bovidens Morton, Am. Jour. Sci., v. 29, p. 150, pl. 2, fig. 4.

1902 Dielasma bovidens: Tschernyshev, Geol. Kom., Trudy, v. 16, n. 2, p. 33, pl. 3, fog. 3; pl. 4, fig. 4.

1903 Dielasma bovidens: Girty, U. S. Geol. Survey, Prof. Pap. 16, p. 409-411, pl 7, fig. 11.

1904 Dielasma bovidens: Reagan, Indiana Acad. Sci., Proc. 1903, p. 242, pl. 1, fig. 11.

1906 Dielasma bovidens: Beede, Kansas Geol. Survey, Rept., v. 6, pt. 2, p. 95-96.

1906 Dielasma bovidens: Woodruff, Nebraska Geol. Survey, v. 2, pt. 2, p. 276, pl. 11, fig. 4.

1909 Dielasma bovidens: Grabau and Shrimer, North American Ind. Foss., v. 1, p. 303, fig. 377.

1914 Dielasma bovidens: Kozlowski, Ann. Paleontology, v. 9, p. 88-90, pl. 9, fig. 61-65.

1914 Dielasma bovidens: Meyer, N. Jahr. Min. Geol. Pal., v. 37, p. 603.

1922 Dielasma bovidens?: Morningstar, Ohio Geol. Survey, ser. 4, Bull. 25, p. 185.

1924 Dielasma bovidens: Morgan, Oklahoma Bur. Geol., Bull. 2, pl. 42, fig. 18.

1930 Dielasma bovidens: Sayre, Univ. Kansas, Sci. Bull., v. 19, n. 8, p. 7, fig. 4-5.

1930 Dielasma bovidens: Frederiks, Akad. Nauk SSR, Inst. Geol., Trudy, v. 2, p. 150-151.

1932 Dielasma bovidens: Dunbar and Condra, Nebraska Geol. Survey, ser. 2, Bull 5, p. 304-306, pl. 37, fig. 33-34.

1935 Dielasma bovidens: Heritsch, Akad. Wiss. Sien, Math-nat. Kla., Sitz., Abt. I, v. 144, p. 366, pl. 1, fig. 6.

1937 Dielasma bovidens: Reichardt, Deux Cong. l'Avanc. Etudes Strat. Carbonifere, C. R., v. 2, p. 1006-1007.

1944 Dielasma bovidens: Cooper, in Shimer and Shrock, Index foss. N. America, p. 364, pl. 143, fig. 6-8.

1946 Dielasma bovidens: Ahlfeld, Mus. La Plata, Rev., n. s. Geol., v. 3, pl. 5, fig. 5

1946 Dielasma cf. bovidens: Sampelayo, Inst. Geol. Min. Espana, Bol, v. 59, p. 16.

1952 Dielasma bovidens: Moore, Lalicker, and Fischer, Invert. foss., p. 234, fig. 5.

1952 Dielasma bovidens: Roger, in Piveteau, Traite de Paleontologie, v. 2, p. 120, fig. 117.

1956 Beecheria bovidens: Stehli, Jour. Paleontology, v. 30, n. 2, p. 299, pl. 40-A, fig. 1-3.

1958 Dielasma bovidens: Fenton and Fenton, The foss. book, p. 107.

1960 Dielasma bovidens: Easton, Invert. Paleontology, p. 295, 318, fig. 8.7:9, fig. 8.20:3.

1961 Beecheria bovidens: Hoare, Univ. Missouri Studies, v. 36, p. 33-34, pl. 1, fig. 25-26.

1962 Dielasma bovidens: Mudge and Yochelson, U. S. Geol. Survey, Prof. Pap. 323, p. 85-86, pl. 15, fig. 9.

1962 Dielasma bovidens: Lane, Jour. Paleontology, v. 36, n. 5, p. 898, pl. 127, fig. 15.

1965 Dielasma bovidens: White, Earth Sci., v. 18, n. 2, p. 71, fig. 21.

1967 Dielasma bovidens: Mironova, Leningrad Gos. Univ., Izd., p. 52, pl. 5, fig. 16.

1968 Beecheria bovidens: Sturgeon and Hoare, Ohio Geol. Survey, Bull. 63, p. 68-69, pl. 22, fig. 15-19.

1969 Dielasma bovidens: Simpson, S. A. S. G. S., Ann. Field Trip, pl. 5, fig. 9.

Diagnosis.---- Small; biconvex; elongate ovate in outline, with maximum width anterior to mid-length, and greatest thickness posterior to mid-length. Shell smooth; finely punctate, arranged in quincunx; marked by concentric growth lines.

Pedicle valve strongly convex in profile; beak incurved over and covering brachial beak; foramen large, encroaching upon umbonal area; broad, shallow, rounded sulcus beginning posterior to umbo, becoming broader anteriorly. Brachial valve evenly convex in profile; beak small, partially concealed by pedicle beak; surface nearly flat to slightly convex, sides sloping steeply away from narrowly rounded median axis, but not in form of fold. Pedicle and brachial valve interiors not observed in specimens collected.

Dimensions (in mm.).----

	pedicle valve length	brachial valve length	width	thickness
Loc. 1-5				
W-16a	13.15	10.68	10.02	8
W-16b	15.97	12.96	13.18	8.53
Loc. 1-5c				
W-61a	7.70	6.53	6.28	3.62
W-61b	8.35	7.30	6.92	4.12
W-61c	11.31	9.45	9.56	5.27

Occurrence.---- Section 1, units 5 and 7 and Section 3, unit 6.

Stratigraphic and Geographic Range.---- Desmoinesian-Wolfcampian. Beecheria bovidens occurs in the Upper Pennsylvanian and Lower Permian formations of the Midcontinent region. The Permian forms

from Texas occur in the Harpersville, Pueblo, and Moran Formations of the north-central portion of the state: Uddenites Shale Member, Gaptank Formation of the Glass Mountains; Powwow Member, Hueco and Hueco Fromations of the Sierra Diablo region; Hueco Canyon Formation of the Hueco Mountains; Hueco Canyon, Cerro Alto, and Alacran Mountain Formations of the Franklin Mountains. In New Mexico it occurs in the Abo and Upper Hueco Limestone Members, Hueco Formation of the Robledo Mountains. Outside the United States it occurs in the Copacabana Group of Bolivia.

Phylum MOLLUSCA Cuvier, 1816

Class GASTROPODA Cuvier, 1797

Order ARCHAEOGASTROPODA Thiele, 1925

Suborder BELLEROPHONTINA Ulrich and Scofield, 1897

Superfamily BELLEROPHONTACEA M'Coy, 1851

Family SINUITIDAE Dall in Zittel-Eastman, 1913

Subfamily EUPHEMITINAE Knight, 1956

Genus Euphemities Warthin, 1930

Euphemites sp. indet.

Diagnosis.---- Large, involute, globose, geniculate, spirally coiled euphemitid: rapidly but regularly expanding whorls. Preserved only as internal molds; ornamentation consisting of approximately 15-17 lirae.

Dimensions (in mm.).----

	height	width	height of aperture	width of aperture
Loc. 1-5c				
W-63a	8.43	5.70	4.47	5.78
W-63b	9.47	6.10	----	6.52

Occurrence.---- Section 1, unit 5c.

Genus Euphemitopsis Yochelson, 1960

Euphemitopsis multinodosa Yochelson

1909 Euphemus subpapillosus: Girty, U. S. Geol. Survey, Bull. 389, p. 99-100.

1960 Euphemitopsis multinodosa Yochelson, American Mus. Nat. History, Bull., v. 119, art. 4, p. 252-253, pl. 48, fig. 1-12.

Diagnosis.---- Small to medium-sized, inflated, globose euphemitid, slightly geniculate: deep slit: numerous pustules present on perinductura; lateral lips sharply bent; anterior lips somewhat arched, near center curving in to form shallow sinus which becomes a narrow deep slit; ornament borne on two or more inductural layers; low, distinct, rounded spiral lirae are formed on higher inductural layer, the number varies from 8 to 17 lirae at varying stages of growth; perinductural ornament consists of numerous small pustules or nodes elongating slightly near the edge of the inductura; area behind the apertural lips smooth with only growth lines visible.

Dimensions (in mm.).----

Loc. 1-5	height	width	height of aperture	width of aperture
W-18a	9.10	7.52	4.32	11.08
W-18b	9.75	8.72	4.25	12.28
W-18c	10.32	9.37	4	13.62
Loc. 2-.6				
W-106a	4.12	2.85	2.23	4.27
W-106b	6	5.27	3.07	7.32

W-106c	6.32	5.11	2.81	8.32
W-106d	9.05	5.52	3.75	8.95
Loc. 3-6				
W-135a	8.02	5.72	3.80	8.87
W-135b	9.72	5.70	3.17	9.98
W-135c	9.64	6.42	3.72	10.64
W-135d	12.55	7.88	6.22	13.65

Occurrence.---- Section 1, units 5 and 7; Section 2, units 7 and 16; and Section 3, unit 6.

Stratigraphic and Geographic Range.---- Wolfcampian-Leonardian? In Texas Euphemitopsis multinodosa occurs in the Wildcat Creek and Jim Ned Shale Members, Admiral; Grape Creek; Talpa; and Lueders Formations of the north-central portion of the state. In New Mexico it occurs in the Hueco Canyon Formation of the Hueco Mountains; Abo and Upper Hueco Limestone Members, Hueco Formation of the Robledo Mountains; and the Abo Formation of the Manzano Mountains. In Arizona it occurs in the Colina Formation of the south-eastern portion of the state.

Family BELLEROPHONTIDAE M'Coy, 1851

Subfamily BELLEROPHONTINAE M'Coy, 1851

Genus Bellerophon Montfort, 1808

Bellerophon (Bellerophon) sp. indet.

Diagnosis.---- Medium-sized to large, subglobose bellerophontid, spirally coiled, involute, internal molds, slightly higher than wide.

Dimensions (in mm.).----

Loc. 1-5	height	width	height of aperture	width of aperture
W-19a	30.05	20.91	----	34.07
W-19c	20.75	8.75	10.05	11.72
W-19t	19.80	12.97	11.12	20.17

Occurrence.---- Section 1, units 5 and 7; Section 2, units 7 and 16; and Section 3, units 6 and 8.

Subfamily KNIGHTITIDAE Knight, 1956

Genus Knightites (Knightites) Moore, 1941

Knightites (Knightites) bransoni Yochelson

1960 Knightites (Knightites) bransoni Yochelson, Am. Mus. Nat. History, Bull., v. 119, art. 4, p. 270, pl. 53, fig. 13-17.

Diagnosis.---- Medium-sized to large, narrowly phaneromphalous bellerophontid, with protuberances along selenizone coalescing to form two revolving ridges; whorls expanding uniformly except at maturity, slightly flaring aperture: nearly straight anterior lips; development of sinus by rounding of corners of slit: deep slit; moderately narrow selenizone, flush in early growth stages, becoming raised with increased maturity; whorl profile convex; narrowly phaneromphalous; in maturity upper whorl surface flattened, with selenizone lying in a trough bordered by two parallel carinae: lateral lips and inductura not observed.

Ornamentation consists of numerous spiral lirae and slight transverse undulations which become distinct proturbances near the selenizone which in turn coalasce to form two spiral carinae. Based on information from Yochelson (1960) and observation.

Occurrence.---- Section 1, units 5 and 7 and Section 2, unit 7.

Stratigraphic and Geographic Range.---- Wolfcampian. In New Mexico Knightites (Knightites) bransoni occurs in the Hueco Canyon Formation of the Hueco Mountains and the Abo Member, Hueco Formation of the Robledo Mountains.

Genus Knightites (Retispira) Knight, 1945

Knightites (Retispira) eximia Yochelson

1960 Knightites (Retispira) eximia Yochelson, Am. Mus. Nat. History, Bull., v. 119, art. 4, p. 273-274, pl. 55, fig. 1-37.

Diagnosis.---- Medium-sized, narrowly phaneromphalous, thin shelled bellerophontid; uniformly arched across dorsum and down lateral slopes, slight flattening in area of selenizone; profile modified by strong, transverse undulations or protuberances; uniformly expanding aperture; narrowly phaneromphalous, umbilicus partially concealed by lateral lips; lateral lips extended and flattened; anterior lips straight with slight rounding of corners of slit; short slit; selenizone flattened, flush to slightly below whorl surface, bordered by lirae; inductura covering inner surface of lateral lips, thickened and knob like within the aperture.

Ornamentation consists of numerous spiral lirae, growth lines, and transverse undulations. Based on information from Yochelson (1960) and observation.

Dimensions (in mm.).----

Loc. 1-5	height	width	height of aperture	width of aperture
W-21	14.68	9.70	10.98	17.33

Occurrence.---- Section 1, units 5 and 7.

Stratigraphic and Geographic Range.---- Wolfcampian. In Texas Knightites (Retispira) eximia occurs in the Hords Creek Limestone and Wildcat Creek Shale Members, Admiral Formation of the north-central portion of the state; Hueco Canyon and Cerro Alto Formation of the Hueco

Mountains; and the Cerro Alto Formation of the Franklin Mountains. In New Mexico it occurs in the Hueco Canyon Formation of the Hueco Mountains; Middle Hueco Limestone Member, Hueco formation of the Dona Ana Mountains; Abo and Upper Hueco Limestone Members, Hueco Formation of the Robledo Mountains; and the Hueco Formation of the Florida Mountains.

Suborder MACLURITINA Cox and Knight, 1960

Superfamily EUOMPHALACEA de Koninck, 1881

Family EUOMPHALIDAE de Koninck, 1881

Genus Straparollus (Euomphalus) Sowerby, 1814

Straparollus (Euomphalus) cornudanus (Shumard)

1859 Straparollus cornudanus Shumard, Acad. Sci. St. Louis, Trans., v. 1, p. 400-401.

1891 Euomphalus subquadratus: White, U. S. Geol. Survey, Bull. 77, pl. 3, fig. 9, not p. 25.

1956 Straparollus (Euomphalus) cornudanus: Yochelson, Am. Mus. Nat. History, Bull., v. 110, art. 3, p. 212-215, pl. 9, fig. 3-8; pl. 10, fig. 1-8

Diagnosis.---- Large, discoidal, nodes are not distinct nor abundant on upper angulation: distinct upper sutures, not impressed; upper whorl surface concave outward from suture to upper angulation: upper angulation bears indistinct keel, commonly irregularly serrated or rarely regularly crenulated on part of mature whorl; outer whorl surface curves into broad, rounded, nodose lower shoulder: basal whorl surface flattened, becoming vertical just before umbilical sutures; phaneromphalus; outer lip orthocline to opisthocline; basal lip prosocline.

Ornamentation consists of regularly spaced nodes on basal shoulder: irregular serrations or crenulations on the upper keel; and occasional rugose growth lines.

Dimensions (in mm.).----

Loc. 1-5	width	height	height of aperture	width of aperture	number of whorls
W-23b	8.57	23.21	8.20	7.91	6
W-23o	14.12	21.98	7.25	6.67	6
Loc. 1-5c					
W-65a	7.80	14.78	5.12	4.82	5
W-65b	14.37	26.64	9.55	10.05	6
W-65c	10.82	30.45	---	---	6

Occurrence.---- Section 1, units 5 and 7; Section 2, unit 7.

Stratigraphic and Geographic Range.---- Wolfcampian-Leonardian? In Texas Straparollus (Euomphalus) cornudanus occurs in the Wildcat Shale Member, Admiral; Grape Creek; and Talpa Formations of the north-central portion of the state; Hess Formation of the Glass Mountains; Powwow Member, Hueco Formation and Hueco Formation of the Sierra Diablo region; Hueco Canyon and Cerro Alto Formations of the Hueco Mountains; and Hueco Canyon and Cerro Alto Formations of the Franklin Mountains. In New Mexico it occurs in the Hueco Canyon Formation of the Hueco Mountains; Abo and Upper Hueco Limestone Members of the Hueco Formation of the Robledo Mountains; Abo Member, Hueco Formation of the Dona Ana Mountains; and the Hueco Formation of the Florida Mountains.

Family OMPHALOTROCHIDAE Knight, 1945

Genus Omphalotrochus Meek, 1864

Omphalotrochus obtusispira (Shumard)

1859 Pleurotomaria obtusispira Shumard, Acad. Sci. St. Louis, Trans., v. 1, p. 401.

1937 Omphalotrochus obtusispira: Girty, Jour. Paleontology, v. 11, n. 3, p. 203, pl. 33, fig. 1-17.

1944 Omphalotrochus obtusispira: Knight, in Shimer and Shrock, Index foss. N. America, p. 467, pl. 191, fig. 12-15.

1953 Omphalotrochus obtusispira: Chronic, in Newell et. al., Geol. Soc. America, Mem. 58, p. 142-143, pl. 29, fig. 17-18.

1956 Omphalotrochus obtusispira: Yochelson, Am. Mus. Nat. History, Bull., v. 110, art. 3, p. 231-233, pl. 15, fig. 1-13.

1962 Omphalotrochus obtusispira: Yochelson, U.S. Geol. Survey, Prof. Pap. 323, p. 92-93, pl. 17, fig. 3-4.

Diagnosis.---- Large, phaneromphalous, trochiform; wide shallow sinus; pronounced forward projecting prong, complex rounded whorl shape; simple protoconch, rounded whorls, planispiral, non depressed; distinct sutures, strongly impressed and overhung until fifth whorl, where the sutures then become smoother; pleural angle expands with maturity, profile of mature specimen concave; umbilical walls curved slightly; ornamentation consisting of occasional rugose growth lines.

Dimensions (in mm.).----

Loc. 1-5c	height	width	height of aperture	width of aperture	pleural angle	number of whorls
W-66a	13.98	18.97	6.68	6.67	58°	5
W-66b	26.12	39.52	11.60	11.70	98°	4
W-66c	29.15	42.92	12.72	12.50	101°	5
W-66d	32.70	44.87	----	----	103°	5

Occurrence.---- Section 1, units 5 and 7: Section 2, unit 16; and Section 3, unit 8.

Stratigraphic and Geographic Range.---- Wolfcampian. In Kansas Omphalotrochus obtusispira occurs in the Florena Shale Member of the Cottonwood Formation. In Texas it occurs in the Sedwick, Coleman Junction, Elm Creek, Grape Creek, and Talpa Formations of the north-central portion of the state: Lenox Hills Formation of the Glass Mountains; Powwow Member, Hueco and Hueco Formations of the Sierra Diablo region: Hueco Canyon and Cerro Alto Formations of the Hueco Mountains; and Hueco Canyon, Cerro Alto, and Alacran Mountain Formations of the Franklin Mountains. In New Mexico it occurs in the Hueco Canyon Formation of the Hueco Mountains: Abo and Upper Hueco Limestone Members, Hueco Formation of the Robledo Mountains; and the Hueco Formation of the Florida Mountains. Outside the United States it occurs in the Copacabana Group of Peru and Bolivia.

Suborder PLEUROTOMARIINA Cox and Knight, 1960

Superfamily PLEUROTOMARIACEA Swainson, 1840

Family SINUOPEIDAE Wenz, 1938

Subfamily PLATYSCHISMATINAE Knight, 1956

Genus Colpites Knight, 1956

Colpites sp.

Diagnosis.---- Small, globose, low spired, pleurotomaroid; height of shell slightly greater than width; shallow suture. Ornamentation consisting or rounded nodes on upper face of whorl; simple nucleus. Only one specimen in collection and exhibits characters ascribable to Colpites.

Dimensions (in mm.).----

	height	width	pleural angle	number whorls
Loc. 1-7				
W-24	5.95	5.15	58°	5

Occurrence.---- Section 1, unit 7. Upper Hueco Limestone Member, Hueco Formation.

Family EOTOMARIIDAE Wenz, 1938

Subfamily NEILSONIINAE Knight, 1956

Genus Peruvispira Chronic, 1949

Peruvispira sp.

Diagnosis.---- Small, anomphalous, turbinate pleurotomaroid. Specimens poorly preserved, appear to have characters ascribable to Peruvispira.

Occurrence.---- Section 1, unit 7. Upper Hueco Limestone Member, Hueco Formation.

Superfamily TROCHONEMATACEA Zittel, 1895

Family TROCHONEMATIDAE Zittel, 1895

Genus Amaurotoma Knight, 1945

Amaurotoma zappa Plas

1972 Amaurotoma zappa Plas, Jour. Paleontology, v. 46, n. 2, p. 255-256, pl. 1, fig. 1-4.

Diagnosis.---- Small to medium sized, turbiniform, dextral, rounded whorls, as many as 5; moderately impressed suture, small narrow umbilicus; aperture nearly circular, slightly elongate.

Ornamentation consisting of 13 to 18 spiral angular carinae separated by shallow concave furrows; carinae evenly developed adapical to periphery, smaller and closer spaced adapical to periphery; as well as growth lines.

Occurrence.---- Section 1, units 5 and 7; and Section 3, unit 8.

Stratigraphic and Geographic Range.---- Wolfcampian-Leonardian. In Texas Amaurotoma zappa occurs in the Hueco Canyon and Cerro Alto Formations of the Franklin Mountains. In New Mexico it occurs in the Abo and Upper Hueco Limestone Members, Hueco Formation of the Robledo Mountains. In Nevada it occurs in the Loray Formation of the eastern portion of the state and the Bird Spring Group of the Arrow Canyon Mountains. In California it occurs in the Bird Spring Group of the Providence Mountains.

Suborder TROCHINA Cox and Knight, 1960

Superfamily MICRODOMATACEA Wenz, 1938

Family MICRODOMATIDAE Wenz, 1938

Genus Glyptospira Chronic, 1952

Glyptospira n. sp.

Diagnosis.---- Small, turbibiform, dextral, with 5-6 regularly expanding whorls; moderately high spired; umbilicus minute; suture impressed, moderately deep; whorl profile convex; base flatly rounded, anomphalous; aperture circular; outer lip moderately thick, gently swinging obliquely backward from upper suture downward to axis of coiling on base; inner lip straight, parietal inductura not observed; selnizone or notch not present.

Ornamentation consisting of two strong revolving carinae, adpical on whorl, evenly spaced on whorl between sutures, one weak carina just below periphery close to second strong carina, partially concealed in upper whorls by suture depression, five revolving carinae on base which become fainter toward axis of coiling; lower suture below first basal carina; fine growth lines or collabral threads, sharply raised creating diagonal nodes on revolving carinae.

Nucleus of 2 1/2 smooth, orthostrophic whorls; spiral ornamentation first appears on third whorl, with second carina appearing first followed by the rest.

Dimensions (in mm.).----

	height	width	height of aperture	width of aperture	pleural angle	number whorls
Loc. 1-7						
W-77a	2.17	1.92	0.52	0.68	35°	5
W-77b	3.90	2.48	1.23	1.12	38°	6
W-77c	4.17	3.17	1.37?	1.37	43°	6
W-77d	4.82	4.12	2.07	1.80	47°	6
W-77e	8	4.80	2.50	1.90	57°	6

Occurrence.---- Section 1, unit 7 and Section 2, unit 16.

Stratigraphic and Geographic Range.---- Wolfcampian. In Texas Glyptospira n. sp. occurs in the Hueco Canyon and Cerro Alto Formations of the Franklin Mountains. In New Mexico it occurs in the Middle Hueco Limestone Member, Hueco Formation of the Dona Ana Mountains and the Upper Hueco Limestone Member, Hueco Formation of the Robledo Mountains.

Suborder NERITOPSINA Cox and Knight, 1960

Superfamily NERITACEA Rafinesque, 1815

Family NERITOPSIDAE Gray, 1847

Subfamily NATICOPSINAE Miller, 1889

Genus Naticopsis M'Coy, 1844

Naticopsis cf. N. apachensis Winters

1909 Naticopsis deformis: Girty, U. S. Geol. Survey, Bull. 389, p. 106, pl. 11, fig. 8, not fig. 9.

1963 Naticopsis apachensis Winters, Geol. Soc. America, Mem. 89, p. 45-46, pl. 5, fig. 14.

Diagnosis.---- Small to large, globose, naticiform, very low spired, gently shouldered with 2 1/2 - 3 very rapidly expanding whorls; height of shell slightly greater than width; shallow suture: irregular, inflated whorl profile; slopes gently outward, convex to rounded shoulder angulation, turns sharply downward with slight to gentle convexity to lower convexity; smoothly rounded base; anomphalous; suture located below shoulder angulation giving spire a broad, step-like configuration; teardrop shaped aperture, widest below mid-point, posterior siphonal channel at bluntly pointed upper end: thin outer lip curves with backward obliquity from upper suture in smooth sweeping curve to junction with inner lip; inner lip greatly thickened by somewhat flattened parietal inductura extending slightly beyond aperture.

Ornamentation consisting of growth lines. Simple nucleus, similar to later whorls. Diagnosis based on Winters (1963) and observation.

Dimensions (in mm.).----

Loc. 1-5	height	width	height of aperture	width of aperture	number of whorls
W-25a	10.66	9.12	10.47	10.53	4
W-25b	26.17	23.72	----	----	5

Occurrence.---- Section 1, units 5 and 7 and Section 2, unit 7.

Stratigraphic and Geographic Range.---- Wolfcampian-Leonardian. In New Mexico Naticopsis apachensis occurs in the Middle Hueco Member, Hueco Formation of the Dona Ana Mountains; Abo Member, Hueco Formation of the Robledo Mountains; and Abo Formation of the Chupadera Mesa and the Manzano and Sandia Mountains. In Arizona it occurs in the Fort Apache Limestone Member, Supai Formation of the Fort Apache Indian Reservation.

Subfamily NERITOPSINAE Gray, 1847

Genus Trachydomia Meek and Worthen, 1866

Trachydomia sp.

Diagnosis.---- Small, neritiform, globular, primarily internal molds with large final whorl: other features unobservable; ornamentation consisting of pustules or nodes.

Occurrence.---- Section 1, unit 7 and Section 2, unit 16-f.

Remarks.---- Majority of specimens too poorly preserved for specific identification, except for single specimen from Section 2, unit 16-f. Specimens of Trachydomia occur in the Hueco Canyon and Cerro Alto Formations of the Franklin Mountains, Texas which appear to be conspecific with the specimen from the Robledo Mountains.

Suborder MURCHISONIINA Cox and Knight, 1960

Superfamily MURCHISONIACEA Koken, 1896

Family MURCHISONIIDAE Koken, 1896

Genus Goniasma Tomlin, 1930

Goniasma terebra (White)

1879 Murchisonia terebra White, U. S. Geol. Geog. Survey Terr., v. 5, p. 219.

1883 Murchisonia terebra: White, U. S. Geol. Geog. Survey Terr., 12th Ann. Rept., Contr. Invert. Paleo., n. 6, p. 139, pl. 34, fig. 4.

1894 Murchisonia terebra: Keyes, Missouri Geol. Survey, v. 5, p. 146, pl. 49, fig. 4.

1909 Murchisonia? terebra: Girty, U. S. Geol. Survey, Bull. 389, p. 99.

1963 Goniasma terebra: Winters, Geol. Soc. America, Mem. 89, p. 37-38, pl. 4, fig. 7-10.

Diagnosis.---- Small to medium-sized, high spired, turreted, anomphalous, internal molds, with 4-10 or more whorls; whorls gradually expand, width of body whorl one-third to two-fifths height of shell. Other features unobservable.

Dimensions (in mm.).----

Loc. 1-5	height	width	height of aperture	width of aperture	pleural angle	number of whorls
W-26a	17.35	10.42	5.03	6.76	20°	4

Loc. 1-5c

W-67a	40.06	16.64	10.27	11.42	13°	7
W-67b	35.11	18.48	10.92	10.44	14°	4
W-67c	28.05	16.57	9.17	9.87	12°	3 1/2

Occurrence.---- Section 1, units 5 and 7; Section 2, unit 16; Section 3, unit 6; and Section 4, unit 3.

Stratigraphic and Geographic Range.---- Wolfcampian-Leonardian. In Texas Goniasma terebra occurs in the Hueco Canyon Formation of the Hueco Mountains. In New Mexico it occurs in the Abo Member, Hueco Formation of the Robledo and Dona Ana Mountains; Abo Formation of the Sandia Mountains; Yeso Formation of the San Andres Mountains; and the San Andres Formation of the Caballos Mountains. In Arizona it occurs in the Fort Apache Limestone Member, Supai Formation of the Fort Apache Indian Reservation.

Order CAENOGASTROPODA Cox, 1959

Superfamily LOXONEMATACEA Koken, 1889

Family PSEUDOZYGOPLEURIDAE Knight, 1930

Genus Palaeostylus Mansuy, 1914

Palaeostylus (Pseudozygopleura) sp.

Diagnosis.---- Single specimen, medium-sized, moderately high spired, with 5, upper whorls eroded away possibly orginally 7-8, regularly expanding whorls; suture impressed; whorl profile gently, asymmetrically arcuate; base gently rounded, anomphalous; aperture, columellar lip, and parietal inductura not observable.

Ornamentation consists of strong transverse costae: about 12-16 costae per whorl, rounded, extending across whorl. Nucleus not preserved.

Dimensions (in mm.).----

Loc. 1-5	height	width	pleural angle	number of whorls
W-27	20.57	14.12	36°	5

Occurrence.---- Section 1, unit 5. Some specimens occur in the upper portion of the Upper Hueco Limestone Member (unit 7), but these are too fragmentary for description or comparison.

Superfamily SUBULITACEA Lindstrom, 1884

Family SUBULITIDAE Lindstrom, 1884

Subfamily SOLENISCINAE Wenz, 1938

Genus Soleniscus Meek and Worthen, 1861

Soleniscus aff. S. altonensis (Meek and Worthen)

1873 Macrocheilus altonensis Meek and Worthen, Illinois Geol. Survey, v. 5, p. 593, pl. 28, fig. 8.

1889 Soleniscus altonensis: Keyes, Am. Nat., v. 23, p. 423.

1889 Soleniscus altonensis: Keyes, Acad. Nat. Sci. Philadelphia, Proc., v. 41, p. 307.

1909 Soleniscus aff. S. altonensis: Girty, U. S. Geol. Survey, Bull. 389, p. 108, pl. 11, fig. 6.

Diagnosis.---- Large, robust, fusiform anomphalous, greatest width slightly greater than half the height, internal molds: suture impressed; distinct narrow siphonal canal; whorl profile convex, rounds smoothly into base: extended base, slightly concave in vicinity of siphonal canal: aperture ovate; columellar lip with narrow siphonal notch; outer lip unknown. Ornamentation and growth lines not preserved; simple smooth nucleus.

Dimensions (in mm.).----

Loc. 1-5	height	width	height of aperture	width of aperture	pleural angle	number of whorls
W-28a	22.76	15.27	15.02	11.65	55°	5

W-28b	22.42	11.07	9.12	8.17	33°	5
W-28e	19.04	13.43	10.07	10.07	46°	5
Loc. 1-5c						
W-68a	27.30	17.50	15.48	10.74	69°	6
Loc. 2-7						
W-88a	12.78	8.32	8.90	5.38	68°	3
Loc. 2-16						
W-113a	15.97	8.61	10.05	----	58°	4

Occurrence.---- Section 1, units 5 and 7 and Section 2, units 7 and 16.

Stratigraphic and Geographic Range.---- Wolfcampian. In New Mexico Soleniscus aff. S. altonensis occurs in the Abo Formation of the Manzano Mountains and the Abo and Upper Hueco Limestone Members, Hueco Formation of the Robledo Mountains.

Family MEEKOSPIRIDAE Knight, 1956

Genus Meekospira Ulrich, in Ulrich and Scofield, 1897

Meekospira knighti Winters

1963 Meekospira knighti Winters, Geol. Soc. America, Mem. 89, p. 48, pl. 5, fig. 8.

Diagnosis.---- Small, thin shell, high spired, rapidly expanding whorls, body whorl approximately two-thirds shell height; shallow impressed suture; gently convex whorl profile rounds smoothly into sloping, rounded, anomphalus base; aperture ovate, sharply pointed at top, base more roundly pointed, greatest width below middle; outer lip thin, straight; inner lip arcuate gently convex near top; ornamentation and growth lines not preserved; simple nucleus.

Dimensions (in mm.).----

	height	width	height of aperture	width of aperture	pleural angle	number whorls
Loc. 1-7						
W-29	9.07	2.62	3	1	21°	9

Occurrence.---- Section 1, units 5 and 7.

Stratigraphic and Geographic Range.---- Wolfcampian-Leonardian. In Texas Meekospira knighti occurs in the Cerro Alto Formation of the Hueco Mountains. In New Mexico it occurs in the Abo and Upper Hueco Limestone Members, Hueco Formation of the Robledo Mountains. In Arizona it occurs in the Fort Apache Limestone Member, Supai Formation of the Fort Apache Indian Reservation.

Class CEPHALOPODA Cuvier, 1797

Subclass NAUTILOIDEA Agassiz, 1847

Order ORTHOCERIDA Kuhn, 1940

Superfamily PSEUDORTHOCERATACEAE Flower and Caster, 1935

Family PSEUDORTHOCERATIDAE Flower and Caster, 1935

Subfamily PSEUDORTHOCERATINAE Flower and Caster, 1935

Genus Mooreoceras Miller, Dunbar, and Condra, 1933

Mooreoceras sp.

Diagnosis.---- Internal molds: long, slender, straight conch, gradually and regularly expanding adorally; subcircular in cross-section. Sutures almost straight and transverse. Internal characters unobservable due to poor preservation.

Occurrence.---- Section 1, unit 5; Section 2, unit 16; and Section 3, unit 6.

Order NAUTILIDA Agassiz, 1847

Superfamily TAINOCERATACEAE Hyatt, 1883

Family TAINOCERATIDAE Hyatt, 1883

Genus Metacoceras Hyatt, 1883

Metacoceras sp.

Diagnosis.---- Internal molds; medium-sized: nautiliconic, subdiscoidal, slightly involute. Ventrolaterally nodose; sutures form broad, shallow rounded ventral, lateral, and dorsal lobes.

Occurrence.---- Section 1, units 5 and 7 and Section 3, unit 8. Abo and Upper Hueco Limestone Members, Hueco Formation.

Superfamily TRIGONOCERATACEAE Hyatt, 1884

Family GRYPOCERATIDAE Hyatt in Zittel, 1900

Genus Stearoceras Hyatt, 1893

Stearoceras sp.

Diagnosis.---- Involute, incomplete internal mold with rapidly expanding whorls: whorl sections subtrapezoidal, depressed, flattened laterally and ventrally. Suture as described for genus.

Occurrence.---- Section 1, unit 5.

Genus Stenopoceras Hyatt, 1893

Stenopoceras sp.

Diagnosis.---- Subdiscoidal, rapidly expanding adaperturally, compressed, flattened laterally, deeply involute, incomplete internal molds. Suture as described for genus.

Occurrence.---- Section 1, unit 5; Section 2, unit 6-a; and Section 3, unit 8-f.

Superfamily AIPOCERATACEAE Hyatt, 1883

Family AIPOCERATIDAE Hyatt, 1883

Genus new Flower

Diagnosis.---- Shell coiled, moderately involute. Sides diverge from a gently rounded umbilical shoulder, moderately convex, adominal shoulders more rapidly expanding, as in Asymptoceras. Sutures show shallow lateral lobes, sloping forward from dorsum to venter, venter with broad shallow but conspicuous lobes. Siphuncle unknown. Surface features; unknown; the shell is clearly devoid of any prominent nodes or ridges.

Discussion.---- This new genus is known from a single rather imperfect specimen which fits into no known genus. It has the general shape of Asymptoceras, but is more involute, the lateral faces are more flattened, the venter is flattened, and there are ventral and lateral lobes. Librovitchiceras is similar in the lateral and ventral lobes, and the flattening of the ventral face, but the whorls are less rapidly enlarging, the shell is scarcely involute, and the lateral faces are higher.

Genus new and species new Flower

Description.---- The type is a coiled shell, a spiral of 130 mm., in which the shell height increases in the last half whorl from 48 to 58 mm. with an umbilical opening of 22 mm. In the last whorl the shell increases from a height of 24 to 58 mm.; evidently nearly half of the preceding whorl is enclosed in an impressed zone. Sutures show lateral lobes, and again lobes on the slightly convex ventral face. Adorally camerae become 10 mm. long on the venter, but at the base of the living chamber there is a poorly preserved region in which several crowded septa to be present; they are

somewhat ambiguous, but if real, show a reduction of the lateral lobes.

Only part, perhaps less than half of the ventral face is retained. It may well be that where the lateral height of the whorl is 40 mm., that the ventral face may have been 45-50 mm. in width. The type preserves only one side of the shell; apparently septa and siphuncle have been destroyed.

Occurrence.---- Section 1, unit 5. Abo Member, Hueco Formation, Robledo Mountains.

Superfamily CLYDONAUTILACEAE Hyatt in Zittel, 1900

Family LIROCERATIDAE Miller and Youngquist, 1949

Genus Liroceras Teichert, 1940

Liroceras sp.

Diagnosis.---- Nautiliconic, subglobose, incomplete internal mold with rapidly expanding whorls; whorl section reniform, broadly rounded ventrally, more narrowly rounded laterally, impressed dorsally; suture as described for genus.

Occurrence.----Section 1, unit 5.

Family EPHIPPIOCERATIDAE Miller and Youngquist, 1949

Genus Ephippioceras Hyatt, 1884

Ephippioceras sp.

Diagnosis.---- Nautiliconic, subglobose, incomplete internal mold, rapidly expanding adorally; whorl section reniform, broadly rounded ventrally and laterally, impressed dorsally; suture as described for genus.

Occurrence.---- Section 1, unit 5.

Subclass AMMONOIDEA de Haan, 1825

Order AMMONOIDEA de Haan, 1825

Suborder GONIATITINA Hyatt, 1884

Superfamily AGATHICERATACEAE Arthaber, 1911

Family PERRINITIDAE Miller and Furnish, 1940

Genus Properrinites Elias, 1938

Properrinites denhami Miller and Furnish

1940 Properrinites boesi denhami Miller and Furnish, Geol. Soc. America, Spec. Pap. 26, p. 141, pl. 33, fig. 5, text fig. 39C.

1957 Properrinites boesi denhami: Miller and Furnish, in Moore Treatise, Pt. L, p. 53, fig. 61A.

1963 Properrinites denhami: Moyle, Unpub. Ph.D. Thesis, Univ. Iowa, p. 87-95, pl. 1, fig. 6-8; pl. 3, fig. 3-5; text fig. 4C, D; 5B; 9.

Diagnosis.---- Based on two specimens, one in block of limestone and the other an almost complete phragmacone, internal molds, septate throughout. Conch uniformly rounded on venter and flanks. Venter broadly rounded; whorls moderately impressed. Moderately sized umbilicus, bounded by rounded shoulders and umbilical walls. Surface marked by straight, broadly rounded, transverse constrictions.

External suture as described by Miller and Furnish (1940) and Moyle (1963). Based on information derived from Miller and Furnish (1940), and Moyle (1963), and observations.

Dimensions (in mm.).---- No measurements available, due to specimen being in possession of Dr. Furnish at University of Iowa.

Occurrence.---- Section 1, unit 5c and Section 3, unit 8a.

Stratigraphic and Geographic Range.---- Wolfcampian. In Texas Properrinites denhami occurs in the Lenox Hills Formation of the Glass Mountains; the Alta Formation of the Chinati Mountains; and the Hueco Canyon Formation of the Hueco Mountains. In New Mexico it occurs in the Abo Member, Hueco Formation of the Robledo Mountains.

Suborder PROLECANITINA Miller and Furnish, 1954

Superfamily MEDLICOTTIACEAE Karpinsky, 1889

Family MEDICOLLIIDAE Karpinsky, 1889

Genus Akmilleria Ruzhencev, 1940

Akmilleria huecoensis (Miller and Furnish)

1940 Artinskia huecoensis Miller and Furnish, Geol. Soc. America, Spec. Pap. 26, p. 48-49, text fig. 8C, pl. 3, fig. 1-3.

1949 Akmilleria huecoensis: Ruzhencev, Acad. Sci. U.S.S.R., Paleont. Inst., Pub., v. 19, p.129-131, pl. 9, fig. 7-8, text fig. 63b.

1963 Akmilleria huecoensis: Moyle, Unpub. Ph. D. Thesis, Univ. Iowa, p. 255-257, pl. 9, fig. 1, 5, 6.

Diagnosis.---- Based on an incomplete single specimen, an internal mold, septate throughout. Discoidal conch, slightly flattened laterally; small open umbilicus; nearly parallel lateral zones; rounded ventrolateral zones. Prominent medial groove on ventral side; whorls attenuate dorsally.

Each side of ventral groove bears a row of prominent rounded nodes confined primarily to ventral side of conch. Nodes are equally spaced and laterally offset; slightly oblique at full maturity.

External suture as described by Miller and Furnish (1940). Based on information derived from Miller and Furnish (1940), Moyle (1963), and observation.

Dimensions (in mm.).----

	height	width
Loc. 1-5c		
W-35	50.43	17.23

Occurrence.---- Section 1, unit 5c.

Stratigraphic and Geographic Range.---- Wolfcampian. In Texas *Akmilleria huecoensis* occurs in the Hueco Canyon Formation of the Hueco Mountains. In New Mexico it occurs in the Abo Member, Hueco Formation of the Robledo Mountains.

Class BIVALVIA Linne, 1758

Order NUCULOIDA Dall, 1889

Superfamily NUCULACEA Gray, 1824

Family NUCULIDAE Gray, 1824

Genus Nuculopsis Girty, 1911

Nuculopsis levatiformis (Walcott)

1884 Nucula levatiforme Walcott, U. S. Geol. Survey, Mon. 8, p. 241, pl. 22, fig. 1.

1909 Nucula levatiformis: Girty, U. S. Geol. Survey , Bull. 389, p. 74, pl. 10, fig. 7-8.

1942 Nucula levatiformis: Clifton, Jour, Paleontology, v. 16, n. 11, p. 693.

1952 Palaeonucula levatiformis: Chronic, Geol. Soc. America, Bull., v. 63, p. 138, pl. 6, fig. 4-9.

1953 Nuculopsis (Palaeonucula?) aff. N. okawensis: Walter, Jour. Paleontology, v. 27, n. 5, p. 694, pl. 73, fig. 9-10.

1953 Palaeonucula cf. P. levatiformis: Chronic, Geol. Soc. America, Mem. 58, p. 151-152, pl. 33, fig. 2.

1953 Paleonucula levatiformis: Newell, et. al., Freeman and Co., pl. 22, fig. 15.

1963 Palaeonucula levatiformis: Winters, Geol. Soc. America, Mem. 89, p. 49-51, pl. 6, fig. 4-7.

1967 Palaeonucula levatiformis: Mayou, Brigham Young Univ., Geol. Studies, v. 14, p. 118, pl. 1, fig. 10.

1969 Palaeonucula levatiformis: Yancey, Paleobios, n. 8, p. 6, fig. 18-20.

Diagnosis.---- Very small, evenly convex, subtrigonal nuculid, somewhat longer than high: hinge margin strongly convex; anterior margin gently convex; posterior margin flat; ventral margin strongly convex, less than dorsal margin, rounding into anterior margin and meeting posterior margin at obtuse angle. Beak pointed, opisthogyre, not strongly incurved.

Ornamentation consisting of low, evenly spaced, fine concentric lirae. Concentric growth constrictions present near ventral margins of some shells.

Taxodont dentition. Interiors of valves not observed due to lack of free valves. Based on information derived from Chronic (1952), Winters (1963), Mayou (1967), Yancey (1969), and observation.

Dimensions (in mm.).----

Loc. 1-5	length	height	thickness	valve
W-36a	5.95	4.20	3.22	both
W-36b	7.44	6.65	3.87	both
W-36c	10.12	9.60	4.00	left

Occurrence.---- Section 1, units 5 and 7.

Stratigraphic and Geographic Range.---- Upper Wolfcampian-Guadalupian. In Texas Nuculopsis levatiformis occurs in Cerro Alto Formation of the Franklin Mountains: the Blaine and Dog Creek Formations of the north portion of the state: and the Rustler Formation of the Rustler Hills. In New Mexico it occurs in the Middle Hueco Limestone Member, Hueco Formation

of the Dona Ana Mountains: the Abo and Upper Hueco Limestone Members, Hueco Formation of the Robledo Mountains: the Yeso Formation of the Chupadera Mesa and San Andres Mountains: the San Andres Formation of the Fra Cristobal and Caballo Mountains; and the Getaway Member, Cherry Canyon Formation of the Guadalupe Mountains. In Arizona it occurs in the Fort Apache Limestone Member, Supai Formation of the Fort Apache Indian Reservation and the Kaibab Formation at Walnut Canyon. In Nevada it occurs in the Bird Spring Formation of the Arrow Canyon Mountains: Lower Arcturus Formation of the Butte Mountains; the Middle and Upper Arcturus Formation at Rib Hill-Murry Summit; Arcturus Formation at Ward Mountain; and Loray Formation of the Butte Mountains and at Illipah Gorge. It also occurs in the Copacabana Group of Peru.

Family NUCULANIDAE Adams and Adams, 1858

Genus Paleyoldia Lintz, 1958

Paleyoldia subscitula (Meek and Hayden)

1858 Leda (Nucula) subscitula Meek and Hayden, Albany Inst., Trans., v. 4, p. 79.

1865 Yoldia? subscitula: Meek and Hayden, Smithsonian Contr. Knowledge, v. 14, p. 60, pl. 2, fig. 4.

1891 Yoldia subscitula: White, U. S. Geol. Survey, Bull. 77, p. 27, pl. 4, fig. 4.

1900 Yoldia subscitula: Beede, Kansas Geol. Survey, Rept., v. 6, p. 152-153, pl. 20, fig. 8.

1962 Yoldia subscitula: Mudge and Yochelson, U. S. Geol. Survey, Prof. Pap. 323, p. 87, pl. 15, fig. 14-15.

Diagnosis.---- Small, internal molds, moderately convex in umbonal region, flattening posteriorly, longer than high: dorsal margin keeled, straight to slightly convex anterior to beaks; anterior margin sharply rounded; ventral margin boradly, uniformly convex; posterior margin sharply rounded, sinuate.

Beaks small, pointed, incurved, directed posteriorly, protruding above dorsal margin, and nearly centrally located. Ornamentation and internal features not observable.

Dimensions (in mm.).----

Loc. 1-5	length	height	thickness	valve
W-37a	8.11	4.28	2.10	both
W-37b	11.22	6	2.82	both
W-37c	13.35	7.58	4.62	both

Occurrence.---- Section 1, unit 5.

Stratigraphic and Geographic Range.---- Wolfcampian. *Paleyoldia subscitula* occurs in the Lower Permian of the Midcontinent region. In Oklahoma it occurs in the Luta Formation. In Texas it occurs in the Grape Creek Formation ? of the north-central portion of the state. In New Mexico it occurs in the Abo Member, Hueco Formation of the Robledo Mountains.

Order MYTILOIDA Ferussac, 1822

Superfamily PINNACEA Leach, 1819

Family PINNIDAE Leach, 1819

Genus Pteronites M'Coy in Griffith, 1844

Pteronites peracuta (Shumard)

1858 Pinna peracuta Shumard, Acad. Sci. St. Louis, Trans., v. 1, p. 19.

1860 Pinna adamsi McChesney, Desc. New Spec. Pal. Foss., p. 74.

1872 Pinna peracuta Shumard: Meek, U. S. Geol. Survey Nebraska, p. 198, pl. 6, fig. 11.

1875 Pinna peracuta?: White, U. S. Geog. Geol. Survey W. 100th Mer., Rept., v. 4, p. 151, pl. 11, fig. 5.

1884 Pinna peracuta: White, Geol. Survey Indiana, 13th Rept., p. 145, pl. 28, fig. 1-2.

1886 Pinna peracuta: Heilprin, Proc. and Coll. Wyoming Hist. and Geol. Soc., v. 2, pt. 2, p. 272, fig. 12, p. 273, fig. 12.

1886 Pinna peracuta: Heilprin, Second Geol. Survey Pennsylvania, Ann. Rept. (1885), p. 455, p. 444, fig. 12, p. 454, fig. 12.

1892 Aviculopinna peracuta: Hyatt, Boston Soc. Nat. Hist., Proc., v. 25, p. 388.

1894 Pinna peracuta: Derby, Jour. Geology, v. 2, p. 485.

1895 Pinna peracuta: Keyes, Missouri Geol. Surv., v. 5, p. 116, pl. 45, fig. 2.

1899 Pinna peracuta: Girty, U. S. Geol. Survey, 19th Ann. Rept., pt. 3, p. 579.

1900 Pinna peracuta: Beede, Univ. Geol. Survey Kansas, Rept., v. 6, p. 144, pl. 17, fig. 3, 3b.

1903 Aviculopinna ? peracuta: Girty, U. S. Geol. Survey, Prof. Pap. 16, p. 432-435, pl. 9, fig. 1-2.

1909 Aviculopinna ? peracuta: Girty, U. S. Geol. Survey, Bull. 389, p. 77-78.

1921 Pinna peracuta: Plummer and Moore, Univ. Texas, Bull. 2132, p. 166, 181, pl. 24, fig. 21.

1929 Pinna peracuta: Boos, Jour. Paleontology, v. 3, n. 3, p. 247.

1932 Pinna peracuta: Fedotov, Russia Ves. Geol. Ob'ed., Trudy, v. 103, p. 93, pl. 10, fig. 9-11, (in Russian).

1942 Pinna peracuta: Seaman, Acad. Sci. Pennsylvania, Proc., v. 16, p. 74.

1944 Aviculopinna peracuta: Shimer and Shrock, Index Foss. N. America, p. 387, pl. 150, fig. 8-9.

1951 Aviculopinna peracuta: Chow, Pennsylvania Geol. Survey, Bull. G 26, p. 6-9, 12, 26, pl. 3, fig. 5-6.

1962 Aviculopinna peracuta: Mudge and Yochelson, U. S. Geol. Survey, Prof. Pap. 323, p. 87, pl. 15, fig. 27.

1969 Aviculopinna peracuta: Simpson, S. A. S. G. S., Ann. Field Trip, pl. 12, fig. 2.

1969 Aviculopinna peracuta: Updegraff, M. S. Thesis, Bowling Green State Univ., Ohio, p. 73-74, pl. 5, fig. 14.

Diagnosis.---- Large, extremely long and narrow, subtriangular in outline, strongly convex. Hinge long, straight, with appearance of keel: anterior and posterior margins not preserved in specimens: dorsal margin long, straight: ventral margin long, straight, slightly convex.

Cross-section anteriorly subcircular, becoming posteriorly elliptical. Ornamentation consisting of faint, radiating lines, and fine, evenly spaced concentric growth lines. Shell composed of two layers.

Dimensions (in mm.).----

	length	height	thickness	valve
Loc. 1-5				
W-38a	53.62	23.40	15.18	both
W-38j	42.90	23.37	17.02	both
W-38k	----	61.12	36.30	both
Loc. 2-7				
W-89a	46.70	37.12	31.92	both
Loc. 2-16				
W-114a	88.20	35.40	30.52	both
W-114b	47.15	30.30	23.38	both

Occurrence.---- Section 1, units 5 and 7: Section 2, units 7 and 16: and Section 3, unit 6.

Stratigraphic and Geographic Range.---- Pennsylvanian-Wolfcampian. Pteronites peracuta occurs in the Upper Pennsylvanian and Lower Permian of the Midcontinent region. In Oklahoma it occurs in the Luta Formation. In Texas it occurs in the Waldrip Member, Harpersville: Camp Colorado Limestone, Watts Creek Shale, and Santa Anna Shale Members, Moran: Bead Mountain; Wildcat Creek and Jim Ned Shale Members, Admiral: Grape Creek: and Talpa Formations of the north-central portion of the state: Cerro Alto Formation of the Hueco Mountains: and Cerro Alto and Alacran Mountain Formations of the Franklin Mountains. In New Mexico it occurs in the Abo and Upper Hueco Limestone Members of the Robledo Mountains and the Abo Formation of the Sandia and Manzano Mountains, and Chupadera Mesa. Outside the United States it occurs in the Carboniferous and Permian of South America and The Permian of the Donetz Basin, Russia.

Order PTERIOIDA Newell, 1965

Superfamily AMBONYCHIACEA Miller, 1877

Family MYALINIDAE Frech, 1891

Genus Septimyalina Newell, 1942

Septimyalina burmai Newell

1858 ?Myalina apachesi Marcou: Geol. North America, p. 44, pl. 7, fig. 6.

1909 Myalina apachesi Girty: U. S. Geol. Survey, Bull. 389, p. 81, pl. 9, fig. 6-7.

1942 Myalina apachesi: Clifton, Jour. Paleontology, v. 16, n. 11, pl. 102, fig. 3-4.

1942 Septimyalina burmai Newell: Kansas Geol. Survey, Rept., v. 10, pt. 2, p. 67-68, pl. 12, fig. 1-6.

1953 Septimyalina cf. S. burmai: Chronic, in Newell et. al., Geol. Soc. America, Mem. 58, p. 158, pl. 34, fig. 1-2.

1962 Septimyalina burmai: Newell, in Mudge and Yochelson, U. S. Geol. Survey, Prof. Pap. 323, p. 88, pl. 15, fig. 21.

1969 Myalina permiana: Simpson, S. A. S. G. S., Ann. Field Trip, pl. 11, fig. 4.

Diagnosis.---- Large to medium-sized, length equal to width, acline to prosocline, shell thick, anterodorsal angle acute; hinge line straight; anterior margin slightly concave, parallel with broadly rounded

posterior margin, anteroventral angle acute; ventral margin broadly rounded; dorsal margin straight: beaks terminal, incurved, distorted; umbonal ridge distinct, anterior side curved under.

Valves ornamented by prominent, regular growth lamellae, which are projected as short, hemicylindrical spines in unworn specimens. Internal characters unobservable in specimens.

Dimensions (in mm.).----

	length	height	thickness	valve
Loc. 1-5				
W-40a	38.42	17.30	14.60	both
W-40k	60.72	26.58	17.83	both
Loc. 2-16				
W-116b	35.48	16.52	23.30	both
W-116e	26.20	15.52	11.88	both

Occurrence.---- Section 1, unit 5; Section 2, units 7 and 16; and Section 3, unit 6.

Stratigraphic and Geographic Range.---- Virgilian-Leonardian. Septimyalina burmai occurs in the Upper Pennsylvanian and Lower Permian of the Midcontinent region. In Texas it occurs in the Camp Colorado Limestone and Watts Creek Shale Members, Moran; Sedwick; and Santa Anna Branch Formations of the north-central portion of the state; Hueco Canyon, Cerro Alto, and Alacran Mountain Formations of the Franklin Mountains; and the Blaine and Dog Creek Formations of the northern portion of the state. In New Mexico it occurs in the Abo Member, Hueco Formation of the Robledo Mountains; Abo Formation of the Sandia, Manzano, and Chupadera Mountains; Yeso Formation of the Chupadera Mesa and the San Andres Mountains; and the San Andres Formation of the Chupadera Mesa and the Caballo Mountains. Outside the United States it occurs in the Copacabana Group of Peru.

Superfamily PTERIACEA Gray, 1847

Family BAKEVELLIIDAE King, 1850

Genus Bakevellia (Bakevellia) King, 1848

Bakevellia (Bakevellia) sulcata (Geinitz)

1866 Gervillia sulcata Geinitz, K. deut Akad. Nat. Zu Halle, Nova Acta Leopoldina 41, Abt. 2, n. 7, p. 33, pl. 2, fig. 16.

1868 Gervillia sulcata: Golowkinsy, Vseros. Min Obhc., v. 1, p. 376, pl. 5, fig. 2.

1909 Pteria sp.: Girty, U. S. Geol. Survey, Bull. 389, p. 79.

1944 Pteria? sulcata: Shimer and Shrock, Index foss. N. America, p. 391, pl. 152, fig. 1.

1952 Bakevellia sulcata: Chronic, Geol. Soc. America, Bull., v. 63, p. 143, pl. 7, fig. 6-9.

1963 Bakevellia sulcata: Winters, Geol. Soc. America, Mem. 89, p. 52-53, pl. 7, fig. 2-4.

Diagnosis.---- Small, oblique, inequivalved pteroid. Long hinge line, straight; anterior margin gently convex curving smoothly into byssal sinus which rounds into convex ventral margin; posterior margin strongly concave below hinge forming sharp posterior wing forward, strongly convex backward smoothly curving into ventral margin. Left valve transversely strongly convex, posterior auricle flattened, deep anterior sulcus which extends from anterior side of umbo to ventral margin; sulcus diverges gradually with posterior margin slightly vertical to hinge, bounded by distinct, rounded ridges.

Right valve less convex; sulcus lacking, nearly vertical groove present opposite posterior margin of sulcus on left valve: ventral margin slightly dorsal of left ventral margin in anterior half of shell. Right valve smaller, less convex, thinner, not as often preserved as left valve. Ornamentation consisting of regular, fine growth lines.

Smooth, moderately wide hinge area, depressed between bordering ridges. Low beaks, orthogyre, incurved left beak, right beak less so. Dentition and muscle scars not observed in specimens available.

Occurrence.---- Section 1, unit 5; Section 2, units 7 and 16; and Section 3, units 6 and 8.

Stratigraphic and Geographic Range.---- Wolfcampian-Leonardian. In Texas Bakevellia (Bakevellia) sulcata occurs in the Hueco Canyon Formation of the Franklin Mountains. In New Mexico it occurs in the Abo Member, Hueco Formation of the Robledo Mountains. In Arizona it occurs in the Fort Apache Limestone Member, Supai Formation of the Fort Apache Indian Reservation and the Kaibab Formation of the Walnut Canyon region. In Nevada it occurs in the Middle and Upper Arcturus Formation of Rib Hill-Murry Summit and the Lower Arcturus Formation of Dry Mountain.

Superfamily PECTINACEA Rafinesque, 1815

Family AVICULOPECTINIDAE Meek and Hayden, 1864

Subfamily AVICULOPECTININAE Meek and Hayden, 1864

Genus Aviculopecten M'Coy, 1851

Aviculopecten girtyi Newell

1877 Aviculopecten mccoyi: White, U. S. Geog. Geol. Survey W. 100th Mer., v. 4, p. 149, pl. 11, fig. 2.

1909 Deltopecten vanvleeti: Girty, U. S. Geol. Survey, Bull. 389, p. 86-87, pl. 9, fig. 5.

1938 Aviculopecten girtyi Newell, Kansas Geol. Survey, Rept., v. 10, pt. 1, p. 58, pl. 5, fig. 4.

1944 Aviculopecten girtyi: Newell, in Shimer and Shrock, Index foss. N. America, p. 401, pl. 159, fig. 23.

1953 Aviculopecten girtyi: Newell, et. al., Freeman and Co., pl. 22, fig. 3.

1963 Aviculopecten girtyi: Ciriacks, Am. Mus. Nat. History, Bull., v. 125, art. 1, p. 47-48, pl. 6, fig. 5-7, 9.

Diagnosis.---- The specimens in the collection are incomplete and fragmentary. The following information is from Newell (1938):

> . . . large . . . : acline, orbicular; left valve moderately ventricose, subhemispherical, with large subequal auricles; umbonal folds nearly straight, the anterior one being particularly prominent and curved outward almost imperceptibly; anterior sulcus deep and broad, posterior one shallow, and narrow with its axis quite close to the body of the shell; shell body ornamented by costae of three distinct sizes corresponding to the oldest three ranks of costae, later costae are scarely differentiated . . .

Occurrence.---- Section 1, unit 5 and Section 3, unit 8.

Stratigraphic and Geographic Range.---- Wolfcampian-Guadalupian. In Texas Aviculopecten girtyi occurs in the Word Formation of the Glass Mountains and Dog Creek Formation of the northern portion of the state In New Mexico it occurs in the Abo Member, Hueco Formation of the Robledo Mountains; Abo Formation of the Manzano Mountains: San Andres Formation of the Caballo and San Andres Mountains; and Getaway Member, Cherry Canyon Formation of the Guadalupe Mountains. In Arizona it occurs in the Kaibab Formation. In Utah it occurs in the Grandeur Member, Park City Formation in Horseshoe Canyon. In Wyoming it occurs in the Grandeur Member, Park City Formation at Fontenelle Creek.

Aviculopecten? coreyanus White

1874 Aviculopecten coreyana White, U. S. Geog. Geol. Survey W. 100th Mer., Prel. Rept. Inv. Foss., p. 21.

1877 Aviculopecten coreyanus: White, U. S. Geog. Geol. Survey W. 100th Mer., Rept., v. 4, p. 147, pl. 11, fig. 1.

1895 Aviculopecten coryanus: Keyes, Missouri Geol. Survey, Rept., v. 5, p. 113.

1909 Deltopecten coreyanus: Girty, U. S. Geol. Survey, Bull. 389, p. 87-89.

1938 Aviculopecten? coreyanus: Newell, Kansas Geol. Survey, Rept., v. 10, pt. 1, p. 59, pl. 5, fig. 1-2.

Diagnosis.---- The specimens in the collection are incomplete. The following information is from Newell (1938):

> . . . large, acline, orbicular, with an extraordinarily long hinge margin . . .: umbonal slopes, particularly the posterior one, poorly defined: anterior sulcus well differentiated, the middle of the auricle: shell surface of the left valve ornamented by a large number of intercalate closely spaced costae . . .

Right valves are lacking in the collection and the following information is from Girty (1909):

> This is considerably less convex than the left, but by no means entirely flat. It has almost the same shape as the other, the byssal sinus being not as deep as in some species. The surface . . . is destitute of any radial markings but crossed by fine lines of growth, some of which are sublamellose.

Hinge and internal characters not observable in specimens.

Dimensions (in mm.).----

Loc. 1-5	length	height	hinge length	valve
W-41a	33	27.08	23	left

Occurrence.---- Section 1, unit 5.

Stratigraphic and Geographic Range.---- Wolfcampian-Leonardian. In New Mexico Aviculopecten? coreyanus occurs in the Abo Member, Hueco Formation of the Robledo Mountains; Abo Formation of the Sandia and Manzano Mountains and Chupadera Mesa; the Yeso Formation of the Chupadera Mesa and the San Andres Mountains; the San Andres Formation of the Chupadera Mesa and the Fra Cristobal Mountains; and the Getaway Member, Cherry Canyon Formation of the Guadalupe Mountains.

Genus Limipecten Girty, 1904

Limipecten sp.

Diagnosis.---- Medium-sized, acline, pectinoid, valve with intercalate costae, crossed by the deges of regular lamellae which swing downward toward the margin between costae in short, flattened, pointed projections similar to those present on Acanthopecten, becoming more numerous and prominent on posterior portion of shell.

Dimensions (in mm.).----

	length	height	hinge length
Loc. 1-5			
W-54	21.32	21.85	14.4

Occurrence.---- Section 1, unit 5.

Order TRIGONIOIDA Dall, 1889

Superfamily TRIGONIACEA Lamark, 1819

Family MYOPHORIIDAE Bronn, 1849

Genus Schizodus de Verneuil and Murchison, 1844

Schizodus texanus Clifton

1876 Schizodus wheeleri: White, U. S. Geol. Geog. Survey Terr., Second Division, Powell's Rept., p. 91.

1877 Schizodus wheeleri: White, U. S. Geol. Geog. Survey W. 100th Merid., Rept., v. 4, p. 154, pl. 11, fig. 6.

1909 Schizodus wheeleri?: Girty, U. S. Geol. Survey, Bull. 389, p. 82-84, pl. 10, fig. 6.

1942 Schizodus texanus Clifton, Jour. Paleontology, v. 16, n. 11, p. 691, pl. 101, fig. 20-28, pl. 102, fig. 10-13.

1952 Schizodus texanus: Chronic, Geol. Soc. America, Bull., v. 63, p. 143, pl. 7, fig. 11.

1975 Schizodus texanus: Newell and Boyd, Am. Mus. Nat. History, Bull., v. 154, art. 2, p. 116-117, fig. 13A, C, 37, n. 10, 52, 53.

Diagnosis.---- Medium-sized, trigonal in outline, moderately convex, most specimens internal molds; short, arcuate cardinal margin; anterior margin circular curving into arcuate ventral margin: posterior margin obliquely truncated, slightly convex. High umbos, beaks pointed, strongly incurved, opisthogyre; slight umbonal ridge; anterior region of shell strongly convex with flattened posterior region.

Ornamentation consisting of fine, regular, concentric lirae; not present on internal molds. Dentition not readily describable, probably as described by Clifton (1942). Anterior muscle scar moderate in size; posterior muscle scar of same size; simple pallial line.

Dimensions (in mm.).----

	length	height	thickness	valve
Loc. 1-5				
W-43a	26.50	21.50	13.92	both
W-43b	33.77	25.27	16.53	both
W-43d	25.77	19.70	13.67	both
W-43e	29.33	22.30	13.27	both
Loc. 2-7				
W-91a	27.35	22.07	15.58	both
Loc. 2-16				
W-118a	18.40	13.87	9.17	both
W-118b	20.15	17	11.05	both
Loc. 3-6				
W-140a	24.70	18.67	11.36	both

Occurrence.---- Section 1, units 5 and 7; Section 2, units 7 and 16; and Section 3, unit 6.

Stratigraphic and Geographic Range.---- Wolfcampian-Guadalupian. Schizodus texanus occurs in the Chase Group of Kansas. In Texas it occurs in the Talpa Formation of the north-central portion of the state; Cerro Alto and Alacran Mountain Formations of the Franklin Mountains; and Blaine and Dog Creek Formations of the northern portion of the state. In New Mexico it occurs in the Abo and Upper Hueco Limestone Members, Hueco Formation of the Robledo Mountains; Abo Formation of the Sandia and Manzano Mountains; Yeso Formation of the Chupadera Mesa, the Fra Cristobal, and

San Andres Mountains; and San Andres Formation of the Chupadera Mesa and the Fra Cristobal, Caballos, and San Andres Mountains. In Arizona it occurs in the Kaibab Formation of the Walnut Canyon region and San Andres Formation near St. Johns.

Order VENEROIDA Adams and Adams, 1856

Superfamily CARDITACEA Fleming, 1820

Family PERMOPHORIDAE van de Poel, 1959

Subfamily PERMOPHORINAE van de Poel, 1959

Genus Permophorus Chavan, 1954

Permophorus albequus (Beede)

1902 Pleurophorus sp. Beede, Oklahoma Geol. Survey, 1st Bien. Rept., Adv. Bull., p. 9, pl. 1, fig. 4.

1907 Pleurophorus? albequus Beede, Kansas Univ. Sci. Bull., v. 4, p. 160, pl. 6, fig. 8.

1907 Pleurophorus? albequus longus Beede, Kansas, Univ. Sci.Bull., v. 4, p. 162, pl. 6, fig. 9.

1940 Pleurophorus albequus: Newell, Geol. Soc. America, Bull., v. 51, p. 298, pl. 3, fig. 1, 4-8, 14, 16-18.

1940 Pleurophorus albequus longus: Newell, Geol. Soc. America, Bull., v. 51, p. 300, pl. 3, fig. 2-3, 15, 19-23.

1942 Pleurophorus albequus: Clifton, Jour. Paleontology, v. 16, n. 11, p. 693, pl. 101, fig. 8-12.

1944 Pleurophorus albequus: Newell, in Shimer and Shrock, Index foss. N. America, p. 415, pl. 165, fig. 35-36.

1952 Pleurophorus albequus: Chronic, Geol. Soc. America, Bull., v. 63, p. 147-148, pl. 9, fig. 5-6.

1953 Pleurophorus cf. P. albequus: Newell, et. al., Freeman and Co., pl. 22, fig. 11.

1963 Pleurophorus albequus: Ciriacks, Am. Mus. Nat. History, Bull., v. 125, art. 1, p. 67-68, pl. 13, fig. 15.

1963 Permophorus albequus: Winters, Geol. Soc. America, Mem. 89, p. 60, pl. 8, fig. 11-14.

Diagnosis.---- Small, elongate, equivalved pleurophorid, moderately convex, becoming somewhat flattened with growth, height increases gradually posteriorly: cardinal margin gently convex rounding smoothly into semicircular posterior margin: ventral margin gently convex; anterior margin convex, slightly projecting forward of beak, slightly curving backward, concave below beak: small, anterior beak, prosogyre; poorly defined umbonal ridge extending to posteroventral margin.

Ornamentation consists of radial ridges extending from umbo to posterior and posteroventral margins, fine growth lines, and fine papillae, on the ventral portion of shell.

Smooth hinge area; internal characters not observable. Based on information from Winters (1963) and observation.

Dimension (in mm.).----

Loc. 1-5	length	height	width	valve
W-44	11.42	6.32	4.52	both

Occurrence.---- Section 1, unit 5.

Stratigraphic and Geographic Range.---- Wolfcampian-Guadalupian. In Kansas Permophorus albequus occurs in the Blaine Formation. In Oklahoma it occurs in the Blaine, Dog Creek, and Whitehorse Formations.

In Texas it occurs in the Blaine and Dog Creek Formations of the north and north-central portion of the state: Whitehorse Formation of the north portion of the state: and Cerro Alto Formation of the Franklin Mountains. In New Mexico it occurs in the Abo Member, Hueco Formation of the Robledo Mountains; the Getaway Member, Cherry Canyon Formation of the Guadalupe Mountains, and the Carlsbad Formation from near Lakewood. In Arizona it occurs in the Fort Apache Limestone Member, Supai Formation of the Fort Apache Indian Reservation and the Kaibab Formation of Walnut Canyon. In Utah it occurs in the Franson Member, Park City Formation at Blind Stream and Coulter Ranger Station, and Grandeur Member, Park City Formation at Cephalopod Gulch. In Wyoming it occurs in the Franson Member, Park City Formation at Wheat Creek, Fontenelle Creek, LaBarge Creek, and Cumberland.

Permophorus mexicanus (Girty)

1909 Pleurophorus mexicanum Girty, U. S. Geol. Survey, Bull. 389, p. 91, pl. 10, fig. 1.

1942 Pleurophorus mexicanus: Clifton, Jour. Paleontology, v. 16, n. 11, p. 693, pl. 101, fig. 4-5.

1952 Pleurophorus cf. P. mexicanus: Chronic, Geol. Soc. America, Bull., v. 63, p. 148.

Diagnosis.---- Large, transverse, equivalved pleurophorid, strongly convex: cardinal margin gently convex, slightly straight rounding into trucated posterior margin; anterior margin convex, projecting forward of beak, curving backward, concave below beak; small, subterminal, slightly projecting anterior beak, prosogyre; well defined umbonal ridge, strongly elevated, extending to posteroventral margin.

Ornamentation consists of fine growth lines. Hinge area smooth: internal characters not observable in specimens available.

Dimensions (in. mm.).----

Loc. 1-5	length	height	width	valve
W-45	21.12	8.15	7.08	both

Occurrence.---- Section 1, unit 5; Section 2, unit 16; and Section 3, unit 6.

Stratigraphic and Geographic Range.---- Wolfcampian-Leonardian. In Oklahoma Permophorus mexicanus occurs in the Blaine Formation. In Texas it occurs in the Blaine and Dog Creek Formations of the north portion of the state. In New Mexico it occurs in the Abo Member, Hueco Formation of the Robledo Mountains; Abo Formation of the Manzano and

Sandia Mountains: Yeso Formation of the Chupadera Mesa; and the San Andres Formation of the Caballo Mountains. In Arizona it occurs in the Kaibab Formation at Walnut Canyon.

Superfamily CRASSATELLACEA Ferussac, 1822

Family ASTARTIDAE d'Orbigny, 1844

Subfamily ASTARTINAE d'Orbigny, 1844

Genus Astartella Hall, 1858

Astartella subquadrata Girty

1909 Astartella subquadrata Girty, U. S. Geol. Survey, Bull. 389, p. 94, pl. 10, fig. 1-13.

1942 Astartella subquadrata: Clifton, Jour. Paleontology, v. 16, n. 11, p. 693.

1952 Astartella subquadrata: Chronic, Geol. Soc. America, Bull., v. 63, p. 150-152, pl. 10, fig. 5-15.

1953 Astartella subquadrata: Newell, et. al., Freeman and Co., pl. 22, fig. 21.

1963 Astartella subquadrata: Ciriacks, Am. Mus. Nat. History, Bull., v. 125, art. 1, p. 65, pl. 12, fig. 6-9.

Diagnosis.---- Small, thick-shelled, subquadrate, greater in length than height, with thickness approximately one-half height. Cardinal and ventral margins gently curved; posterior outline perpendicular to cardinal and ventral margins, gently convex, rounding into ventral margin and meeting cardinal margin at an obscure angle; anterior margin concave in outline below beak, extending downward and somewhat forward for about two-thirds to three-fourths shell length, meeting upward curving end of

ventral margin in distinct angle; beak flattened; umbonal ridge not appreciably developed.

Ornamentation consists of regular concentric ridges, varying in number according to shell size, with distance between ridges increasing from beak to margin.

Hinge structure and dentition astartellid; lunule concave; escutcheon well marked; each valve with strong, triangular cardinal tooth, that in left valve is posterior to deep triangular socket and that in right valve is anterior to socket; along cardinal margin of left valve trough-like depression receives sharply angular edge of right valve; similar groove anterior to beak of right valve receives angular and somewhat extended edge of left valve; anterior muscle scar impressed; posterior muscle scar unknown.

Occurrence.---- Section 1, units 5 and 7 and Section 2, unit 16.

Stratigraphic and Geographic Range.---- Wolfcampian-Guadalupian. In Texas Astartella subquadrata occurs in the Hueco Canyon and Cerro Alto Formations of the Franklin Mountains; the Blaine and Dog Creek Formations of the north portion of the state; and the Word Formation of the Glass Mountains. In New Mexico it occurs in the Bursum Formation of the Cuchillo Mountains; the Abo and Upper Hueco Limestone Members, Hueco Formation of the Robledo Mountains; the Yeso Formation of the Chupadera Mesa and the Fra Cristobal Mountains; the San Andres Formation of the Chupadera Mesa and the Getaway Member, Cherry Canyon Formation of the Guadalupe Mountains. In Arizona it occurs in the Kaibab Formation at Walnut Canyon. In Nevada it occurs in the Bird Spring Formation of the Arrow Canyon Mountains. In Idaho it occurs in the Grandeur Member, Park City Formation at Grizzly Creek. In Utah it occurs in the Grandeur Member, Park City Formation at Cephalopod Gulch.

Order PHOLADOMYOIDA Newell, 1965

Superfamily PHOLADOMYACEA Gray, 1847

Family PHOLADOMYIDAE Gray, 1847

Genus Chaenomya Meek, 1864

Chaenomya leavenworthensis (Meek and Hayden)

1858 Allorisma? leavenworthensis Meek and Hayden, Acad. Nat. Sci. Philadelphia, Proc., v. 10, p. 263.

1864 Chaenomya leavenworthensis: Meek and Hayden, Smithsonian Contr. Knowledge, n. 172, p. 43, pl. 2, fig. 1.

1866 Allorisma leavenworthensis: Geinitz, Carb. und Dyas in Nebraska, p. 15.

1872 Chaenomya leavenworthensis: Meek, U. S. Geol. Survey Nebraska, Rept., p. 216, pl. 2, fig. 9.

1894 Chaenomya leavenworthensis: Keyes, Missouri Geol. Survey, Rept., v. 5, p. 131.

1900 Chaenomya leavenworthensis: Beede, Kansas Geol. Survey, Rept., v. 6, p. 172, pl. 19, fig. 3.

1903 Chaenomya leavenworthensis: Girty, U. S. Geol. Survey, Prof. Pap. 16, p. 436.

1909 Chaenomya leavenworthensis: Girty, U. S. Geol. Survey, Bull 389, p. 73-74.

1944 Chaenomya leavenworthensis: Newell, in Shimer and Shrock, Index foss. N. America, p. 373, pl. 145, fig. 1-2.

1967 Chaenomya leavenworthensis: Runnegar, Australia Bur. Miner. Resour. Geol. Geophys., Bull. 96, pl. 11, fig. 12-13.

1969 Chaenomya leavenworthensis: Newell, in Moore, Treatise, Pt. N., p. 831, fig. F 12:2.

1974 Chaenomya leavenworthensis: Runnegar, Jour. Paleontology, v. 48, n. 5, p. 929, text. fig. 5 G, pl. 3, fig. 7.

Diagnosis.---- Large, thin shelled, oblong to subcylindrical, internal molds, hinge long; anterior margin rounded, closed; posterior margin long, truncated with large gape: dorsal margin straight behind beak rising concave upward meeting posterior margin; ventral margin long, straight curving upward meeting anterior and posterior margins. Low beaks, anteriorly orthogyrate; umbonal ridge not present; shell anteriorly strongly convex, posteriorly concave.

Ornamentation consists of numerous minute papillae, arranged in rows. Internal characters not observable in specimens.

Dimensions (in mm.).----

	length	height	thickness	valve
Loc. 1-5				
W-48	36.65	19.80	12.02	both
Loc. 2-7				
W-121	47.62	21.86	14.48	both
Loc. 3-6				
W-141	58.25	28.45	23.76	both

Occurrence.---- Section 1, unit 5: Section 2, unit 16; and Section 3, unit 6.

Stratigraphic and Geographic Range.---- Pennsylvanian-Wolfcampian.

Chaenomya leavenworthensis occurs in the Pennsylvanian and Lower Permian of the Midcontinent region. In Texas it occurs in the Bead Mountain and Talpa Formations of the north-central portion of the state and Alacran Mountain Formation of the Franklin Mountains. In New Mexico it occurs in the Abo Member, Hueco Formation of the Robledo Mountains and the Abo Formation of the Manzano Mountains and the Chupadera Mesa.

Genus Wilkingia Wilson, 1959

Wilkingia terminale (Hall)

1852 Allerisma terminalis Hall, Stansbury's Exped. to Great Salt Lake, p. 413, pl. 2, fig. 4a-b.

1852 Allorisma regularis?: Owen, Geol. survey Wisconsin, Iowa, and Minnesota, pl. 5, fig. 13.

1858 Allorisma subcuneata: Meek and Hayden, Acad. Nat. Sci. Philadelphia, Proc., p. 263.

1860 Allorisma ensiformis: Swallow, Acad. Sci. St. Louis, Trans., v. 1, p. 656.

1864 Allorisma subcuneata: Meek and Hayden, Smithsonian Cont. Knowledge, v. 14, n. 172, p. 37, pl. 1, fig. 10a-b.

1866 Allorisma subcuneata: Geinitz, Carb. und Dyas in Nebraska, p. 14.

1872 Allorisma subcuneata: Meek, U. S. Geol. Survey Nebraska, p. 221, pl. 2, fig. 10a-b.

1875 Allorisma subcuneata (var.): White, U. S. Geog. Geol. Survey W. 100th Mer., Rept., v. 4, p. 155, pl. 12, fig. 7.

1876 Allorisma subcuneata: White, Powell's Rept. Geol. Uinta Mountains, p. 91.

1881 Allorisma subcuneata?: White, 2nd Ann. Rept. Dept. Stat. and Geol. Indiana, p. 518, pl. 8, fig. 1-2.

1884 Allorisma subcuneata: White, Geol. Survey Indiana, 13th Rept., p. 148, pl. 31, fig. 1-3.

1886 Allorisma subcuneata: Heilprin, 2nd Geol. Survey Pennsylvania, Ann. Rept. for 1885, p. 444, fig. 10, p. 457, fig. 10.

1886 Allorisma subcuneata: Heilprin, Proc. and Coll. Wyoming Hist. and Geol. Soc., v. 2, pt. 2, p. 272, fig. 10, p. 276, fig. 10.

1887 Allorisma subcuneata: Herrick, Sci. Lab. Denison Univ., Bull., v. 2, p. 34, pl. 4, fig. 1-2.

1894 Allorisma subcuneata: Derby, Jour. Geology, v. 2, p. 497.

1895 Allorisma subcuneatum: Keyes, Missouri Geol. Survey, v. 5, p. 129, pl. 47, fig. 5.

1900 Allorisma subcuneatum: Beede, Univ. Geol. Survey Kansas, Rept., v. 6, p. 169, pl. 20, fig. 1.

1903 Allorisma subcuneata: Katzer, Palaon. Anhang. Leipsig, p. 267.

1903 Allerisma terminale: Girty, U. S. Geol. Survey, Prof. Pap. 16, p. 437-438, pl. 8, fig. 4-6.

1909 Allerisma terminale: Girty, U. S. Geol. Survey, Bull. 389, p. 90-91.

1921 Allorisma subcuneata: Plummer and Moore, Univ. Texas, Bull. 2132, pl. 24, fig. 18.

1922 Allerisma terminale: Morningstar, Ohio Geol. Survey, 4th ser., Bull. 25, p. 234, pl. 13, fig. 15.

1944 Allorisma terminale: Shimer and Shrock, Index foss. N. America, p. 414, pl. 165, fig. 10-11.

1952 Allorisma terminale: Chronic, Geol. Soc. America, Bull., v. 63, p. 146-147, pl. 9. fig. 4.

1954 Allorisma terminale: Burk, Jour. Paleontology, v. 38, n. 1, p. 14, pl. 1, fig. 38-40.

1959 Wilkingia terminale: Wilson, Palaeontology, v. 1, p. 401-404, pl. 71.

1961 Wilkingia terminale: Hoare, Univ. Missouri Studies, v. 37, p. 122-123, pl. 15, fig. 18, pl. 16, fig. 3.

1962 Allorisma terminale: Mudge and Yochelson, U. S. Geol. Survey, Prof. Pap. 323, p. 90, pl. 16, fig. 5-6.

1968 Wilkingia terminale: Bird, Am. Paleontology, Bull., v. 54, n. 240, p. 131-133, pl. 12, fig. 16.

1972 Wilkingia terminalis: Runnegar, Malac. Soc. London, Proc., text fig. 3b-c, pl. 1, fig. a, pl. 2, fig. d.

Diagnosis.---- Large, internal molds, transversely ovate, with

nge equal to approximately one-half the length. Dorsal margin straight
nind beak: anterior margin rounded; posterior margin regularly rounded,
eting without angulation cardinal margin, and curving less sharply ven-
ally merging with ventral margin; straight ventral margin. Low beaks;
teriorly orthogyrate; umbonal ridge lacking; shell anteriorly strongly
nvex, posteriorly flattened.

Ornamentation consisting of low, irregular concentric rugae;
merous minute papillae, arranged in irregular radial rows; shell thin,
gae reflected on interior. Dentition and internal features unknown.

Dimensions (in mm.).----

	length	height	thickness	valve
oc. 1-5				
-47a	100.52	37.62	36.94	both
-47d	77.15	34.47	29.95	both
-47s	75.98	31.90	26.08	both
-47t	40.25	28.88	17.18	both
-47u	31.27	16.52	15.02	both
oc. 2-7				
-92a	108.95	47.32	43.86	both
-92b	115.72	46.51	40.73	both
-92d	61.42	31.87	30	both
oc. 2-16				
-122a	76.93	41.45	28.44	both
-122b	41.60	19.80	17.54	both
-122c	31.72	21	14.67	both
oc. 3-6				
-142a	81	39.22	39.10	both
-142b	40.40	21.20	15.50	both

Occurrence.---- Section 1, unit 5; Section 2, units 7 and 16; and Section 3, unit 6.

Stratigraphic and Geographic Range.---- Pennsylvanian-Lower Permian. Wilkingia terminale occurs in the Pennsylvanian and Lower Permian of the Midcontinent region. In Texas it occurs in the Crystal Falls Limestone, Waldrip, and Belknap Limestone Members: Harpersville; Camp Colorado Limestone and Watts Creek Shale Members, Moran; Santa Anna Branch; and Bead Mountain Formations of the north-central portion of the state; and the Cerro Alto and Alacran Mountain Formations of the Franklin Mountains. In New Mexico it occurs in the Abo Member, Hueco Formation of the Robledo Mountains and the Abo Formation of the Sandia Mountains. In Arizona it occurs in the Kaibab Formation of the Walnut Canyon region. Outside the United States it occurs in the Permian of the Lower Amazon, Brazil.

Class SCAPHOPODA Bronn, 1862

Family DENTALIIDAE Gray, 1834

Genus Plagioglypta Pilsbry and Sharp, 1897

Plagioglypta cf. P. canna (White)

1874 Dentalium canna White: U. S. Geog. Geol. Survey W. 100th Mer., Prel. Rept. Inv. Foss., p. 23.

1877 Dentalium canna: White, U. S. Geog. Geol. Survey W. 100th Mer., Rept., v. 4, p. 156, pl. 12, fig. 6.

1903 Plagioglypta canna: Girty, U. S. Geol. Survey, Prof. Pap. 16, p. 452.

1908 Plagioglypta canna?: Girty, U. S. Geol. Survey, Prof. Pap. 58, p. 450, pl. 23, fig. 11-13.

1909 Plagioglypta canna: Girty, U. S. Geol. Survey, Bull. 389, p. 95-96, pl. 11, fig. 11.

1910 Plagioglypta canna: Girty, U. S. Geol. Survey, Bull. 436, p. 44, pl. 6, fig. 14.

1916 Plagioglypta canna: Branson, Jour. Geology, v. 24, p. 657, pl. 3, fig. 13.

1930 Plagioglypta canna: Branson, Missouri Univ. Studies, v. 5, n. 2, p. 58, pl. 15, fig. 6.

1941 Plagioglypta canna?: Stainbrook and Madera, Jour. Paleontology, v. 15, n. 4, p. 382.

1942 Plagioglypta canna: Clifton, Jour. Paleontology, v. 16, n. 11, p. 694, pl. 101, fig. 19.

1944 Dentalium (Plagioglypta) canna: Shimer and Shrock, Index foss. N. America, p. 209, pl. 214, fig. 31.

1952 Plagioglypta canna: Chronic, Geol. Soc. America, Bull., v. 63, p. 153.

1953 Plagioglypta canna: Cooper, Smith. Misc. Coll., v. 119, n. 2, p. 79-80, pl. 24 C, fig. 19-20.

1953 Plagioglypta canna: Newell, et. al., Freeman and Co., pl. 23, fig. 9.

1953 Plagioglypta? canna: Walter, Jour. Paleontology, v. 27, n. 5, p. 700, pl. 73, fig. 18-19.

1963 Plagioglypta canna: Winters, Geol. Soc. America, Mem. 89, p. 63, pl. 9, fig. 9.

1967 Plagioglypta canna: Mayou, Brigham Young Univ., Geol. Sutdies, v. 14, p. 119-120, pl. 2, fig. 9.

1973 Plagioglypta canna: Yochelson and Fraser, U. S. Geol. Survey, Jour. Research, v. 1, n. 1, p. 26, fig. 4.

Diagnosis.---- Long; subcylindrical to cyclindrical, gradually tapering, gently curved, internal molds of scaphopods. No complete specimens with shell remains available.

Dimensions (in mm.).---- All specimens incomplete.

	length	diameter small end	diameter large end
Loc. 1-5			
W-49a	35.47	4.44	6.08
W-49c	42.13	7.67	11.42
Loc. 1-5c			
W-74h	40.60	3.62	5.18?
W-74k	45.43	9.82	12.82
Loc. 2-7			
W-93a	50.47	7.61	13.27
W-93b	19.85	3.85	5.77
Loc. 2-16			
W-123a	23.67	5.60	6.48

Occurrence.---- Section 1, units 5 and 7; Section 2, units 7 and 16; and Section 3, unit 6.

Stratigraphic and Geographic Range.---- Wolfcampian-Guadalupian. In Texas Plagioglypta canna occurs in the Watts Creek and Santa Anna Shale Members, Moran; Wildcat Creek Shale Member, Admiral; and Bead Mountain Formations of the north-central portion of the state; Blaine and Dog Creek Formations of the northern portion of the state; Delaware Mountain Formation of the Guadalupe Mountains; and the Rustler Formation of the Rustler Hills. In New Mexico it occurs in the Abo and Upper Hueco Limestone Members, Hueco Formation of the Robledo Mountains; Abo Formation of the Sandia Mountains and Chupadera Mesa; Yeso Formation of Chupadera Mesa; San Andres Formation of the Fra Cristobal and Caballo Mountains, and Chupadera Mesa; and the Getaway and Goat Seep Members, Cherry Canyon Formation of the Guadalupe Mountains. In Arizona it occurs in the Colina Formation of the southeastern portion of the state; Fort Apache Limestone Member, Supai Formation of the Fort Apache

Indian Reservation; and the Kaibab Formation in the Walnut Canyon region. In Nevada it occurs in the Arcturus Formation of the Rib Hill-Murry Summit and Butte Mountains; Loray Formation of the Butte Mountains; and Plympton Formation of the Pequop Mountains. In Utah it occurs in the Kaibab Formation of the southern portion of the state. In Idaho and Wyoming it occurs in the Phosphoria Formation. Outside the United States it occurs in the Rocky Mountain Quartzite of Alberta, Canada.

Phylum ANNELIDA Lamarck, 1809

Class POLYCHAETIA Grube, 1850

Order SEDENTARIDA Lamarck, 1818

Family SERPULIDAE Burmeister, 1837

Genus Spirorbis Daudin, 1800

Spirorbis sp.

Diagnosis.---- Tube small; coiled in flat spiral with two whorls; aperture circular; smooth surface; attached to the shells of brachiopods and bivalves.

Occurrence.---- Section 1, unit 5 and Section 2, unit 16.

Phylum ARTHROPODA Siebold and Stannius, 1845

Superclass CRUSTACEA Lamarck, 1809

Class CIRRIPEDIA Burmeister, 1834

Order ACROTHORACICA Gruvel, 1905

Family RODGERELLIDAE De Saint-Seine, 1951

Genus Rogerella De Saint-Seine, 1951

Rogerella sp.

Diagnosis.---- Acrothoracic barnacle borings are present on the valves of the brachiopod Squamaria moorei. The borings are about 0.8 mm. wide and 1.77 mm long, elliptical in outline.

Occurrence.---- Section 1, unit 5.

Phylum ECHINODERMATA Leske, 1778

Class CRINIODEA Miller, 1821

Division CRINOSTYLI Moore, 1939

Group PENTAGONOCYCLOPAE Moore, 1939

Section Pentagonocyclopa Moore, 1939

Pentagonocyclopa cf. P. dispar Moore

1939 Pentagonocyclopa dispar Moore, Jour. Sci. Lab., Denison Univ., v. 33, n. 10, p. 193-194, pl. 1, fig. 4-6.

1944 Columnal dispar: Moore and Laudon, in Shimer and Shrock, Index foss. N. America, p. 209, pl. 79, fig. 9.

1953 Pentagonocyclopa cf. P. dispar: Walter, Jour. Paleontology, v. 27 n. 5, p. 701, pl. 73, fig. 15-17.

Diagnosis.---- Stems, columnals; internodals pentagonal in outline, moderately long, with length equaling two-fifths greatest width. Sides concave inward, parallel to axis of stem, giving stem and columnals subpentagonal to stellate shape. Small pentagonal or subcircular lumen in center of columnal. Central area of articular face smooth, flat with collar around lumen. Row of fine, straight crenellae around stellate central area.

Dimensions (in mm.).----

	width	length	thickness
Loc. 1-5			
W-52	3.50	----	1.02
	3.95	----	1.02
	4.46	2.22	----

3	4.62	-----
3.80	1.50	-----

Occurrence.---- Section 1, unit 5; Section 2, units 7 and 16; and Section 3, unit 6.

Stratigraphic and Geographic Range.---- Missourian-Wolfcampian. In Kansas Pentagonocyclopa dispar occurs in the Coffeyville Formation. In Texas it occurs in the Bead Mountain Formation of the north-central portion of the state; Cerro Alto Formation of the Hueco Mountains; and the Rustler Formation of the Rustler Hills. In New Mexico it occurs in the Abo Member, Hueco Formation of the Robledo Mountains.

Subclass INADUNATA Wachsmuth and Springer, 1855

Order DISPARIDA Moore and Laudon, 1943

Crinoid stems and columnals

Diagnosis.---- Numerous round crinoid stems and columnals occur in some of the limestone beds studied. None of these are generically identifiable.

Occurrence.---- Section 1, units 5 and 7; Section 2, units 5, 7, 12, and 16; and Section 3, units 6 and 8.

Class ECHINOIDEA Leske, 1778

Order CIDAROIDEA Claus, 1880

Family ARCHAEOCIDARIDAE M'Coy, 1844

Genus Archaeocidaris M'Coy, 1844

Archaeocidaris trudifer White

1874 Archaeocidaris trudifer White, U. S. Geog. and Geol. Survey W. 100th Mer., Prel. Rept. Inv. Foss., p. 17.

1877 Archaeocidaris trudifer: White, U. S. Geog. and Geol. Survey W. 100th Mer., Rept.,

1912 Archaeocidaris trudifer: Jackson, Boston Soc. Nat. Hist., Mem. 7, v. 1-2, p. 269, pl. 8, fig. 16.

1929 Archaeocidaris trudifer: Boos, Jour. Paleontology, v. 3, n. 3, p. 246.

1963 Echinocrinus trudifer: Winters, Geol. Soc. America, Mem. 89, p. 65, pl. 9, fig. 12-13.

Diagnosis.---- Long, slender, fusiform straight spines, base greater in diameter than shaft of spine; short smooth area above base of shaft covered by spinules; short condyle with deep circular muscle pit. Hexagonal spine plate with numerous secondary tubercules on raised margin; basal terrace unmarked rising centrally to form high wall of outer ring with perforate tubercle raised very slightly above outer ring. Information derived from Winters (1963) and observation.

Dimensions (in mm.).---- Largest plate 22.07 mm. across. No complete spines available. Largest diameters of shaft 3.68 mm.; of base 4.92 mm.; estimated total length of spines between 80 and 100 mm. (Winters, 1963).

Occurrence.---- Section 1, units 5 and 7; Section 2, units 5, 7, 12, 14, and 16; and Section 3, units 2, 6, and 8.

Stratigraphic and Geographic Range.---- Wolfcampian-Leonardian. In New Mexico Archaeocidaris trudifer occurs in the Abo and Upper Hueco Limestone Members, Hueco Formation of the Robledo Mountains. In Arizona it occurs in the Fort Apache Limestone Member, Supai Formation of the Fort Apache Indian Reservation.

Paleoenvironmental Analysis

General Considerations

Stevens (1963, 1966) developed a concept of eight Wolfcampian megafaunal communities based on turbidity, salinity, energy, and depth parameters. These communities, as well as two others, are recognizable with special variations in the Dona Ana and Robledo Mountains. They are defined as deltaic-tidal flat, ostracod, euphemitid, nuculanid, Costellarina, chonetid, productoid-Composita, phylloid algae and coral (gastropod), fusulinid, and palaeotextulariid (Figs. 4, 5, and Tab. I). The chonetid, fusulinid, and palaeotextulariid communities are not recognized in the Abo or Upper Hueco Limestone Members, but are present in the Hueco Group of the Franklin and Hueco Mountains. All communities, with the exception of the deltaic-tidal flat and ostracod, are patterned after the categories of Stevens (1966). Paleoenvironmental conditions as inferred from the presence of specific invertebrate faunal taxons are presented in Appendix II.

Faunal Composition and Environmental Interpretations

D e l t a i c - t i d a l F l a t C o m m u n i t y

The deltaic-tidal flat community occurs in the clastic facies of the Abo Member. It is composed of red, cross-bedded, laminated fine sand, silt, and clay. It contains terrestial megafloral remains, invertebrate, and lower vertebrate trackways. Ripple marks and mud cracks are present in some horizons. The environment of deposition was both subaerial and subaqueous. This community is interpreted as originating in prograding subaerial deltas and tidal flats.

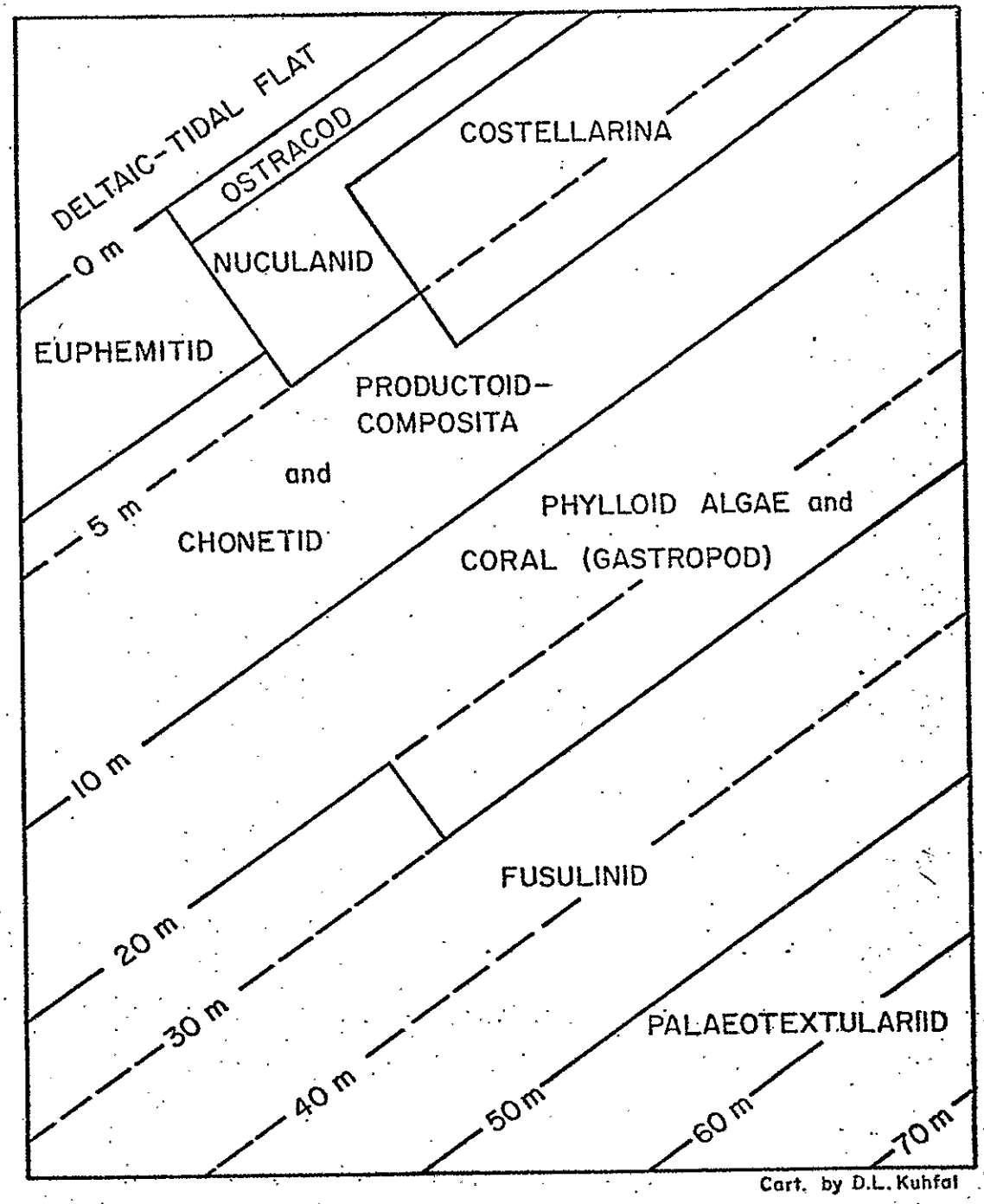


Figure 4. Interpreted distribution of fossil communities relative to one another, ancient shoreline, and depth (modified from Stevens, 1966).

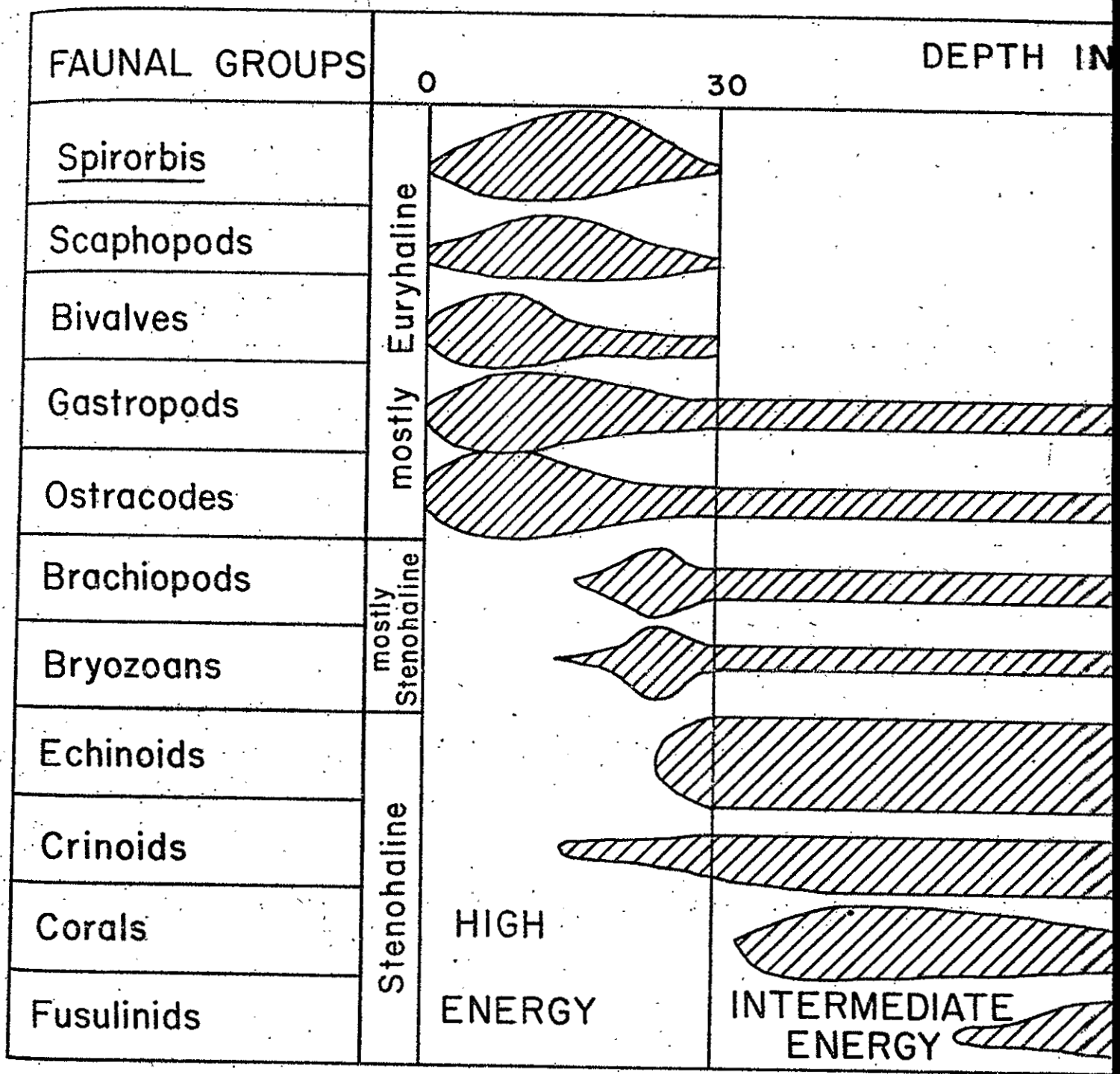
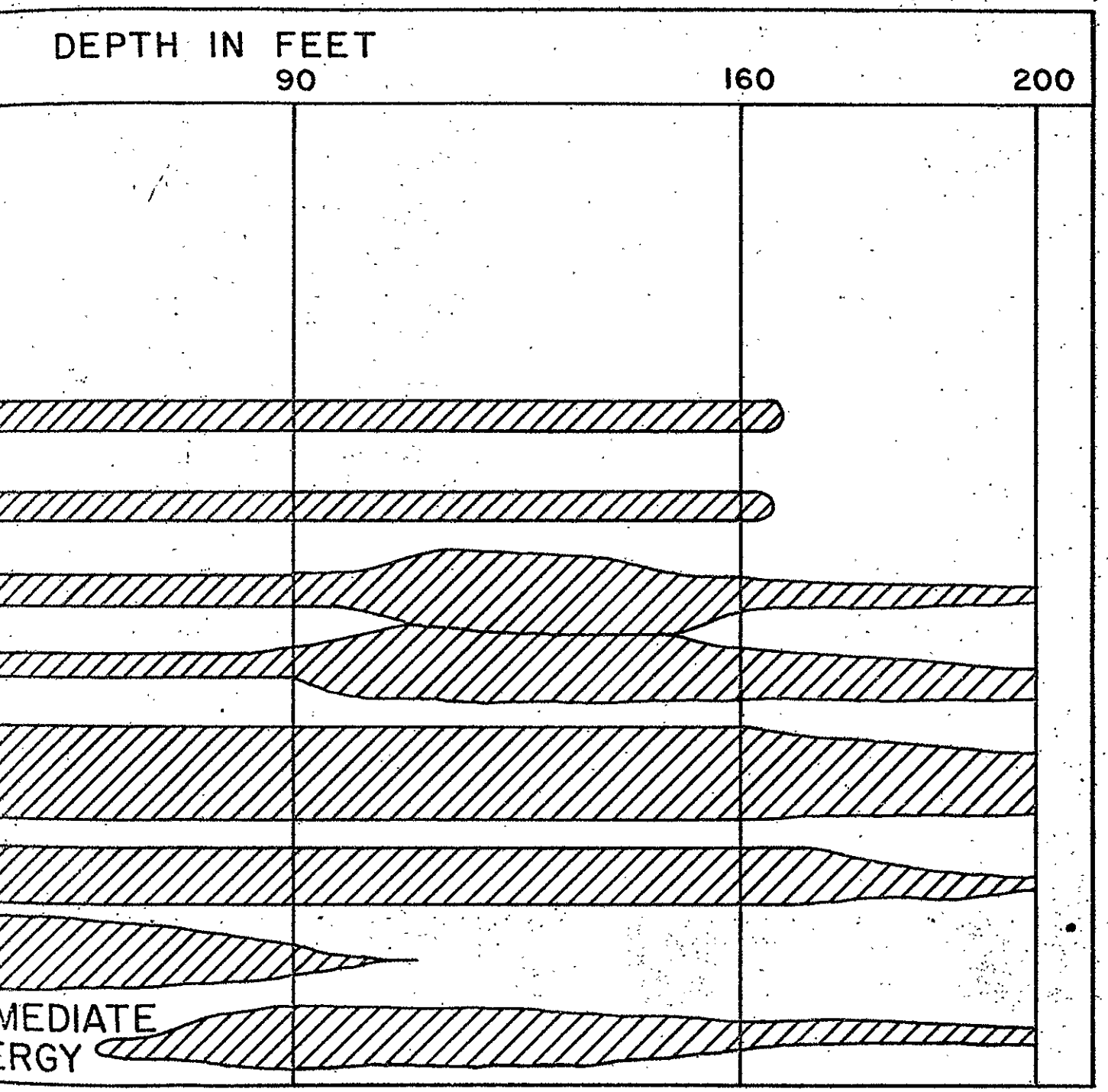


Figure 5. Inferred Ecologic Requirements of Permi



(Modified from Stevens, 1963)

nts of Permian Faunal Groups

Community	Salinity (per mil)	Energy	Turbidity	Depth meters	Depth feet
Palaeotextulariid	35	low	low	>50	>150
Fusulinid	35	low	low-moderate	20-50	60-150
Phylloid Algae-Coral	35	low-moderate	low	7-30	21-90
Productoid-Composita	variable-35	moderate-high	low-moderate	4-10	12-30
Chonetid	variable-35	low	high	4-10	12-30
Costellarina	<35	low-high	moderate-high	2-7	6-21
Nuculanid	<35	low-high	moderate-high	1-5	3-15
Euphemitid	35	low-high	moderate-high	0-4	0-12
Ostracod	variable->35	low-high	low-high	0-1	0-3
Deltaic-tidal Flat	fresh-brackish	low-high	low-high	>0	>0

Table I. Inferred Environmental Requirements of Permian Faunal Communities (After Stevens, 1963, 1966).

Ostracod Community

The ostracod community occurring in carbonate facies of the Abo Member is distinguished by the presence of large numbers of smooth, unornamented ostracodes. They are so numerous as to form ostracod mudstones. They are indicative of variable (brackish) to near normal marine waters. Energy and turbidity range from high to low. This community is very shallow, nearshore with depths of 0 to 3 feet (0 to 1 meter).

Euphemitid Community

This community is present in carbonate facies of the Abo Member. Next to the ostracod community the euphemitid community is the most shoreward of the communities studied. The euphemitid community contains the following fauna: Euphemites sp., Euphemitopsis multinodosa, Straparollus (Euomphalus) cornudanus, Meekospira knighti, Nuculopsis levatiformis, Paleyoldia subscitula, Septimyalina burmai, Bakevellia (Bakevellia) sulcata, Aviculopecten girtyi, Limipecten sp., Schizodus texanus, Spirorbis sp., and unornamented ostracodes. The community is defined as having normal marine salinity, low to high energy, moderate to high turbidity, and depths of 0 to 12 feet (0 to 4 meters).

Nuculanid Community

The nuculanid community is observed in the carbonate facies of the Abo Member. It contains the following fauna: Orthovertella? sp., Bellerophon (Bellerophon) sp., Straparollus (Euomphalus) cornudanus, Goniasma terebra, Meekospira knighti, Nuculopsis levatiformis, Paleyoldia subscitula, Pteronites peracuta, Schizodus texanus, Permophorus albequus,

Permophorus mexicanus, Astartella subquadrata, Chaenomya leavenworthensis, Wilkingia terminale, Plagioglypta canna, and smooth ostracodes. The nuculanid community is defined as having variable salinity (euryhaline), high to low energy, moderate to high turbidity, and depths of 3 to 15 feet (1 to 5 meters).

Costellarina Community

The Costellarina community occurs in the carbonate facies of the Abo Member. This community contains the following fauna: Orthovertella? sp., Tabulipora sp., Costellarina costellata, Squamaria moorei, Crurithyris guadalupensis, Straparollus (Euomphalus) cornudanus, Nuculopsis levatiformis, Paleyoldia subscitula, Plagioglypta canna, Spirorbis sp., unornamented ostracodes, crinoid remains, and Archaeocidaris trudifer. The presence of many euryhaline and brackish species and occurrence of stenohaline species suggest a variable to normal salinity. The energy ranges from high to low, high to moderate turbidity, and depths of 6 to 21 feet (2 to 7 meters).

Chonetid Community

The chonetid community has not been observed in either the Robledo or Dona Ana Mountains, but is present in the carbonates of the Hueco Group in the Franklin and Hueco Mountains. This faunal assemblage is of limited variety, dominated by chonetid brachiopods. It commonly contains ostracodes and crinoid remains. Productoid brachiopods, bryozoans, bivalves, and echinoid remains occur much less commonly. It is defined as having variable to normal salinity, low energy, high turbidity, and depths of 12 to 30 feet (4 to 10 meters).

Productoid-Composita Community

The productoid-Composita community is present in carbonate facies of the Abo and Upper Hueco Limestone Members. The fauna consists of the following: Wewokella (Talpaspongia) clavata, Tabulipora sp., Fenestella sp., Polypora sp., Septopora sp., Meekella mexicana, Derbyia carteri, Squamaria moorei, Linoproductus cora, Cancrinella altissimia, Pontisia franklinensis, Composita mexicana, Crurithyris guadalupensis, Beecheria bovidens, Euphemites sp., Euphemitopsis multinodosa, Bellerophon (Bellerophon) sp., Knightites (Knightites) bransoni, Knightites (Retispira) eximia, Straparollus (Euomphalus) cornudanus, Omphalotrochus obtusispira, Amaurotoma zappa, Glyptospira n. sp., Naticopsis (Naticopsis) cf. N. (N.) apachensis, Trachydomia sp., Goniasma terebra, Palaeostylus (Pseudozyglopleura) sp., Soleniscus aff. S. altonensis, Meekospira knighti, Nuculopsis levatiformis, Schizodus texanus, Spirorbis sp., acrothoracic barnacles, Pentagonocyclopa cf. P. dispar, and Archaeocidaris trudifer. This community is defined as having variable to normal salinity, moderate to high energy, low to moderate turbidity, and depths of 12 to 30 feet (4 to 10 meters).

Phylloid Algae and Coral (Gastropod) Community

This community occurs in the Upper Hueco Limestone Member. It contains the following fossil flora and fauna: phylloid algae, Wewokella (Talpaspongia) clavata, Lophophyllidium sp., fenestrate bryozoa, Composita mexicana, Crurithyris guadalupensis, Euphemites sp., Euphemitopsis multinodosa, Bellerophon (Bellerophon) sp., Knightites (Retispira) eximia, Straparollus (Euomphalus) cornudanus, Omphalotrochus obtusispira, Colpites

sp., Peruvispira sp., Amaurotoma zappa, Glyptospira n. sp., Palaeostylus (Pseudozygopleura) sp., Meekospira knighti, Metacoceras sp., Stenopoceras sp., Properrinites denhami, Akmilleria huecoensis, Nuculopsis levatiformis, Aviculopecten? coreyanus, Schizodus texanus, Astartella subquadrata, ostracodes, crinoid remains, and Archaeocidaris trudifer. Corals are rare in this community in the Robledo Mountains, but gastropods are common and probably grazed on the prolific algae. The phylloid algae and coral (gastropod) community is defined as having normal marine salinity, low to moderate energy, low turbidity, and depths of 21 to 90 feet (7 to 30 meters).

Fusulinid Community

The fusulinid community contains fusulinids, bryozoans, productoid brachiopods, crinoid remains, echinoid remains, Omphalotrochus, and ostracodes. Palaeotextulariid foraminifers are rare. This community is well developed in the Franklin and Hueco Mountains, but has not been recognized in the Dona Ana or Robledo Mountains. The fusulinid community is defined as having normal marine salinity, low energy, low to moderate turbidity, and depths of 60 to 150 feet (20 to 50 meters).

Palaeotextulariid Community

The palaeotextulariid community is distinguished by the presence of large numbers of palaeotextulariid foraminifers of the genera Palaeotextularia, Cribogenerina, Palaeobigenerina, and Climacammina. Small foraminifers, such as Globivalvulina and Geinitzina, massive bryozoans, productoid brachiopods, crinoids, and echinoid remains are present. Fusiform fusulinids are abundant. This community is not present in the Dona Ana or

Robledo Mountains, but is observed in the Wolfcamp of the Franklin and Hueco Mountains. This community is defined as having normal salinity, low energy, low turbidity, and depths greater than 150 feet (greater than 50 meters).

CONCLUSIONS

The following conclusions can be developed from the measured sections of the Hueco Formation in south-central Dona Ana County, New Mexico: thay are as follows:

(1) In the Robledo and Dona Ana Mountains the Hueco Formation can be divided into four members (oldest to youngest): (a) Lower Hueco Limestone Member, (b) Middle Hueco Limestone Member, (c) Abo Member, and (d) Upper Hueco Limestone Member. The Abo and Upper Hueco Limestone Members were the only members considered in detail in this study.

(2) The Abo Member in the Robledo Mountains ranges from 425 to 475 feet (133 to 148 meters) in thickness. The top of the Abo Member is not exposed in the Dona Ana Mountains, the measured thickness there indicates a minimal value of 329 feet (103 meters).

(3) The measured thickness of the Upper Hueco Limestone Member in the Robledo Mountains ranges fromm 55 to 350 feet (17 to 109 meters) in thickness. The Upper Hueco Limestone Member is reportedly not present in the Dona Ana Mountains. The complete thickness is not known in the Robledo Mountains due to post-Wolfcamp erosion.

(4) The Abo and Upper Hueco Limestone Members are lithologically and presumably environmentally comparable to the Permian sequences of south-central and southeast Arizona and southwestern New Mexico.

(5) Alternation between fossiliferous nonmarine red beds and

marine carbonates within the Abo Member in the Robledo and Dona Ana Mountains are suggestive of cyclic deposition whic was first recognized by Jordan (1971). These cycles of deposition may be classified as symmetrical and asymmetrical.

(6) The Abo and Upper Hueco Limestone Members appear to be faunally closely related to the Talpa Formation of north-central Texas, the lower part of the Colina Formation of southeastern Arizona and southwestern New Mexico, and the Hueco Group of the Franklin and Hueco Mountains of west Texas.

(7) A Wolfcampian age is confirmed for the Permian rocks of the Dona Ana and Robledo Mountains. No definitive fossils of Leonard age have been recovered from the Dona Ana or Robledo Mountains. An Upper Wolfcampian age for the Abo and Upper Hueco Limestone Members is substantiated on the basis of the flora and fauna recovered.

(8) The upper part of the Hueco Formation in the Robledo and Dona Ana Mountains contains a brachiopod-mollusk dominated fauna which consists of 61 genera of invertebrates, of which 10 are assigned to the Brachiopoda and 39 to the Mollusca.

(9) Stevens' (1963, 1966) concept of Wolfcampian megafaunal communities has been utilized in the paleoenvironmental analysis of the Abo and Upper Hueco Limestone Members in the Dona Ana and Robledo Mountians. These communities, as well as two others, are rcognized with special variations. They are defined as deltaic-tidal flat, ostracod, euphemitid, nuculanid, Costellarina, chonetid, productoid-Composita, phylloid algae and coral (gastropod), fusulinid, and palaeotextulariid. The chonetid, fusulinid, and palaeotextulariid communities are not recognized in the Abo or Upper Hueco Limestone Members, but have been confirmed

in the Hueco Group of the Franklin and Hueco Mountains.

REFERENCES

Abbott, R. T., 1954, American seashells: Van Nostrand Co., 544 p.

_____ 1968, Seashells of North America: Golden Press, 280 p.

Bachman, G. O., and P. T. Hayes, 1958, Stratigraphy of Upper Pennsylvanian and Lower Permian rocks in the Sand Canyon area, Otero County, New Mexico: Geol. Soc. America, Bull., v. 69, p. 689-700.

Barth, W., 1972, Das Permokarbon bei Zudanez (Bolivien) und eine Ubeisicht des Jungpalaozoikums im zentralen Teil der Anden: Geol. Rundschau, Bd. 61, Hf. 1, p. 249-270.

Batten, R. L., 1958, Permian Gastropoda of the southwestern United States, pt. 2, Pleurotomariacea: Am. Mus. Nat. History, Bull., v. 114, art. 2, p. 159-246.

Beede, J. W., 1906, Carboniferous invertebrates: Kansas Geol. Survey, Rept., v. 6, pt. 2, p. 1-187.

Bird, S. O., 1968, A pelecypod fauna from the Gaptank Formation (Pennsylvanian) west Texas: Am. Paleont., Bull., v. 54, n. 240, p. 111-185.

Bogart, L. E., 1953, The Hueco (Gym) Limestone, Luna County, New Mexico: M. S. Thesis, Univ. New Mexico, 91 p.

Boos, M., 1929, Stratigraphy and fauna of the Luta Limestone (Permian) of Oklahoma and Kansas: Jour. Paleontology, v. 3, n. 3, p. 241-253.

Bowen, Z. P., D. C. Rhoads, and A. L. McAlester, 1974, Marine benthic communities in the Upper Devonian of New York: Lethaia, v. 7, p. 93-120.

Branisia, L., 1965, Los fosiles guias de Bolivia, pt. I, Paleozoico: Bolivia Geol. Servicio, Bol. 6, 282 p.

Branson, C. C., 1948, Bibliographic index of Permian invertebrates: Geol. Soc. America, Mem. 26, 1049 p.

_____ 1964, Reticulatia and Squamaria in Gearyan rocks of Oklahoma: Oklahoma Geol. Notes, v. 24, n. 11, p. 276-277.

Chronic, H., 1952, Molluscan fauna from the Permian Kaibab Formation, Walnut Canyon, Arizona: Geol. Soc. America, Bull., v. 63, p. 95-166.

Ciriacks, K. W., 1963, Permian and Eotriassic bivalves of the middle Rockies: Am. Mus. Nat. History, Bull., v. 125, art. 1, 100 p.

Clifton, R. L., 1942, Invertebrate faunas from the Blaine and Dog Creek Formations of the Permian Leonard Series: Jour. Paleontology, v. 16, n. 11, p. 685-699.

_____ 1944, Paleoecology and environments inferred for some marginal Middle Permian marine strata: Am. Assoc. Pet. Geol., Bull., v. 28, n. 7, p. 1012-1031.

Coker, C. E., 1960, Geology of the Coleman Junction Limestone in Shackelford County, Texas: M. S. thesis, Rice Univ., 82 p.

Cooper, G. A., 1957a, Permian brachiopods from central Oregon: Smithsonian Misc. Coll., v. 134, n. 12, 79 p.

_____ 1957b, Study of the Wolfcamp and related faunas of the Glass Mountains, west Texas, in W. Warren, (ed.), Wolfcamp of the Glass Mountains and the Permian Basin: Soc. Econ. Paleo. Min., Permian Bas. Sec., Guidebook, p. 8-12.

_____ and R. E. Grant, 1964, New Permian stratigraphic units in Glass Mountains, west Texas: Am. Assoc. Pet. Geol., Bull., v. 48, n. 9, p. 1581-1588.

_____ 1966, Permian rock units in Glass Mountains, west Texas: U. S. Geol. Survey, Bull. 1244-E, 9 p.

_____ 1969, New Permian brachiopods from west Texas: Smithsonian Contri. Paleo., n. 1, 20 p.

_____ 1970, New name for brachiopod homonym and citation of types: Jour. Paleontology, v. 20, n. 6, p. 625-626.

_____ 1972, Permian brachiopods of west Texas, I: Smithsonian Contri. Paleo., n. 14, 231 p.

_____ 1973, Dating and correlating the Permian of the Glass Mountains in Texas, in A. Logan and L. V. Hills, (eds.), The Permian and Triassic Systems and their mutual boundary: Can. Soc. Pet. Geol., Mem. 2, p. 363-377.

_____ 1974, Permian brachiopods of west Texas, II: Smithsonian Contri. Paleo., n. 15, p. 232-794.

_____ 1975, Permian brachiopods of west Texas, III: Smithsonian Contri. Paleo., n. 19, p. 795-1922.

_____ 1976, Permian brachiopods of west Texas, IV: Smithsonian Contri. Paleo., n. 21, p. 1923-2607.

_____ and H. M. Muir-Wood, 1967, New names for brachiopod Homonyms: Jour. Paleontology, v. 41, n. 3, p. 808.

_____ et. al., 1953, Permian fauna of El Antimonio, western Sonora, Mexico: Smithsonian Misc. Coll., v. 119, n. 2, 111 p.

Cox, L. R., et. al., 1969, Treatise on invertebrate paleontology, R. C. Moore and C. Teichert, (eds.), pt. N, Mollusca 6--Bivalvia: Geol. Soc. America and Univ. Kansas Press, 1-2, 952 p.

Croneis, C., and D. F. Toomey, 1965, Gunsight (Virgilian) Wewokellid sponges and their depositional environment: Jour. Paleontology, v. 39, n. 1, p. 1-16.

Cuffey, R. J., 1967, Bryozoan Tabulipora carbonaria in Wreford Megacyclothem (Lower Permian) of Kansas: Univ. Kansas, Paleo. Contri., Bryozoa, art. 1, 96 p.

Darton, N. H., 1928, Red beds and associated formations in New Mexico, with an outline of the geology of the state: U. S. Geol. Survey, Bull. 794, 356 p.

DeLaubenfels, M. W., 1955, Treatise on invertebrate paleontology, R. C. Moore, (ed.), pt. E, Porifera: Geol. Soc. America and Univ. Kansas Press, p. 21-112.

Dunbar, C. O., and G. E. Condra, 1932, Brachiopoda of the Pennsylvanian System in Nebraska: Nebraska Geol. Survey, Bull. 5, ser. 2, 377 p.

_____ et. al., 1960, Correlation of the Permian formations of North America: Geol. Soc. America, Bull., v. 71, p. 1763-1806.

Elias, M. K., 1937, Depth of deposition of the Big Blue (Late Paleozoic) sediments in Kansas: Geol. Soc. America, Bull., v. 48, p. 403-432.

_____ and G. E. Condra, 1957, Fenestella from the Permian of west Texas: Geol. Soc. America, Mem. 70, 158 p.

Finks, R. M., 1971, Sponge zonation in the west Texas Permian type section, in J. T. Dutro, (ed.), Paleozoic perspectives: a paleontological tribute to G. Arthur Cooper: Smithsonian Contri. Paleo., n. 3, p. 285-300.

_____ E. L. Yochelson, and R. P. Sheldon, 1961, Stratigraphic implications of a Permian sponge occurrence in the Park City Formation of western Wyoming: Jour. Paleontology, v. 35, n. 3, p. 564-568.

Gauri, K. L., 1965, Uralian stratigraphy trilobites and brachiopods of the western Carnic Alps (Austria): Jahr. Geol. Bund., Sb. 11, 94 p.

Gilluly, J., J. R. Cooper, and J. S. Williams, 1954, Late Paleozoic stratgraphy of central Cochise County, Arizona: U. S. Geol. Survey, Prof. Pap. 266, 49 p.

Gilmore, C. W., 1926, Fossil footprints from the Grand Canyon: Smithsonian Misc. Coll., v. 77, n. 9, 41 p.

_____ 1927, Fossil footprints from the Grand Canyon: Second Contri.: Smithsonian Misc. Coll., v. 80, n. 3, 78 p.

_____ 1928, Fossil footprints from the Grand Canyon: Third Contri.: Smithsonian Misc. Coll., v. 80, n. 8, 16 p.

Girty, G. H., 1903, The Carboniferous formations and faunas of Colorado: U. S. Geol. Survey, Prof. Pap. 16, 544 p.

_____ 1909, Paleontology of the Manzano Group, in W. T. Lee and G. H. Girty, The Manzano Group of the Rio Grande Valley, New Mexico: U. S. Geol. Survey, Bull. 389, p. 41-141.

_____ 1915, Fauna of the Wewoka Formation of Oklahoma: U. S. Geol. Survey, Bull. 544, 353 p.

_____ 1937, Three Upper Carboniferous gastropods from New Mexico and Texas: Jour. Paleontology, v. 11, n. 3, p. 202-211.

Grant, R. E., 1963, Unusual attachment of a Permian Linoproductid brachiopod: Jour. Paleontology, v. 37, n. 1, p. 134-140.

_____ 1965, The brachiopod superfamily Stenoscimatacea: Smithsonian Misc. Coll., v. 148, n. 2, 105 p.

Greene, F. C., 1908, Fauna of the Florena Shale of the Grand Summit section of Kansas, and remarks on the development of Derbyia multistriata Meek and Hayden: Indiana Acad. Sci., Proc., p. 114-127.

Grinell, R. S., and G. W. Andrews, 1964, Morphologic studies of the brachiopod genus Composita: Jour. Paleontology, v. 38, n. 2, p. 227-248.

Grunt, T. A., and V. J. Dimitriev, 1973, Permian Brachiopoda of the Pamir: Acad. Sci. U.S.S.R., Palaeont. Inst., Trans., v. 136, 209 p. (In Russian).

Hantzschel, W., 1975, Treatise on invertebrate paleontology, C. Teichert, (ed.), pt. W, Miscellanea, supp. 1, Trace fossils and problematica: Geol. Soc. America and Univ. Kansas Press, 269 p.

Harbour, R. L., 1972, Geology of the northern Franklin Mountains, Texas and New Mexico: U. S. Geol. Survey, Bull. 1298, 129 p.

Hoare, R. D., 1960, New Pennsylvanian brachiopods from southwest Missouri: Jour. Paleontology, v. 34, n. 2, p. 217-232.

_____ 1961, Desmoinesian Brachiopoda and Mollusca fron southwestern Missouri: Univ. Missouri Studies, v. 36, 262 p.

_____ and M. T. Sturgeon, 1972, Pteronites americana (Meek) from

the Brush Creek (Conemaugh) southeastern Ohio: Compass, v. 49, n. 2, p. 61-64.

Hyatt, A., 1892, Remarks on the Pinnidae: Boston Soc. Nat. History, Proc., v. 25, p. 335-346.

Johnson, R. G., 1962, Interspecific associations in Pennsylvanian fossil assemblages: Jour. Geology, v. 70, p. 32-55.

Jordan, C. F., Jr., 1971, Lower Permian stratigraphy of southern New Mexico and west Texas: Ph. D. thesis, Rice Univ., 136 p.

_____ and J. L. Wilson, 1971, The Late Paleozoic section of Franklin Mountains, in J. M. Cys, (ed.), Robledo Mountains, New Mexico and Franklin Mountains, Texas, 1971 Field Conference Guidebook: Soc. Econ. Paleo. Min., Permian Bas. Sec., p. 77-85.

Kashirtsev, A., 1959, Field atlas of Permian fauna of the eastern Soviet Union: Acad. Nauk U.S.S.R., 85 p. (In Russian).

Kelley, V. C., and L. E. Bogart, 1952, Gym Limestone, New Mexico: Am. Assoc. Pet. Geol., Bull., v. 36, n. 8, p. 1644-1648.

King, P. B., 1965, Geology of the Sierra Diablo region: U. S. Geol. Survey, Prof. Pap. 480, 185 p.

_____ R. E. King, and J. B. Knight, 1945, Geology of the Hueco Mountains, El Paso and Hudspeth Counties, Texas: U. S. Geol. Survey, Oil and Gas Inv. Prelim. Map 36.

King, R. E., 1931, The geology of the Glass Mountains, Texas, pt. 2, faunal summary and correlation of the Permian formations with description of Brachiopoda: Univ. Texas, Bull. 3042, 245 p.

King, R. H., 1938, New Chonetidae and Productidae from Pennsylvanian and Permian strata of north-central Texas: Jour. Paleontology, v. 12, n. 3, p. 257-279.

_____ 1943, New Carboniferous and Permian sponges: Kansas Geol. Survey, Bull. 47, p. 1-36.

King, W. E., J. W. Hawley, A. M. Taylor, and R. P. Wilson, 1971, Geology and ground-water resources of central and western Dona Ana County, New Mexico: New Mexico, Bur. Mines and Min. Res., Hydro. Rept. 1, 64 p.

Kirkland, P. L., 1963, Permian stratigraphy and stratigraphic paleontology of a part of the Colorado Plateau: Four Corners Geol. Soc., Guidebook, p. 80-100.

Knight, P. B., et. al., 1960, Treatise on invertebrate paleontology, R. C. Moore, (ed.), pt. I, Mollusca 1--Gastropoda: Geol. Soc. America and Univ. Kansas Press, 331 p.

Kottlowski, F. E., 1960, Reconnaissance geologic map of Las Cruces thirty minute quadrangle: New Mexico, Bur. Mines and Min. Res., Geol. Map 14.

_____ 1963, Paleozoic and Mesozoic strata of southwestern and south-central New Mexico: New Mexico, Bur. Mines and Min. Res., Bull. 79, 100 p.

_____ 1969, Summary of Late Paleozoic in El Paso border region, in F. E. Kottlowski and D. V. LeMone, (eds.), Border stratigraphy symposium: New Mexico, Bur. Mines and Min. Res., Cir. 104, p. 38-51.

_____ R. H. Flower, M. L. Thompson, and R. W. Foster, 1956, Stratigraphic studies of the San Andres Mountains, New Mexico: New Mexico, Bur. Mines and Min. Res., Mem. 1, 132 p.

Laporte, L. F., 1962, Paleoecology of the Cottonwood Limestone (Permian), northern Midcontinent: Geol. Soc. America, Bull., v. 73, p. 521-544.

Lee, W. T., and G. H. Girty, 1909, The Manzano Group of the Rio Grande Valley, New Mexico: U. S. Geol. Survey, Bull. 389, 141 p.

LeMone, D. V., K. W. Klement, and W. E. King, 1967, Permian (Wolfcamp) phylloid algal mounds in the southern Robledo Mountains, Dona Ana County, New Mexico (abs.): New Mexico Acad. Sci., Bull., v. 8, n. 2, p. 24-25.

_____ 1971, Abo-Hueco facies of the Upper Wolfcamp Hueco Formation of the southeastern Robledo Mountains, Dona Ana County, New Mexico, in J. M. Cys, (ed.), Robledo Mountains, New Mexico and Franklin Mountains, Texas, 1971 Field Conference Guidebook: Soc. Econ. Paleo. Min., Permian Bas. Sec., p. 137-134.

_____ R. D. Simpson, and K. W. Klement, 1975a, Paleoecology of transition beds of Abo and Upper Members of Hueco Formation (Lower Permian), southern New Mexico (abs.): Am. Assoc. Pet. Geol., Bull., v. 59, n. 5, p. 914-915.

_____ 1975b, Wolfcampian Upper Hueco Formation of the Robledo Mountains, Dona Ana County, New Mexico, in W. R. Seager, R. E. Clemons, and J. F. Callender, (eds.), Las Cruces country---central-southern New Mexico: New Mexico Geol. Soc., Guidebook, p. 119-121.

Levinton, J. S., and R. K. Bambach, 1975, A comparative study of Silurian and Recent deposit-feeding bivalve communities: Paleobiology, v. 1, n. 1, p. 97-124.

Lokke, D. H., 1964, Calcareous spicules in Talpaspongia clavata R. H. King, Lower Permian of Concho County, Texas: Jour. Paleontology, v. 38, nn. 4, p. 778-781.

Mayou, T. V., 1967, Paleontology of the Permian Loray Formation in White Pine County, Nevada: Brigham Young Univ., Geol. Studies, v. 14, p. 101-122.

Meyer, R. F., 1966, Geology of Pennsylvanian and Wolfcampian rocks in southeast New Mexico: New Mexico, Bur. Mines and Min. Res., Mem. 17, 123 p.

Miller, A. K., C. O. Dunbar, and G. E. Condra, 1933, The nautiloid cephalopods of the Pennsylvanian System in the Mid-continent region: Nebraska Geol. Survey, Bull. 9, ser. 2, 240 p.

_____ and W. M. Furnish, 1940, Permian ammonoids of the Guadalupe Mountain region and adjacent areas: Geol. Soc. America, Spec. Pap. 26, 242 p.

_____ and O. H. Schindewolf, 1957, Treatise on invertebrate paleontology, R. C. Moore, (ed.), pt. L, Mollusca 4, Ammonoidea: Geol. Soc. America and Univ. Kansas Press, p. 11-79.

_____ and E. J. Parizek, 1948, A lower Permian ammonoid fauna from New Mexico: Jour. Paleontology, v. 22, n. 4, p. 350-358.

_____ and W. Youngquist, 1949, American Permian nauriloids: Geol. Soc. America, Mem. 41, 218 p.

Moore, R. C., 1939, The use of fragmentary crinoidal remains in stratigraphic paleontology: Denison Univ., Jour. Sci. Lab., v. 33, n. 10, p. 165-250.

_____ and R. M. Dudley, 1944, Cheilotrypid bryozoans from Pennsylvanian and Permian rocks of the Midcontinent region: Kansas Geol. Survey, Bull. 52, pt. 6, p. 229-408.

Morris, P. A., 1973, A field guide to shells of the Atlantic and Gulf Coasts and the West Indies: Houghton Mifflin Co., 330 p.

Moyle, R. W., 1963, Ammonoids of Wolfcampian age from the Glass Mountains and contiguous areas in west Texas: Ph. D. thesis, Univ. Iowa, 318 p.

Mudge, M. R., and E. L. Yochelson, 1962, Stratigraphy and paleontology of the Uppermost Pennsylvanian and Lowermost Permian rocks in Kansas: U. S. Geol. Survey, Prof. Pap. 323, 213 p.

Muir-Wood, H., and G. A. Cooper, 1960, Morphology, classification and life habits of the Productoidea (Brachiopoda): Geol. Soc. America, Mem. 81, 447 p.

Myers, D. A., 1968, Schwagerina crassitectoria Dunbar and Skinner, 1937, a fusulinid from the upper part of the Wichita Group, Lower Permian, Coleman County, Texas: U. S. Geol. Survey, Prof. Pap. 600-B, p.

133-139.

Newell, N. D., 1938, Late Paleozoic pelecypods, Pectinacea: Kansas Geol. Survey, Rept., v. 10, pt. 1, 123 p.

_____ 1942, Late Paleozoic pelecypods, Mytilacea: Kansas Geol. Survey, Rept., v. 10, pt. 2, 115 p.

_____ et. al., 1940, Invertebrate fauna of the Late Permian Whitehorse Sandstone: Geol. Soc. America, Bull., v. 51, p. 261-336.

_____ 1953, The Permian reef complex of the Guadalupe Mountains region, Texas and New Mexico: W. H. Freeman and Co., 236 p.

_____ and D. W. Boyd, 1975, Parallel evolution in early trigoniacean bivalves: Am. Mus. Nat. History, Bull., v. 154, art. 2, 162 p.

_____ J. Chronic, and T. G. Roberts, 1953, Upper Paleozoic of Peru: Geol. Soc. America, Mem. 58, 276 p.

Nicol, D., 1944, Paleoecology of three faunules in the Permian Kaibab Formation at Flagstaff, Arizona: Jour. Paleontology, v. 18, n. 6, p. 553-557.

_____ 1965, An ecological analysis of four Permian faunas: Nautilus, v. 78, p. 86-95.

Parker, R. H., 1956, Macro-invertebrate assemblages as indicators of sedimentary environments in east Mississippi Delta region: Am. Assoc. Pet. Geol., Bull., v. 40, p. 295-376.

_____ 1959, Macro invertebrate assemblages of central Texas coastal bays and Laguna Madre: Am. Assoc. Pet. Geol., Bull., v. 43, p. 2100-2166.

Pederson, S. L., 1954, A Permian (Wolfcampian) fauna of the Casper Formation of southeastern Wyoming: Jour. Paleontology, v. 28, n. 1, p. 17-21.

Plas, Jr., L. P., 1972, Upper Wolfcampian (?) Mollusca from the Arrow Canyon Range, Clark County, Nevada: Jour. Paleontology, v. 46, n. 2, p. 249-260.

Plummer, F. B., and R. C. Moore, 1922, Stratigraphy of the Pennsylvanian formations of north-central Texas: Univ. Texas, Bull. 2132, 237 p.

Pray, L. C., 1959, Stratigraphy and structure of the Sacramento Mountains: Soc. Econ. Paleo. Min., Permian Bas. Sec. and Roswell Geol. Soc., Guidebook of the Sacramento Mountains, p. 86-130.

_____ and C. Otte, Jr., 1954, Correlation of the Abo Formation of south-central New Mexico (abs.): Geol. Soc. America, Bull., v. 63,

p. 1342.

Read, C. B., and S. H. Mamay, 1964, Upper Paleozoic floral zones and floral provinces of the United States: U. S. Geol. Survey, Prof. Pap. 454-K, 35 p.

Reynolds, C. B., 1959, Geology of the Jarilla Mountains, Otero County, New Mexico: Soc. Econ. Paleo. Min., Permian Bas. Sec. and Roswell Geol. Soc., Guidebook of the Sacramento Mountains, p. 278-284.

Rhoads, D. C., I. G. Speden, and K. M. Waage, 1972, Trophic group analysis of Upper Cretaceos (Maestrichtian) bivalve assemblages from South Dakota: Am. Assoc. Pet. Geol., Bull., v. 56, n. 6, p. 1100-1113.

Rigby, J. K., and R. W. Moyle, 1959, Some Mississippian and Pennsylvanian sponges from Utah: Jour. Paleontology, v. 33, n. 3, p. 399-403.

Rodda, P. U., and W. L. Fisher, 1962, Upper Paleozoic acrothoracic barnacles from Texas: Texas Jour. Sci., v. 14, n. 4, p. 460-479.

Ross, C. A., 1963, Standard Wolfcampian Series (Permian), Glass Mountains, Texas: Geol. Soc. America, Mem. 88, 205 p.

_____ 1973, Pennsylvanian and Early Permian depositional history, southeastern Arizona: Am. Assoc. Pet. Geol., Bull., v. 57, n. 5, p. 887-912.

Rudwick, M. J. S., 1970, Living and fossil brachiopods: Hutchinson Univ. Library, 199 p.

Runnegar, B., 1974, Evolutionary history of the bivalve subclass Anomalodesmata: Jour, Paleontology, v. 48, n. 5, p. 904-939.

Sabins, Jr., F. F., 1957, Stratigraphic relations in Chiricahua and Dos Cabezas Mountains, Arizona: Am. Assoc. Pet. Geol., Bull., v. 41, n. 3, p. 466-510.

Saint-Seine, R., 1951, Un Cirripede acrothoracique du Cretace: Rogerella lecontrei n. g., n. sp.: Acad. Sci. (Paris), Comptes Rendus, v. 233, p. 1051-1053.

_____ 1956, Les Cirripedes acrothoraciques echinocoles: Soc. Geol. France, Bull., ser. 6, v. 5, p. 299-303.

Schenk, H. G., 1939, Revised nomenclature for some nuculid pelecypods: Jour. Paleontology, v. 13, n. 1, p. 21-41.

Schlaudt, C. M., and K. Young, 1960, Acrothoracic barnacles from the Texas Permian and Cretaceous: Jour. Paleontology, v. 34, n. 5, p. 903-907.

Sellards, E. H., W. S. Adkins, and F. B. Plummer, 1932, The geology of Texas, v. 1, stratigraphy: Univ. Texas, Bull. 3232, 1007 p.

Shrock, R. R., and W. H. Twenhofel, 1953, Principles of invertebrate paleontology: McGraw-Hill Book Co., 816 p.

Simpson, R. D., 1969a, Faunal list of Pueblo Formation, in Hardin-Simmons Geol. Club, Environmental studies west central Texas: Ann. Southwestern Assoc. Student Geol. Soc. Field Trip, p. 31.

_____ 1969b, Fauna of the Watts Creek Shale Member of the Moran Formation, in Hardin-Simmons Geol. Club, Environmental studies west central Texas: Ann. Southwestern Assoc. Student Geol. Soc. Field Trip, p. 32-33.

_____ 1969c, Pennsylvanian and Permian fossil plates, in Hardin-Simmons Geol. Club, Environmental studies west central Texas: Ann. Southwestern Assoc. Student Geol. Soc. Field Trip, p. 49-75.

Stanley, S. M., 1972, Functional morphology and evolution of bysally attached bivalve mollusks: Jour. Paleontology, v. 46, n. 2, p. 165-212.

Stehli, F. G., 1954, Lower Leonardian Brachiopoda of the Sierra Diablo: Am. Mus. Nat. History, Bull., v. 105, art. 3, p. 261-358.

_____ 1956, Dielasma and its external homeomorph Beecheria: Jour. Paleontology, v. 30, n. 2, p. 299-302.

_____ and R. E. Grant, 1970, Permian brachiopods from Huehuetenango, Guatemala: Jour. Paleontology, v. 44, n. 1, p. 23-36.

Stevens, C. H., 1963, Paleoecology and stratigraphy of pre-Kaibab Permian rocks in the Ely Basin, Nevada and Utah: Ph. D. thesis, Univ. Southern California, 251 p.

_____ 1966, Paleoecological implications of Early Permian fossil communities in eastern Nevada and western Utah: Geol. Soc. America, Bull., v. 77, p. 1121-1130.

_____ 1971, Distribution and diversity of Pennsylvanian marine faunas relative to water depth and distance from shore: Lethaia, v. 4, p. 403-412.

Sutherland, P. K., and F. H. Harlow, 1967, Late Pennsylvanian brachiopods from north central New Mexico: Jour. Paleontology, v. 41, n. 5, p. 1065-1089.

Sturgeon, M. T., and R. D. Hoare, 1968, Pennsylvanian brachiopods of Ohio: Ohio Geol. Survey, Bull. 63, 95 p.

Tasch, P., 1973, Paleobiology of the fossil invertebrates: John Wiley and Sons, Inc., 946 p.

Thayer, G. W., 1974, Marine paleoecology in the Upper Devonian of New York: Lethaia, v. 7, p. 121-155.

Thompson, M. L., 1954, American Wolfcampian fusulinids: Univ. Kansas, Paleo. Contri., Protozoa, art. 5, 226 p.

Tomlinson, J. T., 1969, The burrowing barnacles (Cirripedia: Order Acrothoracica): U. S. Nat. Mus., Bull. 296, 162 p.

Toomey, D. F., 1976, A Permian plant controlled community, northern Franklin Mountains, west Texas, in D. V. LeMone and E. M. P. Lovejoy, (eds.), Symposium on the Franklin Mountains: El Paso Geol. Soc., Quinn Memorial Volume, p. 67-76.

Updegraff, N. A., 1969, Pelecypoda of the Brush Creek (Pennsylvanian), Ohio: M. S. thesis, Bowling Green State Univ., 101 p.

Walker, K. R., and R. K. Bambach, 1974, Feeding by benthic invertebrates: classification and terminology for paleoecology analysis: Lethaia, v. 7, p. 67-78.

Walter, Jr., J. C., 1953, Paleontology of the Rustler Formation, Culberson County, Texas: Texas Bur. Econ. Geol., Rept. Invest. 19, p. 679-702.

White, C. A., 1891, The Texan Permian and its Mesozoic types of fossils: U. S. Geol. Survey, Bull. 77, 51 p.

White, W. D., 1965, Pennsylvanian fossils of eastern Nebraska and western Iowa, pt. 2: Earth Sci., v. 18, n. 2, p. 66-74.

Wilde, G. L., 1962, Lower Permian biostratigraphic relationships and sedimentation, in A. Thomson, (ed.), Leonardian facies of the Sierra Diablo region, west Texas: Soc. Econ. Paleo. Min., Permian Bas. Sec., Guidebook, p. 68-77.

Williams, A., et. al., 1965, Treatise on invertebrate paleontology, R. C. Moore, (ed.), pt. H, Brachiopoda: Geol. Soc. America and Univ. Kansas Press, 1-2, 927 p.

Williams, T. E., 1963, Fusulinidae of the Hueco Group (Lower Permian) Hueco Mountains, Texas: Peabody Mus. Nat. History, Bull. 18, 122 p.

_____ 1966, Permian Fusulinidae of the Franklin Mountains, New Mexico---Texas: Jour. Paleontology, v. 40, n. 5, p. 1142-1156.

Wilson, R. B., 1959, Wilkingia gen. nov. to replace Allorisma for a genus of Upper Paleozoic Tamellibranchs: Palaeontology, v. 1, p. 401-404.

Winters, S. S., 1963, Supai Formation (Permian) of eastern Arizona: Geol. Soc. America, Mem. 89, 99 p.

Yancey, T. E., 1969, A molluscan faunal assemblage from the Arcturus Formation, Nevada: Paleobios, n. 8, p. 1-20.

Yochelson, E. L., 1953, Jedria, a new subgenus of Naticopsis: Washington Acad. Sci. Jour., v. 43, n. 3, p. 65.

_____ 1954, Some problems concerning the distribution of the Late Paleozoic gastropod Omphalotrochus: Sci., v. 120, n. 3110, p. 233-234.

_____ 1956, Permian Gastropoda of the southwestern United States, pt. 1, Euomphalacea, Trochonematacea, Pseudophoracea, Anomphalacea, Craspedostomatacea, and Platyceratacea: Am. Mus. Nat. History, Bull., v. 110, art. 3, 275 p.

_____ 1960, Permian Gastropoda of the southwestern United States, pt. 3, Bellerophontacea and Patellacea: Am. Mus. Nat. History, Bull., v. 119, art. 4, 293 p.

_____ and G. D. Fraser, 1973, Interpretation of depositional environment in the Plympton Formation (Permian), southern Pequop Mountains, Nevada, from physical stratigraphy and a faunle: U. S. Geol. Survey, Jour. Research, v. 1, n. 1, p. 19-32.

Ziegler, A. M., L. R. Cocks, and R. K. Bambach, 1968, The composition and structure of Lower Silurian marine communities: Lethaia, v. 1, p. 1-27.

Zittel, K. von, C. R. Eastman, (ed.), 1927, Textbook of paleontology: Macmillan Co., 839 p.

APPENDIX I. DESCRIPTION OF STRATIGRAPHIC SECTIONS

Three stratigraphic sections in the Robledo Mountains and one section in the Dona Ana Mountains, Dona Ana County, New Mexico were measured. Section locations are graphically displayed on Plates I and II.

The general order of data in the formal lithostratigraphic descriptions are as follows: rock name, selective Dunham's classification on carbonate units, weathered and fresh color, composition, other data, and fossil taxons present. Rock colors utilized are those recorded in the "GSA Rock Color Chart" Geological Society of America (1963). Beds and/or stratigraphic units are numbered consecutively from the base to the top.

All sections were measured utilizing a Jacob's staff and brunton compass. Samples were collected at every five foot (1.5 meter) stratigraphic interval or at significant lithological changes in units less than five feet (1.5 meter).

Shalem Colony Section (Section 1)

SE 1/4, SW 1/4, Sec. 19, T. 22 S., R. 1 E., Southeastern Robledo Mountains, Dona Ana County, New Mexico.

Sample No.	Description	Feet	(Meters)
	HUECO FORMATION		
Upper Hueco Limestone Member			
R-14	Limestone. Unit 7-G. Weathered-light gray, N 7; fresh-medium dark gray, N 4. Homogeneous. Fossils rare.	1	(.3)
R-13	Limestone. Unit 7-G. Weathered-light olive gray, 5 Y 6/1; fresh-medium dark gray, N 4. Homogeneous. Fossils rare.	4.8	(1.4)
	Total Unit 7-G	5.8	(1.7)
R-12	Limestone. Unit 7-F. Weathered-light olive gray, 5 Y 6/1; fresh-olive gray, 5 Y 6/1. Homogeneous. Fossils are silicified phylloid algae and brachiopods.	4.8	(1.4)
R-11	Limestone. Unit 7-F. Weathered-pale yellowish brown, 10 YR 6/2; fresh-olive gray, 5 Y 4/1. Homogeneous. Chert is present in the form of lenticular bodies. Fossils include phylloid algae, brachiopods, crinoids, and echinoid spines. Fossils are silicified on surface and iron stained.	4.8	(1.4)
R-10	Limestone. Unit 7-F. Weathered-light olive		

gray, 5 Y 6/1; fresh-olive gray, 5 Y 4/1. Homogeneous. Fossils are silicified and include phylloid algae; sponge, Wewokella (Talpaspongia); brachiopods; and gastropods. 4.8 (1.4)

Total Unit 7-F 14.4 (4.4)

R-9 Limestone. Unit 7-E. Weathered-light olive gray, 5 Y 6/1; fresh-dark yellowish brown, 10 YR 4/2. Mottled. Fossils include silicified echinoid spines. 4.8 (1.4)

Total Unit 7-E 4.8 (1.4)

R-8 Limestone. Unit 7-D. Weathers-light olive gray, 5 Y 6/1; fresh-olive gray, 5 Y 4/1. Homogeneous. Nodular chert. Fossils silicified on surface include phylloid algae; brachiopod, Composita; ostracodes; and Archaeocidaris spines and plates. 4.8 (1.4)

R-7 Limestone. Unit 7-D. Weathers-pale yellowish brown, 10 YR 6/2; fresh-olive gray, 5 Y 4/1. Banded, color varies toward red. Small poor exposures. Fossils include gastropods and echinoid spines. 4.8 (1.4)

R-6 Limestone. Unit 7-D. Weathers-pale yellowish brown, 10 YR 6/2; fresh-olive gray, 5 Y 4/1. Homogeneous. Cliff former. Nodular chert. Fossils include phylloid algae and gastropods that are iron stained and silici-

	fied on the surface.	6.6	(2)
R-5	Limestone. Unit 7-D. Weathers-pale yellowish brown, 10 YR 6/2; fresh-olive gray, 5 Y 4/1. Homogeneous. Nodular brown chert. Partially silicified fossils include phylloid algae; sponge, Wewokella (Talpaspongia); nonfenestrate bryozoa; trochoid gastropods; and brachiopods.	4.8	(1.4)
R-4	Limestone. Unit 7-D. Weathers-light olive gray, 5 Y 6/1; fresh-olive gray, 5 Y 4/1. Homogeneous. Fossils include phylloid algae; sponge, Wewokella (Talpaspongia); and gastropods.	4.1	(1.2)
R-3	Limestone. Unit 7-D. Weathers-light olive gray, 5 Y 6/1; fresh-olive gray, 5 Y 4/1. Homogeneous. Fossils include phylloid algae; sponge, Wewokella (Talpaspongia); fenestrate bryozoa; brachiopods; gastropods and echinoid spines.	4.8	(1.4)
	Total Unit 7-D	29.9	(9.1)
R-2	Limestone. Unit 7-C. Weathers-moderate yellowish brown, 10 YR 5/4; fresh-dark yellowish brown, 10 YR 4/2. Slabby beds. 1.6 feet (0.4 meter) above base is a thin clay bed. Fossils include phylloid algae, productoid brachiopods, a planispiral gast-		

	ropod 4 inches in diameter, and other gastropods. Unit has a fetid odor.	4.8	(1.4)
	Total Unit 7-C	4.8	(1.4)
	Concealed. Unit 7-B.	9.8	(2.9)
	Total Unit 7-B	9.8	(2.9)
R-1	Limestone. Unit 7-A. Weathers-pale yellowish brown, 10 YR 6/2; fresh-dark yellowish brown, 10 YR 4/2. Contains phylloid algae, brachiopods, gastropods, and echinoid spines.	5.9	(1.7)
	Total Unit 7-A	5.9	(1.7)
	Total Upper Hueco Limestone Member	75.4	(22.9)
Abo Member			
RE-27	Sandstone and siltstone. Unit 6. Very fine grained and cross-bedded.	28	(8.5)
	Total Unit 6	28	(8.5)
RE-26	Limestones and shales. Unit 5-D. Upper ten feet (3 meters) form a resistant ledge, particularly at 24-25 (7.3-7.6) and 20-21 feet (6.1-6.4 meters) above the base. Quite shaly. Contains fenestrate bryozoa, brachiopods, Pteronites and other bivalves, gastropods, ostracodes, and echinoid spines and plates.	25	(7.6)
	Total Unit 5-D	25	(7.6)

RE-25	Limestone and shaly limestone. Unit 5-C. Weathers tan. Much slope talus. Very rich fauna of invertebrates including bryozoa, productoid and other brachiopods, bivalves, gastropods, cephalopods, and echinoid spines and plates. Lithologic sample taken from lower five feet (1.5 meters).	25	(7.6)
	Total Unit 5-C	25	(7.6)
	Concealed. Unit 5-B. Covered with brachiopod fauna and float.	24	(7.3)
	Total Unit 5-B	24	(7.3)
RE-24	Limestone. Unit 5-A. Weathers-dark yellowish brown, 10 YR 4/2; fresh-olive gray, 5 Y 4/1. Top of key basal bed a cliff 8 to 12 feet (2.4 to 3.6 meters) in thickness. Fossils include productoid brachiopods, omphalotrochoid gastropods, other gastropods, and echinoid spines and plates.	3	(.9)
RE-23	Limestone. Unit 5-A. Weathers-dark yellowish brown, 10 YR 4/2; fresh-olive gray, 5 Y 4/1. Fossils include scattered productoid brachiopods, and some gastropods. Base of cliff in slope.	5	(1.5)
	Total Unit 5-A	8	(2.4)
	Total Unit 5	82	(25)

	Concealed. Unit 4-F.	6	(1.8)
	Total Unit 4-F	6	(1.8)
RE-22	Sandstone to siltstone. Unit 4-E. Weathers-pale brown, 5 YR 5/2; fresh-light olive gray, 5 YR 6/1. Very fine grained.	4	(1.2)
	Total Unit 4-E	4	(1.2)
RE-21	Shales and siltstones. Unit 4-D. Weathers-pale brown, 5 YR 5/2; fresh-moderate brown, 5 YR 3/4. Thin bedded.	4	(1.2)
	Total Unit 4-D	4	(1.2)
	Concealed. Unit 4-C.	5	(1.5)
	Total Unit 4-C	5	(1.5)
RE-20	Siltstone, some fine bedded shale and siltstone below the top which is 2.5 feet (0.7 meters) in thickness. Unit 4-B. Weathers-moderate brown, 5 YR 4/4; fresh-light brownish gray, 5 YR 6/1.	5	(1.5)
	Total Unit 4-B	5	(1.5)
RE-19	Siltstone. Unit 4-A. Weathers-pale brown, 5 Y 5/2; fresh-brownish gray, 5 YR 4/1. Well indurated. Calcareous cement.	5	(1.5)
	Total Unit 4-A	5	(1.5)
	Total Unit 4	29	(8.8)

	Concealed. Unit 3-F.	12	(3.6)
	Total Unit 3-F	12	(3.6)
RE-18	Limestone. Unit 3-E. Weathers-moderate yellowish brown, 10 YR 5/4; fresh-olive gray, 5 Y 4/1. Thin bedded. Fauna good but may have come from upper limestones above.	5	(1.5)
RE-17	Limestone. Unit 3-E. Weathers-moderate yellowish brown, 10 YR 5/4; fresh-olive gray, 5 Y 4/1. Irregularly bedded. Fossiliferous.	5	(1.5)
	Total Unit 3-E	10	(3)
RE-16	Limestone. Unit 3-D. Partially covered. Lower 4 feet (1.2 meters) especially poor. Fossiliferous.	5	(1.5)
	Total Unit 3-D	5	(1.5)
RE-15	Limestone. Unit 3-C. Poor exposure, weathers-moderate yellowish brown, 10 YR 5/4; fresh-dark yellowish brown, 10 YR 4/2. Spotted. Fossiliferous.	5	(1.5)
	Total Unit 3-C	5	(1.5)
	Concealed. Unit 3-B. Rubble no distinct outcrop.	5	(1.5)
	Total Unit 3-B	5	(1.5)
RE-14	Limestone. Unit 3-A. Weathers-moderate yellowish brown, 10 YR 5/4; fresh-dark yellowish brown, 10 YR 4/2. Basal cliff of good beds of		

	limestone about 2 feet (0.6 meter) in thickness. Limonite staining in part. Contains ostracodes.	8	(2.4)
	Total Unit 3-A	8	(2.4)
	Total Unit 3	45	(13.7)
RE-13	Shaly limestone. Unit 2-I. Weathers-moderate yellowish brown, 10 YR 5/4; fresh-pale yellowish brown, 10 YR 6/2. Thin bedded. Transitional into Unit 3.	2	(.6)
RE-12	Limestone and siltstone. Unit 2-I. Weathers-dark yellowish brown, 10 YR 4/2; fresh-olive gray, 5 Y 4/1. Fairly pure 3-4 feet (0.9-1 meter) above the base of the unit. Silty above and below. Lower foot (0.3 meter) shows light brown clay weathering clasts in a micritic matrix. Fossiliferous	5	(1.5)
	Total Unit 2-I	7	(2.1)
	Concealed. Unit 2-H.	6.5	(1.9)
	Total Unit 2-H	6.5	(1.9)
RE-11	Siltstone. Unit 2-G. Weathering-pale brown, 5 YR 5/2; fresh-pale brown, 5 YR 5/2.	2.5	(.7)
	Total Unit 2-G	2.5	(.7)
RE-10	Sandstone and siltstone. Unit 2-F. Weathers-		

	moderate yellowish brown, 10 YR 5/4; fresh-brownish gray, 5 YR 4/1. Very fine grained. Massive limestone marker lowest 3 feet (0.9 meter) of unit.	5	(1.5)
	Total Unit 2-F	5	(1.5)
RE-9	Siltstone and very fine sandstone. Unit 2-E. Weathers-pale yellowish brown, 10 YR 5/4; fresh-pale brown, 5 YR 5/2.	5	(1.5)
RE-8	Siltstone to very fine sandstone. Unit 2-E. Weathers-moderate yellowish brown, 10 YR 5/4; fresh-pale brown, 5 YR 5/2.	5	(1.5)
RE-7	Siltstone to very fine sandstone. Unit 2-E. Weathers-pale yellowish brown, 10 YR 6/2; fresh-pale brown, 5 YR 5/2. Somewhat thinner bedded than RE-6.	5	(1.5)
RE-6	Siltstone to very fine sandstone. Unit 2-E. Weathers-pale brown, 5 YR 5/2; fresh-pale brown, 5 YR 5/2. Well indurated.	5	(1.5)
	Total Unit 2-E	20	(6.1)
	Concealed. Unit 2-D. Covered with red clay material.	3	(.9)
	Total Unit 2-D	3	(.9)
RE-5	Siltstone. Unit 2-C. Weathers-light brown, 5 YR 6/4; fresh-pale brown, 5 YR 5/2. Cross-bedded, well indurated red bed marker unit.	2.5	(.7)

RE-4	Very fine sandstone and siltstone. Unit 2-C. Weathers-pale brown, 5 YR 5/2; fresh-pale brown, 5 YR 5/2. Cross-bedded, calcareous cement.	5	(1.5)
	Total Unit 2-C	7.5	(2.2)
RE-3, RE-2	Siltstone. Unit 2-B. Weathered-pale yellowish brown, 10 YR 6/2; fresh-light olive gray, 5 Y 6/1. Micaceous, cross-bedded, calcareous cement. Green, glauconitic-like band 3.5 to 4 feet (1.1 to 1.2 meters) above base.	5	(1.5)
	Total Unit 2-B	5	(1.5)
	Concealed. Unit 2-A. Covered with rubble.	5	(1.5)
	Total Unit 2-A	5	(1.5)
	Total Unit 2	66.5	(20.2)
RE-1	Limestone. Unit 1. Weathers-dark yellowish brown, 10 YR 4/2; fresh-medium dark gray, N 4. Fossiliferous, contains ostracodes. Unit in channel of arroyo. Base concealed.	1.5	(.4)
	Total Unit 1	1.5	(.4)
	Total Abo Member	252	(76.8)
	Total Hueco Formation	327.4	(99.8)

Corralitos Ranch Faulted Section (Section 2)

Sec. 15 and 22, T. 22 S., R. 1 W., Southwestern Robledo Mountains, Dona Ana County, New Mexico.

Strike: N. 25° W. Dip: 15°

Sample No.	Description	Feet	(Meters)
	HUECO FORMATION		
	Upper Hueco Limestone Member		
CR-985	Limestone, wackestone to packstone. Unit 16-G. Weathered-light olive gray, 5 Y 6/1; fresh-medium dark gray, N 4. Thin to thick bedded. Nodular chert. Fossils silicified and iron stained and include phylloid algae; sponge, Wewokella (Talpaspongia); brachiopods, Costellarina, Pontisia, and Crurithyris; gastropods, Omphalotrochus, Amaurotoma, Glyptospira, Naticopsis, Trachydomia, and Meekospira; cephalopod, Metacoceras; and bivalves, Nuculopsis and Pteronites; crinoid remains; echinoid remains; enigmatic unknown fossils; and other undiscernable debris. Insoluble residue studies have yielded the following additional forms not described in the taxonomy: gastropods, Peruvispira and Orthonema and scaphopod, Prodentalium.	5	(1.5)
CR-980	Limestone, wackestone to packstone. Unit 16-G.		

	Weathered-light olive gray, 5 Y 6/1; fresh-medium dark gray, N 4. Thin to thick bedded. Nodular chert. Fossils silicified and iron stained and include phylloid algae, gastropods, enigmatic unknown fossil, and other undiscernable debris.	5	(1.5)
CR-975	Limestone, wackestone to packstone. Unit 16-G. Weathered-light olive gray, 5 Y 6/1; fresh-medium dark gray, N 4. Thin to thick bedded. Nodular chert. Fossils silicified and iron stained and include phylloid algae, bryozoa, gastropods, enigmatic unknown fossil, and other undiscernable debris.	5	(1.5)
CR-970	Limestone, wackestone. Unit 16-G. Weathered-light olive gray, 5 Y 6/1; fresh-medium dark gray, N 4. Thin to thick bedded. Nodular chert. Fossils silicified and iron stained and include bryozoa, murchisonid gastropods, and other undiscernable debris.	5	(1.5)
CR-965	Limestone, wackestone. Unit 16-G. Weathered-light olive gray, 5 Y 6/1; fresh-medium dark gray, N 4. Thin to thick bedded. Nodular chert. Fossils silicified and iron stained and include gastropods and other undiscernable debris.	5	(1.5)
CR-960	Limestone, wackestone to packstone. Unit 16-G.		

	Weathered-light olive gray, 5 Y 6/1; fresh-medium dark gray, N 4. Thin to thick bedded. Nodular chert. Fossils silicified and iron stained and include fenestrate and ramose bryozoa, gastropods, echinoid spines, and egnimatic unknown fossil.	5	(1.5)
	Total Unit 16-G	30	(9.1)
CR-955	Limestone, wackestone. Unit 16-F. Weathered-light olive gray, 5 Y 6/1; fresh-medium dark gray, N 4. Thin to thick bedded. Fossils silicified and iron stained and include gastropods and other undiscernable debris.	5	(1.5)
CR-950	Limestone, wackestone. Unit 16-F. Weathered-light olive gray, 5 Y 6/1; fresh-medium dark gray, N 4. Thin to thick bedded. Fossils silicified and iron stained and include gastropods and other undiscernable debris.	5	(1.5)
CR-945	Limestone, wackestone. Unit 16-F. Weathered-light olive gray, 5 Y 6/1; fresh-medium dark gray, N 4. Thin to thick bedded. Fossils silicified and iron stained and include bellerophontid, omphalotrochoid gastropods, and other undiscernable debris.	5	(1.5)
CR-940	Limestone, wackestone. Unit 16-F. Weathered-light olive gray, 5 Y 6/1; fresh-medium dark gray, N 4. Thin to thick bedded. Fossils		

	silicified and iron stained and include phylloid algae, gastropods, and other undiscernable debris.	5	(1.5)
CR-935	Limestone, wackestone. Unit 16-F. Weathered-light olive gray, 5 Y 6/1; fresh-medium dark gray, N 4. Thin to thick bedded. Fossils silicified and iron stained and include gastropods, ostracodes, and other undiscernable debris.	5	(1.5)
	Total Unit 16-F	25	(7.6)
CR-930	Limestone, wackestone. Unit 16-E. Weathered-light olive gray, 5 Y 6/1; fresh-light olive gray, 5 Y 6/1. Thin bedded. Fossiliferous, contains gastropods, brachiopods, and echinoids.	2	(.6)
	Total Unit 16-E	2	(.6)
	Concealed. Unit 16-D. Possibly limestone. Covered by limestone debris.	7	(2.1)
	Total Unit 16-D	7	(2.1)
CR-920	Limestone, wackestone. Unit 16-C. Weathered-light olive gray, 5 Y 6/1; fresh-olive gray, 5 Y 4/1. Thin bedded. Fossiliferous; contains bryozoa, Polypora; brachiopods, Squamaria; bivalves, Pteronites and Septimyalina; gastropods; and echinoid spines, Archaeocidaris.	2.5	(.7)

CR-917.5	Limestone, wackestone. Unit 16-C. Weathered-light olive gray, 5 Y 6/1; fresh-olive gray, 5 Y 4/1. Thin bedded. Fossiliferous; contains bryozoa, Polypora; brachiopods, Squamaria; bivalves, Pteronites and Septimyalina; gastropods; and echinoid spines, Archaeocidaris. Base of unit.	0	(0)
	Total Unit 16-C	2.5	(.7)
	Concealed. Unit 16-B. Possibly limestone. Covered by limestone debris.	7.5	(2.2)
	Total Unit 16-B	7.5	(2.2)
CR-910	Limestone, wackestone. Unit 16-A. Weathered-grayish orange, 10 YR 7/4; fresh-yellowish gray, 5 Y 7/2. Thin bedded. Fossiliferous; contains sponge, Wewokella (Talpaspongia); brachiopods, Squamaria; bivalves, Septimyalina; gastropods, Omphalotrochus; ostracodes; and echinoid spines, Archaeocidaris.	2	(.6)
CR-908	Limestone, wackestone. Unit 16-A. Weathered-grayish orange, 10 YR 7/4; fresh-yellowish gray, 5 Y 7/2. Thin bedded. Fossiliferous; contains bryozoa, Fenestella; brachiopods, Squamaria; bivalves, Pteronites, Bakevellia (Bakevellia), and Permophorus; gastropods, Bellerophon (Bellerophon) and Omphalotrochus; annelids, Spirorbis; ostracodes; crinoids,		

	Pentagonocyclopa; and echinoid spines, Archaeocidaris.	3	(.9)
CR-905	Limestone, wackestone. Unit 16-A. Weathered-light olive gray, 5 Y 6/1; fresh-medium gray, N 4. Thin bedded. Fossiliferous; contains gastropods, Bellerophon (Bellerophon) and Omphalotrochus; ostracodes; and echinoid spines, Archaeocidaris.	2	(.6)
	Total Unit 16-A	7	(2.1)
	Total Upper Hueco Limestone Member	81	(24.7)

Abo Member

	Concealed. Unit 15-B. Possibly siltstone. Covered by siltstone debris.	3	(.9)
	Total Unit 15-B	3	(.9)
CR-895	Siltstone, noncalcareous. Unit 15-A. Weathered-moderate brown, 5 YR 3/4; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-890	Siltstone, noncalcareous. Unit 15-A. Weathered-moderate brown, 5 YR 3/4; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)

CR-885 B	Siltstone, noncalcareous. Unit 15-A. Weathered-moderate brown, 5 YR 3/4; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place. Base of unit.	0	(0)
	Total Unit 15-A	10	(3)
	Total Unit 15	13	(3.9)
CR-885 A	Limestone, wackestone. Unit 14-D. Weathered-light olive gray, 5 Y 6/1; fresh-olive gray, 5 Y 4/1. Thin bedded. Fossiliferous; contains gastropods, ostracodes, and echinoid spines.	5	(1.5)
CR-880	Limestone, wackestone. Unit 14-D. Weathered-light olive gray, 5 Y 6/1; fresh-olive gray, 5 Y 4/1. Thin bedded. Fossiliferous; contains gastropods and ostracodes.	1	(.3)
	Total Unit 14-D	6	(1.8)
	Concealed. Unit 14-C. Covered with gray limestone float and debris.	8	(2.4)
	Total Unit 14-C	8	(2.4)
CR-870	Calcareous marl, mudstone. Unit 14-B. Weathered-grayish orange, 10 YR 7/4; fresh-grayish brown, 5 YR 3/2 to moderate yellowish brown, 10 YR 5/4. Thin bedded, laminated. Biotur-		

	bated (burrows). No discernable fossils.	2	(.6)
	Total Unit 14-B	2	(.6)
	Concealed. Unit 14-A. Covered with limestone debris and float.	6	(1.8)
	Total Unit 14-A	6	(1.8)
	Total Unit 14	20	(6.1)
CR-860	Siltstone, noncalcareous. Unit 13-C. Weathered-moderate brown, 5 YR 3/4; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	8	(2.4)
CR-855	Siltstone, calcareous. Unit 13-C. Weathered-moderate brown, 5 YR 3/4; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-850	Siltstone, slightly calcareous. Unit 13-C. Weathered-moderate brown, 5 YR 3/4; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
	Total Unit 13-C	18	(5.4)
CR-845	Siltstone to sandstone, calcareous. Unit 13-B.		

	Weathered-moderate orange pink, 5 YR 8/4; fresh-grayish orange pink, 5 YR 7/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-840	Siltstone to sandstone, calcareous. Unit 13-B. Weathered-pale red, 5 R 6/2; fresh-pale red, 5 R 6/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-835	Siltstone to sandstone, calcareous. Unit 13-B. Weathered-pale red, 10 R 6/2; fresh-pale red, 5 R 6/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-830	Siltstone to sandstone, calcareous. Unit 13-B. Weathered-moderate orange pink, 10 R 7/4; fresh-moderate pink, 5 R 7/4. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-825	Siltstone to sandstone, calcareous. Unit 13-B. Weathered-grayish orange pink, 5 YR 7/2; fresh-pale red, 5 YR 6/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
	Total Unit 13-B	25	(7.6)

CR-820	Siltstone, calcareous. Unit 13-A. Weathered-moderate brown, 5 YR 3/4; fresh-dark yellowish brown, 10 YR 4/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-815	Siltstone, calcareous. Unit 13-A. Weathered-moderate brown, 5 YR 3/4; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-810	Siltstone, calcareous. Unit 13-A. Weathered-moderate brown, 5 YR 3/4; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-805	Siltstone, calcareous. Unit 13-A. Weathered-pale red, 10 R 6/2; fresh-pale grayish red, 5 R 5/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-800	Siltstone, calcareous. Unit 13-A. Weathered-pale yellowish brown, 10 YR 6/2; fresh-pale red, 5 R 6/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-795	Siltstone, calcareous. Unit 13-A. Weathered-grayish orange, 10 YR 7/4; fresh-grayish red,		

	5 R 4/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-790	Siltstone, calcareous. Unit 13-A. Weathered-pale red, 10 R 6/2; fresh-pale red, 5 R 6/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-785	Siltstone, calcareous. Unit 13-A. Weathered-moderate yellowish brown, 10 YR 5/4; fresh-pale yellowish brown, 10 YR 6/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	1.5	(.4)
	Total Unit 13-A	36.5	(11.1)
	Total Unit 13	79.5	(24.2)
CR-783.5	Limestone, wackestone to packstone. Unit 12-H. Weathered-pale yellowish brown, 10 YR 6/2; fresh-dark yellowish brown, 10 YR 4/2. Thin bedded. Fossiliferous, contains ostracodes and echinoid spines.	5.5	(1.6)
CR-778	Limestone, wackestone. Unit 12-H. Weathered-pale yellowish brown, 10 YR 6/2; fresh-dark yellowish brown, 10 YR 4/2. Thin bedded. Fossiliferous, contains ostracodes and echinoid spines.	3	(.9)

CR-775	Limestone, wackestone. Unit 12-H. Weathered-pale yellowish brown, 10 YR 6/2; fresh-dusky yellowish brown, 10 YR 2/2. Thin bedded. Fossiliferous, contains ostracodes.	.5	(.1)
	Total Unit 12-H	9	(2.7)
	Concealed. Unit 12-G. Possibly limestone. Covered with gray limestone float and debris.	14.5	(4.4)
	Total Unit 12-G	14.5	(4.4)
CR-760	Limestone, wackestone. Unit 12-F. Weathered-light olive gray, 5 Y 6/1; fresh-olive gray, 5 Y 4/1. Thin bedded. Fossiliferous, contains gastropods and ostracodes.	8	(2.4)
	Fault. Left lateral strike slip fault trending in a North-South direction with approximately 5 feet displacement.		
CR-752	Limestone, wackestone. Unit 12-F. Weathered-light olive gray, 5 Y 6/1; fresh-olive gray, 5 Y 4/1. Thin bedded. Fossiliferous, contains gastropods.	2	(.6)
CR-750	Limestone, wackestone to packstone. Unit 12-F. Weathered-light olive gray, 5 Y 6/1; fresh-olive gray, 5 Y 4/1. Thin bedded. Fossiliferous, contains murchisonid and other types of gastropods.	4.5	(1.3)
	Total Unit 12-F	14.5	(4.4)

CR-745	Limestone, wackestone. Unit 12-E. Weathered-grayish orange, 10 YR 7/4; fresh-dark yellowish brown, 10 YR 4/2. Thin bedded. Fossiliferous, contains ostracodes and rare crinoid stems and columnals.	5.5	(1.6)
CR-740	Limestone, wackestone. Unit 12-E. Weathered-light olive gray, 5 Y 6/1; fresh-olive gray, 5 Y 4/1. Thin bedded. Fossiliferous; contains murchisonid and other types of gastropods, ostracodes, and other undiscernable debris.	5	(1.5)
CR-735	Limestone, wackestone. Unit 12-E. Weathered-light olive gray, 5 Y 6/1; fresh-olive gray, 5 Y 4/1. Thin bedded. Fossiliferous; contains murchisonid and other gastropods, ostracodes, and other undiscernable debris. Base of unit.	0	(0)
	Total Unit 12-E	10.5	(3)
	Concealed. Unit 12-D. Possibly limestone: Covered with gray limestone float and debris.	8	(2.4)
	Total Unit 12-D	8	(2.4)
CR-725	Limestone, mudstone. Unit 12-C. Weathered-grayish orange; 10 YR 7/4; fresh-dark yellowish brown, 10 YR 4/2. Thin bedded. Fossiliferous, nondiscernable.	2.5	(.7)
	Total Unit 12-C	2.5	(.7)

CR-720	Calcareous mudstone. Unit 12-B. Weathered-pale yellowish brown, 10 YR 6/2; fresh-very pale orange, 10 YR 8/2. Thin bedded. No discernable fossils.	9.5	(2.8)
	Total Unit 12-B	9.5	(2.8)
CR-715	Limestone, wackestone to mudstone. Unit 12-A. Weathered-grayish orange, 10 YR 7/4; fresh-olive gray, 5 Y 4/1. Thin bedded. Bioturbated (recrystallized burrows). Fossiliferous, contains ostracodes.	8	(2.4)
CR-707 B	Limestone, mudstone. Unit 12-A. Weathered-grayish orange, 10 YR 7/4; fresh-moderate yellowish brown, 10 YR 5/4. Thin bedded. Bioturbated (recrystallized burrows). Fossiliferous, contains ostracodes. Base of unit.	0	(0)
	Total Unit 12-A	8	(2.4)
	Total Unit 12	76.5	(23.3)
CR-707 A	Siltstone to sandstone, noncalcareous. Unit 11-B. Weathered-moderate brown, 5 YR 3/4; fresh-grayish red, 5 R 6/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place.	2	(.6)
CR-705	Siltstone to sandstone, noncalcareous. Unit		

	11-B. Weathered-moderate brown, 5 YR 3/4; fresh-grayish red, 5 R 6/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-700	Siltstone to sandstone, calcareous. Unit 11-B. Weathered-moderate brown, 5 YR 3/4; fresh-grayish red, 5 R 6/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-695	Siltstone to sandstone, slightly calcareous. Unit 11-B. Weathered-moderate brown, 5 YR 3/4; fresh-grayish red, 5 R 6/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
	Total Unit 11-B	17	(5.1)
CR-690	Siltstone, calcareous. Unit 11-A. Weathered-grayish brown, 5 YR 3/2; fresh-grayish red, 5 R 6/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-685	Siltstone, slightly calcareous. Unit 11-A. Weathered-grayish brown, 5 YR 3/2; fresh-grayish red, 5 R 6/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)

CR-680	Siltstone, calcareous. Unit 11-A. Weathered-grayish brown, 5 YR 3/2; fresh-grayish red, 5 R 6/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place.	2	(.6)
CR-678	Siltstone, calcareous. Unit 11-A. Weathered-moderate brown, 5 YR 3/4; fresh-grayish red, 5 R 6/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place. Base of unit.	0	(0)
	Total Unit 11-A	12	(3.6)
	Total Unit 11	29	(8.8)
CR-677	Limestone, wackestone. Unit 10. Weathered-light olive gray, 5 Y 6/1; fresh-medium gray, N 5. Thin bedded. Fossiliferous, contains gastropods and ostracodes. Thinned by intrusion of andesite, appears to be thicker on the flanks of intrusion.	1	(.3)
	Total Unit 10	1	(.3)
CR-675, 670, 668.5	Hornblende Andesite. Unit 9. Color; ground mass weathers-dusky yellowish brown, 10 YR 2/2; feldspars-light bluish gray, 5 B 7/1; other phenocrysts-grayish orange, 10 YR 7/4; ground mass fresh-medium gray, N 5. Contains		

	the following minerals; hornblende, biotite, and plagioclase. Weathers down into clay minerals. Appears to be layered, probable replacement of limestone.	6.5	(1.9)
	Total Unit 9	6.5	(1.9)
	Concealed. Unit 8-D. Probably siltstone. Covered with siltstone debris and float.	5	(1.5)
	Total Unit 8-D	5	(1.5)
-658.5	Claystone, slightly calcareous. Unit 8-C. Weathered-moderate red, 5 R 5/4 to grayish orange, 10 YR 7/4; fresh-very dark red, 5 R 2/6 to dark yellowish orange, 10 YR 6/6. Thin bedded. Vugs filled with calcite.	10	(3)
	Total Unit 8-C	10	(3)
-653.5	Siltstone to sandstone, slightly calcareous. Unit 8-B. Weathered-pale red, 5 R 6/2; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
-648.5	Siltstone to sandstone, calcareous. Unit 8-B. Weathered-moderate brown, 5 YR 3/4; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous.	2.5	(.7)
-645	Siltstone to sandstone, slightly calcareous.		

	Unit 8-B. Weathered-grayish brown, 5 YR 3/2; fresh-pale red, 5 R 6/2. Very fine grained. Hematitic, micaceous.	3	(.9)
CR-640	Siltstone to sandstone, calcareous. Unit 8-B. Weathered-dusky reddish brown, 10 R 2/4; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-635	Siltstone to sandstone, calcareous. Unit 8-B. Weathered-moderate brown, 5 YR 3/4; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-630	Siltstone to sandstone, calcareous. Unit 8-B. Weathered-moderate brown, 5 YR 3/4; fresh-pale red, 10 R 6/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-625	Siltstone to sandstone, calcareous. Unit 8-B. Weathered-moderate brown, 5 YR 3/4; fresh-grayish red, 5 R 6/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
	Total Unit 8-B	30.5	(9.1)
CR-620	Siltstone, slightly calcareous. Unit 8-A. Weathered-dusky reddish brown, 10 R 2/4;		

	fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-630	Siltstone to sandstone, calcareous. Unit 8-B. Weathered-moderate brown, 5 YR 3/4; fresh-pale red, 10 R 6/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-625	Siltstone to sandstone, calcareous. Unit 8-B. Weathered-moderate brown, 5 YR 3/4; fresh-grayish red, 5 R 6/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
	Total Unit 8-B	30.5	(9.1)
CR-620	Siltstone, slightly calcareous. Unit 8-A. Weathered-dusky reddish brown, 10 R 2/4; fresh-grayish red, 5 R 6/2. Thin bedded, thin laminae. Traces or evidence of mud cracks. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-615	Siltstone, calcareous. Unit 8-A. Weathered-dusky reddish brown, 10 R 2/4; fresh-grayish red, 5 R 6/2. Thin bedded, thin laminae. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
	Total Unit 8-A	10	(3)

	Total Unit 8	55.5	(16.9)
CR-610	Limestone, wackestone. Unit 7-M. Weathered-grayish orange, 10 YR 7/4 to pale red purple, 5 RP 6/2; fresh-dark yellowish brown, 10 YR 4/2 to pale reddish brown, 10 R 5/4. Thin bedded. Fossiliferous, contains murchisonid gastropods and ostracodes.	1.5	(.4)
CR-608.5	Limestone, mudstone to wackestone. Unit 7-M. Weathered-dark yellowish brown, 10 YR 4/2 to moderate yellowish brown, 10 YR 4/2; fresh-brownish gray, 5 YR 4/1. Thin bedded. Fossiliferous, contains murchisonid gastropods.	3	(.9)
	Total Unit 7-M	4.5	(1.3)
CR-603.5	Calcareous mudstone. Unit 7-L. Weathered-grayish orange, 10 YR 7/4; fresh-mottled pale red purple, 5 RP 6/2, moderate yellowish brown, 10 YR 5/4, dark yellowish brown, 10 YR 4/2. Laminated, thin bedded. No discernable fossils.	6	(1.8)
CR-598.5	Calcareous mudstone. Unit 7-L. Weathered-dark yellowish brown, 10 YR 4/2; fresh-yellowish brown, 10 YR 3/2. Laminated, thin bedded. No discernable fossils. Base of unit.	0	(0)
	Total Unit 7-L	6	(1.8)

	Concealed. Unit 7-K. Possibly limestone. Covered with limestone float and debris.	87.5	(26.6)
	Total Unit 7-K	87.5	(26.6)
	Total Units 7-K to M	98	(29.8)
	Total Partial Abo Member	379	(115.5)
	Normal Fault, repetition of section		
Upper Hueco Limestone Member			
CR-510	Limestone, wackestone. Unit 7-J. Weathered-medium light gray, N 5; fresh-medium dark gray N 4. Thin bedded. Fossiliferous; contains brachiopods, Squamaria; bivalves, Septimyalina, Pteronites, and Wilkingia; gastropods, Bellerophon (Bellerophon), Straparollus (Euomphalus), and indeterminate forms; and echinoid spines, Archaeocidaris.	6	(1.8)
	Total Unit 7-J	6	(1.8)
	Concealed. Unit 7-I. Possibly limestone. Covered by gray limestone float and debris.	23	(7)
	Total Unit 7-I	23	(7)
CR-480	Limestone, wackestone to packstone. Unit 7-H. Weathered-medium light gray, N 6; fresh-medium		

gray, N 5. Thin bedded. Limonite filling in some cracks. Fossiliferous; contains sponge, Wewokella (Talpaspongia); brachiopods, Squamaria and Linoproductus; bivalves, Septimyalina and Pteronites; gastropods, Bellerophon (Bellerophon) and other indeterminable forms; ostracodes; and echinoid spines, Archaeocidaris. 3 (.9)

Total Unit 7-H 3 (.9)

Concealed. Unit 7-G. Possibly limestone. Covered by limestone float and debris. 8.5 (2.5)

Total Unit 7-G 8.5 (2.5)

CR-470 Limestone, wackestone. Unit 7-F. weathered-medium light gray, N 6; fresh-medium gray, N 5. Thin bedded. Fossiliferous; contains brachiopods, Squamaria and Linoproductus; bivalves, Pteronites; gastropods, Bellerophon (Bellerophon) and other indeterminate forms; ostracodes; and echinoid spines, Archaeocidaris. 1.5 (.4)

Total Unit 7-F 1.5 (.4)

Concealed. Unit 7-E. Possibly limestone. Covered by gray limestone float and debris. 9 (2.7)

Total Unit 7-E 9 (2.7)

CR-460 Calcareous marl, mudstone. Unit 7-D. Weathered-pale grayish orange, 10 YR 8/4; fresh-

grayish orange, 10 YR 7/4. Thin bedded. Fossiliferous, contains gastropods and other undiscernable debris. 1.5 (.4)

Total Unit 7-D 1.5 (.4)

CR-455 Limestone, wackestone to packstone. Unit 7-C. Weathered-light olive gray, 5 Y 6/1; fresh-light olive gray, 5 Y 6/1. Thin bedded. Fossiliferous; contains sponge, Wewokella (Talpaspongia); bryozoa, Fenestella, Polypora, and Septopora; brachiopods, Squamaria; bivalves, Pteronites, Bakevellia (Bakevellia), Septimyalina, and Wilkingia; gastropods, Euphemitopsis, Bellerophon (Bellerophon), Straparollus (Euomphalus), and indeterminate forms; ostracodes; crinoids, Pentagonocyclopa columnals and round stems; and echinoid spines, Archaeocidaris. 8.5 (2.5)

CR-450 Limestone, wackestone to packstone. Unit 7-C. Weathered-light olive gray, 5 Y 6/1; fresh-olive gray, 5 Y 4/1. Thin bedded. Fossiliferous; contains sponge, Wewokella (Talpaspongia); bryozoa, Fenestella and Polypora; brachiopods, Squamaria; bivalves, Pteronites, Septimyalina, Schizodus, and Wilkingia; gastropods, Euphemitopsis, Bellerophon (Bellerophon), Naticopsis (Naticopsis), Soleniscus, and other indeterminate forms; scaphopod, Plagioglypta; ostra-

	codes; echinoid spines, Archaeocidaris; and shark tooth, Petalodus?.	5	(1.5)
CR-445	Limestone, wackestone to packstone. Unit 7-C. Weathered-light olive gray, 5 Y 6/1; fresh-olive gray, 5 Y 4/1. Thin bedded. Fossiliferous; contains sponge, Wewokella (Talpaspongia); brachiopods, Squamaria; bivalves, Septimyalina; gastropods, Bellerophon (Bellerophon) and other indeterminate forms; and echinoid spines, Archaeocidaris.	1	(.3)
	Total Unit 7-C	14.5	(4.4)
	Concealed. Unit 7-B. Possibly limestone. Covered by limestone float and debris.	6	(1.8)
	Total Unit 7-B	6	(1.8)
CR-435	Limestone, wackestone. Unit 7-A. Weathered-medium gray, N 5; fresh-medium dark gray, N 4. Thin bedded. Fossiliferous; contains bivalve fragments; gastropods; crinoid stems; and echinoid spines, Archaeocidaris.	8	(2.4)
	Total Unit 7-A	8	(2.4)
	Total Upper Hueco Limestone Member	81	(24.7)

Reverse Fault, additional section

Abo Member

CR-430	Siltstone, slightly calcareous. Unit 6-C.		

	Weathered-pale reddish brown, 10 R 5/4 to grayish orange, 10 YR 7/4; fresh-grayish red, 5 R 4/2 to moderate yellowish brown, 10 YR 5/4. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-425	Siltstone, noncalcareous. Unit 6-C. Weathered-grayish red, 10 R 4/6 to grayish orange, 10 YR 7/4; fresh-grayish red, 5 R 4/2 to pale brown, 5 YR 5/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-420	Siltstone, calcareous. Unit 6-C. Weathered-grayish red, 10 R 4/6; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place.		
	Total Unit 6-C	15	(4.5)
CR-415	Siltstone to sandstone, calcareous. Unit 6-B. Weathered-pale red, 5 R 6/2; fresh-pale red, 10 R 6/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-410	Siltstone to sandstone, calcareous. Unit 6-B. Weathered-pale red, 5 R 6/2; fresh-pale red, 10 R 6/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous.		

	ceous. 0.5 feet (0.1 meter) exposed on surface.	5	(1.5)
	Total Unit 6-B	10	(3)
CR-405	Siltstone, calcareous. Unit 6-A. Weathered-moderate reddish brown, 10 R 4/6; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-400	Siltstone, slightly calcareous. Unit 6-A. Weathered-deep reddish brown, 10 R 4/4; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-395	Siltstone, slightly calcareous. Unit 6-A. Weathered-moderate brown, 5 YR 3/4; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-390	Siltstone, slightly calcareous. Unit 6-A. Weathered-moderate reddish brown, 10 R 4/6; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-385	Siltstone, calcareous. Unit 6-A. Weathered-grayish red, 10 R 4/2; fresh-grayish red, 5 R		

	4/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic-micaceous. Sample probably not in place.	5	(1.5)
CR-380	Siltstone, calcareous. Unit 6-A. Weathered-grayish red, 10 R 4/2; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-375	Siltstone, calcareous. Unit 6-A. Weathered-grayish red, 10 R 4/2; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-370	Siltstone, calcareous. Unit 6-A. Weathered-moderate reddish brown, 10 R 4/6; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
	Total Unit 6-A	40	(12.2)
	Total Unit 6	65	(19.8)
CR-365	Limestone, wackestone. Unit 5-I. Weathered-light olive gray, 5 Y 6/1; fresh-pale brown, 5 YR 5/2. Laminae-moderate yellowish brown, 10 YR 5/4. Thin bedded, laminated. Fossiliferous, contains gastropods, ostracodes, and		

	echinoid spines.	5	(1.5)
CR-360	Limestone, wackestone. Unit 5-I. Weathered-light olive gray, 5 Y 6/1; fresh-pale brown, 5 YR 5/2. Laminae-moderate yellowish brown, 10 YR 5/4. Thin bedded, laminated. Fossiliferous, contains gastropods, ostracodes, and echinoid spines.	5	(1.5)
	Total Unit 5-I	10	(3)
CR-355	Limestone, wackestone. Unit 5-H. Weathered-medium light gray, N 6; fresh-medium gray, N 5. Thin bedded. Fossiliferous, contains gastropods and ostracodes.	2	(.6)
	Total Unit 5-H	2	(.6)
CR-350	Limestone, wackestone. Unit 5-G. Weathered-light olive gray, 5 Y 6/1; fresh-dark yellowish brown, 10 YR 4/2. Thin bedded. Fossiliferous, contains ostracodes and echinoid spines.	4.5	(1.3)
CR-348.5	Limestone, wackestone. Unit 5-G. Weathered-moderate yellowish brown, 10 YR 5/4 to dark yellowish orange, 10 YR 6/6; fresh-dark yellowish brown, 10 YR 4/2 to moderate yellowish brown, 10 YR 5/4. Thin bedded. Fossiliferous, contains gastropods, ostracodes, and echinoid spines.	3.5	(1)
CR-345	Limestone, wackestone. Unit 5-G. Weathered-		

	moderate yellowish brown, 10 YR 5/4 to dark yellowish brown, 10 YR 6/6; fresh-dark yellowish brown, 10 YR 4/2 to moderate yellowish brown, 10 YR 5/4. Thin bedded. Fossiliferous, contains gastropods, ostracodes, and echinoid spines and plates. Base of unit.	0	(0)
	Total Unit 5-G	8	(2.4)
CR-340	Limestone, wackestone. Unit 5-F. Weathered-light olive gray, 5 Y 6/1; fresh-pale yellowish brown, 10 YR 6/2. Thin bedded. Fossiliferous, contains gastropods, coiled nautiloids, and ostracodes.	5	(1.5)
CR-335	Limestone, wackestone. Unit 5-F. Weathered-light olive gray, 5 Y 6/1; fresh-olive gray, 5 Y 4/1. Thin bedded. Fossiliferous, contains gastropods and ostracodes.	5	(1.5)
CR-330	Limestone, wackestone. Unit 5-F. Weathered-light olive gray, 5 Y 6/1; fresh-dark yellowish brown, 10 YR 4/2. Thin bedded. Fossiliferous, contains gastropods and ostracodes.	5	(1.5)
CR-325	Limestone, wackestone. Unit 5-F. Weathered-light olive gray, 5 Y 6/1; fresh-olive gray, 5 Y 4/1. Thin bedded. Fossiliferous, contains gastropods and ostracodes.	5	(1.5)
CR-320	Limestone, wackestone. Unit 5-F. Weathered-light olive gray, 5 Y 6/1; fresh-olive gray,		

	5 Y 4/1. Thin bedded. Fossiliferous, contains gastropods and ostracodes. Base of unit.	0	(0)
	Total Unit 5-F	25	(7.6)
CR-315	Limestone, mudstone to wackestone. Unit 5-E. Weathered-pale yellowish orange, 10 YR 8/6, grayish pink, 5 YR 7/2, and pale yellowish brown, 10 YR 6/2; fresh-dark yellowish orange, 10 YR 6/6, dark reddish brown, 5 YR 4/4, moderate brown, 5 YR 4/4, and pale brown, 5 YR 5/2. Varigated. Thin bedded. Fossiliferous, contains ostracodes and other undiscernable debris.	10	(3)
	Total Unit 5-E	10	(3)
CR-310	Limestone, wackestone. Unit 5-D. Weathered-light olive gray, 5 Y 6/1; fresh-olive gray, 5 Y 4/1. Thin bedded. Vugs filled with calcite crystals. Fossiliferous, contains gastropods and ostracodes.	5	(1.5)
CR-305	Limestone, wackestone. Unit 5-D. Weathered-light olive gray, 5 Y 6/1; fresh-dark yellowish brown, 10 YR 4/2. Thin bedded. Fossiliferous, contains gastropods, nautiloid cephalopods, and ostracodes.	5	(1.5)
CR-300	Limestone, wackestone. Unit 5-D. Weathered-grayish orange, 10 YR 7/4; fresh-moderate yellowish brown, 10 YR 5/4. Thin bedded.		

	Fossiliferous, contains gastropods and ostracodes.	5	(1.5)
CR-295	Limestone, wackestone. Unit 5-D. Weathered-grayish orange, 10 YR 7/4; fresh-dark yellowish brown, 10 YR 4/2. Thin bedded. Secondary formation of calcite crystals along fracture lines. Fossiliferous, contains ostracodes.	1	(.3)
	Total Unit 5-D	16	(4.8)
CR-290	Limestone, wackestone to mudstone. Unit 5-C. Weathered-pale yellowish orange, 10 YR 8/6 to pale red purple, 5 RP 6/2; fresh-dark yellowish orange, 10 YR 6/6 to grayish red purple, 5 RP 4/2. Thin bedded. Bioturbated. Fossiliferous, contains ostracodes.	6	(1.8)
	Total Unit 5-C	6	(1.8)
	Concealed. Unit 5-B. Possibly limestone. Covered by limestone float and debris.	17	(5.1)
	Total Unit 5-B	17	(5.1)
	Total Repeated Abo Member	159	(48.4)
	Normal Fault, repetition of section		
Abo Member			
CR-270	Limestone, wackestone. Unit 5-A. Weathered-medium light gray, N 6; fresh-medium gray, N		

	5. Thin bedded. Fossiliferous, contains ostracodes.	6	(1.8)
CR-265	Limestone, wackestone. Unit 5-A. Weathered-medium light gray, N 6; fresh-medium light gray, N 6. Thin bedded. Fossiliferous, contains ostracodes, small crinoid stems, and small echinoid spines.	5	(1.5)
CR-260	Limestone, wackestone. Unit 5-A. Weathered-medium light gray, N 6; fresh-medium light gray, N 6. Thin bedded. Fossiliferous, contains ostracodes and other undiscernable debris.	4	(1.2)
	Total Unit 5-A	15	(4.5)
CR-255	Siltstone, calcareous. Unit 4-B. Weathered-pale red, 10 R 6/2; fresh-pale reddish brown, 10 R 5/4. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Two feet (0.6 meter) exposed.	6	(1.8)
CR-250	Siltstone, noncalcareous. Unit 4-B. Weathered-pale dark reddish brown, 10 YR 4/4; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-245	Siltstone, noncalcareous. Unit 14-B. Weathered-pale dark reddish brown, 10 R 4/4; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic,		

	micaceous. Sample probably not in place.	5	(1.5)
	Total Unit 4-B	16	(4.8)
CR-240	Siltstone, noncalcareous. Unit 4-A. Weathered-pale reddish brown, 10 R 4/4; fresh-pale brown, 5 YR 5/2 with grayish red, 5 R 4/2, laminae. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-235	Siltstone, noncalcareous. Unit 4-A. Weathered-pale dark reddish brown, 10 R 4/4; fresh-pale brown, 5 YR 5/2 with grayish red, 5 R 4/2, laminae. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place,	5	(1.5)
CR-230	Siltstone, calcareous. Unit 4-A. Weathered-moderate yellowish brown, 10 R 4/6; fresh-moderate yellowish brown, 10 YR 5/4. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
	Total Unit 4-A	15	(4.5)
	Total Unit 4	31	(9.4)
CR-225	Limestone, wackestone. Unit 3-F. Weathered-light olive gray, 5 Y 6/1; fresh-dark yellow-		

	ish brown, 10 YR 4/2. Thin bedded. Bioturbated (burrows) with limonite stains outlining bioturbated zones on weathered surface. Fossiliferous, contains ostracodes.	5	(1.5)
CR-220	Limestone, wackestone. Unit 3-F. Weathered-light olive gray, 5 Y 6/1; fresh-dark yellowish brown, 10 YR 4/2. Thin bedded. Fossiliferous, contains gastropods and ostracodes.	5	(1.5)
	Total Unit 3-F	10	(3)
CR-215	Limestone, mudstone. Unit 3-E. Weathered-yellowish gray, 5 Y 7/2; fresh-dark yellowish brown, 10 YR 4/2. Thin bedded. Bioturbated (burrows). Fossiliferous, contains ostracodes and other undiscernable remains.	5	(1.5)
CR-210	Limestone, mudstone. Unit 3-E. Weathered-grayish orange, 10 YR 7/4; fresh-dark yellowish brown, 10 YR 4/2. Thin bedded. Bioturbated (burrows). Fossiliferous, contains ostracodes and other undiscernable debris.	5	(1.5)
	Total Unit 3-E	10	(3)
CR-205	Argillaceous limestone, claystone. Unit 3-D. Weathered-pale red, 5 R 6/2 and grayish orange, 10 YR 7/4; fresh-grayish red, 5 R 4/2 and dark yellowish brown, 10 YR 4/2. Thin bedded. Laminated, bioturbated. No discernable fossils.	2	(.6)

CR-203	Argillaceous limestone, mudstone. Unit 3-D. Weathered-pale yellowish brown, 10 YR 6/2; fresh-grayish red, 5 R 4/2. Thin bedded. Appears unfossiliferous.	1	(.3)
	Total Unit 3-D	3	(.9)
CR-202	Limestone, wackestone to mudstone. Unit 3-C. Weathered-light olive gray, 5 Y 6/1; fresh-dark yellowish brown, 10 YR 4/2. Thin bedded. Fossiliferous, contains ostracodes.	1.5	(.4)
	Total Unit 3-C	1.5	(.4)
	Concealed. Unit 3-B. Possibly limestone. Covered by limestone float and debris.	10.5	(3.2)
	Total Unit 3-B	10.5	(3.2)
CR-190	Limestone, wackestone to mudstone. Unit 3-A. Weathered-dark yellowish brown, 10 YR 6/6; fresh-dark yellowish brown, 10 YR 4/2. Thin bedded. Fossiliferous, contains bivalves, ostracodes, and other undiscernable debris.	3	(.9)
	Total Unit 3-A	3	(.9)
	Total Unit 3	38	(11.5)
CR-185	Argillaceous limestone, claystone. Unit 2-I. Weathered-pale red, 5 R 6/2 and grayish orange, 10 YR 7/4; fresh-dusky red, 5 R 3/4 and dark		

	yellowish orange, 10 YR 6/6. Thin bedded, laminated. Bioturbated, intraclastal with some undiscernable fossil debris.	7	(2.1)
CR-180	Argillaceous limestone, claystone. Unit 2-I. Weathered-light brown, 5 YR 6/4; fresh-dusky red, 5 R 3/4. Thin bedded, laminated. Bioturbated, intraclastal with minor amount of undiscernable fossil debris.	1	(.3)
	Total Unit 2-I	8	(2.4)
	Concealed,. Unit 2-H. Covered with siltstone float and debris.	6	(1.8)
	Total Unit 2-H	6	(1.8)
CR-173	Siltstone, noncalcareous. Unit 2-G. Weathered-moderate brown, 5 YR 4/4; fresh-grayish red, 5 R 4/2 and moderate yellowish brown, 10 YR 5/4. Thin bedded, thin laminae. Bioturbated (burrows). Very fine grained. Hematitic, micaceous. 0.5 feet (0.1 meter) exposed.	3	(.9)
	Total Unit 2-G	3	(.9)
CR-170	Siltstone, slightly calcareous. Unit 2-F. Weathered-light reddish brown, 10 R 4/4; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)

CR-165	Siltstone, slightly calcareous. Unit 2-F. Weathered-pale reddish brown, 10 R 5/4; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-160	Siltstone, slightly calcareous. Unit 2-F. Weathered-grayish red, 10 R 4/2; fresh-moderate yellowish brown, 10 YR 5/4. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
	Total Unit 2-F	15	(4.5)
CR-155	Siltstone, calcareous. Unit 2-E. Weathered-pale reddish brown, 10 R 5/4; fresh-pale red, 5 R 6/2 to grayish red, 5 R 4/2. Thin bedded, thin laminae. Bioturbated (burrows). Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-150	Siltstone, calcareous. Unit 2-E. Weathered-pale red, 5 R 6/2; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae. Bioturbated (burrows). Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
	Total Unit 2-E	10	(3)
CR-145	Siltstone, noncalcareous. Unit 2-D. Weathered-		

	moderate brown, 5 YR 3/4; fresh-pale red, 5 R 6/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous.	5	(1.5)
CR-140	Siltsone, slightly calcareous. Unit 2-D. Weathered-dark reddish brown, 10 R 3/4; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous.	5	(1.5)
	Total Unit 2-D	10	(3)
CR-135	Siltstone, slightly calcareous. Unit 2-C. Weathered-light reddish brown, 10 R 4/4; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae. Bioturbated (burrows and trails). Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-130	Siltstone, calcareous. Unit 2-C. Weathered-pale reddish brown, 10 R 5/4; fresh-moderate red, 5 R 5/4. Thin bedded, thin laminae. Bioturbated (burrows). Suggestion of ripple marks. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-125	Siltstone, slightly calcareous. Unit 2-C. Weathered-pale grayish red, 5 R 5/2; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)

CR-120	Siltstone, slightly calcareous. Unit 2-C. Weathered-dark reddish brown, 10 R 3/4; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae. Suggestion of ripple marks. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-115	Siltstone, slightly calcareous. Unit 2-C. Weathered-dark reddish brown, 10 R 3/4; fresh-pale grayish red, 5 R 5/2. Thin bedded, thin laminae. Suggestion of ripple marks. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-110	Siltstone, calcareous. Unit 2-C. Weathered-dark reddish brown, 10 R 3/4; fresh-pale grayish red, 5 R 5/2. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
	Total Unit 2-C	30	(9.1)
CR-105	Siltstone, slightly calcareous. Unit 2-B. Weathered-moderate brown, 5 YR 3/4; fresh-moderate brown, 5 YR 3/4. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-100	Siltstone, slightly calcareous. Unit 2-B. Weathered-moderate brown, 5 YR 3/4 to dusky brown, 5 YR 2/2; fresh-moderate		

	brown, 5 YR 4/4. Thin bedded, thin laminae. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
	Total Unit 2-B	10	(3)
CR-95	Siltstone, slightly calcareous. Unit 2-A. Weathered-dark reddish brown, 10 R 3/4; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-90	Siltstone, slightly calcareous. Unit 2-A. Weathered-dark reddish brown, 10 R 3/4; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous. Sample probably not in place.	5	(1.5)
CR-85	Siltstone, calcareous. Unit 2-A. Weathered-light brown, 5 YR 6/4; fresh-grayish red, 5 R 4/2. Thin bedded, thin laminae. Bioturbated (trails). Very fine grained. Hematitic, micaceous. Three inches (0.09 meter) exposed.	5	(1.5)
	Total Unit 2-A	15	(4.5)
	Total Unit 2	107	(32.6)
	Total Abo Member	177	(53.9)

Middle Hueco Limestone Member

	Concealed. Unit 1-D. Possibly limestone. Covered by limestone float and debris.	25	(7.6)
	Total Unit 1-D	25	(7.6)
CR-55	Limestone, mudstone to wackestone. Unit 1-C. Weathered-light olive gray, 5 Y 6/1; fresh-dark yellowish brown, 10 YR 4/2. Thin bedded. Fossiliferous, contains ostracodes.	5	(1.5)
CR-50	Limestone, mudstone to wackestone. Unit 1-C. Weathered-light olive gray, 5 Y 6/1; fresh-dark yellowish brown, 10 YR 4/2. Thin bedded. Fossiliferous, contains ostracodes. Base of unit.	0	(0)
	Total Unit 1-C	5	(1.5)
CR-45	Limestone, mudstone. Unit 1-B. Weathered-light olive gray, 5 Y 6/1; fresh-pale yellowish brown, 10 YR 6/2. Thin bedded. Fossiliferous, contains ostracodes.	10	(3)
CR-40	Limestone, mudstone. Unit 1-B. Weathered-light olive gray, 5 Y 6/1; fresh-pale yellowish brown, 10 YR 6/2. Thin bedded. Fossiliferous, contains ostracodes.	5	(1.5)
CR-35	Limestone, mudstone. Unit 1-B. Weathered-pale yellowish brown, 10 YR 6/2; fresh-pale yellowish brown, 10 YR 6/2. Thin bedded.		

	Fossiliferous, contains ostracodes and other undiscernable debris.	5	(1.5)
CR-30	Limestone, mudstone. Unit 1-B. Weathered-grayish orange, 10 YR 7/4; fresh-light brown, 5 YR 6/4. Thin bedded. Fossiliferous; contains ostracodes and other undiscernable debris.	5	(1.5)
CR-25	Limestone, mudstone. Unit 1-B. Weathered-light olive gray, 5 Y 6/1; fresh-pale yellowish brown, 10 YR 6/2. Thin bedded. Fossiliferous, contains ostracodes and other undiscernable debris. Base of unit.	0	(0)
	Total Unit 1-B	25	(7.6)
CR-20	Limestone, mudstone. Unit 1-A. Weathered-grayish orange, 10 YR 7/2; fresh-dark yellowish brown, 10 YR 4/2. Thin bedded. Fossiliferous, contains ostracodes. Bioturbated (burrows, recrystallized). Laminated.	10	(3)
CR-15	Limestone, mudstone. Unit 1-A. Weathered-grayish orange, 10 YR 7/2; fresh-dark yellowish brown, 10 YR 4/2. Thin bedded. Fossiliferous, contains ostracodes.	5	(1.5)
CR-10	Limestone, mudstone. Unit 1-A. Weathered-grayish orange, 10 YR 7/2; fresh-dark yellowish brown, 10 YR 4/2. Thin bedded. Fossiliferous, contains ostracodes and other undis-		

	cernable debris.	5	(1.5)
CR-5	Limestone, mudstone. Unit 1-A. Weathered-light olive gray, 5 Y 6/1; fresh-dark yellowish brown, 10 YR 4/2. Thin bedded. Fossiliferous, contains ostracodes. Bioturbated (burrows, recrystallized). Slabby weathering.	5	(1.5)
CR-0	Limestone, mudstone. Unit 1-A. Weathered-light olive gray, 5 Y 6/1; fresh-pale yellowish brown, 10 YR 6/2. Thin bedded. Fossiliferous, contains ostracodes. Beginning of measured section. Middle Hueco Limestone Member not completely measured.	0	(0)
	Total Unit 1-A	25	(7.6)
	Partial Total Upper Middle Hueco Limestone Member	80	(24.4)
	Total Faulted Hueco Formation	985	(300)

Hawkins East Tank Section (Section 3)

NW 1/4, NE 1/4, Sec. 28, T. 22 S., R. 1 W., Southwestern Robledo Mountains, Dona Ana County, New Mexico.

Strike: N. 25° W. Dip: 15°

Sample No.	Description	Feet	(Meters)
	HUECO FORMATION		
	Upper Hueco Limestone Member		
HE-269	Limestone, wackestone. Unit 8-F. Weathered-medium gray, N 5; fresh-dark olive gray, 5 Y 3/1. Thin to thick bedded. Small amount of chert. Silicified fossils iron stained and include gastropods and echinoid spines.	4	(1.2)
	Total Unit 8-F	4	(1.2)
	Concealed. Unit 8-E. Possibly limestone, covered by limestone float and debris.	5	(1.5)
	Total Unit 8-E	5	(1.5)
HE-260	Limestone, wackestone. Unit 8-D. Weathered-medium gray, N 5; fresh-dark olive gray, 5 Y 3/1. Thin to thick bedded. Fossils silicified and iron stained and include phylloid algae, gastropods, and echinoid spines.	5	(1.5)
HE-255	Limestone, wackestone. Unit 8-D. Weathered-medium light gray, N 6; fresh-dark olive gray, 5 Y 3/1. Thin to thick bedded. Fossils sil-		

	icified and iron stained and include gastropods and echinoid spines.	5	(1.5)
HE-250	Limestone, wackestone. Unit 8-D. Weathered-light olive gray, 5 Y 6/1; fresh-dark olive gray, 5 Y 3/1. Thin to thick bedded. Fossils silicified and iron stained and include gastropods and echinoid spines.	5	(1.5)
	Total Unit 8-D	15	(4.5)
	Concealed. Probably limestone. Unit 8-C. Covered by limestone debris.	3	(.9)
	Total Unit 8-C	3	(.9)
HE-242	Limestone, wackestone. Unit 8-B. Weathered-medium gray, N 5; fresh-dark olive gray, 5 Y 3/1. Thin to thick bedded. Fossils silicified and iron stained and include phylloid algae; sponges, Wewokella (Talpaspongia); brachiopods; bivalves, Septimyalina; and gastropods, Bellerophon (Bellerophon) and Omphalotrochus, others indeterminate. Calcite in the form of veinlettes.	7	(2.1)
HE-235	Limestone, wackestone to mudstone. Unit 8-B. Weathered-light olive gray, 5 Y 6/1; fresh-dark olive gray, 5 Y 3/1. Thin to thick bedded. Fossils silicified and iron stained and include phylloid algae; sponges, Wewokella (Talpaspongia); brachiopods; gastropods,		

	Bellerophon (Bellerophon) and Omphalotrochus; and unidentifiable debris.	5	(1.5)
	Total Unit 8-B	12	(3.6)
	Concealed. Unit 8-A. Possibly limestone. Covered by limestone debris.	10	(3)
	Total Unit 8-A	10	(3)
	Total Upper Hueco Limestone Member	49	(14.9)
Abo Member			
	Concealed. Siltstone. Unit 7. Covered with siltstone float and debris. Hematitic, micaceous. Slope former.	40	(12.2)
	Total Unit 7	40	(12.2)
HE-180	Limestone, wackestone. Unit 6-J. Weathered-light olive gray, 5 Y 6/1; fresh-olive gray, 5 Y 4/1. Thin bedded. Fossiliferous; contains sponges, Wewokella (Taldaspongia); brachiopods, Squamaria; bivalves; and echinoid spines.	5	(1.5)
	Total Unit 6-J	5	(1.5)
	Concealed. Unit 6-I. Covered by limestone float and debris.	5	(1.5)
	Total Unit 6-I	5	(1.5)

HE-170 Limestone, wackestone. Unit 6-H. Weathered-light gray, N 6; fresh-dark olive gray, 5 Y 3/1. Thin bedded. Fossils include brachiopods, Squamaria; bivalves, Pteronites; gastropods; and echinoid spines. 5 (1.5)

HE-165 Limestone, wackestone. Unit 6-H. Weathered-light olive gray, 5 Y 6/1; fresh-dark olive gray, 5 Y 3/1. Thin bedded. Fossils include brachiopods, Squamaria; bivalves; gastropods; scaphopods; and echinoid spines. 5 (1.5)

HE-160 Limestone, wackestone. Unit 6-H. Weathered-light olive gray, 5 Y 6/1; fresh-dark olive gray, 5 Y 3/1. Thin bedded. Fossils include fenestrate bryozoa; brachiopods, Squamaria; bivalves, Pteronites; gastropods; and echinoid remains, Archaeocidaris. 5 (1.5)

HE-155 Limestone, wackestone. Unit 6-H. Weathered-light olive gray, 5 Y 6/1; fresh-dark olive gray, 5 Y 3/1. Thin bedded. Fossils include brachiopods, Squamaria; bivalves, Pteronites; gastropods; and echinoid remains, Archaeocidaris. 5 (1.5)

HE-150 Limestone, wackestone. Unit 6-H. Weathered-light olive gray, 5 Y 6/1; fresh-dark olive gray, 5 Y 3/1. Thin bedded. Fossils include brachiopods, Squamaria; bivalves, Pteronites; gastropods; and echinoid remains, Archaeocid-

	aris.	5	(1.5)
HE-145	Limestone, wackestone. Unit 6-H. Weathered-medium light gray, N 6; fresh-dark olive gray, 5 Y 3/1. Thin bedded. Fossils include brachiopods, Derbyia and Squamaria; bivalves, Pteronites; gastropods; and echinoid remains, Archaeocidaris.	5	(1.5)
	Total Unit 6-H	30	(9.1)
	Concealed. Unit 6-G. Possibly limestone. Covered with limestone debris.	10	(3)
	Total Unit 6-G	10	(3)
HE-130	Limestone, wackestone. Unit 6-F. Weathered-light olive gray, 5 Y 6/1; fresh-olive gray, 5 Y 4/1. Thin bedded. Fossils include brachiopods, Squamaria; and echinoid remains, Archaeocidaris.	5	(1.5)
	Total Unit 6-F	5	(1.5)
	Concealed. Unit 6-E. Possibly limestone. Covered by limestone debris.	2	(.6)
	Total Unit 6-E	2	(.6)
HE-123	Limestone, wackestone. Unit 6-D. Weathered-light olive gray, 5 Y 6/1; fresh-olive gray, 5 Y 4/1. Thin bedded. Fossils include brachiopods, Squamaria; gastropods; and ostracodes.	3	(.9)
	Total Unit 6-D	3	(.9)

	Concealed. Unit 6-C. Possibly limestone. Covered by limestone debris.	3.5	(1)
	Total Unit 6-C	3.5	(1)
HE-115	Limestone, wackestone to packstone. Unit 6-B. Weathered-light olive gray, 5 Y 6/1; fresh-olive gray, 5 Y 4/1 to light olive gray, 5 Y 6/1. Thin bedded. Fossils include brachiopod, Squamaria; gastropods, bellerophontid; cephalopods, Mooreoceras; crinoid remains; and echinoid spines.	6.5	(1.9)
	Total Unit 6-B	6.5	(1.9)
	Concealed. Unit 6-A. Possibly limestone. Covered by limestone debris.	5	(1.5)
	Total Unit 6-A	5	(1.5)
	Total Unit 6	75	(22.8)
	Concealed. Unit 5-C. Probably siltstone. Covered by siltstone and limestone debris.	5	(1.5)
	Total Unit 5-C	5	(1.5)
HE-100	Siltstone, calcareous. Unit 5-B. Weathered-grayish red, 10 R 4/2; fresh-grayish red, 5 R 4/2. Thin bedded, cross-bedded, thin laminae. Hematitic, micaceous. Very fine grained.	5	(1.5)
	Total Unit 5-B	5	(1.5)

	Concealed. Unit 5-A. Probably siltstone.		
	Covered by siltstone debris.	5	(1.5)
	Total Unit 5-A	5	(1.5)
	Total Unit 5	15	(4.5)
HE-84	Limestone, mudstone. Unit 4-E. Weathered-light olive gray, 5 Y 6/1; fresh-olive gray, 5 Y 4/1. Thin bedded. Fossiliferous.	.25	(.07)
	Total Unit 4-E	.25	(.07)
	Concealed. Unit 4-D. Possibly limestone.		
	Covered by limestone debris.	8.75	(2.6)
	Total Unit 4-D	8.75	(2.6)
HE-75	Limestone, wackestone. Unit 4-C. Weathered-light olive gray, 5 Y 6/1; fresh-olive gray, 5 Y 4/1. Thin bedded. Fossiliferous, contains ostracodes.	.5	(.1)
	Total Unit 4-C	.5	(.1)
	Concealed. Unit 4-B. Possibly limestone.		
	Covered by grayish limestone debris.	9.5	(2.8)
	Total Unit 4-B	9.5	(2.8)
	Concealed. Unit 4-A. Possibly limestone.		
	Covered by yellowish limestone debris.	10	(3)
	Total Unit 4-A	10	(3)

	Total Unit 4	35	(10.6)
HE-55	Sandstone, calcareous. Unit 3-C. Weathered-very dusky red, 5 R 3/2; fresh-pale red, 5 R 6/2. Thin bedded, thin laminae. Very fine grained, hematitic.	5.5	(1.6)
	Total Unit 3-C	5.5	(1.6)
	Concealed. Unit 3-B. Probably sandstone or siltstone. Covered by siltstone debris.	10	(3)
	Total Unit 3-B	10	(3)
	Concealed. Unit 3-A. Probable contact between siltstone and limestone. Abundant siltstone with small amount of limestone debris.	5	(1.5)
	Total Unit 3-A	5	(1.5)
	Total Unit 3	20.5	(6.2)
	Concealed. Unit 2-E. Probably limestone. Covered by limestone debris, with minor amount of siltstone float in upper 20 feet (6.1 meters). Slope former.	33.5	(10.2)
	Total Unit 2-E	33.5	(10.2)
HE-1.5	Limestone, wackestone. Unit 2-D. Weathered-medium light gray, N 6; fresh-dark gray, N 3.		

	Thin bedded. Fossils include brachiopods, Squamaria; gastropods; echinoid spines; and other debris.	1.5	(.4)
HE-0	Limestone, wackestone. Unit 2-D. Weathered-medium light gray, N 6; fresh-dark gray, N 3. Thin bedded. Fossils include brachiopods, Squamaria; gastropods; echinoid spines; and other debris. Base of unit.	0	(0)
	Total Unit 2-D	1.5	(.4)
	Concealed. Unit 2-C. Possibly limestone. Covered by limestone debris.	20	(6.1)
	Total Unit 2-C	20	(6.1)
HEX-35	Limestone, wackestone. Unit 2-B. Weathered-light olive gray, 5 Y 6/1; fresh-olive gray, 5 Y 4/1. Thin bedded, bioturbated. Fossiliferous, contains bivalves and ostracodes.	2	(.6)
	Total Unit 2-B	2	(.6)
	Concealed. Unit 2-A. Possibly limestone. Covered by limestone debris.	6	(1.8)
	Total Unit 2-A	6	(1.8)
	Total Unit 2	63	(19.2)
HEX-28	Calcareous mudstone. Unit 1-D. Weathered-grayish orange, 10 YR 7/4; fresh-moderate		

	brown, 5 YR 3/4. Thin bedded, laminated. Nonfossiliferous.	1	(.3)
HEX-27	Calcareous mudstone. Unit 1-D. Weathered-pale red, 5 R 6/2 to grayish orange, 10 YR 7/4; fresh-grayish red, 5 R 4/2 to dark yellowish orange, 10 YR 6/6. Thin bedded. Nonfossiliferous.	3.1	(.9)
	Total Unit 1-D	4.1	(1.2)
	Concealed. Unit 1-C. Possibly siltstone. Covered by siltstone debris.	9.9	(3)
	Total Unit 1-C	9.9	(3)
HEX-15	Siltstone, calcareous. Unit 1-B. Weathered-dark reddish brown, 10 R 3/4; fresh-grayish red, 5 R 4/2. Thin bedded, fissile, thin laminae, cross-bedded. Hematitic, micaceous.	5	(1.5)
	Total Unit 1-B	5	(1.5)
	Concealed. Unit 1-A. Possibly siltstone. Covered by siltstone debris. Unit in channel of arroyo. Base concealed.	10	(3)
	Total Unit 1-A	10	(3)
	Total Unit 1	29	(8.8)
	Total Abo Member	277.5	(84.6)

Total Hueco Formation 326.5 (99.5)

Dona Ana Mountains Section (Section 4)

NW 1/4, SE 1/4, Sec. 8, T. 21 S., R. 1 E., Western Dona Ana Mountains, Dona Ana County, New Mexico.

Strike: N. 23° W. Dip: 23°-10°

Sample No.	Description	Feet	(Meters)
	HUECO FORMATION		
	Abo Member		
SDA-325.1	Limestone, mudstone-wackestone. Unit 14-B. Weathered-medium dark gray, N 4; fresh-dark gray, N 3; homogeneous. Thin bedded. Fossiliferous, contains ostracodes and other undiscernable debris.	2.8	(.8)
	Total Unit 14-B	2.8	(.8)
SDA-322.3	Limestone, wackestone. Unit 14-A. Weathered-yellowish gray, 5 Y 7/2 to 5 Y 8/1; fresh-light olive gray, 5 Y 6/1; mottled. Thin bedded. Fossiliferous; contains gastropods, ostracodes, and other undiscernable debris.	5	(1.5)
	Total Unit 14-A	5	(1.5)
	Total Unit 14	7.8	(2.3)
SDA-312.3	Siltstone, calcareous. Unit 13. Weathered-moderate brown, 5 YR 4/4; fresh-grayish red, 5 R 4/2. Thin bedded, fissile, cross-bedded,		

	ripple marked. Very fine grained. Hematitic, micaceous.	10	(3)
SDA-307.3	Siltstone, noncalcareous. Unit 13. Weathered-moderate brown, 5 YR 4/4; fresh-grayish red, 5 R 4/2. Thin bedded, fissile, cross-bedded, ripple marked. Very fine grained. Hematitic, micaceous. Base of unit at 305 feet (93 meters).	2.3	(.7)
	Total Unit 13	12.3	(3.7)
SDA-302.3	Limestone, mudstone. Unit 12. Weathered-yellowish gray, 5 Y 7/2; fresh-light olive gray, 5 Y 6/1; homogeneous. Thin bedded. Fossiliferous, contains undiscernable debris.	5	(1.5)
	Total Unit 12	5	(1.5)
SDA-300	Siltstone, calcareous. Unit 11-C. Weathered-pale red, 5 R 6/2; fresh-grayish red, 5 R 4/2. Thin bedded, fissile, bioturbated (burrows), cross-bedded. Very fine grained. Hematitic, micaceous.	2.7	(.8)
SDA-297.3	Siltstone, calcareous. Unit 11-C. Weathered-pale brown, 5 YR 5/2; fresh-grayish red, 5 R 4/2. Thin bedded, fissile, bioturbated, cross-bedded, ripple marked. Very fine grained. Hematitic, micaceous.	5	(1.5)
	Total Unit 11-C	7.7	(2.3)

SDA-292.3	Siltstone, calcareous. Unit 11-B. Weathered-pale red, 5 R 6/2; fresh-grayish red, 5 R 4/2. Thin bedded, fissile, cross-bedded, ripple marked. Very fine grained. Hematitic, micaceous.	5	(1.5)
	Total Unit 11-B	5	(1.5)
SDA-287.3	Siltstone, calcareous. Unit 11-A. Weathered-moderate brown, 5 YR 3/4; fresh-grayish red, 5 R 4/2. Thin bedded, fissile, ripple marked. Very fine grained. Hematitic, micaceous.	5	(1.5)
	Total Unit 11-A	5	(1.5)
	Total Unit 11	17.7	(5.3)
SDA-282.3	Limestone, wackestone. Unit 10-G. Weathered-medium gray, N 5; fresh-medium dark gray, N 4; homogeneous. Thin bedded. Fossiliferous, contains ostracodes and other debris. Base of unit at 277.3 feet (84.5 meters).	5	(1.5)
	Total Unit 10-G	5	(1.5)
SDA-275.3	Silty limestone, mudstone. Unit 10-F. Weathered-moderate brown, 5 YR 4/4; fresh-dark gray, N 3; mottled. Thin bedded. Fossiliferous, unrecognizable on surface due to silt. Bioturbated, cross-bedded, soft sediment deformation. Silt stands out in re-		

	lief.	5	(1.5)
SDA-272.3	Silty limestone, mudstone. Unit 10-F. Weathered-moderate brown, 5 YR 4/4; fresh-dark gray, N 3; mottled. Thin bedded. Fossiliferous, contains gastropods and ostracodes. Bioturbated. Base of unit.	0	(0)
	Total Unit 10-F	5	(1.5)
SDA-267.3	Marly mudstone. Unit 10-E. Weathered-yellowish gray, 5 Y 8/1 to light gray, N 7; fresh-yellowish gray, 5 Y 7/2 to light bluish gray, 5 B 7/1; mottled. Thin, irregular bedded. Nonfossiliferous.	10	(3)
	Total Unit 10-E	10	(3)
	Concealed. Unit 10-D. Covered by marly mudstone and silty limestone debris.	5	(1.5)
	Total Unit 10-D	5	(1.5)
SDA-257.3	Limestone, wackestone to packstone. Unit 10-C. Weathered-yellowish gray, 5 Y 7/2; fresh-olive gray, 5 Y 4/1; homogeneous. Thin bedded. Fossiliferous, contains ostracodes.	1	(.3)
	Total Unit 10-C	1	(.3)
SDA-256.3	Limestone, wackestone. Unit 10-B. Weathered-light olive gray, 5 Y 6/1; fresh-dark gray, N 3; homogeneous. Thin bedded. Bioturbated. Fossiliferous; contains gastropods, ostracodes,		

	and other undiscernable debris.	4	(1.2)
	Total Unit 10-B	4	(1.2)
	Concealed. Unit 10-A. Covered by limestone debris. Exposed as limestone on back slope.	5	(1.5)
	Total Unit 10-A	5	(1.5)
	Total Unit 10	35	(10.6)
SDA-247.3	Siltstone, noncalcareous. Unit 9-B. Weathered-moderate brown, 5 YR 4/4; fresh-pale red, 5 R 6/2. Thin bedded, fissile, thin laminae, cross-bedded, ripple marked. Very fine grained. Hematitic, micaceous.	5	(1.5)
	Total Unit 9-B	5	(1.5)
SDA-242.3	Siltstone, noncalcareous. Unit 9-A. Weathered-moderate brown, 5 YR 4/4; fresh-grayish brown, 5 YR 3/2. Thin bedded, fissile, thin laminae. Very fine grained. Hematitic, micaceous.	5	(1.5)
SDA-237.3 B	Siltstone, calcareous. Unit 9-A. Weathered-moderate brown, 5 YR 4/4; fresh-pale brown, 5 YR 5/2. Thin bedded, fissile, thin laminae. Very fine grained. Hematitic, micaceous. Base of unit.	0	(0)
	Total Unit 9-A	5	(1.5)
	Total Unit 9	10	(3)

SDA-237.3 A	Limestone, mudstone. Unit 8-B. Weathered-grayish orange, 10 YR 7/4; fresh-moderate yellowish brown, 10 YR 5/4; homogeneous. Thin bedded. Fossiliferous, contains ostracodes.	5	(1.5)
	Total Unit 8-B	5	(1.5)
SDA-232.3	Limestone, wackestone. Unit 8-A. Weathered-light olive gray, 5 Y 6/1; fresh-medium gray, N 5; homogeneous. Thin bedded, bioturbated. Fossiliferous, contains ostracodes.	5	(1.5)
	Total Unit 8-A	5	(1.5)
	Total Unit 8	10	(3)
SDA-227.3	Siltstone, calcareous. Unit 7-B. Weathered-pale red, 10 R 6/2; fresh-grayish red, 10 R 4/2. Thin bedded, fissile, thin laminae, cross-bedded. Very fine grained. Hematitic, micaceous.	5	(1.5)
	Total Unit 7-B	5	(1.5)
SDA-222.3	Siltstone, calcareous. Unit 7-A. Weathered-moderate brown, 5 YR 4/4; fresh-moderate yellowish brown, 10 YR 5/4. Thin bedded, fissile, thin laminae, ripple marked. Very fine grained. Hematitic, micaceous.	5	(1.5)

SDA-217.3	Siltstone, calcareous. Unit 7-A. Weathered-moderate yellowish brown, 10 YR 4/4; fresh-very dark yellowish brown, 10 YR 3/2. Thin bedded, fissile, thin laminae, mud cracks. Very fine grained. Hematitic, micaceous.	5	(1.5)
	Total Unit 7-A	10	(3)
	Total Unit 7	15	(4.5)
SDA-212.3	Limestone, wackestone. Unit 6-B. Weathered-light olive gray, 5 Y 6/1; fresh-medium dark gray, N 4; homogeneous. Thin bedded, bioturbated. Fossiliferous, contains gastropods, ostracodes, and other undiscernable debris.	5	(1.5)
	Total Unit 6-B	5	(1.5)
SDA-207.3	Limestone, wackestone. Unit 6-A. Weathered-light olive gray, 5 Y 6/1; fresh-dark gray, N 3; homogeneous. Thin bedded, bioturbated. Fossiliferous; contains algal oncalites; gastropods, bellerophontid and straparollid; productoid brachiopods; ostracodes; and other undiscernable debris.	5	(1.5)
SDA-202.3	Limestone, wackestone to mudstone. Unit 6-A. Weathered-light olive gray, 5 Y 6/1; fresh-dark gray, N 3; homogeneous. Thin bedded, bioturbated. Fossiliferous; contains pro-		

	ductoid brachiopods; gastropods, bellerophontid; ostracodes; and other undiscernable debris.	5	(1.5)
SDA-197.3	Limestone, mudstone. Unit 6-A. Weathered-light olive gray, 5 Y 6/1; fresh-dark gray, N 3; homogeneous. Thin bedded. Fossiliferous, contains gastropods and ostracodes.	5	(1.5)
SDA-192.3	Limestone, mudstone. Unit 6-A. Weathered-light olive gray, 5 Y 6/1; fresh-dark gray, N 3; homogeneous. Thin bedded. Fossiliferous; scarce, contains ostracodes.	3	(.9)
SDA-189.3	Limestone, wackestone. Unit 6-A. Weathered-light olive gray, 5 Y 6/1; fresh-dark gray, N 3; homogeneous. Thin bedded. Fossiliferous, contains ostracodes. Base of unit.	0	(0)
	Total Unit 6-A	18	(5.4)
	Total Unit 6	23	(7)
	Concealed. Unit 5-B. Covered by limestone and siltstone debris. Probably siltstone.	12	(3.6)
	Total Unit 5-B	12	(3.6)
SDA-177.3	Siltstone, calcareous. Unit 5-A. Weathered-pale yellowish brown, 10 YR 6/2; fresh-moderate yellowish brown, 10 YR 5/2. Thin bedded, fissile, thin laminae, cross-bedded. Parti-		

	ally covered by limestone debris.	5	(1.5)
	Total Unit 5-A	5	(1.5)
	Total Unit 5	17	(5.1)
SDA-172.3	Limestone, mudstone. Unit 4-C. Weathered-light gray, N 7; fresh-medium dark gray, N 3; homogeneous. Thin bedded. Fossiliferous, contains gastropods and ostracodes.	5	(1.5)
	Total Unit 4-C	5	(1.5)
SDA-167.3	Limestone, wackestone. Unit 4-B. Weathered-light gray, N 7; fresh-medium dark gray, N 4; homogeneous. Thin bedded. Fossiliferous; contains gastropods; bivalves; ostracodes; and echinoid remains, Archaeocidaris.	5	(1.5)
	Total Unit 4-B	5	(1.5)
SDA-162.3	Limestone, wackestone. Unit 4-A. Weathered-light olive gray, 5 Y 6/1; fresh-dark gray, N 3; homogeneous. Thin bedded. Fossiliferous; contains gastropods, bivalves, and ostracodes.	5	(1.5)
SDA-157.3 B	Limestone, wackestone. Unit 4-A. Weathered-light olive gray, 5 Y 6/1; fresh-dark gray, N 3; homogeneous. Thin bedded, bioturbated. Fossiliferous, contains gastropods and ostracodes. Base of unit.	0	(0)
	Total Unit 4-A	5	(1.5)

	Total Unit 4	15	(4.5)
SDA-157.3 A	Siltstone, slightly calcareous. Unit 3. Weathered-pale brown, 5 YR 5/2; fresh-pale yellowish brown, 10 YR 6/2. Thin bedded, fissile, thin laminae, ripple marked. Hematitic, micaceous.	5	(1.5)
SDA-152.3	Siltstone, calcareous. Unit 3. Weathered-pale yellowish brown, 10 YR 6/2; fresh-light brown, 5 YR 6/4. Thin bedded, fissile, thin laminae, ripple marked. Hematitic, micaceous.	5	(1.5)
SDA-147.3	Siltstone, calcareous. Unit 3. Weathered-pale yellowish brown, 10 YR 6/2; fresh-grayish orange pink, 5 YR 7/2. Thin bedded, fissile, thin laminae, cross-bedded, ripple marked. Hematitic, micaceous.	5	(1.5)
SDA-142.3	Siltstone, calcareous. Unit 3. Weathered-pale yellowish brown, 10 YR 6/2; fresh-grayish red, 10 R 4/2. Thin bedded, fissile, thin laminae, cross-bedded. Hematitic, micaceous.	5	(1.5)
SDA-137.3	Siltstone, calcareous. Unit 3. Weathered-light brown, 5 YR 6/4; fresh-grayish red, 5 R 4/2. Thin bedded, fissile, thin laminae. Hematitic, micaceous.	3.3	(1)
	Total Unit 3	23.3	(7.1)

SDA-134	Limestone, wackestone. Unit 2-F. Weathered-yellowish gray, 5 Y 7/2; fresh-dark gray, N 3; homogeneous. Thin bedded, bioturbated. Fossiliferous; contains gastropods, Bellerophon and Goniasma; bivalves; and ostracodes.	1.7	(.5)
	Total Unit 2-F	1.7	(.5)
SDA-132.3	Calcareous mudstone. Unit 2-E. Weathered-light yellowish gray, 5 Y 9/1; fresh-yellowish gray, 5 Y 8/1; homogeneous. Nonfossiliferous, contains calcite crystals.	5	(1.5)
	Total Unit 2-E	5	(1.5)
SDA-127.3	Limestone, wackestone. Unit 2-D. Weathered-medium gray, N 5; fresh-dark gray, N 3; homogeneous. Thin bedded, bioturbated. Fossiliferous; contains gastropods, Bellerophon, and Omphalotrochus, and Meekospira; and ostracodes.	5	(1.5)
SDA-122.3	Limestone, wackestone. Unit 2-D. Weathered-medium gray, N 5; fresh-dark gray, N 3; homogeneous. Thin bedded. Fossiliferous, contains gastropods and ostracodes.	1.8	(.5)
	Total Unit 2-D	6.8	(2)
	Concealed. Unit 2-C. Covered by limestone debris.	8.2	(2.5)
	Total Unit 2-C	8.2	(2.5)

SDA-112.3	Limestone, wackestone. Unit 2-B. Weathered-medium gray, N 5; fresh-dark gray, N 3; homogeneous. Thin bedded. Fossiliferous; contains gastropods and others; and ostracodes.	1.9	(.5)
	Total Unit 2-B	1.9	(.5)
	Concealed. Unit 2-A. Covered by limestone debris.	8.1	(2.4)
	Total Unit 2-A	8.1	(2.4)
	Total Unit 2	31.7	(9.6)
SDA-102.3	Fine grained sandstone to siltstone, noncalcareous. Unit 1-D. Weathered-light olive gray, 5 Y 6/1; fresh-medium light gray, N 6. Thin bedded, fissile, thin laminae.	.6	(.1)
	Total Unit 1-D	.6	(.1)
	Concealed. Unit 1-C. Covered by red bed debris.	14.4	(4.3)
	Total Unit 1-C	14.4	(4.3)
SDA-87.3	Fine grained sandstone to siltstone. Unit 1-B. Weathered-pale yellowish brown, 10 YR 6/2; fresh-yellowish gray, 5 Y 7/2. Thin bedded, fissile, thin laminae. Micaceous.	5	(1.5)
SDA-82.3	Fine grained sandstone to siltstone. Unit 1-B. Weathered-pale yellowish brown, 10 YR 6/2;		

	fresh-yellowish gray, 5 Y 7/2. Thin bedded, fissile, thin laminae. Micaceous.	5	(1.5)
SDA-77.3	Fine grained sandstone to siltstone, calcareous. Unit 1-B. Weathered-pale yellowish brown, 10 YR 6/2; fresh-yellowish gray, 5 Y 7/2. Thin bedded, fissile, thin laminae, ripple marked. Micaceous.	5	(1.5)
SDA-72.3	Fine grained sandstone to siltstone, calcareous. Unit 1-B. Weathered-pale yellowish brown, 10 YR 6/2; fresh-yellowish gray, 5 Y 7/2. Thin bedded, fissile, thin laminae. Micaceous.	5	(1.5)
SDA-67.3	Fine grained sandstone to siltstone, calcareous. Unit 1-B. Weathered-pale yellowish brown, 10 YR 6/2; fresh-yellowish gray, 5 Y 7/2. Thin bedded, fissile, thin laminae, ripple marked. Micaceous.	5	(1.5)
SDA-62.3	Fine grained sandstone to siltstone, calcareous. Unit 1-B. Weathered-pale yellowish brown, 10 YR 6/2; fresh-yellowish gray, 5 Y 7/2. Thin bedded, fissile, thin laminae, ripple marked. Micaceous.	5	(1.5)
SDA-57.3	Fine grained sandstone to siltstone, calcareous. Unit 1-B. Weathered-pale yellowish brown, 10 YR 6/2; fresh-yellowish gray, 5 Y 7/2. Thin bedded, fissile, thin laminae.		

	Micaceous.	5	(1.5)
SDA-52.3	Fine grained sandstone to siltstone, calcareous. Unit 1-B. Weathered-pale yellowish brown, 10 YR 6/2; fresh-light gray, N 7. Thin bedded, fissile, thin laminae. Micaceous.	5	(1.5)
SDA-47.3	Fine grained sandstone to siltstone, noncalcareous. Unit 1-B. Weathered-pale yellowish brown, 10 YR 6/2; fresh-light gray, N 7. Thin bedded, fissile, thin laminae, cross-bedded. Micaceous.	5	(1.5)
SDA-42.3	Fine grained sandstone to siltstone, calcareous. Unit 1-B. Weathered-pale yellowish brown, 10 YR 6/2; fresh-light gray, N 7. Thin bedded, fissile, thin laminae, cross-bedded. Micaceous.	5	(1.5)
SDA-37.3	Fine grained sandstone to siltstone, calcareous. Unit 1-B. Weathered-pale yellowish brown, 10 YR 6/2; fresh-light gray, N 7. Thin bedded, fissile, thin laminae, ripple marked. Micaceous.	5	(1.5)
SDA-32.3	Fine grained sandstone to siltstone, calcareous. Unit 1-B. Weathered-pale yellowish brown, 10 YR 6/2; fresh-very pale orange, 10 YR 8/2. Thin bedded, fissile, thin laminae, ripple marked. Micaceous.	5	(1.5)

SDA-27.3	Fine grained sandstone to siltstone, calcareous. Unit 1-B. Weathered-pale yellowish brown, 10 YR 6/2; fresh-very pale orange, 10 YR 8/2. Thin bedded, fissile, thin laminae, ripple marked. Micaceous.	5	(1.5)
SDA-22.3	Fine grained sandstone to siltstone, calcareous. Unit 1-B. Weathered-pale yellowish brown, 10 YR 6/2; fresh-very pale orange, 10 YR 8/2. Thin bedded, fissile, thin laminae, ripple marked. Micaceous.	5	(1.5)
	Total Unit 1-B	70	(21.3)
SDA-17.3	Fine grained sandstone to siltstone, calcareous, and limestone, packstone. Unit 1-A. Micro-intertonguing siltstone and limestone. Weathers-pale yellowish brown, 10 YR 6/2; fresh-very pale yellowish brown, 10 YR 7/2 ---siltstone. Weathers-light bluish gray, 5 B 7/1; fresh-olive gray, 5 Y 4/1---limestone. Thin bedded, fissile, thin laminae. Limestone coarse grained, thin bedded, fossiliferous containg shell hash and gastropods. Intertonguing ranges in thickness from mm. to cm. Gradual between Abo and Middle Hueco Limestone Members.	3	(.9)
	Total Unit 1-A	3	(.9)

Total Unit 1	88	(26.8)
Total Abo Member	310.8	(94.7)

Middle Hueco Limestone Member

SDA-12.3	Limestone, wackestone to mudstone. Weathered-grayish orange, 10 YR 7/4; fresh-dark yellowish brown, 10 YR 4/2; homogeneous. Thin bedded. Fossiliferous; contains fenestrate bryozoa; productoid brachiopods; gastropods, omphalotrochid and Straparollus; crinoid remains; and other undiscernable debris.	2	(.6)
	Concealed. Covered by yellow limestone debris. Possibly continuation of upper limestone.	12.3	(3.7)
	Partial Middle Hueco Limestone Member	14.3	(4.3)
	Total Hueco Formation	325.1	(99.1)

APPENDIX II. PALEOENVIRONMENTAL CONDITIONS AS EXPRESSED BY FAUNAL TAXONS

PHYLUM	SUBSTRATE	WATER DEPTH (METERS)	SALINITY
PORIFERA			
Wewokella (Talpaspongia)	Firm, carbonate	2-7	Normal
COELENTERATA			
Lophophyllidium	Firm, carbonate	10-30	Normal
BRYOZOA			
Tabulipora	Variable	2-30	Normal
Fenestella	Firm, calcareous	2-70	Variable
Polypora	Firm, calcareous	2-70	Variable
Septopora	Firm, calcareous	2-70	Variable
BRACHIOPODA			
Meekella	Soft, carbonate	2-70	Normal
Derbyia	Soft, carbonate	2-70	Normal
Costellarina	Variable	2-70	Variable
Squamaria	Soft to firm	2-70	Variable
Linoproductus	Soft to firm	2-70	Variable
Cancrinella	Soft to firm	2-70	Variable
Pontisia	Soft to firm	2-70	Normal
Composita	Soft to firm	2-70	Normal
Crurithyris	Vegetation	4-10	Normal
Beecheria	Soft to firm	2-70	Normal
GASTROPODA			
Euphemites	Soft, calcareous	0-10	Variable
Euphemitopsis	Soft, calcareous	0-10	Variable

ENERGY LEVEL	LIVING TYPE	MOBILITY	MODE OF FEEDING
Quiet to rough	Epifaunal	Attached	Filterer
Low to moderate low	Epifaunal	Attached	Suspension
Moderate to high	Epifaunal	Encrusting	Suspension
Low to high	Epifaunal	Attached	Suspension
Low to high	Epifaunal	Attached	Suspension
Low to high	Epifaunal	Attached	Suspension
Low to high	Epifaunal	Free	Suspension
Low to high	Epifaunal	Free	Suspension
Low to high	Epifaunal	Attached	Suspension
Low to high	Epifaunal	Free	Suspension
Low to high	Epifaunal	Free	Suspension
Low to high	Epifaunal	Free or attached	Suspension
Low to moderate	Epifaunal	Attached	Suspension
Low to moderate	Epifaunal	Attached	Suspension
Low to moderate	Epifaunal	Attached	Suspension
Low to moderate	Epifaunal	Attached	Suspension
Low to high	Epifaunal	Mobile	Browser
Low to high	Epifaunal	Mobile	Browser

PHYLUM	SUBSTRATE	WATER DEPTH (METERS)	SALINITY
Bellerophon (Bellerophon)	Soft, calcareous	0-10	Variable
Knightites (Knightites)	Soft, calcareous	0-10	Variable
Knightites (Retispira)	Soft, calcareous	0-10	Variable
Straparollus (Euomphalus)	Soft, calcareous	0-10	Variable
Omphalotrochus	Soft, calcareous	2-10	Variable
Colpites	Soft, calcareous	7-20	Normal
Peruvispira	Soft, calcareous	7-20	Normal
Amaurotoma	Soft, calcareous	2-10	Variable
Glyptospira	Soft, calcareous	7-20	Normal
Naticopsis	Soft, calcareous	2-10	Variable
Trachydomia	Soft, calcareous	2-10	Variable
Goniasma	Soft, calcareous	2-7	Variable
Palaeostylus	Soft, calcareous	2-10	Variable
Soleniscus	Soft, calcareous	2-10	Variable
Meekospira	Soft, calcareous	2-10	Variable
CEPHALOPODA			
Mooreoceras	No influence	2-20	Normal
Metacoceras	No influence	2-10	Normal
Stenopoceras	No influence	2-10	Normal
Stearoceras	No influence	2-10	Normal
Liroceras	No influence	2-10	Normal
Genus New	No influence	2-10	Normal
Ephippioceras	No influence	2-10	Normal
Akmilleria	No influence	2-10	Normal
Properrinites	No influence	2-10	Normal

ENERGY LEVEL	LIVING TYPE	MOBILITY	MODE OF FEEDING
Low to high	Epifaunal	Mobile	Browser
Low to high	Epifaunal	Mobile	Browser
Low to high	Epifaunal	Mobile	Browser
Low to high	Epifaunal	Mobile	Browser
Low to high	Epifaunal	Mobile	Browser
Low to moderate	Epifaunal	Mobile	Browser
Low to moderate	Epifaunal	Mobile	Browser
Low to high	Epifaunal	Mobile	Browser
Low to moderate	Epifaunal	Mobile	Browser
Low to high	Epifaunal	Mobile	Browser
Low to high	Epifaunal	Mobile	Browser
Low to high	Epifaunal	Mobile	Browser
Low to high	Epifaunal	Mobile	Browser
Low to high	Epifaunal	Mobile	Browser
Low to high	Epifaunal	Mobile	Browser
Low to high	Nectobenthic	Swimmer	Carnivore
Low to high	Nectobenthic	Swimmer	Carnivore
Low to high	Nectobenthic	Swimmer	Carnivore
Low to high	Nectobenthic	Swimmer	Carnivore
Low to high	Nectobenthic	Swimmer	Carnivore
Low to high	Nectobenthic	Swimmer	Carnivore
Low to high	Nectobenthic	Swimmer	Carnivore
Low to high	Nectobenthic	Swimmer	Carnivore
Low to high	Nectobenthic	Swimmer	Carnivore

PHYLUM	SUBSTRATE	WATER DEPTH (METERS)	SALINITY
BIVALVIA			
Nuculopsis	Muddy, calcareous	1-5	Variable
Paleyoldia	Muddy, calcareous	1-5	Variable
Pteronites	Muddy or sandy	1-30	Variable
Septimyalina	Muddy or sandy	0-10	Variable
Bakevellia (Bakevellia)	Plants or debris	1-10	Variable
Aviculopecten	Soft, calcareous	1-10	Variable
Limipecten	Soft, calcareous	1-10	Variable
Schizodus	Muddy or sandy	2-7	Variable
Permophorus	Soft, calcareous	1-10	Variable
Astartella	Soft, calcareous	1-10	Variable
Chaenomya	Soft, calcareous	1-10	Variable
Wilkingia	Soft, calcareous	1-10	Variable
SCAPHOPODA			
Plagioglypta	Muddy or sandy	0-10	Variable
ANNELIDA			
Spirorbis	Firm, attached	0-30	Variable
ARTHROPODA			
Rogerella	Hard, firm	2-70	Variable
Ostracodes	Soft, calcareous	0-50	Variable
CRINOIDEA			
Pentagonocyclopa	Soft, calcareous	2-70	Variable

ENERGY LEVEL	LIVING TYPE	MOBILITY	MODE OF FEEDING
Low to high	Infaunal	Burrower	Deposit
Low to high	Infaunal	Burrower	Deposit
Low to high	Infaunal	Attached	Suspension
Low to high	Epifaunal	Free or attached	Suspension
Low to high	Epifaunal	Attached	Suspension
Low to high	Epifaunal	Swimmer	Suspension
Low to high	Epifaunal	Swimmer	Suspension
Low to high	Infaunal	Burrower	Suspension
Low to high	Infaunal	Burrower	Suspension
Low to high	Infaunal	Burrower	Deposit
Low to high	Infaunal	Burrower	Deposit?
Low to high	Infaunal	Burrower	Deposit?
Low to high	Infaunal	Burrower	Carnivore
Low to high	Epifaunal	Encrusting	Suspension
Low to high	Infaunal	Borer	Suspension
Low to high	Epifaunal	Swimmer-Creeper	Scavenger
Low to high	Epifaunal	Attached	Suspension

PHYLUM	SUBSTRATE	WATER DEPTH (METERS)	SALINITY
ECHINOIDEA			
Archaeocidaris	Soft, calcareous	2-70	Variable
CHONDRICHTHYES			
Petalodus?	No influence	1-?	Variable

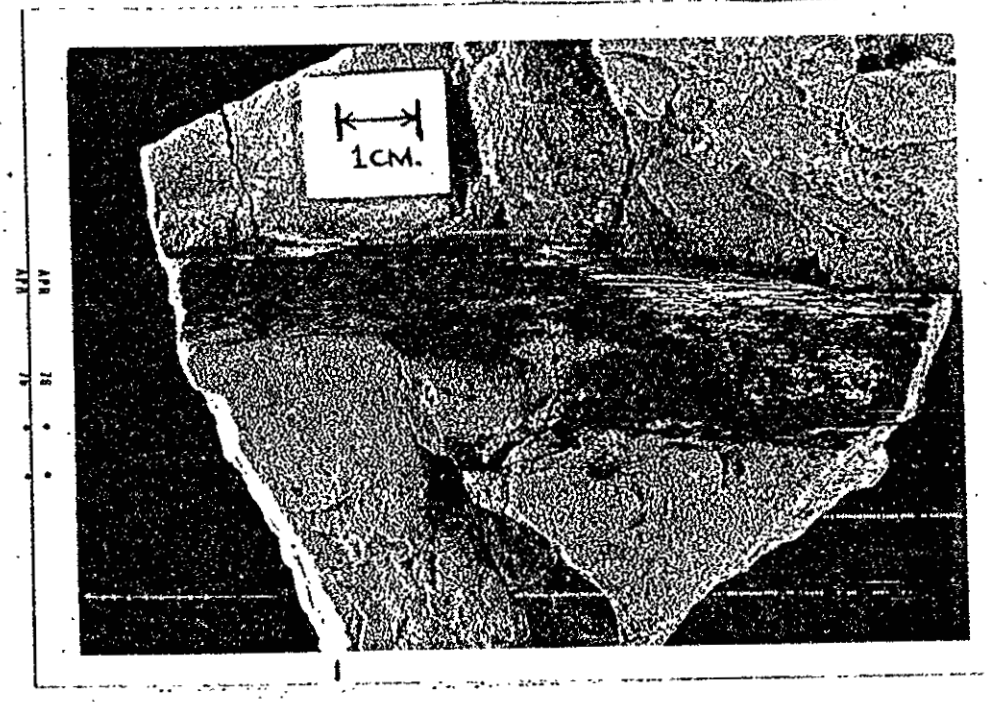
ENERGY LEVEL	LIVING TYPE	MOBILITY	MODE OF FEEDING
Low to high	Epifaunal	Mobile	Browser
Low to high	Nectobenthic	Swimmer	Carnivore

EXPLANATION OF PLATE VI

Figure 1. *Cordaites* sp. Abo Member, Hueco Formation, Dona Ana Mountains, Dona Ana County, New Mexico. View of stem.

Figure 2. *Walchia piniformis* (Schlotheim) Sternberg. Abo Member, Hueco Formation, Dona Ana Mountains, Dona Ana County, New Mexico. View of leaf twig.

PLATE VI



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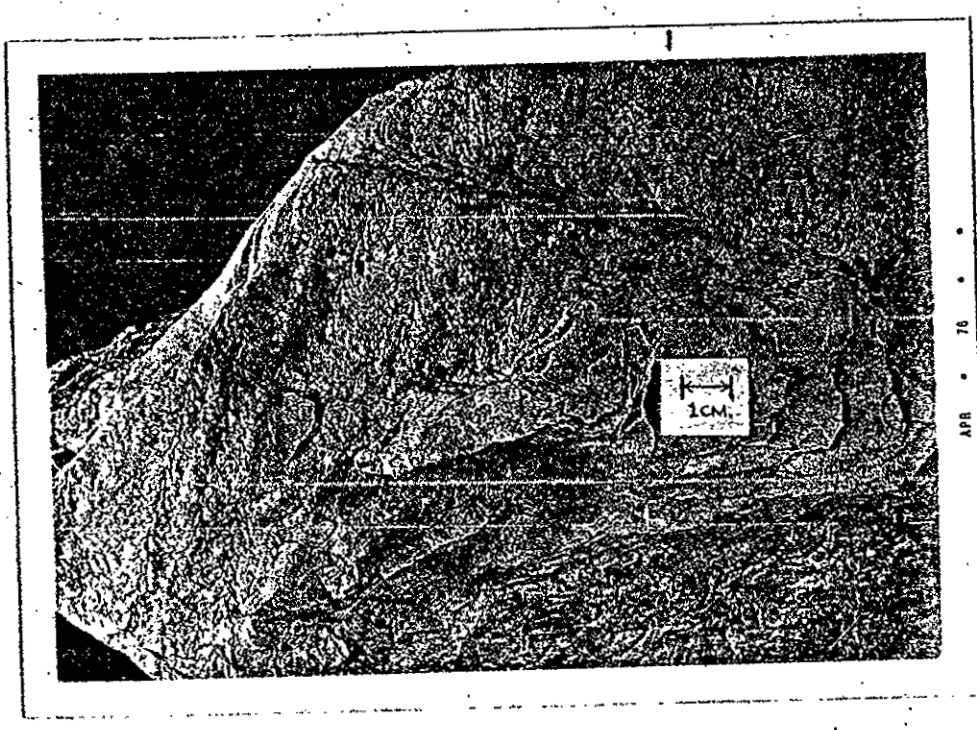

2

VITA

Ronald De Simpson, son of Billy and JD Simpson, was born in Mesa, Arizona, September 24, 1947. After graduation from Minot High School in Minot, North Dakota, he entered Hardin-Simmons University at Abilene, Texas. He worked for the geology department there until May, 1969, when he then went to work for the Perini Library (Petroleum geology related) in July, 1969 until March, 1972. He received the Bachelor of Science degree from Hardin-Simmons University in December, 1971. After completion of the United States Army Air Defense Officers Basic Course at Fort Bliss, El Paso, Texas in July, 1972, he entered the Graduate School of the University of Texas at El Paso in January, 1973.

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This thesis was typed by Ronald De Simpson, with taxonomy by Rosemary Whisenant.

PLATE I

LOCATION OF MEASURED SECTIONS SOUTHERN ROBLEDO MOUNTAINS, DONA ANA COUNTY, NEW MEXICO

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PLATE 1

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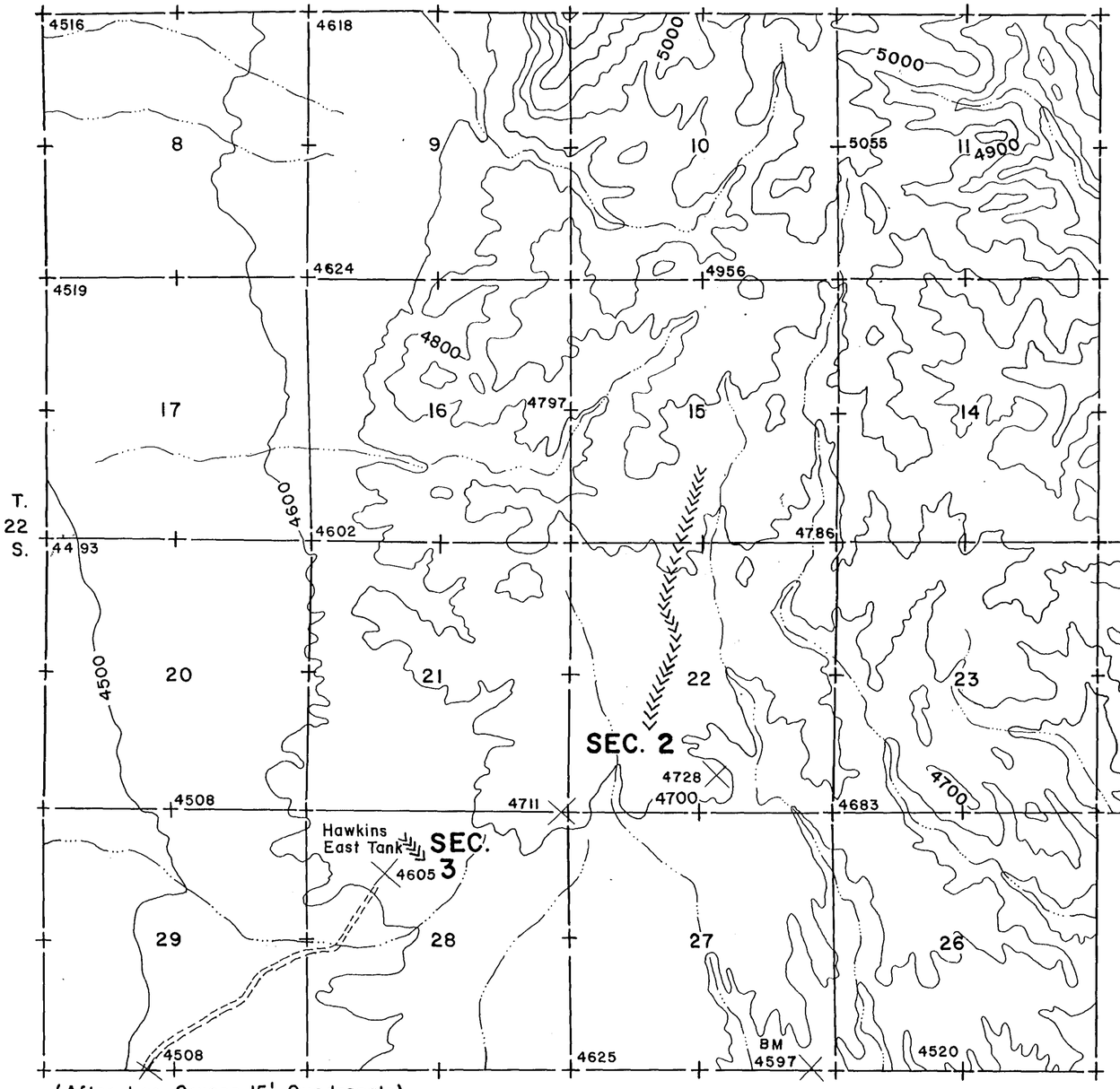
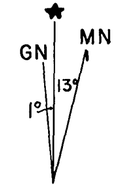
UNIV. OF TEXAS AT EL PASO
1976

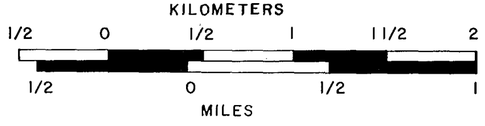


(After Las Cruces 15' Quadrangle)

LINE OF SECTION



1941 Magnetic North Declination



CONTOUR INTERVAL: 100 FEET

SECTION 1. SHALEM COLONY SECTION
SECTION 2. CORRALITOS RANCH FAULTED SECTION
SECTION 3. HAWKINS EAST TANK SECTION

106°52'30"

32°30'

R. 1 W.

R. 1 E.

T. 21 S.

I.H. 25

1 6 5 4

12 7 8 9

13 18 17 16

Sec. 4

Loc. 4-5

LOCATION OF MEASURED SECTION

DONA ANA MOUNTAINS DONA ANA COUNTY, NEW MEXICO

<<<<<< Line of Section

× Loc. 4-5 Fossil Locality

N

Miles

0 1/2 1

0 1/2 1 2

Kilometers

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PLATE II

(After New Mexico Bureau Mines, Dona Ana Study)

PLATE III

STRATIGRAPHIC SECTIONS OF ABO MEMBER AND UPPER HUECO LIMESTONE MEMBER, HUECO FORMATION OF THE ROBLEDO AND DONA ANA MOUNTAINS, DONA ANA COUNTY, NEW MEXICO

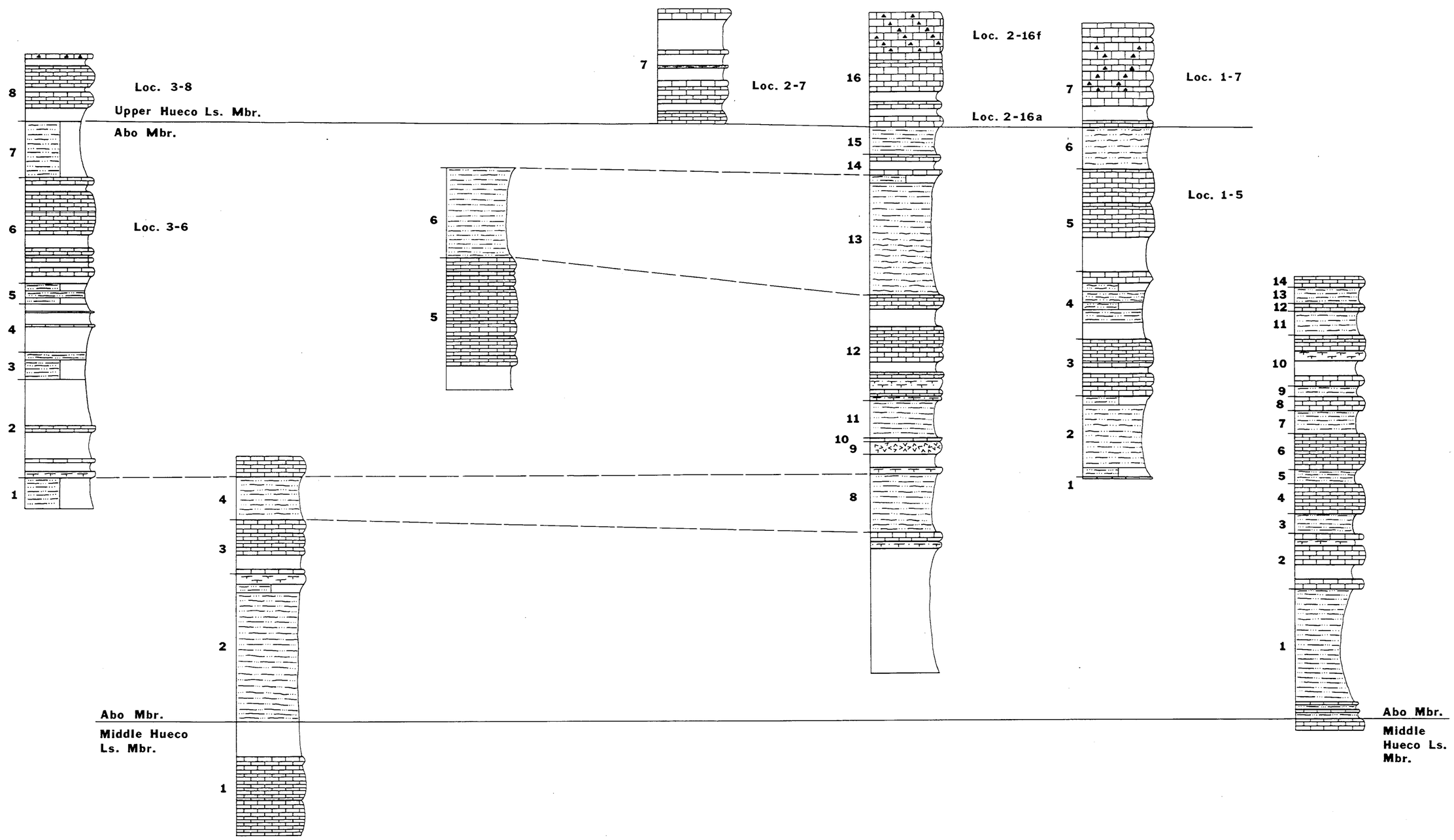
Explanation of Symbols

- Limestone
- Chert
- Mudstone
- Claystone
- Siltstone
- Igneous
- Loc. 1 — Fossil Collection Locality

Meters Feet
60 — 200
30 — 100
15 — 50
Vertical Scale

Hawkins East Tank Section — Corralitos Ranch Faulted Section — Shalem Colony Section — Dona Ana Mtns Section

WEST — EAST



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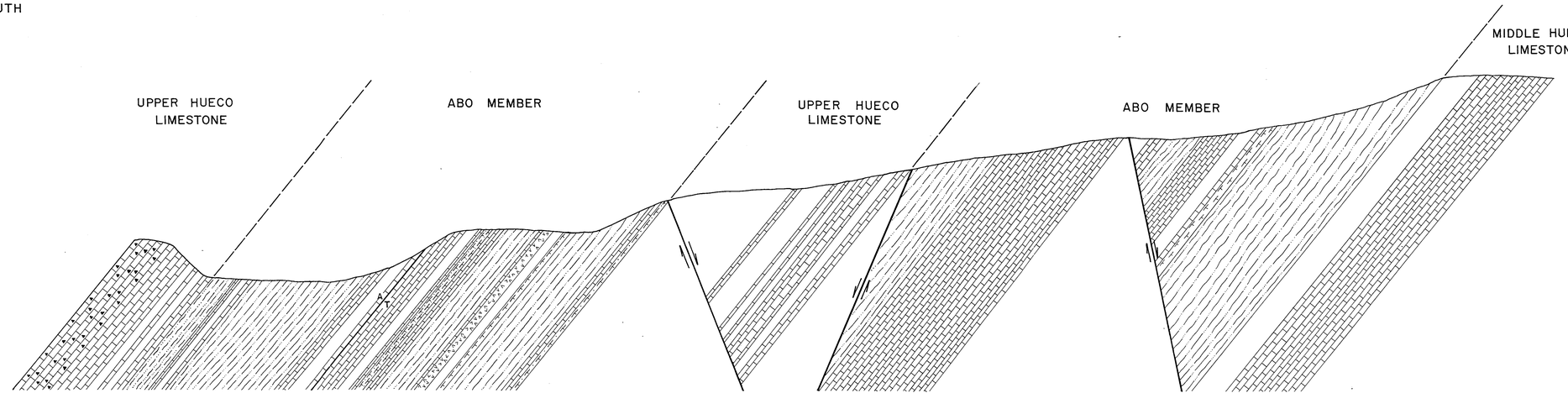
SOUTH

NORTH



CORRALITOS RANCH SECTION
ROBLEDO MOUNTAINS
DONA ANA COUNTY, NEW MEXICO

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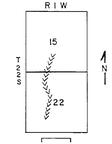
PLATE 4

SYMBOLS

- FAULT
- A / T — STRIKE SLIP FAULT
- CONTACT BETWEEN FORMATIONS
- >>>>>>> DIRECTION OF TRAVERSE OF SECTION

FOR EXPLANATION OF SEDIMENTARY ROCK SYMBOLS, REFER TO PLATE III.

EXAGGERATED DIP — 55°
TRUE DIP — 15°



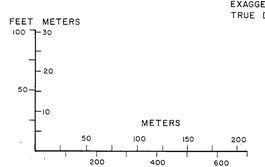


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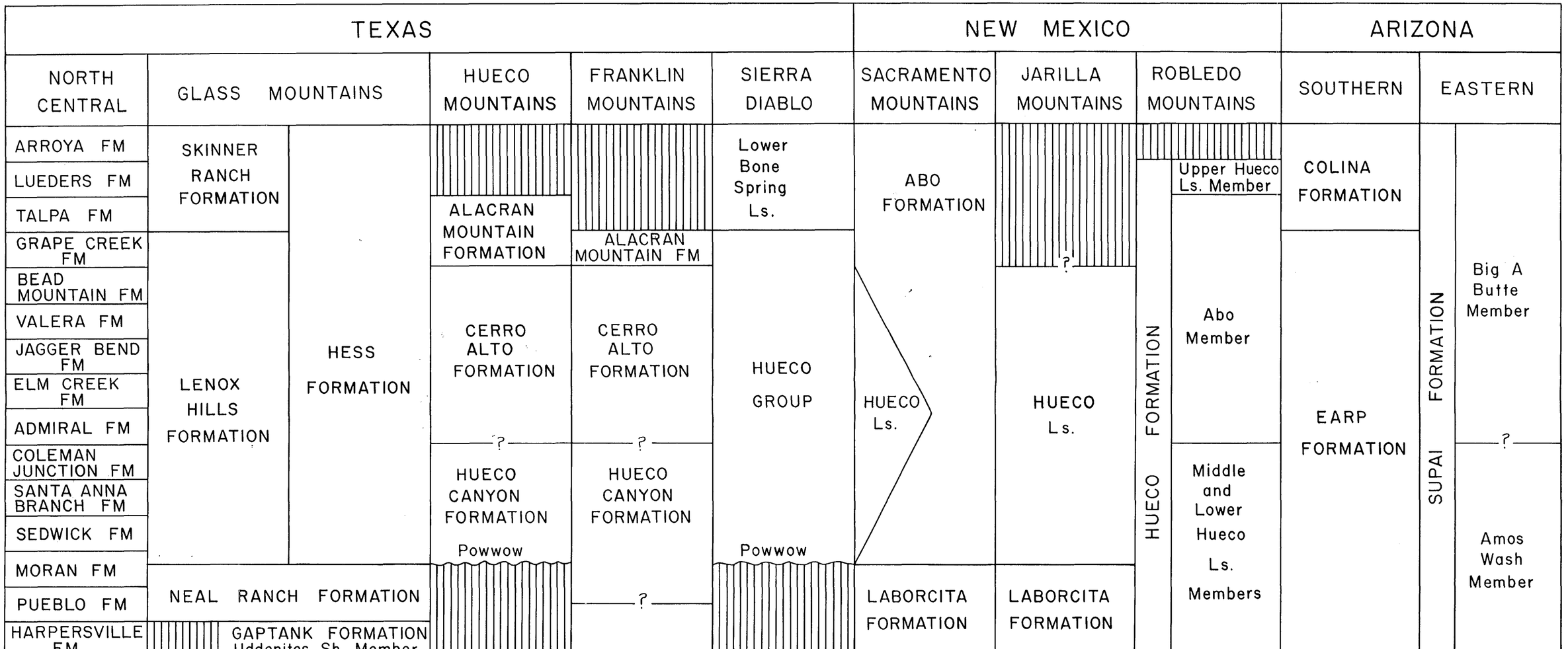
PLATE V



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REGIONAL WOLFCAMPIAN CORRELATIONS IN ARIZONA, SOUTHERN NEW MEXICO, AND TEXAS

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PLATE 5