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Paleontology of the Rustler Formation, Culberson County, Texas

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PALEONTOLOGY OF RUSTLER FORMATION, CULBERSON COUNTY, TEXAS[1]

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ABSTRACT—The fossils described in this paper substantiate the Permian age of the Rustler formation. The Rustler fauna is largely molluscan and has a Whitehorse aspect. Four species of the Rustler fauna are similar to species from Russian and Indian faunas, suggesting possible correlations with Upper Permian rocks. Environments have had more influence on the fauna than has geologic age, giving the Rustler fauna a striking resemblance to faunas of older Permian rocks which occupied similar biotopes. The Rustler fauna is large and varied, containing 35 species of invertebrates. Because of the fragmentary condition of the fossils, many species are uncertainly identified.

FOREWORD

Ronald K. DeFord[2]

THE most distinctive member of the Rustler formation is the layer of limestone or dolomite that has been called the Culebra member (Adams, 1944, p. 1614). Its mean thickness in the subsurface of the Delaware Basin is perhaps 25 feet; it is present almost everywhere in the basin east of the outcrop in the Rustler Hills and extends beyond the rim of the basin to the north and the east. Recent field mapping has shown that Walter's member N is the Culebra member.

In a recent review of opinions about the age of the Rustler that have been published during the past 50 years (Donegan and DeFord, 1950) one item was overlooked. Stone (1920, p. 258) cited a letter from J. A. Udden dated February 6, 1917. Copies of the correspondence have been found in the file of the Bureau of Economic Geology, The University of Texas. The letter of February 6 addressed to Stone does not mention the Rustler; an earlier letter dated October 18, 1915, addressed to N. H. Darton, is the one referred to. The complete text is as follows:

> Your letter of the 14th is received. I am mailing you today a copy of my paper on Age of Castile Gypsum and Rustler Spring formation. I hope before long to be able to make another statement on this same subject. Mr. C. L. Baker and Dr. Böse, of this Bureau, have lately examined the formation for us, near Rustler Springs, and they report clear proof that the Rustler formation and the Castile gypsum is palaeozoic. The information is not given for publication, and I trust you will consider it confidential.

The living principals do not recall further details. Baker's field notes, not presently available, may contain additional information. "Another statement" (Udden, 1922) was made, but it did not mention the clear proof.

INTRODUCTION

The fossils collected by Donegan in 1947 (Donegan and DeFord, 1950) are undoubtedly Paleozoic, and by stratigraphic position therefore Permian, but they are so poorly preserved that taxonomic classification beyond the generic level is impossible. In the summer of 1950 John E. Wilson and the writer mapped the fossiliferous area and made additional collections from new and old localities. The summer work increased fossil collections, determined the local stratigraphic distribution of previously known fossil zones, and revealed a local gastropod zone in the lower member of the Rustler formation.

The fauna was collected from Culberson County, Texas, between the parallels N 31°30′ and 31°45′ and the meridians 104°10′ and 104°14′W; it also includes specimens from the lower member of the Rustler formation in the vicinity of U. S. Coast and

[1] Based on a thesis presented to the faculty of the Graduate School of The University of Texas in partial fulfillment of the requirements for the degree of Master of Arts, August, 1951.

[2] Professor of Geology, The University of Texas, Austin.

Geodetic Survey triangulation station "Harral" in the southwestern corner of Harral quadrangle.

Collections are the property of the Department of Geology, The University of Texas, Austin, Texas.

The writer is indebted to Ronald K. DeFord for his supervision and assistance, particularly in regard to stratigraphic problems in the Rustler formation; to James Lee Wilson for supervision of the paleontologic research; and to John A. Wilson for suggestions and assistance in the field.

Grateful thanks are extended to John E. Wilson, an excellent field partner; and to Ben Donegan, E. J. Travis and J. L. Hutchison who made their fossil collections available for study.

This paper has been critically read by Ronald K. DeFord, James Lee Wilson, and John A. Wilson. It has also been read by G. A. Cooper, Carl O. Dunbar, J. Brookes Knight, and Norman D. Newell.

METHODS OF COLLECTION AND PREPARATION

Collection.—The Rustler formation contains a large and varied fauna. Fossils obtained from the siltstone of the lower member are preserved as external casts or molds or by calcite replacement. Only the fossils replaced by calcite are sufficiently preserved to permit specific classification. The casts and molds attest to the varied fauna present, and yield added information about certain morphologic features not visible on the calcite-replaced species.

Specimens in the dolomite of the lower member are replaced by calcite and anhydrite. The best localities are where the dolomite is severely weathered and where it contains numerous nodules of the replacing materials.

In November, 1950, it was discovered that samples of the dolomite from locality No. 55–16 would yield excellent fossils of anhydrite when dissolved in hydrochloric acid (HCl). Previously the true value of the lower dolomite as a fossil bed had not been recognized. Only the calcite-replaced fossils that weathered out on the surface could be studied. A brief return to the locality to collect more of the etchable anhydrite fossils increased the quantity and quality of the fossil material available. Because of the hardness of the dolomite, attempts to remove the fossils by crushing were unsuccessful.

The fossils in the limestone of the lower member and member N exhibit the same type of preservation as those in the dolomite of the lower member, but with less calcite replacement. Samples of the limestones of these two members have yielded fossils even though their presence could not be detected at the surface.

Preparation.—Some specimens in the dolomite of the lower member are replaced by calcite; others are replaced by anhydrite. Although anhydrite is soluble in concentrated hydrochloric acid (HCl), removal of the anhydrite-replaced fossils was facilitated by dissolving the dolomite matrix in a dilute solution of hydrochloric acid, tech. (muriatic acid 33 percent by volume). Etching the anhydrite fossils destroyed any calcite-replaced fossils in the matrix, but the excellence of the anhydrite specimens obtained justified the destruction. After acidizing the dolomite, the extraneous material (silt and anhydrite particles) was decanted

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EXPLANATION OF PLATE 70

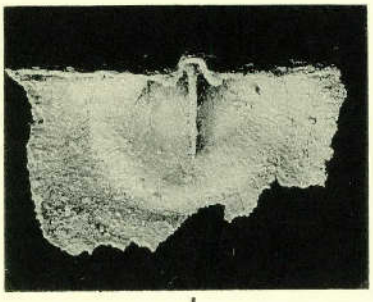
FIGS. *1, 3, 4, 7–9, 11—Derbya sulcata* Walter, n. sp. *1*, ventral interior showing median septum; *3*, cardinal area of ventral valve showing horizontal striae, grooved pseudodeltidium, and teeth, ×2; *4*, dorsal interior exhibiting bilobed cardinal process with bifid posterior extremities and bases of apophyses, ×2; *7*, oblique view of shell interior showing anterior convexity of well-developed apophyses-bearing crural plates, ×1½; *8*, posterior view of fig. *7*, ×1½; *9*, dorsal valve showing diverging crural plates and supports, ×3; *11*, dorsal exterior, showing intercalation of secondary and tertiary lirae, ×3. (p. 687)

2—Pleurophorus sp., interior view of left valve. (p. 692)

5—Echinoid spine, ×4. (p. 701)

6—Crinoid plate, ×2. (p. 701)

10—Euphemites sp. (a), showing inner whorl and closely spaced costae, ×3. (p. 696)



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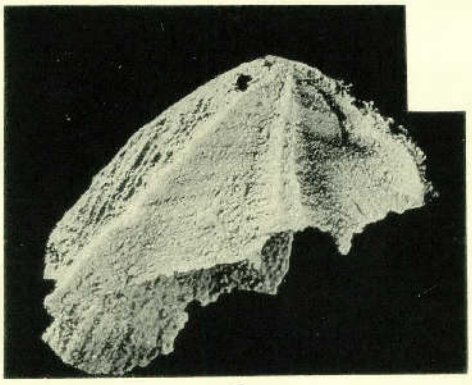

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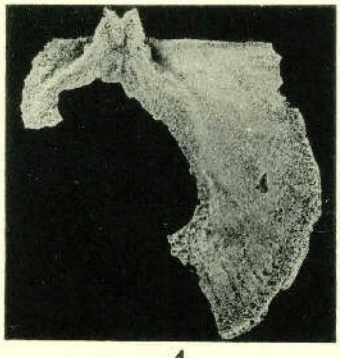

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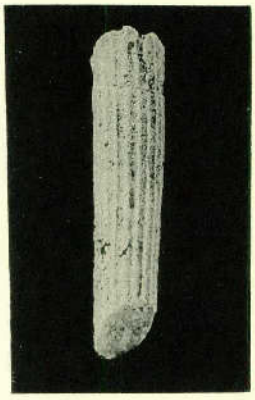

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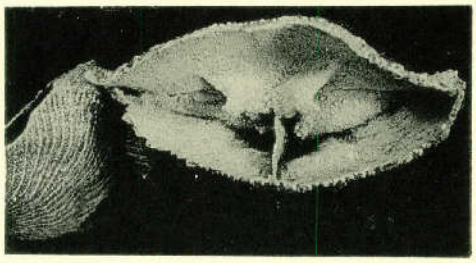

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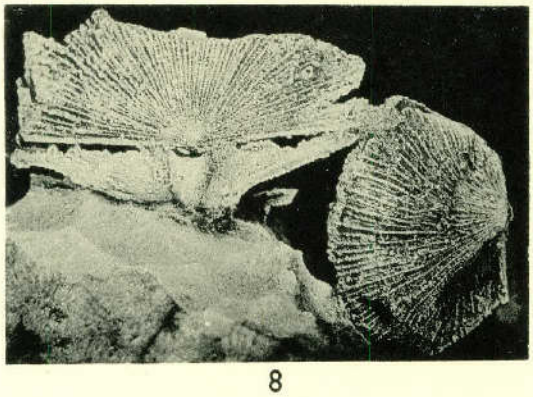

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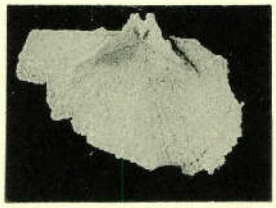

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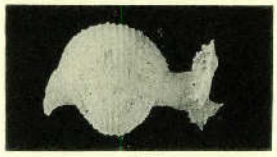

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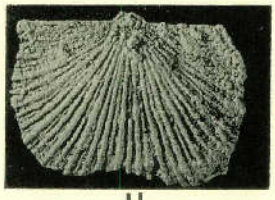

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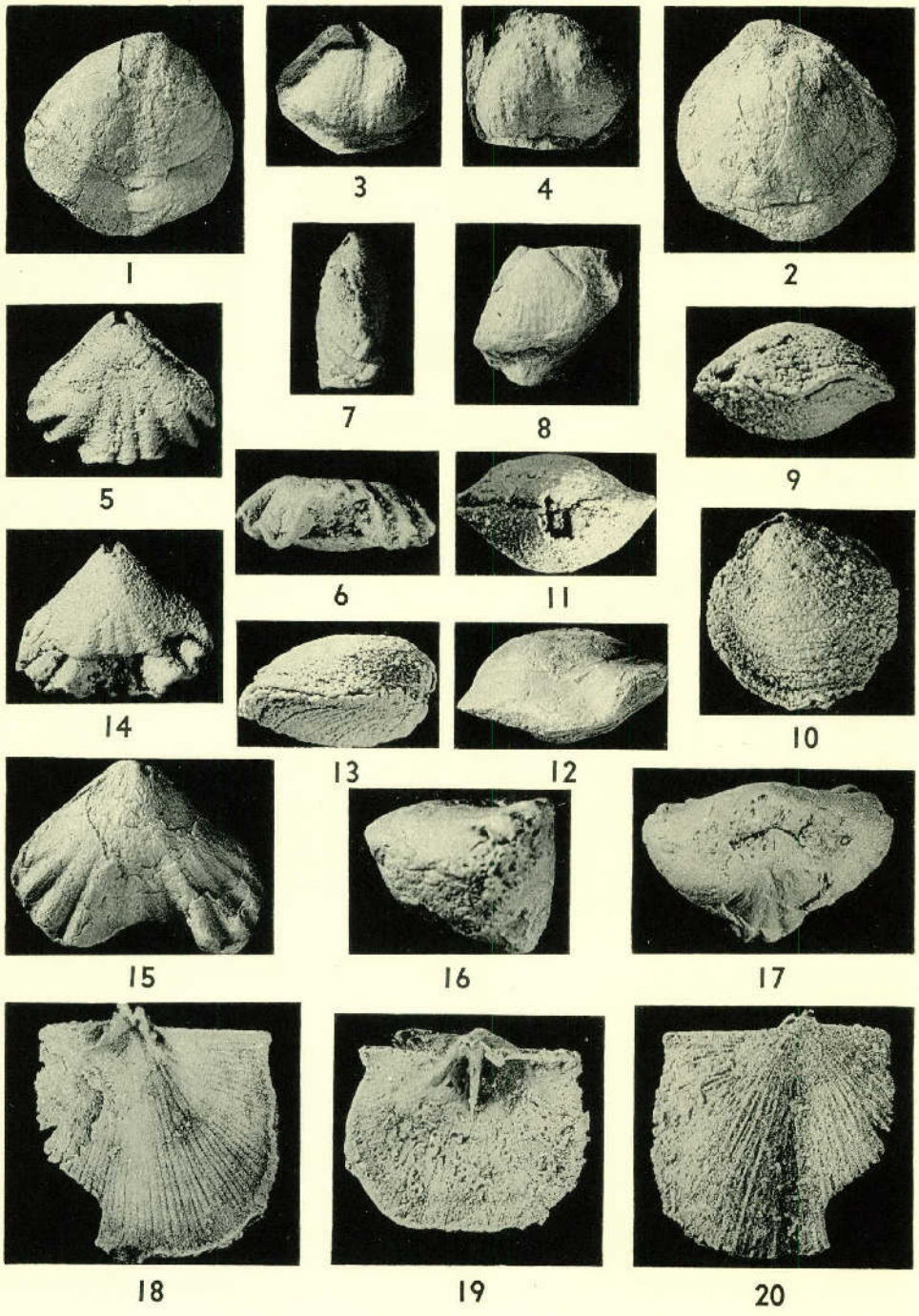
Walter, Permian (Rustler) fossils, Texas



Walter, Permian (Rustler) fossils, Texas

and fossils were dried. Samples of the decanted residue were analyzed for organic remains.

The anhydrite-replaced fossils in the silty limestone of the lower member and member N were etched with a dilute solution of muriatic acid (15–20 percent by volume) and strengthened with a thin Alvar solution.

Fossils preserved by calcite in the lower dolomite could not be studied unless exposed at the surface, because the poor preservation did not warrant the time consumed in removing the hard dolomite matrix.

A technique used in removing calcitic fossils from the surface of silty limestones and siltstones consisted of covering the fossil with solid potassium hydroxide (KOH) which reacts fairly promptly with the silty calcareous material to form a thick sludge but reacts with the crystalline calcite very slowly. A protective surface of Alvar insures preservation of the calcite fossils. The reaction requires 8 to 10 hours for completion. The technique is slow and requires repeated applications, but the condition of the specimens obtained warrants it as a desirable etching procedure.

All specimens photographed were first coated with magnesium oxide to bring out the detail of the ornamentation. The minute gastropods were not coated prior to photographing, as both magnesium oxide and ammonium chloride obscured their microscopic details of ornamentation.

OCCURRENCE OF BIOFACIES

There are four fossiliferous lentils in the Rustler formation. They are the dolomite, siltstone, and limestone lentils of the lower member, and the dolomitic limestone lentil of member N. Some of the fossils range through two or more of the fossiliferous lentils, while others are restricted to a single bed. The fossiliferous rocks are continuous throughout the area, except the dolomite lentil which is discontinuous north of Blk. 110, PSL.

The calcite- and anhydrite-replaced fossils in the lower member are the best preserved specimens in the formation. The irregular assortment, lack of orientation, fragility of some specimens, together with recovery of brachiopod specimens which are attached to each other, indicate that the fossils were preserved in situ. Incomplete specimens are due to inadequate replacement and not to the destructive effects of transportation.

Dolomite facies of the lower member.—The fossiliferous dolomite contains a balanced invertebrate fauna in which brachiopods, pelecypods, and gastropods were equally represented. The fossiliferous dolomite has yielded 20 forms of which 6 were brachiopods, 7 pelecypods, and 6 gastropods. The brachiopods are principally orthotetinid (*Derbya sulcata*) and rhynchonellid (*Wellerella*) forms. The pelecypods are not so numerous but are more varied. The most abundant genus is *Pleurophorus*.

The characteristic fauna of the dolomite lentil, in the lower member, though more abundant, has less variety in the southern portion of the area. At locality No. 55–16 there is an increase in the proportion of brachiopods but a striking decrease in the relative number of pelecypods and gastropods. Here the dolomite lentil is *underlain*

EXPLANATION OF PLATE 71

FIGS. *1, 2, 12*—*Composita* sp. *1*, ventral exterior ×1; *2*, dorsal exterior ×1; *12*, anterior profile ×1. (p. 690)

4—*Productus* ? sp. Ventral exterior; note medial sulcus and fine ornamentation ×1. (p. 691)

5–7, 14–17—*Wellerella elegans* (Girty). *5*, dorsal exterior ×3; *6*, anterior profile ×3; *7*, lateral view ×3; *14*, ventral exterior ×3; *15*, ventral exterior ×3; *16*, lateral view ×3; *17*, posterior profile ×3. Specimens *5–7* are crushed. (p. 689)

3, 8—*Marginifera* sp. ×1. (p. 701)

9–11, 13—*Composita* cf. *C. guadalupensis* ×2; *9*, anterior profile; *10*, dorsal exterior; *11*, posterior profile; *13*, lateral view. (p. 690)

18–20—*Derbya sulcata* Walter n. sp. *18*, dorsal interior ×3; *19*, ventral interior ×1½; *20*, dorsal exterior, same specimen as Fig. *18* ×3. (p. 687)

MEASURED SECTION

Loc. No 55–3

W. slope of hill in SW ¼, Sec. 11, Blk. 42, PSL., Culberson Co., Texas

	Thickness Feet
Rustler formation—	
Member N—	
11. Limestone, very hard, yellowish gray, thinly bedded, jointed, micrograined, contains anhydrite nodules and fossils. The thickness of the beds varies from 1 inch or less in the upper 2 feet of the unit to 4 to 8 inches in the lower portion. There is a random occurrence of large gastropods and numerous poorly preserved minute gastropods..	19.0
Member M—	
10. Siltstone, medium hard, pale yellowish orange, thinly bedded, severely jointed, calcareous, platy on weathered surface.....	4.8
9. Limestone, very hard, pale red, massively bedded, sandy, coarse-grained, contains calcite veins; weathers to a rough irregular surface.....	1.5
8. Dolomitic limestone, very hard, moderate yellowish brown, massively bedded, brecciated, dense, medium to fine paurograined, contains anhydrite nodules. The upper 8 feet of the bed is grayish orange, and is medium crystalline and sandy..... Bed 8 forms a massive bench throughout the area, appearing in many places as two benches due to differential weathering. This is the basal bed of member M.	20.5
Lower member—	
7. Siltstone, hard, grayish orange, thinly bedded, finely muscovitic, highly calcareous. Closely resembles the underlying limestone on the weathered surface.....	8.9
6. Limestone, very hard, olive gray, thinly bedded, severely jointed, very fine to fine paurograined, contains fossils and weathers to a white calcareous deposit on the weathered surface..... The fossils in this bed include *Pleurophorus* sp. (b), *Nuculopsis* (*Paleonucula?*) aff. *N. okawensis*, *Euphemites circumcostatus* Walter, n. sp., *Murchisonia ?* cf. *M. gouldii*, *Goniasma* sp., *Loxonematidae* (*Donaldina ?*), *Worthenia ?* sp., and others.	14.3
5. Siltstone, medium hard, grayish orange, thinly bedded, severely jointed, finely muscovitic, calcareous; weathers to grayish orange, and has a limy crust on the severely fractured and weathered portions..... The bed contains an abundant fauna characterized by *Derbya sulcata* Walter, n. sp., *Dictyoclostus ?* sp., *Marginifera* sp., Chonetids, *Hustedia* cf. *H. meekana*, *Myalina* sp., *Allorisma* aff. *A. dubium*, and plant fragments?	23.8
4. Dolomite, very hard, grayish orange, massively bedded, contains gypsum nodules, fine calcite veins, and ferruginous stains on the weathered surface. The upper 4.7 feet are more thinly bedded and bear a white limy crust on the severely weathered portions..... Fossils include *Derbya sulcata* Walter, n. sp., *Wellerella elegans* (Girty), *Euphemites circumcostatus* Walter, n. sp., *Murchisonia ?* cf. *M. gouldii*, *Goniasma* sp., and others.	6.7
3. Quartz sandstone, hard, grayish orange, massively bedded, friable, very fine subangular grained, contains finely divided muscovite. This bed is slightly casehardened, bearing irregular fractures on the weathered surface.....	7.8
2. Gypsum, soft, white, massively bedded, granular; contains yellowish gray, wavy bands from 1 to 5 mm thick.....	12.7
1. Gypsum, soft, moderate red, massively bedded, leached in spots; contains undulating bands of gypsum from 1 to 5 mm thick. These bands were originally white and subsequently stained to grayish pink by the surrounding red material.....	4.2
Total thickness Rustler formation.....	124.2

by a siltstone lentil similar in lithic and faunal content to the siltstone lentil that *overlies* the dolomite lentil farther north.

Farther south, at U. S. Coast and Geodetic Survey's triangulation station Harral, the dolomite lentil is not present in the exposures of the lower member. It has either lensed out or graded into the siltstone facies at Harral. Nevertheless, the fauna in the siltstone at locality No. 55–19 (200 yards northwest of triangulation station Harral) contains the characteristic forms of the dolomite and siltstone assemblages at locality No. 55-16 (Rustler Spring area). No mollusks have been found at Harral, although scarce crinoid remains previously believed peculiar to the Rustler Spring area have been collected from the siltstone at locality No. 55-19 (Harral).

Siltstone facies of the lower member.—In the siltstone lentils of the lower member, 9 of the 13 species collected were brachiopods.

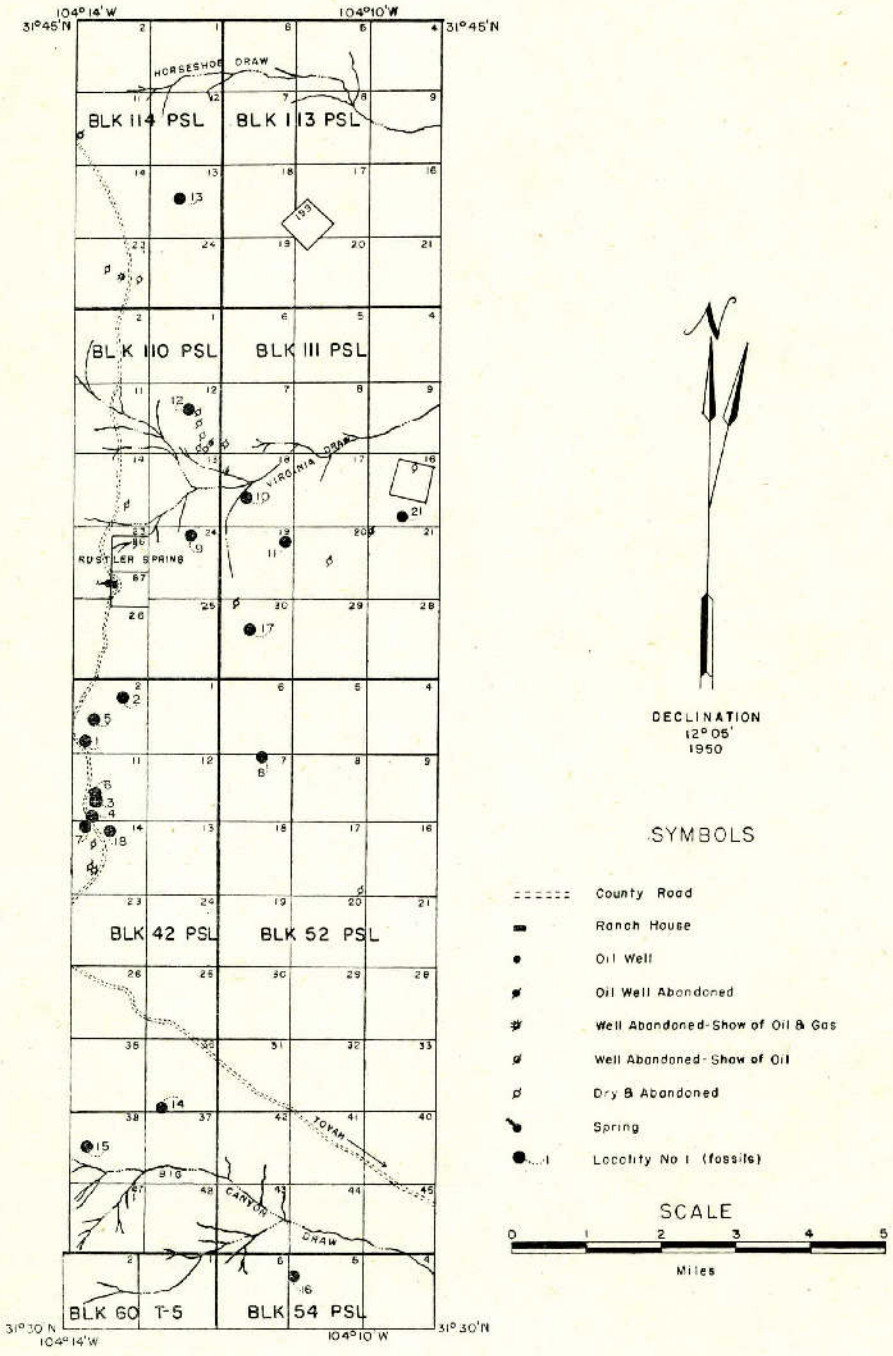


FIG. 1—Map of area investigated, showing localities where fossils were collected.

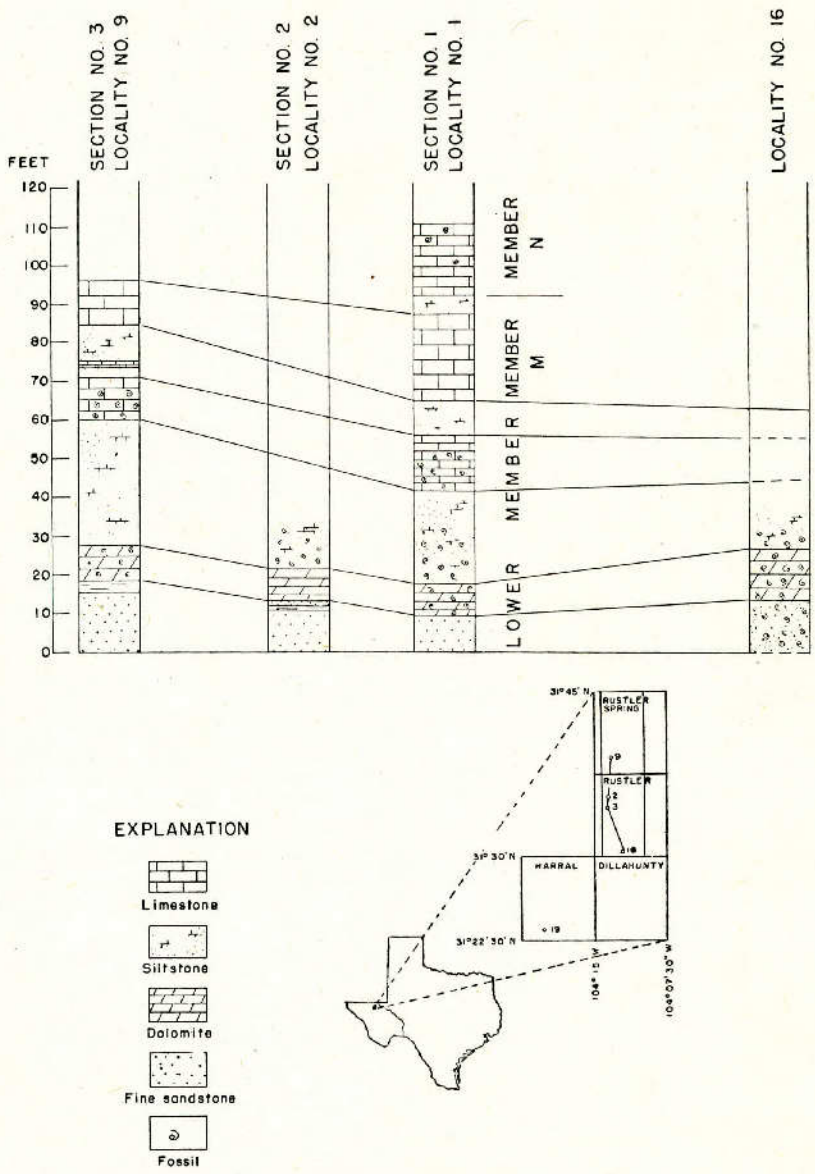


FIG. 2—Correlation of Rustler section, Culberson County, Texas. Datum: Base of sandstone lentil of lower member of Rustler formation. Horizontal distance not to scale.

Orthotetinid, productid, and rhynchonellid brachiopods comprise 70 percent of the specimens collected. "Plant fragments" are also abundant in the brachiopod-bearing siltstone. The uniform distribution, irregular arrangement, and thorough intermixing of the "plant fragments" with the invertebrate fauna indicate the "plants" are indigenous and occupied a shallow-water habitat. *Myalina* sp. and *Allorisma* cf. *A. dubium* occur in the siltstone, but no gastropods have been collected.

Fossils are plentiful in the basal portion of the siltstone and diminish in abundance

approaching the upper contact. In the vicinity of U. S. Coast and Geodetic Survey's triangulation station Harral at locality No. 55-19, fossils were collected from a 7- to 8-foot interval approximately 34.6 feet above the base of the siltstone.

It is probable that many of the species found in the dolomite also exist in the overlying siltstone, but they have not been found because of poor preservation. Should such species be found in the siltstone they would be associated with a more varied and abundant brachiopod fauna.

Limestone facies of the lower member.—The extremely fossiliferous limestone lentil of the lower member contains a fauna that is entirely molluscan. This unique Rustler assemblage is composed almost exclusively of gastropods. Of approximately 200 specimens (12 species) collected, there are but 12 specimens of pelecypods (three species), and five specimens of scaphopods (two species). *Euphemites circumcostatus* Walter n. sp. is the most abundant gastropod in the assemblage. Some of the gastropod genera (*Worthenia*? sp., *Murchisonia*? sp.) occur in the Whitehorse fauna, but no late Permian deposit of North America is known to have such a varied and populous gastropod fauna.

The exact stratigraphic limits of the limestone biofacies are not fully known, but fossils occur from the base of the limestone lentil (siltstone-limestone contact) to 11.5 feet above the base of the limestone at locality No. 55-3; the highest known occurrence is 9 feet below member M at locality No. 55-17.

The geographic extent of the limestone is unknown. The most northern collection came from the very fossiliferous limestone at locality No. 55-12. The limestone lentil is known to occur in the hills on the south side of Horseshoe Draw in the northeastern part of the area. It crops out in the hills on the north side of Big Canyon Draw in the southern portion of the area, but fossils have not been collected from these outcrops.

Fossils in the limestone lentil of the lower member were discovered in the summer of 1950. They were first observed at locality No. 55-17. The small size and abundance of the fossils allow a large number of specimens to be recovered from relatively small samples of the limestone. Very fossiliferous samples commonly have no surface indication of the fauna contained, and fossils are easily overlooked in the field.

Limestone facies of member N.—The fossiliferous limestone of member N contains a meager fauna of high-spired gastropods, but the specimens collected are too poorly preserved for definite identification. The fossils are mostly replaced by anhydrite, but a few external casts composed of limonite have been collected.

Although the specimens are not abundant, they have been collected from several widespread localities in the area. Their scarce, random occurrence prevents exact delineation of their stratigraphic limits. The limestone in this member is thinly bedded, silty, and contains a small amount of very fine-grained sand.

Figure 3, showing the stratigraphic and geographic distribution of the Rustler species, is a tabulation of all localities where fossils were obtained. Meager collections made while mapping were tabulated with the collections obtained from more thoroughly investigated localities. The apparent inconsistencies in the occurrence of certain species at some localities are due either to the local lack of an exposed fossiliferous lentil or to inadequate collections.

A large portion of the fauna remains undiscovered and further acidization of the rock containing the etchable fossils will increase the known fauna.

Fossil material from localities Nos. 55-1, 55-2, and 55-3 was supplemented with collections made by Ben Donegan during the summer of 1949.

The fossils from localities Nos. 55-19 and 55-20 in Harral quadrangle were collected by J. L. Hutchison and E. J. Travis.

VERTICAL RELATION OF BIOFACIES

The faunal assemblages obtained from the four fossiliferous lentils are characteristic of three distinct biotopes and are here considered as facies faunas.

The genera found in the dolomite lentil of the lower member suggest a marine environment. *Composita*, *Wellerella*, the pelecypod genera *Acanthopecten*, *Pleurophorus*, and the gastropod genera are known to occur only in marine assemblages (Newell, 1940). The dolomite is silty and limonitic, containing

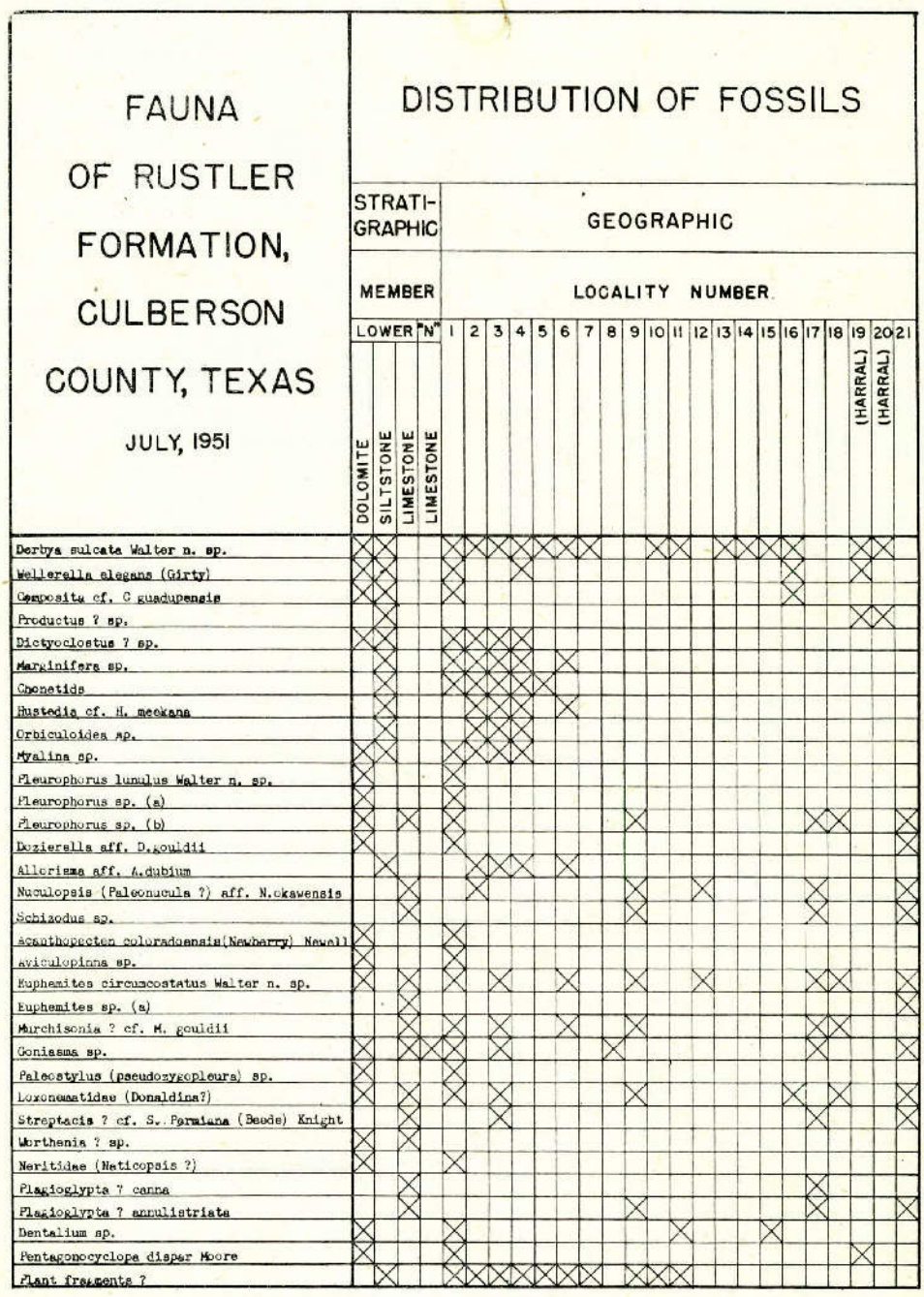


FIG. 3—Geographic and stratigraphic distribution of the Rustler fauna, Culberson County, Texas.

very small amounts of sand and varying amounts of anhydrite. The relatively fewer pelecypod and gastropod species and the abundance of orthotetinid brachiopods in the southern portion of the area indicate a variation in the normal marine biotope manifested by the facies fauna of the dolomite. This same lateral variation in environment, as indicated by faunal change, is seen in the back-reef facies of the Guadalupian series (Carlsbad formation) where certain characteristic Permian brachiopods are scarce or absent.

The fauna in the siltstone of the lower member is characterized by abundant and varied brachiopods, a small proportion of pelecypod species, and the absence of gastropods. Productids, chonetids, rhynchonellids, and the ubiquitous orthotetinid *Derbya* suggest a calcareous mud bottom habitat. The absence of anhydrite and abundance of marine brachiopods are indications that a normally saline environment existed while the siltstone was deposited.

The thin-bedded, silty limestone of the lower member and of member N contains principally gastropods. The severity of the biotope is evidenced by the large amount of anhydrite deposited, and is in agreement with the sulphatic condition of the sea during late Ochoan time. There is no doubt that the hypersaline water had a marked effect on the inhabitants and perhaps resulted in the aberrant biocoenose found in the limestone of the lower member and member N. The limestone contains a large molluscan fauna and no brachiopods, but the siltstone and dolomite usually considered molluscan lithotopes, contain principally brachiopods. This is additional evidence of the peculiar environment in which the limestone was deposited.

Certain gastropod species occur both in the limestone lentil and in the dolomite of the lower member. These species may be eurytropic and possibly would have been found in the intervening siltstone except for poor preservation. The rest of the underlying dolomite fauna does not occur higher either because the forms died out or migrated with a changing biotope. On the other hand, the gastropods may represent a recurring biofacies controlled by environmental factors of which we have no evidence. The fauna of member N is probably a relic of the recurrent gastropod fauna just discussed, for member M between the two is unfossiliferous.

AGE OF THE FAUNA

The Rustler fossils may constitute the youngest Permian fauna of North America. Because of its high stratigraphic position, there is perhaps no Permian fauna in this continent to which it can be precisely compared. It would seem that more fruitful correlations could be made with foreign Permian deposits of comparable age and stratigraphic position.

The Rustler species shown at the top of the next page bear comparison to foreign Permian faunas.

Although these species exhibit many similar morphologic features, in each form there are marked differences. As a result, contemporaneity can only be conjectured in these long-range correlations.

The comparison between the Rustler and Guadalupian species shows a striking resemblance between the Rustler and Guadalupian *forms* that occupy similar biotopes. These affinities are not limited to the Guadalupian faunas, for pronounced similarities can be recognized in the Phosphoria faunas.

The severe environment in which the Rustler, Whitehorse, and Blaine formations were deposited has had a more pronounced influence on their respective faunas than has geologic age.

The brachiopod fauna is diagnostic of neither time nor facies. With the exception of *Euphemites circumcostatus* Walter n. sp., which may be significant of the young age, the gastropods are not particularly diagnostic (Newell, written communication). Of the known Guadalupian faunas, those of the Whitehorse more closely resemble the Rustler molluscan fauna.

SYSTEMATIC DESCRIPTIONS

Phylum BRACHIOPODA

Genus DERBYA Waagen 1884 (emend. Girty 1908)

DERBYA SULCATA Walter, n. sp.

Plate 70, figures 1, 3, 4, 7–9

Plate 71, figures 18–20

Description.—Shell moderately biconvex with greatest thickness in uncrushed speci-

Comparable Rustler and Guadalupian Species

Rustler Species		*Guadalupian Species*
Composita cf. C. guadalupensis	=	C. guadalupensis Girty Blaine
Wellerella elegans (Girty)	=	W. elegans (Girty) Capitan
Dozierella aff. D. gouldii	similar to	D. gouldii (Beede) Whitehorse
Streptacis cf. permiana	=	S. permiana (Beede) Knight Dozier Whitehorse
Murchisonia ? cf. M. gouldii	=	M. gouldii Beede Whitehorse
Acanthopecten coloradoensis Newell	=	A. coloradoensis Newell Word

Similar Species in the Rustler and Russian Faunas

Rustler Species		*Russian Species*
Aviculopinna sp.	similar to	Aviculopinna timanica Maslennikow Timan; Zechstein, Vymskii Basin
Murchisonia sp.	similar to	Murchisonia golowkinshyi Yakovlew Zechstein, Russian Platform

Similar Species in the Rustler and Indian Faunas

Rustler Species		*Indian Species*
Pleurophorus lunulus Walter, n. sp.	similar to	Pleurophorus subovalis Upper Productus Ls.
Allorisma aff. A. dubium	similar to	Allorisma dubium Upper Productus Ls.

mens about two-fifths distance to anterior margin.

Species highly variable in shape, of medium size. Mature shells, 2.5 to 3 cm long, young individuals much shorter. Many immature shells subquadrate in outline, but shell growth anteriorly with a lateral extension of the hinge-line results in a subcircular outline at maturity. Little information on ontogeny of shell is available from a single specimen, growth lines indistinct or absent. Hinge-line approximately equal to medial width of most immature shells but exceeds width of shell in some specimens. Cardinal extremities are obtuse. Anterior margin of shell not fully known, yet two specimens with complete margins exhibit an evenly curved outline with a very slight medial truncation when viewed dorsoventrally.

Dorsal valve moderately convex, attaining its maximum height one-third distance from beak, with slight depression or median sulcus from there to anterior margin. Although all specimens possess a dorsal sulcus, this feature is more pronounced on some individuals. Posterior extremities of dorsal valve flatten laterally. Cardinal area extremely narrow and linear. Umbo moderately tumid. Ventral valve less convex than dorsal; its greatest height one-third distance from anterior margin. Apsacline beak low and cardinal area one-third to one-fourth high as wide. Pseudodeltidium strongly convex; its sides form an angle of 30°. Shallow medial groove extends entire length of pseudodeltidium in some specimens. Perideltidial area not distinguishable, but entire cardinal area finely striated horizontally.

Surface marked by narrow, smooth, sharply rounded radial lirae separated by broad, flat-bottomed striae. Radial lirae increase by intercalation at margin of shells, where they number 19 to 14 lirae per cm, totaling 150 to 180. Moderate fasciculation of the lirae at anterior margin of shell. Primary and secondary lirae separated by tertiary and quaternary lirae, approximately one-half height of primary and secondary. Some individuals do not illustrate this fasciculation as well as others.

Internally, ventral valve has strong teeth which form ridges under each side of pseudodeltidium, no dental lamellae present. Strong median septum extends from beak one-third distance toward anterior margin. Median septum and "dental ridges" unite in apex of shell. Junction commonly obscured by callus-like deposit in apex of shell.

Construction of muscles unknown, impressions not visible on these thin shells.

In dorsal valve cardinal process large and bilobed, and changes shape as shell approaches maturity. In young shells cardinal process low, narrow, simply bilobed, and crural plates diverge anterolaterally to an angle of about 110°. Pronounced apophyses near anterior end of crural plate. Posterior extremities of cardinal process finely notched, even in youngest specimens collected. Muscle tracks on posterior face of cardinal process almost parallel to plane of commissure. With maturity, posterior face of cardinal process widens as it becomes higher with a "rapid" divergence of muscle tracks. Anterior portions of crural plates increase in length and height, with slight increase in divergence of crural bases; divergence accompanied by posterolateral trending of apophyses, resulting in a convex surface of crural plate when viewed from ventral interior, and concave surface when viewed from posterior. Anterior face of cardinal process at junction with crural plates forms shallow groove complementary in position with posterior muscle tracks.

Discussion.—The shapes of individuals in the same population differ appreciably. Although growth lines are indistinguishable on single specimens, comparison of shells of different sizes gives some indication of ontogeny. Many available specimens could not be used to determine shape because of crushing. In any event, the taxonomic importance of shape is doubtful. Dunbar and Condra (1938, p. 77) state:

> In delimiting species in this group we have found shape to be a character applicable only within broad limits and difficult to apply in many individual cases.

The most distinctive morphologic character of this species is the medial sulcus in the dorsal valve. Although the sulcus is not pronounced in all the dorsal valves collected, it can be distinguished in all specimens available for study. The radial lirae are smooth, narrow, and sharply curved on top; their height equals their width. The flat-bottomed striae are approximately twice as wide as the lirae.

Although the shape and outline of this species shows affinity to *Derbya arizonensis* McKee, which also has a median sulcus, the Kaibab species has fewer lirae per unit width and is coarsely ornamented. McKee did not describe the internal characters of his species.

Internally the cardinal process closely resembles that of *Derbya crassa*; nevertheless the greater divergence of the crural plates (110°), and the accentuated bending of the apophyses posterolaterally, and the shallowness of the muscle cavity should distinguish this species from *D. crassa*. External ornamentation and the median sulcus should distinguish the species from *D. buchi* and *D. cymbula*.

Occurrence.—*Derbya sulcata* (Sp. No. 1A and 1B) occurs in the dolomite and calcareous siltstone of the lower member of the Rustler formation.

Genus WELLERELLA Dunbar & Condra 1932

WELLERELLA ELEGANS (Girty) 1909

Plate 71, figures 5–7, 14–17

1909 *Pugnax elegans* GIRTY, U. S. Geol. Survey Prof. Paper 58, p. 317, pl. 15, figs. 13–14a.

1930 *Pugnoides elegans* (Girty). KING, Univ. Texas Bull. 3042, pl. 33, figs. 12–13; pl. 34, figs. 2–4, var. Renz (1940b), p. 178; pl. 4, figs. 14a–c.

1948 *Wellerella elegans* BRANSON, Geol. Soc. America Mem. 26, p. 556.

Description.—Shell small, subtriangular in outline, wider than long, and bears three plications on fold and two in sinus. Ventral valve relatively flat, moderately convex over umbo and sub-concave between umbo and lateral margin. Ventral beak acutely pointed with an oval foramen at its apex. Ventral sinus severe and begins one-third the distance from posterior toward anterior margin. Two rather broad plications in sinus and three plications on lateral portions of shell. Lateral and medial plications extend posteriorly one-half length of shell. Plications in sinus twice width of those on lateral edges of specimen studied; lateral plications more rounded on top and attain greater height.

Dorsal valve moderately convex but ventral bending of lateral portions and accentuated dorsal fold give a strongly convex appearance. Dorsal fold bears three small, sharp plications more pronounced than those present on ventral sinus. Lateral portions of valve bear three plications; width of each approximately those on fold. Dorsal lateral

plications less distinct than those on lateral portions of ventral valve.

Internally, ventral valve reveals two vertical deltidial plates extending from floor of valve to support two well-developed teeth.

Dorsal interior bears short, low, median septum, which supports an undivided hinge-plate. Attached to anterior extremities of hinge-plate are two vertically curved crura. Only one specimen revealed dorsal interior, but its crushed condition does not reveal the exact construction of the septum-hinge-plate junction.

Discussion.—The genus *Wellerella* Dunbar and Condra 1932 was established to include a group of Pennsylvanian species previously referred to *Pugnax*. It is distinguished from *Pugnax* on the basis of internal characters. *Pugnax* has a divided dorsal hinge-plate and lacks a median septum.

> The genera *Camarotoechia, Wilsonia, Leiorhynchus, Paraphorhynchus, Pugnoides,* and *Hemiplethorhynchus* are somewhat similar externally but all are distinguished by having a divided dorsal hinge-plate and a small crural cavity above the median septum. (Dunbar and Condra, 1932).

Using these criteria, Branson chooses to refer King's *Pugnoides elegans* to *Wellerella* (Branson, 1948).

The most distinguishing morphologic features of the shell are its severe sulcus which forms a gap in the anterior margin when viewed in a ventrodorsal direction and the sharp convergence of the ventral sulcus when viewed in longitudinal profile. The marked difference in the strength and width of the lirae on the ventral sulcus and the dorsal fold are distinctive in this species.

The shell's spreading triangular shape, and two broad lirae in the ventral sinus and three fine lirae on the dorsal fold distinguish the species from *Wellerella swalloviana*.

Occurrence.—The species *Wellerella elegans* has been reported from the Hess, Leonard, and Word formations of the Glass Mountains (King, 1931), and the upper Hueco limestone at Sierra Diablo. Affinitives also occur in specimens from the Lower Permo-Carboniferous of the Caracorum Range. The Rustler species occurs in the lower siltstone and dolomite of the lower member at localities Nos. 55-1, 55-4, and 55-16, and in the lower siltstone at U. S. Coast and Geodetic Survey's triangulation station "Harral" (Harral quadrangle, fig. 2).

Genus COMPOSITA Brown 1890

COMPOSITA cf. C. GUADALUPENSIS (Girty)

Plate 71, figures 9–11, 13

1909 *Composita mexicana* var. *guadalupensis* GIRTY, U. S. Geol. Survey Prof. Paper 58, p. 390, pl. 24, figs. 11–13b.
1931 *Composita mexicana* (Hall), KING, Univ. Texas Bull. 3042, p. 129.
1941 *Composita guadalupensis* (Girty), STAINBROOK & MADERA, Jour. Paleontology, vol. 15, p. 381, pl. 55, figs. 19–21.

Description.—Shells small, biconvex, subovate in outline, with rounded anterolateral and posterolateral margins. Immature shells subcircular in outline and strongly biconvex but anterior and anterolateral growth results in a subovate shell at maturity, with greatest width at midlength. Some information about ontogeny is available: growth lines readily distinguishable on larger shells. Diminishing anterior growth, accompanied by ventrodorsal bending of shell at maturity, results in a low dorsal fold and shallow ventral sulcus. Anterior margin of shell slightly truncated.

Rounded beak of ventral valve bears small oval foramen. Ventral valve arched, point of greatest convexity slightly posterior to midlength. From midpoint to anterior margin curvature is greater than in a posterior direction, with a slight dorsal bending of anterolateral portions of shell. Shallow mesial sulcus confined to anterior one-third of shell.

Dorsal valve attains about same convexity as ventral valve, arching rapidly anterior of beak. Slope of shell decreases slightly anteriorly, accompanied by a flattening of anterolateral portions to form a medial fold. Both valves marked by concentric lines of growth which become closely spaced at anterior margin.

Incomplete preservation prevents complete understanding of internal morphology, but two well-developed teeth can be observed in the pedicle valve. Dental supports and septa described by Stainbrook and Madera were not observable.

Discussion.—Although Girty's variety *Composita mexicana* var. *guadalupensis* is considered synonymous with *C. mexicana*

Hall by King (1931), Stainbrook and Madera look upon *C. guadalupensis* as a separate species after a comparison of Girty's and Hall's illustrations. The writer supports this differentiation; his shells show close agreement with figures of Girty's variety, and vary from Stainbrook and Madera's description only in the uncertainties of the two ventral septa, which are not present probably owing to poor preservation. One might explain an affinity with *C. mexicana* on the basis that the shells were dwarfed because of the severity of environment; yet if shape relationships and the character of the mesial sulcus were taken as characters of specific importance, they would not support such a hypothesis.

Using these criteria in comparing *C. subtilita* and *C. arizonica*, the Kaibab species, the stronger fold and sulcus of *C. subtilita* should distinguish the two forms.

Occurrence.—In the dolomite lens in the lower member of the Rustler at localities Nos. 55-1 and 55-16.

PRODUCTUS? sp.
Plate 71, figure 4

Description.—Shells small, strongly inflated, and approximately 16 mm long. Ventral valve irregularly curved longitudinally, tumid, and of greater width than length. Umbonal regional too poorly preserved to distinguish presence of fine reticulation, but flattened posterior is apparent. A slight geniculation marks beginning of uniformly curved anterior portion of shell. Transversely, valve regularly curved, slightly flattened medially, and bears mesial sinus. Deep narrow sinus begins near umbo and extends to anterior margin. The coarse, irregular radial ribs bear spines that have no definite pattern, but external casts exhibit very meager evidence of spine insertions.

Dorsal valve and internal characters of this species are not known to writer.

Dimensions of two specimens are as follows:

Length, straight line	15 mm ±
Length, curve	—
Width	20 mm ±
Thickness	7 mm

Discussion.—The spirally enrolled form, the coarse radial ornamentation and medial sinus are well developed in the Rustler shell, yet neither of these morphologic features is of taxonomic importance.

Occurrence.—In the lower siltstone of localities Nos. 2 and 3 and in the lower dolomite of locality No. 1.

Class PELECYPODA
Genus PLEUROPHORUS
PLEUROPHORUS LUNULUS Walter, n. sp.
Plate 72, figures 9, 12

Description.—Relatively flat, biconvex shell with a low indistinct umbonal fold extending posteriorly to midpoint of posterior margin thus accentuating convexity in this area. Posteroventral sulcus indistinct or absent with no lobation of shell. Hinge-line elongate and straight, slight ventral bending in anterior part. Entire surface of valve bears numerous distinct (both fine and coarse) concentric growth lines; no radial costellae present. Distinctive posterior margin extends obliquely ventrad, curving sharply anteroventrad below midpoint. Anterior margin almost evenly curved, with greatest convexity at midpoint.

Dentition of left valve: one cardinal and one lateral tooth. Narrow, elongate-triangular cardinal tooth just behind the beak with apex directed toward it. Margin of tooth and overlying socket slightly convex-dorsad. Socket of same shape as cardinal tooth but more elongate; its upper margin approximately parallel to dorsal margin.

Below cardinal tooth an ovoid depression is separated from anterior adductor impression by an elevated ridge extending from posterior extremity of cardinal tooth to midpoint of anterior margin. Narrow posterior lateral tooth extends to within one-quarter shell length anterior to posterior margin trending slightly posteroventrad to form a wedge-shaped furrow between hingeline and lateral tooth.

Anterior adductor muscle impression ovoid and separated from main visceral cavity by an elevated buttress inclined anteriorly and directed toward beak. Impression under beak ventrad of the midlength. Posterior adductor scar and pallial line unknown, but lunule and escutcheon well defined. Dimensions of shell: height, 5 mm; length, 12.5 mm; maximum convexity of left valve, 2 mm.

Discussion.—The shells described are

fragmentary, exhibiting only the beak area of the species with the exception of one specimen of a left valve which is completely preserved. The valve has approximately the same dimensions of *Pleurophorus albequus* Beede, but internal characters resemble *P. costatus* (Brown) illustrated by Newell (1940 pl. 3, figs. 9–13). The outline of the shell closely resembles that of *P. albequus longus* Beede, but the anterior margin of the shell from the Rustler is more symmetrical, less angular, and it possesses a straighter hingeline. The most characteristic morphologic features are the low indistinct or absent umbonal fold, distinct form of the posterior margin, absence of radial costellae, nearly semicircular anterior margin, and the flattened, elongate cardinal tooth and socket. *P. subovalis* Waagen (1881) from the Upper Productus limestone of India has the same proportions as this species and bears close comparison; its dimensions are: length, 44 mm; height, 18 mm; thickness of left valve, 8 mm; apical angle, 150°.

Occurrence.—The Indian shell was found in a "very hard, compact limestone" at Khura at the upper limit of the Middle Productus limestone and in a "hard, somewhat oolitic limestone" in the lower beds of the Upper Productus limestone at Chidru. The Rustler species is common in the dolomite of the lower member at locality No. 55-1.

PLEUROPHORUS sp. (a)
Plate 72, figure 13

Description.—Fragmentary shell exhibiting only dentition and a portion of anterior shell; inferred dimensions: length, 48.5 mm; height, 18 mm; convexity of right valve, 7 mm. Faint growth lines distinguished on poorly preserved shell, scant and incomplete. Dentition of shell definitely that of genus *Pleurophorus* and resembles that of *P. albequus*. Large size of shell, near semicircular anterior margin, and increased elevation of posterior lateral tooth are most distinctive morphologic features of this probably new species. Additional material is needed to establish its identity.

Occurrence.—Only one fragmentary right valve of the species was found in the dolomite of the lower Rustler member at locality No. 55-1.

PLEUROPHORUS sp. (b)
Plate 70, figure 2

Description.—Shells moderately elongate, of average convexity. Anterior half of shell has a greater convexity than posterior; however, anterior convexity does not reach proportions of an umbonal fold. Postero-ventrad sulcus indistinct or absent. No surface ornamentation observed on specimen. Extraneous material and granular texture of replacing material obscure external ornamentation. Dorsal margin slightly oblique to ventral margin with a moderate ventrad bending anteriorly approaching beak. Prominent beak accented by abrupt indentation in dorsal margin, whence it continues anteroventrad to anterior margin. Anterior margin sharply curved anterodorsad, becoming more gently curved approaching ventral margin.

Dentition of left valve: one cardinal tooth and one lateral tooth. Elongate triangular cardinal, straight, and apex is directed posteriorly. Anterior portion of tooth more pronounced, and situated immediately below beak. Upper margin of tooth and overlying socket straight and horizontal. Triangular socket very slightly curved dorsad with apex directed anteriorly. Narrow lateral tooth extends posteriorly within one-fourth shell length in front of posterior margin of shell with a slight posteroventrad trend, to form wedge-shaped furrow between hingeline and lateral tooth at posterior extremity.

Anterior adductor muscle scar ovoid and separated from main visceral cavity by an elevated buttress inclined anteriorly to form approximately a 60° angle with horizontal. Anterior adductor muscle scar slightly anterior of beak and at midwidth of shell. Main visceral cavity ovoid with greatest depth in anterior one-third of shell. Posterior adductor scar and pallial line unknown.

Dimensions as follows: height, 2.3 mm; length, 5.1 mm; approximate convexity of left valve, 0.8 mm.

Discussion.—Except for the well-defined posteroventrad sulcus and radial costellae, absent in this specimen, the species has a striking similarity to *P. albequus*. Except for these disparities the writer would prefer such a designation, but until better material

is available for study it shall be designated *Pleurophorus* sp. (b).

Occurrence.—Although complete specimens are rare, fragments of the shells exhibiting the structure of the hingeline and dental area are abundant in the limestone of the lower member. Specimens have been collected from localities Nos. 55-9, 55-17, 55-18, and 55-21.

Genus DOZIERELLA Newell 1940

DOZIERELLA aff. D. GOULDII (Beede)
Plate 72, figure 7

Description.—An external cast of a small pteriacid, moderately convex, noncostate. Auricles short and well defined, posterior auricle approximately twice length of anterior auricle. Posterior portion extends approximately one-third shell length behind posterior extremity of hingeline.

Beak acute (80°), relatively convex, extending over hingeline; approximately one-fifth shell length behind anterior margin. Spreading umbonal fold extends obliquely from hingeline at an angle of 60°, bounded on each side by a sulcate flattening of shell boundaries.

Right valve and internal character of shell unknown. Left valve has the following dimensions:

Length of shell	9.5 mm
Height of shell	5.0 mm
Length of hingeline	6.0 mm

The surface of valve is marked by very fine indistinct concentric growth lines, which become more prominent over umbonal fold.

Discussion.—The specimen resembles *Dozierella gouldii* (Beede) Newell 1940, but the angle formed by the bisectrix of the umbonal fold and hingeline (80°) is somewhat greater than *D. gouldii* Newell (p. 284, pl. 1, fig. 14) giving less obliquity to the Rustler species. According to Newell, *D. gouldii* is the most abundant species in the Custer fauna; nevertheless, he found some variation in the large collection studied. The few specimens at hand allow only a tentative designation of *D. gouldii*, pending further study of additional material.

Occurrence.—*Dozierella gouldii* (Beede) is reportedly abundant wherever fossils are found in the Whitehorse sandstone of Oklahoma and Texas, and also occurs in the Azotea tongue of the Carlsbad limestone (at the top of the Seven Rivers formation in southeastern New Mexico). The specimens here described were found in the dolomite of the lower member at locality No. 55-1, and in the limestone of the lower member at locality No. 55-21.

Genus ALLORISMA

ALLORISMA aff. A. DUBIUM Waagen
Plate 72, figure 3

1881 *Allorisma dubium* WAAGEN, Palaeontologica Indica, Mem. Geol. Survey India, ser. 13, vol. 1, pt. 3, p. 196, pl. 17, figs. 7a, b.

Description.—Small, biconvex, elongate-oval external casts with a length approximately twice greatest width. Posterior margin high, obliquely curved from hingeline to midlength where it curves subangularly and obliquely forward. Ventral margin evenly rounded and convex as far as beak; it curves upward toward hingeline to form a not quite semicircular anterior margin. Beak low, rounded, incurved to hingeline with spreading umbonal fold that forms an apical angle of 120° and slopes gently antero-ventrad to reach maximum convexity at midpoint. From this point to ventral margin the curvature of the shell increases. Posterior margin curves gently to dorsal margin making a sharp turn dorsoanteriorly at midpoint continuing with a dorsal convexity above hingeline, whence it slopes ventrad to dorsal margin. Posterior portion of valve flat; disappearance of umbonal fold in front of rear margin produces a spatulate posterior portion of valve.

Entire surface of valve bears distinct growth lines interspaced by finer concentric striae. Ontogeny of shell indicates a uniform growth elongating posteriorly as shell approaches maturity.

Internal character of shell unknown, but dimensions are as follows:

	1 (left valve)	2 (right valve)
Length of shell	10.5 mm	18.5 mm
Height of shell (max.)	5.5 mm	8.2 mm
Convexity of single valve	1.8 mm	2.8 mm
Apical angle (approx.)	120°	120°

Discussion.—The outline of the shells resembles that of *Allorisma dubium* Waagen

which has the following dimensions:

Length of shell	21 mm
Height of shell	10 mm
Thickness of single valve	5 mm
Apical angle	135°

Waagen (1881) stated of *A. dubium*,

> Of all the genera hitherto described, it can be most probably attributed to the genus *Allorisma*, though the well-developed area does not agree very well with that genus.

The American and Indian shells are alike except that the posterior portion of the Indian shell is slightly less convex. The interrelations of the two valves of the American shell cannot be observed, and the posterodorsal curve of the dorsal margin is different from that of *Allorisma*. Thus although the writer has not definitely assigned the species to this genus, the American shell is in close agreement with the Indian shell designated *A. dubium* by Waagen (pl. 17, figs. 7a, b), and so far as the writer knows, Waagen's designation is undisputed. The distinctive posterior outline of the shell distinguishes the species from other species of *Allorisma*.

Occurrence.—*Allorisma dubium* Waagen was found in a "friable sandstone" in the middle of the Upper Productus limestone in the Salt Range of India. Three specimens were collected from the siltstone of the lower Rustler member, two at locality No. 55–3, one at locality No. 55–4, and one at locality No. 55–6.

Genus NUCULOPSIS (Walcott) Schenck 1939
NUCULOPSIS (PALAEONUCULA?) aff. N. OKAWENSIS Schenck
Plate 73, figures 9, 10

Description.—Specimens very small, bivalved, subtrigonal shells, approximately 2 mm long. Dorsal margin gently rounded, flattened in front of beaks, but ventral margin strongly curved. Curvature increases anteriorly to form a narrowly curved anterior margin. Posterior margin relatively straight; its junction with dorsal margin forms a right angle; an acute angle in some specimens is formed by the junction. Angle formed by the dorsal and posterior margins governed somewhat by width of umbone. Faint ligamental groove present along hinge margin. Taxodont dentition obscured by poor preservation, but nine posterior and four to six anterior teeth distinguished. Shell strongly convex with point of greatest convexity at midlength in front of peak. Surface ornamentation indistinct or absent; two to three very faint growth lines near ventral margin. Dentition of shells not known.

Discussion.—The specimens are very similar to those of "*Nucula*" *levatiformis* Walcott illustrated by Girty (1909, pl. 10, figs. 7–8). Schenck (1939) states that "*Nucula*" *levatiformis* Walcott is insufficiently diagnosed to permit a generic assignment, but believes the species may be a "nuculid, related to *Nuculopsis okawensis* Schenck." A comparison of the Rustler species with illustrations of *N. okawensis* Schenck shows that the Rustler shell is much smaller and possesses a more sharply curved anterior margin. Ornamentation is not sufficiently preserved on the Rustler shell to permit a comparison.

Occurrence.—This species is abundant in the gray limestone of the lower Rustler member; it occurs with the gastropod fauna. Specimens have been collected at localities No. 55–12, 55–3, 55–9, 55–17, and 55–21.

Genus ACANTHOPECTEN
ACANTHOPECTEN COLORADOENSIS (Newberry) Newell 1937
Plate 72, figure 14

1861 *Pecten coloradoensis* NEWBERRY, Geol. Rept., U. S., 36th Congress, 1st Sess., Senate Exec. Document and House Exec. Document No. 90, pt. 3, pp. 1–154.
1936 *Acanthopecten coloradoensis* (Newberry). STOYANOW, Geol. Soc. America Bull., vol. 47, p. 498.
1937 *Acanthopecten coloradoensis* (Newberry). NEWELL, Kansas State Geol. Survey, vol. 10, p. 75, pl. 12, figs. 7a, b, 13, 14, 15a, b.
1938 *Acanthopecten coloradoensis* (Newberry). MCKEE, Carnegie Inst., Pub. 492, pp. 161–162.
1944 *Acanthopecten coloradoensis* (Newberry). NEWELL, in Shimer and Shrock, Index Fossils of North America, p. 445, pl. 159, fig. 5.
1948 *Acanthopecten coloradoensis* (Newberry). BRANSON, Geol. Soc. America Mem. 26, p. 559.

Description.—Specimens large, biconvex shells bearing numerous relatively large costae on moderately convex exterior. On

dorsal portion of shell costae closely spaced diverging ventrally to a density of three costae per cm at ventral margin. Newell (1937) reports 23 costae on a nearly complete hypotype.

Fila crossing costae and interspaces not easily distinguished on all portions of shell owing to poor preservation, but appear more prominent and closely spaced dorsoanteriorly. Fila occupying ventral third of the shell relatively straight, but those on dorsal portion ventrally curved, pointed in interspaces, and more severely arched on costae. This trend increases in a ventral direction until fila resemble edges of imbricating lamellae. Fila less pronounced and moderately curved on anterior and posterior portions of shell. Spreading umbonal fold nearly uniform in curvature with a flattening of anterior and posterior areas.

Discussion.—The specimens here described are an incomplete external cast and external mold. The structure of the beak and hingeline could not be observed on the specimens at hand. Although no dimensions are available, the diagnostic ornamentation of the specimens leaves little doubt as to their identity. A comparison of the specimens with those illustrated by Newell (1937, pl. 12, figs. 7a, b, 13, 15, 15a, b), with due regard for the preservation of the Rustler forms, shows a striking agreement in the two shells.

Occurrence.—The Rustler formation contains the highest occurrence of *Acanthopecten coloradoensis* recorded to date. The species was found in the dolomite of the lower member at locality No. 55-1. *A. coloradoensis* has been reported from the limestone of the Kaibab formation in northwestern Arizona, from Las Vegas quadrangle, Nevada, and from the Word formation of the Glass Mountains.

Genus AVICULOPINNA Meek 1864
AVICULOPINNA sp.
Plate 73, figure 1

Description.—Shell elongate, biconvex, with an apical angle of 20° and a posterior margin not quite semicircular in outline. Posterior margin greatly curved, oblique to hingeline, increasing its ventroanterior curvature below midpoint. Only posterior portion of shell exposed; hard dolomite matrix could not be removed without injuring shell. Exposed surface bears numerous, very fine, concentric lirae which parallel posterior margin, increasing their anterior curvature and becoming more closely spaced ventrad. Average width of interspaces approximately four times that of lirae. No apparent thickening of dorsal margin. Inferred length of shell, assuming a uniform convergence of dorsal and ventral margins, is 40 mm. Character of anterior margin and location of beak unknown; however, no exposed features justify a reference to *Pinna*.

Occurrence.—One specimen retaining its original shell material was collected from the dolomite in the lower member of the Rustler at locality No. 55-1.

Class GASTROPODA
Genus EUPHEMITES
EUPHEMITES CIRCUMCOSTATUS Walter, n. sp.
Plate 73, figures 20, 21, 23, 24

Description.—Specimens small to medium, globose, planospiral, convolute gastropods; height slightly less than breadth. Whorls slightly depressed, rounded, bearing conspicuous spiraled costae well developed on the parietal inductura. Bilobed dorsal lip, expanded at sides, split by a narrow sinus forming an angular notch at dorsum. Dorsal margin gently curved into median insinuation.

Ventral lip covered by narrow, rounded, revolving costae which extend out on outer whorl about two-thirds distance to margin of dorsal lip; beyond, costae continue as small nodes to within one-twelfth whorl circumference of dorsal extremity. Lateral costae, shorter than medial costae, begin their nodal habit at a greater distance from dorsal margin. Eight costae divided by a medial furrow or selenizone narrower than those on either side. Medial furrow referred to as a selenizone; no growth lines can be distinguished. Approaching umbilical region costae decrease in height and width. Between last lateral costae and umbilical region a series of nodes extends from axis to half distance to margin of dorsal lip (Pl. 73, fig. 21).

Dimensions as follows:

Length of shell.....	7.5 mm	12.5 mm
Width of shell.....	8.5 mm	13.5 mm
Height of aperture.....	2.0 mm	3.0 mm

Discussion.—The shells studied were incomplete and fragmentary. Only one specimen showed the shape of the aperture and median insinuation in the dorsal lip. The writer knows of no other species which closely compares with the Rustler form. *Euphemites apertus* (Waagen) from the "topmost beds" of the Upper Productus limestone, India, is similar in size and shape to the Rustler shell but the two sharp peripheral carinae and the greater glabrous portion of the outer whorl are pronounced differences observed in the Indian shell. The only known American species to which the shell could be compared is *Euphemites subpapillosus* White.

The spiraled costae or ribs do not terminate in the aperture, but have been observed on the surface of the enveloped volutions of broken specimens retaining their same number and distribution. The small number, wide spacing and greater extension of the revolving ribs, plus their nodose habit near the outer lip and umbilical region are distinctive of this new Rustler species.

Occurrence.—This distinctive form is the most abundant and persistent species in the gray thin-bedded limestone of the lower member of the Rustler. Specimens have been collected throughout the area, but are particularly abundant at localities Nos. 55-3, 55-6, 55-9, 55-17, and 55-21. One specimen was collected from the dolomite bed at locality No. 55-12.

EUPHEMITES sp. (a)
Plate 70, figure 10

Description.—Specimen small to medium, globose, planospiral, convolute gastropods; height slightly less than breadth. Whorls slightly depressed, rounded, similar in outline to *E. circumcostatus* Walter, n. sp., but bearing 12 spiraled costae. Dorsal lip and parietal inductura not present.

Twelve very fine, uniform, rounded, equally spaced, revolving costae ornament the enveloped whorls. Two lateral costae less pronounced than medial costae. No nodes observed on the interwhorls, ornamentation of outer whorls unknown. Selenizone or medial insinuation cannot be distinguished; growth lines absent.

Dimensions as follows:

Length of shell	incomplete
Width of shell	8.0 mm
Height of aperture	incomplete

Discussion.—This species is almost identical to *E. circumcostatus* Walter n. sp.; however, the finer, more numerous spiraled costae make it distinctive. A study of more complete specimens will probably determine this species to be new, but the writer hesitates to make such an assignment until the structure of the aperture and morphology of the outer whorl have been determined.

Occurrence.—A single fragmentary specimen was collected from the base of the lime-

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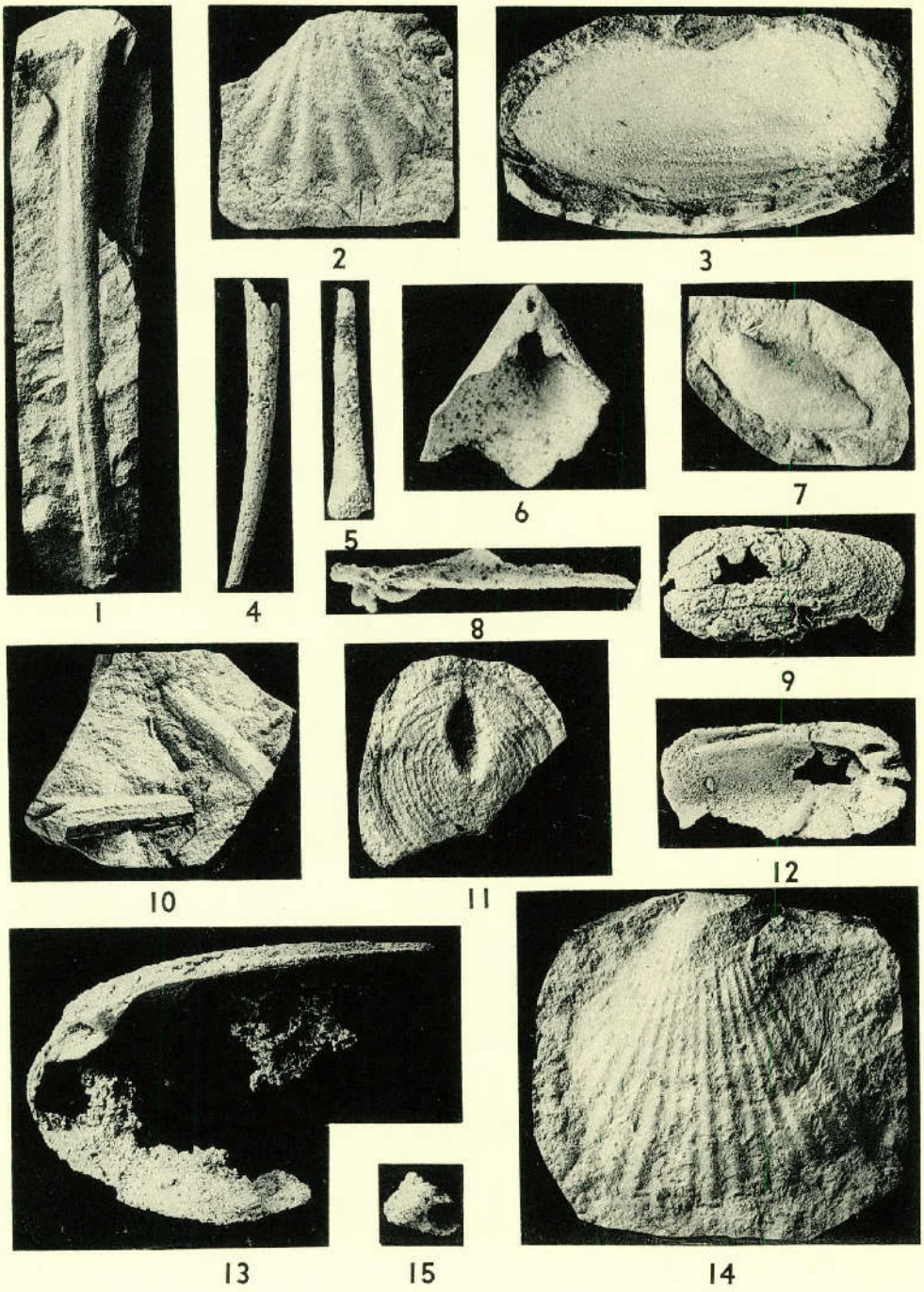
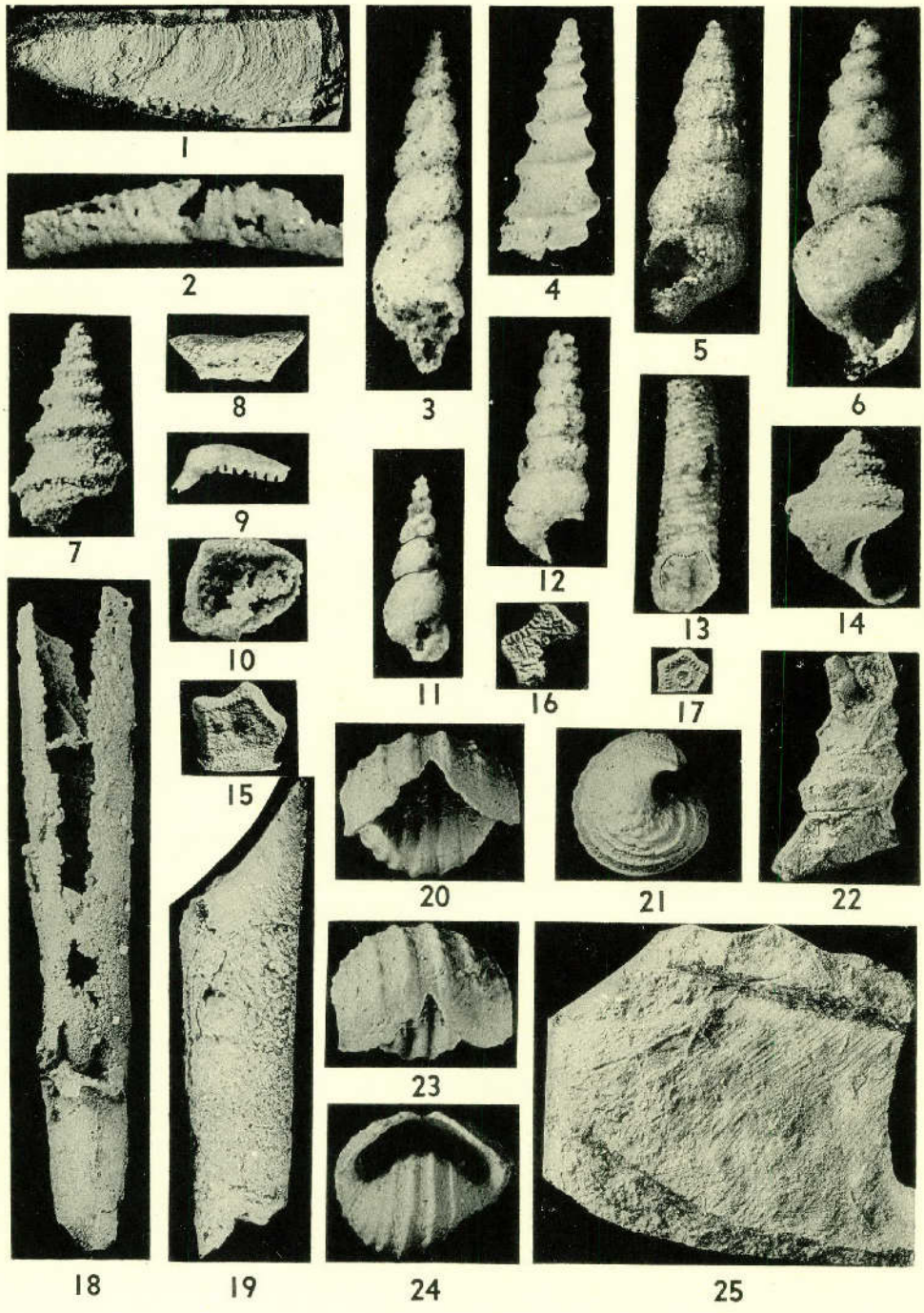
EXPLANATION OF PLATE 72

FIGS. *1*, *10*—Plant fragments, showing octagonal faceting, ×1. (p. 684)
2—*Hustedia* cf. *H. meekana*, external cast of ventral valve ×3. (p. 701)
3—*Allorisma* aff. *A. dubium*, external cast of a right valve ×3. (p. 693)
4—*Dentalium* sp. ×3. (p. 700)
5—Echinoid spine ×3. (p. 701)
6—*Wellerella elegans* (Girty). Ventral interior showing well-developed teeth and oval foramen ×3. (p. 689)
7—*Dozierella* aff. *D. gouldii*. External cast of the left valve ×3. (p. 693)
8—*Schizodus* sp. Oblique ventral view of dentition of a right valve ×5. (p. 686)
9, *12*—*Pleurophorus lunulus* Walter n. sp., holotype *9*, exterior of left valve showing obliquity of the posterior margin, as determined from growth lines, posterior margin incomplete ×3; *12*, interior of same specimen; note large lunular cavity and divergence of hingeline and posterolateral tooth, and deep anterior adductor muscle cavity ×3. The deposit in the center of valve is Alvar. (p. 691)
11—*Orbiculoidea* sp. Mold of ventral valve ×4. (p. 701)
13—*Pleurophorus* sp. (a). Fragment of right valve, large lateral tooth ×2. (p. 692)
14—*Acanthopecten coloradoensis* (Newberry). External cast exhibiting arched fila ×1. (p. 694)
15—Trochiform gastropod ×10. (p. 702)



Walter, Permian (Rustler) fossils, Texas



Walter, Permian (Rustler) fossils, Texas

stone in the lower member of the Rustler formation at locality No. 55–21.

GONIASMA sp.
Plate 73, figure 4

Description.—High-spired shells of medium size, fractured anteriorly so that aperture and base of shell unknown. Whorl profile similar to that of Murchisoniidae, inclined from upper suture at an angle of approximately 25° from vertical, rounding outward to a strongly elevated selenizone-bearing carina. Below carina, profile slopes sharply inward to lower suture at a slightly greater angle than slope above carina.

Selenizone slightly concave, narrow and bounded on each side by two fine, distinct, revolving costae. Selenizone-bearing carina situated low on periphery of whorl in lower edge of carina. Seemingly two lower sutures present; lower of two covered by succeeding whorl, but observed in broken shells. Growth lines and ornamentation obscure or absent, but faint revolving lirae exist near upper suture. Protoconch faint and obscure, and first three whorls show very little angularity; carina not well developed until fourth whorl.

Dimensions of fragments of shells are as follows:

	(6 whorls)	(8 whorls)
Height of shell.....	5.0 mm	7.8 mm
Width of whorl (max.).	2.8 mm	3.5 mm
Pleural angle.....	22°	22°

Discussion.—The shells are moderately well preserved, exhibiting faint ornamentation, but the critical apertural margin and other basic characters of taxonomic importance are not fully known. A shell of very similar size and whorl profile is illustrated by Girty (1909, pl. 29, fig. 20), but he was uncertain of the specific identity. The Rustler shell appears to be better preserved and is more suitable for identification but the writer prefers to wait until better material is available. *Murchisonia conjungens* Waagen, the Indian shell from the top beds of the Upper Productus limestone, bears comparison.

Occurrence.—Specimens are common in both the gray limestone and the lower dolomite of the lower Rustler member at localities Nos. 55-1, 55-13, 55-17, 55-21, and in the dolomitic limestone of member N at locality No. 55-8.

Genus MURCHISONIA d'Archiac & de Verneuil, 1841

MURCHISONIA? cf. M. GOULDII Beede
Plate 73, figure 7

1907 *Murchisonia gouldii* BEEDE, Kansas Univ. Sci. Bull., vol. 4, p. 167, pl. 8, fig. 6.
1907 *Murchisonia collingsworthensis* BEEDE, Kansas Univ. Sci. Bull., vol. 4, p. 166, pl. 8, figs. 7, 7a.
1907 *Orthonema ? texana* BEEDE, Kansas Univ. Sci. Bull., vol. 4, p. 168, pl. 8, figs. 5, 5a.
1940 *Murchisonia gouldii* (Beede) NEWELL, Geol. Soc. America Bull., vol. 51, pp. 306–

EXPLANATION OF PLATE 73

FIG. *1*—*Aviculopinna* sp. Left valve ×1. (p. 695)
2, 6, 13—*Plagioglypta ? annulistriata* (Meek and Worthen); ×10. (p. 700)
3, 11—*Streptacis ?* cf. *S. permiana* (Beede) Knight. *3*, ×10; *11*, specimen showing outline of outer lip and tilted nuclear whorl ×10. (p. 699)
4—*Goniasma* sp. ×5. (p. 697)
5—*Paleostylus* (*Pseudozygopleura*) sp. Specimen exhibiting sinuate transverse costae, and adpressed whorls ×10. (p. 698)
7—*Murchisonia ?* cf. *M. gouldii* ×10. (p. 697)
8, 15–17—Crinoidea. *8*, Crinoid plate ×3; *15, 16*, Pentagonocyclopa ×3; *17*, Pentagonocyclopa, showing rimmed lumen and crenulate margin ×5. (p. 701)
9—Nuculid. Fragment of beak area bearing part of dentition ×10. (p. 694)
10—*Nuculopsis* (*Palaeonucula ?*) aff. *N. okawensis*. View of right valve interior ×10. (p. 694)
12—Loxonematoid gastropod, revolving ornamentation not clearly visible ×10. (p. 702)
14—*Worthenia ?* sp. Note revolving ornamentation ×10. (p. 699)
18, 19—*Plagioglypta ? canna* (White). *19*, specimen exhibiting a truncated posterior ×2. (p. 700)
20, 21, 23, 24—*Euphemites circumcostatus* Walter n. sp. *20*, profile view of outer lip; *21*, lateral view showing nodose umbilical area; *23*, view showing median insinuation in dorsal margin and nodose habit of revolving costae near dorsal margin; *24*, apertural view of crushed specimens ×4. (p. 695)
22—Gastropod ×10. (p. 701)
25—*Pinna ?* sp. ×1. (p. 695)

309, pl. 5, figs. 1–14, pl. 6, fig. 1a–e.
1942 *Murchisonia gouldii* (Beede) CLIFTON, Jour. Paleontology, vol. 16, p. 694, pl. 101, fig. 29.
1944 *Murchisonia gouldii* (Beede) NEWELL in Shimer and Shrock, Index Fossils of North America, p. 459, pl. 186, figs. 6–8.
1948 *Murchisonia gouldii* (Beede) BRANSON, Geol. Soc. America Mem. 26, p. 712.

Description.—Species characterized as "high spired gastropods of ten to twelve whorls when mature, with a wide shallow sinus in outer lip culminating on a rounded carina in a seemingly short slit that gives rise to a selenizone" (Knight, 1940). These morphologic features unobserved on Rustler shells either because of poor preservation or immature shells. Shells possess a distinct, elevated selenizone, and two faint, closely spaced spiral costae at lower suture. Whorl gently shouldered against previous whorl and gently concave from shoulder to selenizone-bearing carina; beyond this point whorl profile concave to two costae at lower suture. Selenizone-bearing carina varies its position from middle to very low on outer surface of whorl (Knight, 1940), latter position more common in Rustler shells.

Base of shells, though incomplete, small, flatly rounded to subconcave, anomphalous, exhibiting a short columella approximately three-fourths height of body whorl, with a slightly calloused and reflected columellar lip. Outer lip unknown. Extremely faint and incomplete growth lines distinguished on lower portion of whorls. Extending below selenizone, they have a strong forward obliquity to lower revolving costae from which point they obtain a moderate forward convexity, and backward obliquity approaching columella.

Selenizone, occupying the strong carina, bounded by two very fine revolving lirae. No other ornamentation distinguished.

Dimensions are:

Height of shell	3.2 mm	1.9 mm	1.8 mm	3.3 mm
Width of shell (max.)	1.3 mm	1.0 mm	1.2 mm	1.3 mm
Pleural angle	28°	30°		

Discussion.—The low position of the selenizone, angularity of the whorls, and faintness of shoulder in the upper portion of the whorl obscures their identity; moreover, the general small size, high angularity, and small number of whorls probably indicates a neanic growth stage.

Occurrence.—*Murchisonia gouldii* has been reported from the Capitan limestone in Winkler County, Texas, and in the Blaine and Dog Creek of Texas and the Whitehorse of Oklahoma. The Rustler shells occur in the upper gray limestone and lower dolomite in the lower member at localities Nos. 55-1, 55-3, 55-9, 55-17, and others.

Genus PALEOSTYLUS Mansuy 1914
Subgenus PSEUDOZYGOPLEURA Knight 1930
PALEOSTYLUS (PSEUDOZYGOPLEURA) sp.
Plate 73, figure 5

Description.—Specimens minute, high-spired, loxonematoid shells with slightly sinuate transverse costae on ephebic whorls. Nuclear whorls are indistinct, but faint, seemingly highly sinuate costae present. Whorl profile adpressed and slightly arcuate. Transgression from highly sinuate costae of nuclear whorls to less sinuous ephebic costae not distinguished.

Base rounded, anomphalous, with columella slightly reflexed. Character of outer lip not fully known, ornamentation unknown, except for prominent, slightly sinuous transverse costae, which obtain a distinct forward obliquity in lower portion of whorl. Costae evenly spaced, rounded, and present on all whorls.

Dimensions are:

Height	4.0 mm	3.5 mm	2.3 mm
Width (max.)	1.5 mm	1.5 mm	1.1 mm
Pleural angle	23°	18°	

Discussion.—Of the three shells assigned to *Paleostylus* (*Pseudozygopleura*) sp. only one retains the nuclear whorls. The costae are faint and their shape cannot be determined, thus any generic assignment is made with reserve. It is most unfortunate that the shells from these young Permian deposits are not sufficiently preserved to exhibit all of their morphologic features, for the information gained in their study might augment Knight's excellent work on this unique group.

Occurrence.—All the specimens of this species were obtained in the dolomite of the lower Rustler member at locality No. 55-1.

Genus STREPTACIS Meek 1871
STREPTACIS ? cf. S. PERMIANA
(Beede) 1907 Knight 1940
Plate 73, figures 3, 11

Description.—Very small, high-spired, many-whorled shells. Whorl profile slightly arched between sutures, shell base rounded and anomphalous. Columellar lip rather strongly arcuate. Aperture not fully known, lower part of outer lip has a rounded tongue-like form. Growth lines indistinct or absent, but presence of numerous faint, very fine revolving lirae distinguishable. Exact number of lirae undetermined, width of the lirae approximately equaling width of interspaces.

Dimensions of average specimens of six whorls from the Rustler and the Whitehorse.

	Rustler sp.	Whitehorse sp.
Height of shell.....	5.2 mm	7.0 mm
Width of shell (max.).....	2.0 mm	2.1 mm
Pleural angle.....	17°	20°

Discussion.—The shells described by Knight (1940) had no distinguishable ornamentation except growth lines. This could be due to poor preservation which failed to reproduce all the details of the ornamentation in the external molds. The growth lines of the Rustler shells are not sufficiently preserved to justify a comparison of the two species, but the nuclear whorls of the Rustler shells are present and have the characteristic form of *Streptacis*. According to Knight, the form of *Streptacis* is so general that it is of little value in correlation; nevertheless, a further study of the Rustler species with supplementary collections will give more information which might improve the value of the shell for stratigraphic use.

Occurrence.—The species is common in the gray limestone of the lower member at localities Nos. 55-17, 55-3, and 55-21.

?Genus WORTHENIA Koninck, 1883
WORTHENIA ? sp.
Plate 73, figure 14

Description.—Small trochiform shells with a shallow, angular slit or notch above periphery of whorl, giving rise to a selenizone. Body-whorl profile slopes flatly from upper suture at an angle of approximately 55° from vertical making a carinate angulation nearly vertical downward to lower suture, whence it makes a sharp rounded curve onto base. Base rounded, nearly flat, and narrowly phaneromphalous. Columellar lip thin, first bending gently toward umbilicus, then swinging sharply outward to outer lip. Form of outer lip not fully known, its probable shape determined from faint growth lines on the outer whorl. Growth lines leave upper boundary with an acute backward obliquity, rounding quickly forward to form a small rounded sinus, adjacent to first peripheral suture whence it curves sharply downward over angulation of the whorl (direction not determined), entering base with a strong forward obliquity rounding backward to obtain a moderately strong forward convexity before entering umbilicus. It must be understood that the above description is based on very faint growth lines, parts of which are indistinguishable, particularly in the critical region of the selenizone; nevertheless, the writer is reasonably assured that the selenizone occupies the outer surface of the whorl shoulder for there is a slight depression adjacent to the suture inside the angulation of the body whorl. No concavity or accentuated bordering of selenizone, can be distinguished. Ornamentation, three to six very fine revolving lirae on upper surface of whorl, three slightly coarser lirae on periphery of whorl, eight to ten revolving lirae on base with numerous fine lirae on umbilical slope.

Dimensions are:

	Average specimen	Maximum specimen
Height of shell.....	5.0 mm	–
Width (body whorl)....	3.6 mm	10.0 mm
Pleural angle.....	73°	–

Angularity of shell decreases posteriorly; neanic whorls low and rounded, and nucleus unknown.

Discussion.—The shells, though numerous, are fragmentary. The material is sufficiently preserved to show the size and shape of the species and faint revolving ornamentation, yet none of the specimens exhibits the complete outline of the outer lip, and growth lines are scant and obscure.

The carina appears to bear crenulations but their presence cannot be definitely established. Until better specimens are avail-

able for study the writer prefers a tentative assignment to *Worthenia*.

Dr. J. Brookes Knight has collected similar specimens probably belonging to the same genus "near the base of the Bone Spring limestone in the Sierra Diablo in the Leonard and in the lower Word of the Glass Mountains," yet the upper limits of these forms have not been definitely established.

Occurrence.—The shells are numerous in the gray limestone of the lower Rustler member, second in numbers only to *Euphemites circumcostatus*. Collections have been made at localities Nos. 55-3, 55-6, 55-17, 55-9, and 55-12, and it occurs less abundantly in the dolomite at locality No. 55-1.

Class SCAPHOPODA
Genus PLAGIOGLYPTA Pilsbry 1898
PLAGIOGLYPTA ? CANNA (White) 1874
Plate 73, figures 18, 19

1874 *Dentalium canna* WHITE, U. S. Geogr. Survey, W. 100th Mer., Preliminary Rept. Inv. Fossils, p. 23.
1877 *Dentalium canna* WHITE, U. S. Geogr. Survey, W. 100th Mer., Rept. Vol. 4, p. 156, pl. 12, figs. 6a, b.
1903 *Plagioglypta canna* GIRTY, U. S. Geol. Survey, Prof. Paper 16, p. 452.
1909 *Plagioglypta canna ?* GIRTY, U. S. Geol. Survey, Prof. Paper 58, p. 450, pl. 23, figs. 11–13.
1909 *Plagioglypta canna* GIRTY, U. S. Geol. Survey, Bull. 389, p. 95, pl. 11, fig. 11.
1910 *Plagioglypta canna* GIRTY, U. S. Geol. Survey, Bull. 436, p. 44, pl. 6, fig. 14.
1916 *Plagioglypta canna* (White), E. BRANSON, Jour. Geology, vol. 24, p. 657, pl. 3, fig. 13.
1930 *Plagioglypta canna* (White), C. BRANSON, Missouri Univ. Studies, vol. 5, no. 2, p. 58, pl. 15, fig. 6.

Description.—Specimens characterized by large, straight, tapered shells 47 mm. long, 8 mm. wide at apertural end, and 3.5 mm. near apex. No surface ornamentation distinguished. A spoon-like truncation noted on posterior extremity of one specimen (Pl. 73, fig. 19). Apical end of shell unknown and surficial striations indistinct or absent.

Occurrence.—*Plagioglypta canna* has been found in the Delaware Mountain group of Texas, in the Phosphoria formation of Idaho and Wyoming, and in the Kaibab of northern Arizona and southern Utah. The specimens at hand were collected from the gray limestone of the lower Rustler member at locality No. 55-17. This species was abundant at locality No. 55-21, with *Euphemites* and *Goniasma* comprising the majority of the fauna.

PLAGIOGLYPTA ? ANNULISTRIATA
(Meek & Worthen)
Plate 73, figures 2, 6, 13

1870 *Dentalium annulostriatum* MEEK & WORTHEN, Acad. Nat. Sci., Philadelphia, Proc., p. 45.
1873 *Dentalium ? annulostriatum* MEEK & WORTHEN, Illinois Geol. Survey, vol. 5, p. 589, pl. 29, fig. 7.
1889 *Dentalium annulostriatum* KEYES, Acad. Nat. Sci., Philadelphia, Proc., p. 234.
1892 *Dentalium annulostriatum* KEYES, Acad. Nat. Sci., Philadelphia, Proc., p. 251.
1903 *Plagioglypta annulistriata* GIRTY, U. S. Geol. Survey, Prof. Paper 16, p. 452.
1915 *Plagioglypta annulistriata* GIRTY, U. S. Geol. Survey, Bull. 544, p. 147, pl. 15, figs. 15–16a.

Description.—Specimens very small, moderately curved, elongate shells with numerous annular lirae. Shells approximately 1 mm in diameter and taper to 0.6 mm near apex. Shells incomplete and apex absent. Fine annular lirae oblique and irregularly bundled on concave surface of shell.

Dimensions of two specimens are:

Length	5.2 mm.	3.5 mm.
Width	1.0 mm.	.6 mm.
Narrow	.06 mm.	.09 mm.
Lirae/mm	8.0	—

Occurrence.—*P. annulistriata* is common in the gray limestone of the lower Rustler member at localities Nos. 55-9, 55-3, 55-1, 55-16, and 55-21. The species is known in the Wewoka formation, Oklahoma.

Genus DENTALIUM Linné 1758
DENTALIUM sp.
Plate 72, figure 4

Description.—Shells small, moderately curved, elongate, approximately 15 mm long, with a maximum diameter of 1.8 mm tapering to 0.8 mm. Shell has 16 to 20 fine, distinct, longitudinal lirae on average specimen.

Occurrence.—This species is common in the dolomite of the lower member of the Rustler at localities Nos. 55-1 and 55-3.

Division CRINOSTYLI Moore
Main Group PENTAGONOSTYLI Moore
Group PENTAGONOCYCLOPAE Moore
Section PENTAGONOCYCLOPA Moore
PENTAGONOCYCLOPA cf. P. DISPAR Moore
Plate 73, figures 15–17

Description.—Columnals, internodals with a definite pentagonal outline, moderately long, length equaling two-fifths greatest width. Each of five sides concave inward, and parallels axis of stem, giving columnal a subpentagonal to stellate appearance. Small subcircular to pentagonal lumen at center of columnal approximately equals one-tenth of width. Central area of articular face smooth and flat with a sharp rim or collar around periphery of lumen. In weathered specimens, collar not present, giving lumen an apparently larger diameter than actually exists. Stellate central area bounded by a row of fine, straight, non-bifurcating crenellae. Crenellae occur in a single row normal to sides of columnal. Crenellae are very regular, not increasing in number by bifurcation or implantation; visible on the angles of the pentagon. Crenellae present increase in length between angles of pentagon.

Measurements of small internodals of *Pentagonocyclopa dispar* Moore: "width of the articulate face (same as width of segment), 3.0 mm; length of segments, 0.42 mm (average) to 0.84" as compared with an average width of 4.9 mm, length 1.8 mm measured on Rustler specimens.

Discussion.—The ossicles resemble columnals of Pentacrinidae but this latter group bears crenellae which form a petaloid pattern on the articular face. Since no close affinity could be established with the Pentacrinidae or other groups except on the basis of its distinct pentagonal outline, Moore's system of classifying crinoid fragments was used (Moore, 1939). This specimen closely resembles *Pentagonocyclopa dispar* Moore, bearing a rimmed lumen and crenellae at the angles of the pentagon. No columnals containing cirri bases have been collected.

Occurrence.—The group-type occurs in the Checkerboard? limestone in southeastern Kansas near the base of the Coffeyville shale, Ochelata group, Missouri series, Pennsylvanian.

This type occurs intermittently in the dolomite lens of the lower member of the Rustler formation, but is found in abundance at locality No. 55-1 with occasional occurrence at locality No. 55-19 (Harral triangulation station).

ADDITIONAL SPECIES REPRESENTED BY FRAGMENTS

Brachiopods

Hustedia cf. *H. meekana* (Shumard) (Pl. 72, fig. 2). External casts of three incomplete brachial valves were found in the siltstone of the lower member at localities Nos. 55-3, 55-4, and 55-6.

Orbiculoidea sp. (Pl. 72, fig. 11). An external cast of a single ventral valve was collected at locality No. 55-4 in the lower siltstone. It is impossible to determine the location and height of the apex from this flattened specimen. The outline is nearly circular, diameter 9.5 mm.; 12 closely arranged concentric lirae are exhibited by the specimen. The pedicle slit gapes, occupying approximately one-third the distance of the shell.

Chonetids. Specimens occurring as molds were found in the lower siltstone of locality No. 55-3.

Marginifera sp. Specimens are numerous at localities Nos. 55-2, 55-3, and 55-4, but are poorly preserved.

Pelecypods

Myalina sp. A single specimen is the external cast of the left valve; the anterior portion of the shell is broken, preventing further classification. The species was found in the siltstone of the lower member of the Rustler formation at localities Nos. 55-1, 55-2, 55-3 and 55-4.

Ostracodes

Bairdia sp. The specimens of *Bairdia* are too granularly replaced to exhibit the specific characters of the genus. The forms were noted in the insoluble residues of the dolomite in the lower member of the Rustler formation at localities Nos. 55-1 and 55-16.

Echinoids

Fragmentary echinoid spines were collected from the dolomite in the lower mem-

ber of the Rustler formation at locality No. 55-1.

Bryozoans?

Poorly preserved, branched forms have been found in the dolomite in the lower member of the Rustler formation at locality No. 55-1. This assignment is only tentative.

Gastropods

Loxonematidae.—Donaldina? sp. (Pl. 73, fig. 12). Very small, high-spired, anomphalous shells with revolving costae; aperture is not present and growth lines are not readily distinguishable. The shells resemble the form of *Donaldina*, but it cannot be determined whether they are heterostrophic. The dimensions are: height, 3.4 mm; width, 0.5 mm; pleural angle, 15.5.°

The species occur in abundance in the gray limestone of the lower member of the Rustler formation at localities Nos. 55-1, 55-3, 55-6, 55-9, 55-12, 55-17, 55-18, and 55-21.

Neritidae.—A single specimen of the family Neritidae is severely worn and incomplete. The shell is phaneromphalous, low-spired, with a form resembling that of *Naticopsis*. The only specimen was collected from the dolomite of the lower member of the Rustler formation at locality No. 55-1.

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Page 687, second column, line 39. For "Newell" read "Knight".

Page 697, Explanation of Plate 73, lines 2 and 3. Transfer "6" from line 2 to line 3. The specimen is *Streptacis* ? cf. *S. permiana* (Beede) Knight.