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Conodonts from the Marathon basin, Brewster County, Texas

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CONODONTS FROM THE MARATHON BASIN, BREWSTER COUNTY, TEXAS.

BY

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A

THESIS

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INTRODUCTION

Conodonts were discovered in the limestones of the Marathon region in the Big Bend country, Brewster County, Texas, as a result of field work during the summer of 1939. This was not the first known occurrence of these fossils from this region, however, as King[1] earlier mentioned the occurrence of conodonts in siliceous shales of Devonian (?) age.

The discovery of conodonts in the Ordovician and Pennsylvanian limestones of the area had its inception in the attempt to determine whether the Dimple limestone (lower Pennsylvanian) or Maravillas limestone (upper Ordovician) was involved in a fault that was being mapped. These limestones are similar lithologically and the nature of the outcrop along the fault trace was such that the age relations of the limestone involved could not be determined.

Samples were taken from localities of undoubted Dimple and Maravillas sections and these samples were digested in hydrochloric acid. The insoluble residues were so nearly alike that it was impossible to make a distinction on this basis. Acetic acid was then used and it was found

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1. King, P. B., Geology of the Marathon Region, Texas: U. S. Geol. Survey Prof. Paper 187, p. 53, 1937.

that the two limestones could be distinguished on the basis of the conodonts which remained in the residues.

Consequently, during the summer of 1940, collections were made from several limestone and shale formations in the Marathon region. In many instances the collections were made at the localities of measured stratigraphic sections published by King.[2] These and the sections measured by the writer in 1940 are shown graphically on the accompanying charts.

A total of 33 shale and 85 limestone samples were collected. The shales were treated by the boiling and flushing method as outlined by Branson and Mehl[3] but only four of them yielded conodonts. Sixty-three of the limestone samples contained conodonts. The limestones were broken into pieces one-eighth to one-fourth inch in diameter and digested in 2.0 Normal acid for about 48 to 72 hours. The 2.0 Normal acetic acid was found to be most efficient from the point of view of time consumed for complete digestion. This substantiates the work of St. Clair[4] who advocated a ratio of seven parts of water to one part of glacial acetic acid.

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2. King, P. B., op. cit., pp. 28-59.
3. Branson, E. B. and Mehl, M. G., Conodont Studies: University of Missouri Studies, vol. 8, pp. 1-19, 1934.
4. St. Clair, D. W., The use of acetic acid to obtain insoluble residues: Jour. Sed. Petr., vol. 5, pp. 146-149, 1935.

The acetic acid insoluble residues and the concentrated shale samples were further concentrated by means of acetylene tetrabromide (sp. gr. 2.7) and the heavy residues inspected for conodonts. Individual specimens were picked out of these residues and mounted on paper micropaleontological slides, whitened with a sublimate of ammonium chloride, and photographed. The photographs were taken with a Leica 35 mm. camera on Eastman Panatomic-X fine grained film through a microtessar lens (aperture f. 4.5) in a metallographic microscope at a magnification of 20 diameters with an exposure time of 10 seconds. Enlarged prints with a magnification of 80 diameters were made from the film and the prints arranged on black cardboard plates 10 x 14 inches. The plates were photographed on 35 mm. film and printed to a size of 5 x 7 inches, giving a specimen magnification of 40 diameters on the final plates.

The stratigraphic distribution, systematic descriptions, and illustrations of conodonts of Ordovician and Pennsylvanian age from the Marathon region form the basis of this thesis. In some instances, such as the occurrence in the Dimple formation, conodonts are the only positively identifiable fossils found in the rocks and, for this reason, have special significance in determining the age of these beds. The Ordovician conodont faunas are of importance because the occurrence in this region extends their known geographic and geologic range.

GENERAL GEOLOGY

The Marathon region is structurally a broad dome, in the central part of which are exposed Paleozoic rocks flanked by gently dipping Cretaceous strata. Topographically the area is a basin which has been formed by the removal of the Cretaceous cover from the underlying highly folded and faulted Paleozoic sediments.[5]

The total thickness of the Paleozoic rocks exposed in the basin and including those in the Glass Mountains to the north is approximately 21,000 feet. These sediments are thought to have been deposited in a subsiding trough, the Llanoria geosyncline. The oldest rocks exposed are sandstones and shales of upper Cambrian age. Overlying them are 2000 feet of limestones, shales, and cherts of Ordovician age. The Ordovician strata are overlain by approximately 500 feet of novaculite and chert of probable Devonian age.

The novaculite and chert beds are succeeded by lower Pennsylvanian clastics, which attain thicknesses up to 12,000 feet in the southeastern part of the basin but become thinner to the northwest. The lower part of

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5. King, P. B., op. cit., pp. 7-141.

these beds consists of two series of sandstones and shales separated by a limestone facies. The upper part is mainly conglomerates, sandstones, and limestones. All beds Pennsylvanian or older in age are deformed into a series of northeast-southwest trending close folds which have been broken by numerous high and low angle thrust faults.

The Permian rocks, consisting of some 5000 feet of complexly interfingering limestones and shales, in the Glass Mountains rest with angular unconformity on the older beds. The strata are tilted away from the Marathon basin toward the northwest and are not so strongly folded as are the Pennsylvanian beds. Marine fossils similar to the Guadalupian fauna of northern trans-Pecos Texas are developed in great abundance.

About 1200 feet of Cretaceous limestones surround the Marathon basin and dip gently away to the north, east and south. On the west side they are sharply folded, faulted and cut by igneous intrusions. West of the Marathon basin Tertiary lavas and tuffs overlie the Cretaceous limestones and within the region itself small intrusions of alkalic igneous rocks penetrate the Paleozoic and Cretaceous sediments. Gravel deposits covering the lowlands appear to be the only rocks younger than the igneous intrusions.

STRATIGRAPHY

General Relations

The stratigraphic relationships in the Marathon region are summarized in the following table:[6]

Geologic formations in Marathon region

Age	Formation	Thickness (feet)
Recent	Alluvium	--------
Pleistocene (?)	Terrace gravel	10-100
Tertiary (Eocene)	Lava and tuff	--------
	Unconformity	
Upper Cretaceous	Eagle Ford formation	200 +
Lower Cretaceous		
Washita Group	Buda limestone	60
	Del Rio shale	30
	Georgetown limestone	175
Fredericksburg Group	Edwards limestone	150
	Comanche Peak and Walnut	50
Trinity Group	Maxon sandstone	0-100
	Glen Rose formation	0-500
	Unconformity	
Triassic (?)	Bissett conglomerate	700
	Unconformity	

6. Modified from King, P. B., op. cit, p. 21.

Geologic formations in Marathon region (Continued)

Age	Formation	Thickness (feet)
Permian	Tessey limestone	1,000
	Capitan limestone	1,800
	Word formation	1,500
	Leonard formation	1,800
	Unconformity	
	Wolfcamp formation	500
	Unconformity	
Pennsylvanian	Gaptank formation	1,800
	Haymond formation	3,000
	Dimple limestone	300-1,000
	Tesnus formation	300-7,000
	Unconformity	
Devonian (?)	Caballos novaculite	250-600
	Unconformity	
Upper Ordovician	Maravillas chert	100-400
Middle Ordovician	Woods Hollow shale	180-500
	Fort Pena formation	175
Lower Ordovician	Alsate shale	25-100
	Marathon limestone	350-900
Upper Cambrian	Dagger Flat sandstone (base concealed)	300 +

Dagger Flat Formation

General Features.--The Dagger Flat formation was named by King[7] in 1931 for rocks of late Cambrian age outcropping in Dagger Flat, 13 miles south of Marathon. These rocks were first described by Baker and Bowman[8] in 1917, at which time the beds were not given a definite age assignment.

The bases of the exposed sections of the Dagger Flat formation are predominately compact, sugary-textured, buff sandstones which grade upward into shale and flaggy sandstone interbedded with a few thin layers of limestone. These are the oldest rocks found in the Marathon basin. The base of the formation is not exposed and the rocks at all outcrops are so contorted that the true thickness cannot be determined. The thickness of the beds on the south side of Dagger Flat is approximately 300 feet.

Location of Samples.--One shale sample and one sample of dark gray, sandy, thin bedded limestone weathering chocolate brown, were collected at a locality

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7. King, P. B., Pre-Carboniferous stratigraphy of the Marathon uplift: Am. Assoc, Petroleum Geologists Bull., vol. 15, pp. 1064-1065, 1931.
8. Baker, C. L. and Bowman, W. F., Geologic exploration of the southeastern front range of trans-Pecos Texas: Texas Univ. Bull. 1753, p. 83, 1917.

in the Marathon anticlinorium three and one-half miles southwest of Fort Pena Colorada, on the south side of the road to Robert's ranch. The outcrop is mapped by King[9] as Dagger Flat and the lithology is similar to that described as belonging to the Dagger Flat formation and occurring "2 miles northwest of the fort, on the south side of the road to the Robert's ranch (Pl. 24). The formation here consists of much crumpled and indurated greenish shale with several layers of fine to coarse-grained sandstone, in part calcareous. There are some arkosic pebbly layers and a few nodular layers of very fine-grained dark-gray or black limestone, weathering chocolate brown. These beds contain scattered fragments of brachiopods and trilobites." Robert's ranch is located about 10 miles southwest of old Fort Pena and the road to the ranch does not extend northwest of the fort. In all probability, the locality from which the above mentioned samples were taken is that described by King, as above.

Insoluble residues.--The residues contain rounded to subrounded, frosted quartz sand grains, some porous siliceous material, a few

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9. King, P. B., op. cit., (U. S. Geol. Survey Prof. Paper 187), p. 23.

sponge spicules, black limonite pseudomorphic after pyrite, pyrite, and a few grains of glauconite.

Correlation.—The formation is considered by King,[10] on the basis of the occurrence of Agnostus, Lingula, and Obulus, as equivalent to strata of upper Cambrian age.

Stratigraphic relations.—Since the base of the Dagger Flat formation is nowhere exposed, its relationship to pre-Cambrian or Cambrian formations beneath is unknown. The upper contact with the Marathon formation is not a distinct one because folding has complicated the relationship. In places a thin conglomerate overlies the Dagger Flat shales and in others the contact is marked by thin graptoliferous limestones resting on the green, upper shales of the Dagger Flat.

Marathon Formation

General features.—"Marathon limestone" is the name given by King[11] to the limestone and associated rocks which outcrop in the town of Marathon. The term is a restriction of the name "Marathon Series" as applied by Baker and Bowman to the middle and lower Ordovician rocks

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10. King, P. B., op. cit., p. 23.
11. King, P. B., op. cit., p. 26.

of the Marathon region.

The greater part of the formation is composed of dark gray to black, flaggy limestones that weather to an ash gray to bluish gray color. Light tan to buff to greenish shale partings separate most of the limestone beds and make up one-third to one-half of the formation. There are a few interbedded thin sandstones and generally five to six beds of intraformational, edgewise conglomerates. Near the middle of the formation is the Monument Springs dolomite member which has been named by King[12] for the exposures near Monument Spring, 12 miles southwest of Marathon. It is a dense, dark bluish gray dolomitic limestone which weathers to light gray rounded boulders or disconnected ledges. The member has a maximum thickness of 94 feet near Fort Pena Colorada but thins to 25 feet near Monument Springs.

The formation ranges between 500 to 1000 feet in thickness over most of the area but it decreases to a thickness of about 350 feet in the southernmost part of the basin.

Location of samples.--Collections of limestone samples were made from two sections of the formation at localities measured and described by King.[13]

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12. King, P. B., op. cit., p. 26.
13. Idem., p. 28.

One, a composite section, is located in the hills on the south side of the road to the Robert's ranch, six miles southwest of Marathon (Figure 1). The other section is located nearby on the east side of the road, in the bed of Alsate Creek (Figure 2).

Insoluble residues.--The residues from the limestone samples of the Marathon formation contain a great number of slender, siliceous sponge spicules, very fine grained amber dolomite rhombohedrons, some organic material, a few glauconite grains, and a number of rounded to sub-rounded, moderately frosted quartz sand grains.

Correlation.--According to King[14] "the faunas of the upper and lower members of the Marathon limestone are similar in character, although they represent distinct zones in the Deep Kill section of New York. The most common graptolite genera are Tetragraptus, Phyllograptus, and Didymograptus, but at some localities Goniograptus and Loganograptus are also found."

Stratigraphic relations.--In the Marathon anticlinorium the top of the formation is marked by the distinct basal conglomerate of the overlying Alsate shale.

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14. King, P. B., op. cit., p. 30.

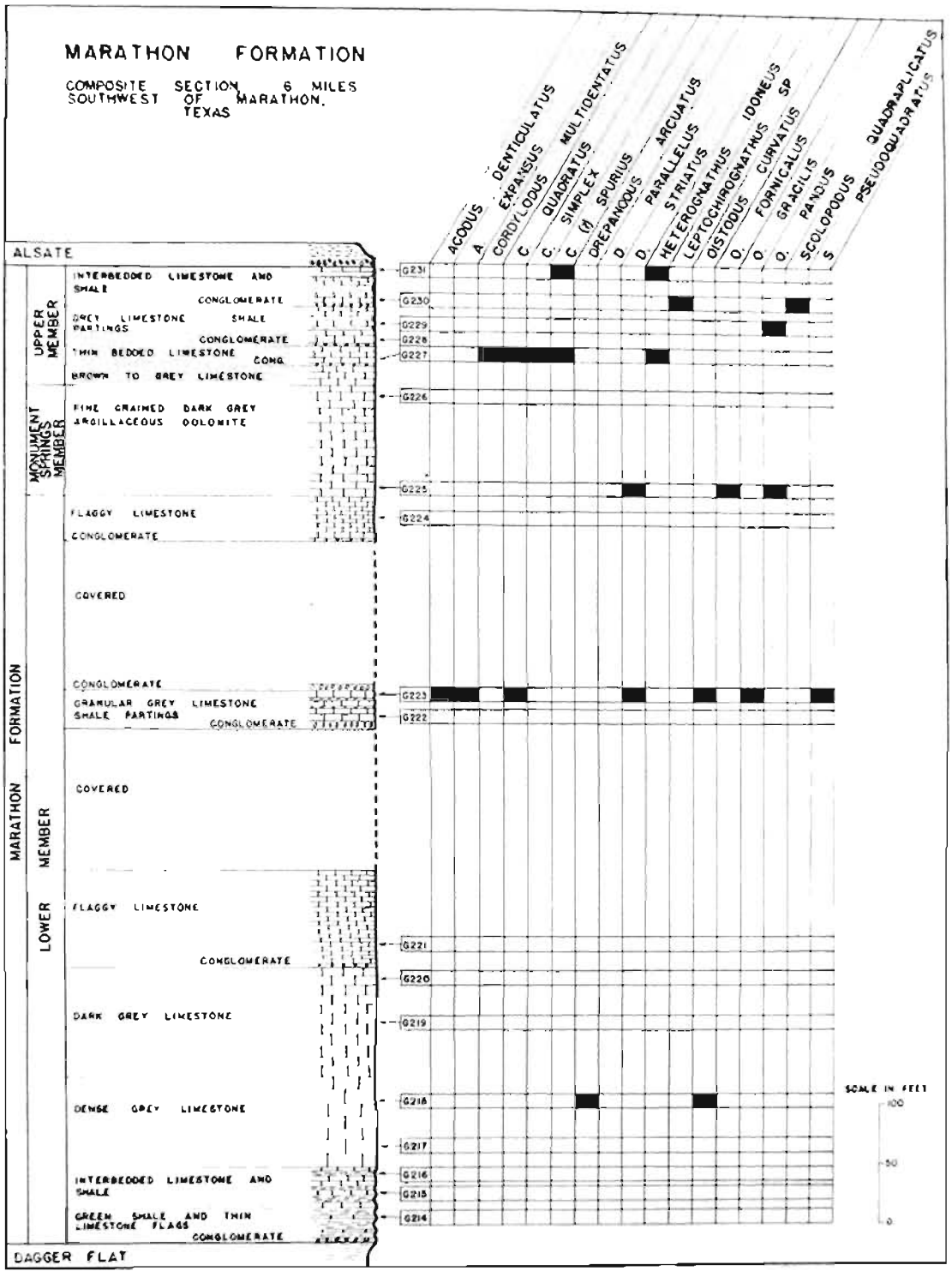
MARATHON FORMATION
COMPOSITE SECTION 6 MILES SOUTHWEST OF MARATHON, TEXAS
ACODUS A
DENTICULATUS
EXPANSUS
CORDYLODUS C.
QUADRATUS
MULTIDENTATUS
SIMPLEX
C. (?) SPURIUS
DREPANODUS D.
PARALLELUS
ARCUATUS
STRIATUS
HETEROGNATHUS
LEPTOCHIROGNATHUS
IDONEUS
DISTODUS O.
CURVATUS
SP
FORNICALUS O.
GRACILIS
PANDUS O.
SCOLOPODUS
PSEUDOQUADRATUS
QUADRAPLICATUS
ALSATE
MARATHON FORMATION
UPPER MEMBER
MONUMENT SPRINGS MEMBER
LOWER MEMBER
DAGGER FLAT
INTERBEDDED LIMESTONE AND SHALE
CONGLOMERATE
GREY LIMESTONE SHALE PARTINGS
CONGLOMERATE
THIN BEDDED LIMESTONE CONG.
BROWN TO GREY LIMESTONE
FINE GRAINED DARK GREY ARGILLACEOUS DOLOMITE
FLAGGY LIMESTONE
CONGLOMERATE
COVERED
CONGLOMERATE
GRANULAR GREY LIMESTONE SHALE PARTINGS
CONGLOMERATE
COVERED
FLAGGY LIMESTONE
CONGLOMERATE
DARK GREY LIMESTONE
DENSE GREY LIMESTONE
INTERBEDDED LIMESTONE AND SHALE
GREEN SHALE AND THIN LIMESTONE FLAGS
CONGLOMERATE
G231
G230
G229
G228
G227
G226
G225
G224
G223
G222
G221
G220
G219
G218
G217
G216
G215
G214
SCALE IN FEET
100
50
0

FIGURE 1

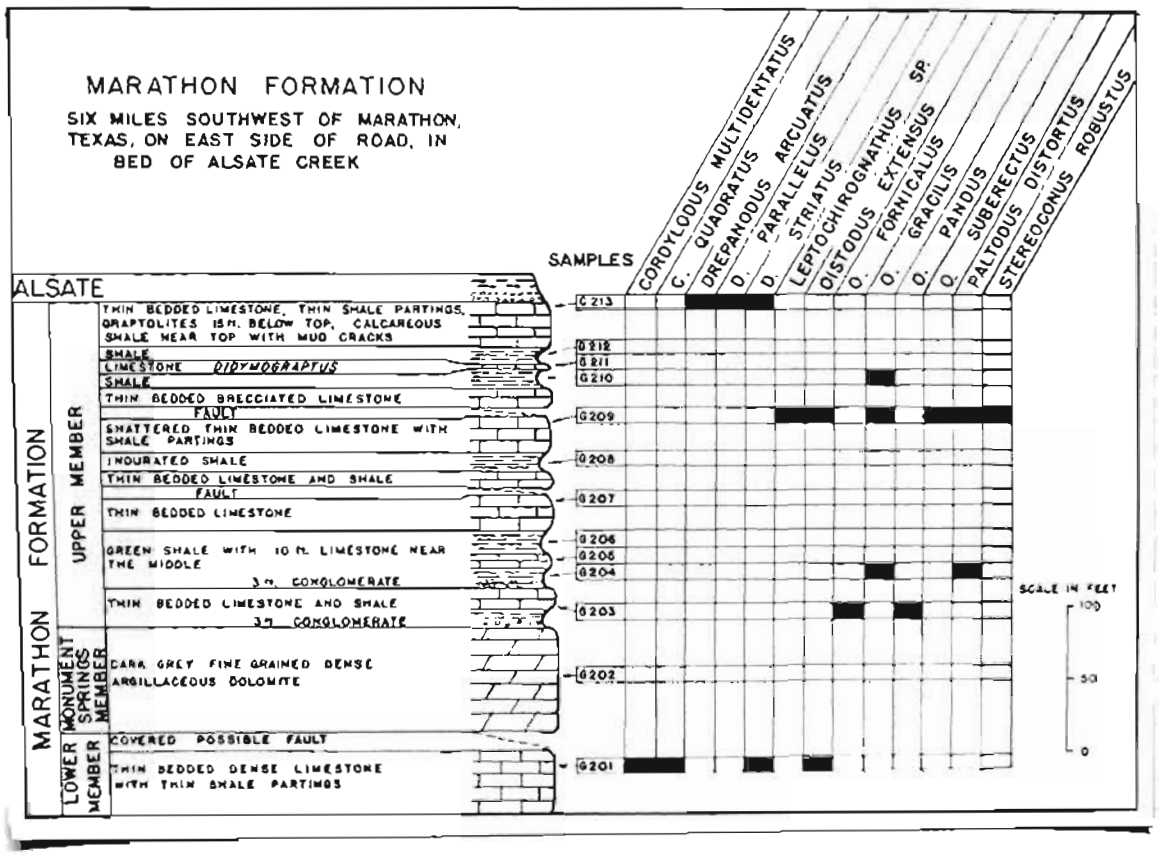
MARATHON FORMATION
SIX MILES SOUTHWEST OF MARATHON, TEXAS, ON EAST SIDE OF ROAD, IN BED OF ALSATE CREEK
SAMPLES
CORDYLODUS MULTIDENTATUS
C. QUADRATUS
DREPANODUS ARCUATUS
D. PARALLELUS
D. STRIATUS
LEPTOCHIROGNATHUS SP.
DISTODUS EXTENSUS
O. FORNICALUS
O. GRACILIS
O. PANDUS
Q. SUBERECTUS
PALTODUS DISTORTUS
STEREOCONUS ROBUSTUS
ALSATE
MARATHON FORMATION
UPPER MEMBER
MONUMENT SPRINGS MEMBER
LOWER MEMBER
THIN BEDDED LIMESTONE, THIN SHALE PARTINGS, GRAPTOLITES 15 M. BELOW TOP, CALCAREOUS SHALE NEAR TOP WITH MUD CRACKS
SHALE
LIMESTONE DIDYMOGRAPTUS
SHALE
THIN BEDDED BRECCIATED LIMESTONE
FAULT
SHATTERED THIN BEDDED LIMESTONE WITH SHALE PARTINGS
INDURATED SHALE
THIN BEDDED LIMESTONE AND SHALE
FAULT
THIN BEDDED LIMESTONE
GREEN SHALE WITH 10 M. LIMESTONE NEAR THE MIDDLE
3 M. CONGLOMERATE
THIN BEDDED LIMESTONE AND SHALE
3? CONGLOMERATE
DARK GREY FINE GRAINED DENSE ARGILLACEOUS DOLOMITE
COVERED POSSIBLE FAULT
THIN BEDDED DENSE LIMESTONE WITH THIN SHALE PARTINGS
C 213
G 212
G 211
G 210
G 209
G 208
G 207
G 206
G 205
G 204
G 203
G 202
G 201
SCALE IN FEET
100
50
0

FIGURE 2

The upper limit in the Dagger Flat anticlinorium is drawn at a conglomerate but the beds above and below are similar.

Alsate Formation

General features.—The Alsate formation was named by King[15] for Alsate Creek which empties into Pena Colorada Creek at old Fort Pena Colorada. The formation is distributed widely throughout the Marathon and Dagger Flat anticlinoria. In most places the shale occupies a covered area between the outcrops of Marathon and Fort Pena limestones. The formation ranges in thickness from 25 to 100 feet, is predominately olive green shale to the north, and contains interfingering gray limestone beds toward the south.

Location of samples.—Two samples of Alsate shale were collected from the bed of Alsate Creek and one from outcrops above the Marathon section of Figure 1. No limestone samples were taken.

Correlation.—King[16] reported that graptolites found in the Alsate formation are of late Deepkill age and that a Maclurites found in Alsate Creek indicates that

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15. King, P. B., op. cit., (Am. Assoc. Petroleum Geologists Bull.), p. 1069.
16. King, P. B., op. cit., (U. S. Geol. Survey Prof. Paper 187), p. 32.

the formation should also be correlated with some part of the latest Beekmantown.

Stratigraphic relations.—The Alsate shale is everywhere separated from the Fort Pena above by conglomerate beds which are most prominent in the Marathon anticlinorium. The abrupt change in this area from Alsate shale below to the cherty limestones of the Fort Pena above probably indicates a distinct unconformity.

Fort Pena Formation

General features.—The Fort Pena formation is the chief ridgemaker in the lower Ordovician section of the basin and forms low hogbacks in the otherwise level country of the Dagger Flat and Marathon anticlinoria. It was named by King[17] for exposures on one of the ridges, or hogbacks, immediately north of old Fort Pena Colorada. The formation consists of alternating thick bedded, sandy, gray limestone and blue to gray chert. Near the base are one or more beds of conglomerate separating the formation from the Alsate shale. Near the top of

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17. King. P. B., op. cit., (Am. Assoc. Petroleum Geologists Bull.), p. 1070.

the formation the limestones are separated by numerous bluish to gray or brown shale partings. The formation ranges in thickness from 125 to 200 feet.

Location of samples.--Samples were taken from one section, measured and described by King,[18] three miles west-southwest of Fort Pena Colorada on the south side of the road to the Robert's ranch (Figure 3). Another section was sampled in the bed of the nearby Alsate Creek[19] (Figure 4).

Insoluble residues.--The residues contain very fine grained dolomite rhombohedrons, glauconite, large and small subangular slightly frosted quartz sand grains, a few rather large flakes of biotite, numerous slender siliceous sponge spicules cemented with light blue chalcedonic quartz, some spongy-appearing tan to cream to buff siliceous interstitial material, a few grains of organic material, and numerous large and small grains of white to bluish white, irregular, ropy to botryoidal masses of chalcedony.

Correlation.--King[20] reported Diplograptus, Ceraurus, Bucania, a rafinesquinoid probably related to Ptychoglyptus,

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18. King, P. B., op. cit. (U. S. Geol. Survey Prof. Paper 187), p. 33.
19. King, P. B., op. cit., Pl. 3, fig. D.
20. King, P. B., op. cit., p. 34.

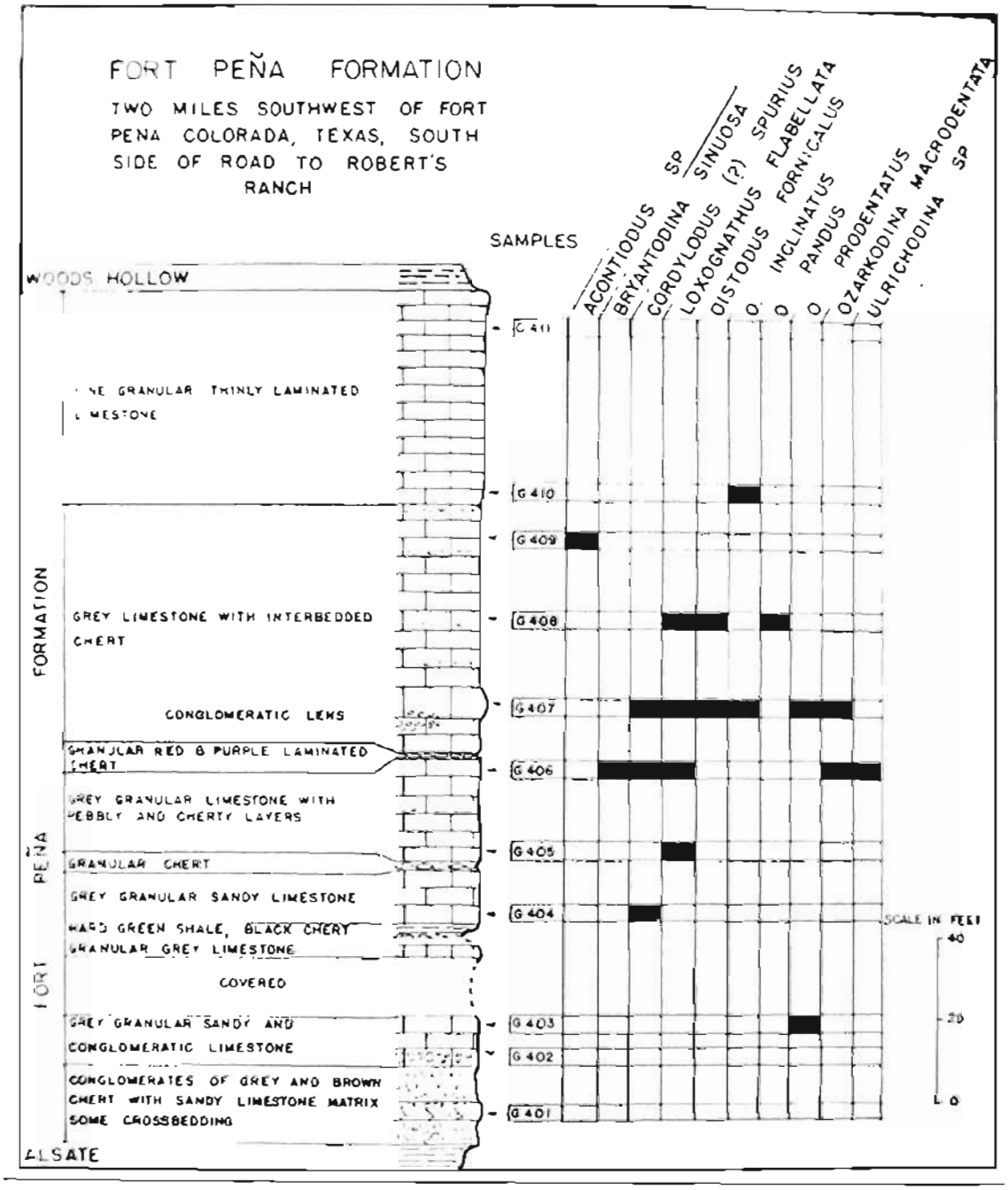
FORT PEÑA FORMATION
TWO MILES SOUTHWEST OF FORT PENA COLORADA, TEXAS, SOUTH SIDE OF ROAD TO ROBERT'S RANCH
SAMPLES
ACONTIODUS
BRYANTODINA
CORDYLODUS
LOXOGNATHUS
OISTODUS
O.
O.
O.
OZARKODINA
ULRICHODINA
SP
SINUOSA
(?) SPURIUS
FLABELLATA
FORNICALUS
INCLINATUS
PANDUS
PRODENTATUS
MACRODENTATA
SP
WOODS HOLLOW
FORMATION
PEÑA
FORT
ALSATE
G 411
G 410
G 409
G 408
G 407
G 406
G 405
G 404
G 403
G 402
G 401
GRANULAR THINLY LAMINATED LIMESTONE
GREY LIMESTONE WITH INTERBEDDED CHERT
CONGLOMERATIC LENS
GRANULAR RED & PURPLE LAMINATED CHERT
GREY GRANULAR LIMESTONE WITH PEBBLY AND CHERTY LAYERS
GRANULAR CHERT
GREY GRANULAR SANDY LIMESTONE
HARD GREEN SHALE, BLACK CHERT
GRANULAR GREY LIMESTONE
COVERED
GREY GRANULAR SANDY AND CONGLOMERATIC LIMESTONE
CONGLOMERATES OF GREY AND BROWN CHERT WITH SANDY LIMESTONE MATRIX SOME CROSSBEDDING
SCALE IN FEET
40
20
0

FIGURE 3

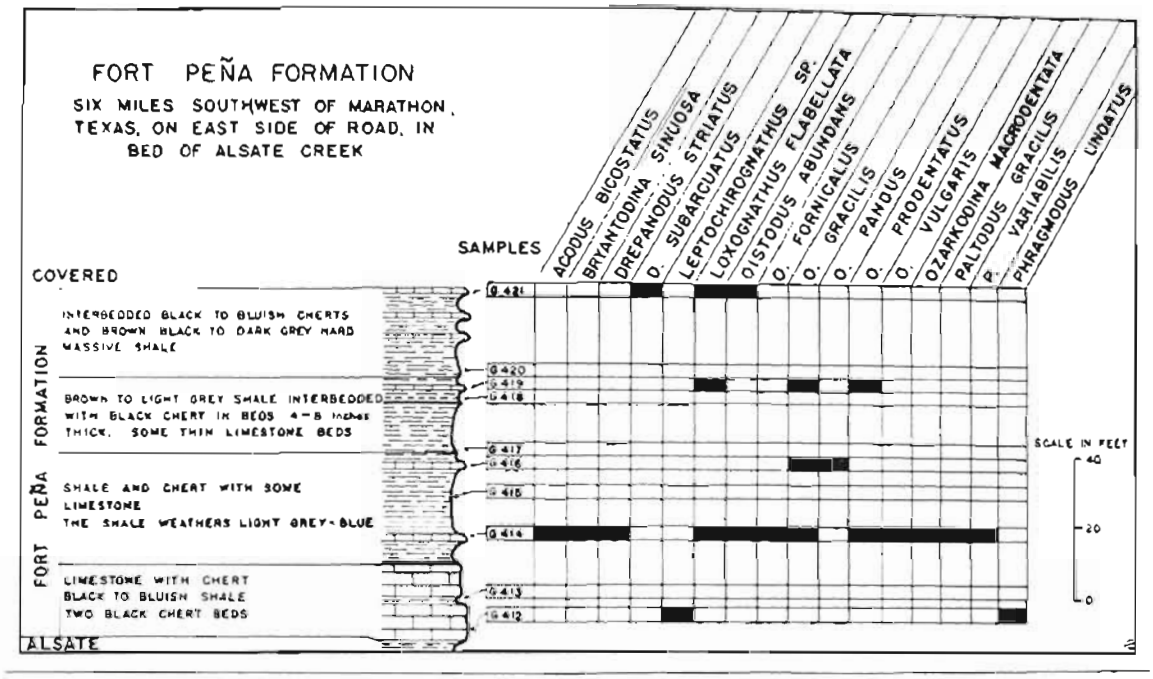
FORT PEÑA FORMATION
SIX MILES SOUTHWEST OF MARATHON, TEXAS, ON EAST SIDE OF ROAD, IN BED OF ALSATE CREEK
SAMPLES
ACODUS BICOSTATUS
BRYANTODINA SINUOSA
DREPANODUS STRIATUS
O. SUBARCUATUS
LEPTOCHIROGNATHUS SP.
LOXOGNATHUS FLABELLATA
OISTODUS ABUNDANS
O. FORNICALUS
O. GRACILIS
O. PANDUS
O. PRODENTATUS
O. VULGARIS
OZARKODINA MACRODENTATA
PALTODUS GRACILIS
P. VARIABILIS
PHRAGMODUS UNDATUS
COVERED
INTERBEDDED BLACK TO BLUISH CHERTS AND BROWN BLACK TO DARK GREY HARD MASSIVE SHALE
BROWN TO LIGHT GREY SHALE INTERBEDDED WITH BLACK CHERT IN BEDS 4-8 inches THICK. SOME THIN LIMESTONE BEDS
SHALE AND CHERT WITH SOME LIMESTONE
THE SHALE WEATHERS LIGHT GREY-BLUE
LIMESTONE WITH CHERT
BLACK TO BLUISH SHALE
TWO BLACK CHERT BEDS
FORT PEÑA FORMATION
ALSATE
G 421
G 420
G 419
G 418
G 417
G 416
G 415
G 414
G 413
G 412
SCALE IN FEET
40
20
0

FIGURE 4

Climacograptus, Orthis of the type O. tricenaria, Tetragraptus, and Didymograptus from the limestones of the Fort Pena formation. As to correlation he reported that "most of this fauna is suggestive of the Black River, but the occurrence here and there of the two primitive genera last named, ... suggests that the formation is older and possibly Chazyan. The field relations of the Fort Pena formation suggest that it is of Middle rather than Lower Ordovician age, as its massive sandy limestones rest with coarse basal conglomerate on dissimilar Lower Ordovician strata and appear to grade up into the Wood's Hollow shale."

Stratigraphic relations.—The contact of the Fort Pena formation with the Wood's Hollow shale is apparently conformable. Near the top of the formation the beds pass from massive limestones to drab shales and thin flaggy limestones which, in turn, grade upward into the olive drab shales and scattered thin flaggy limestones of the Wood's Hollow. This relation is well shown at the type locality of the Wood's Hollow formation.

Wood's Hollow Formation

General features.--The Wood's Hollow shale was named by King[21] for exposures in the anticlinal valley between Wood's Hollow and Little Wood's Hollow, six miles southeast of Marathon. The formation is composed of olive drab indurated shales interbedded with thin laminated gray to light brown sandy limestones and calcareous sandstones. It has a thickness ranging from 300 to over 400 feet.

Location of samples.--Samples were collected from the type locality of the formation, the line of the measured section running northwest from the abandoned wildcat well, King and Franklin Gage No. 1 (Figure 5).

Insoluble residues.--The residues from the Wood's Hollow limestone are characterized by grains of white, ropy to botryoidal chalcedony, large and small subrounded, frosted quartz sand grains, some organic material, a few doubly terminated quartz crystals, and some amber dolomite rhombohedrons. The siliceous sponge spicules so conspicuous in the Fort Pena are not found in the Wood's Hollow samples.

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21. King, P. B., op. cit., (Am. Assoc. Petroleum Geologists Bull.), p. 1071.

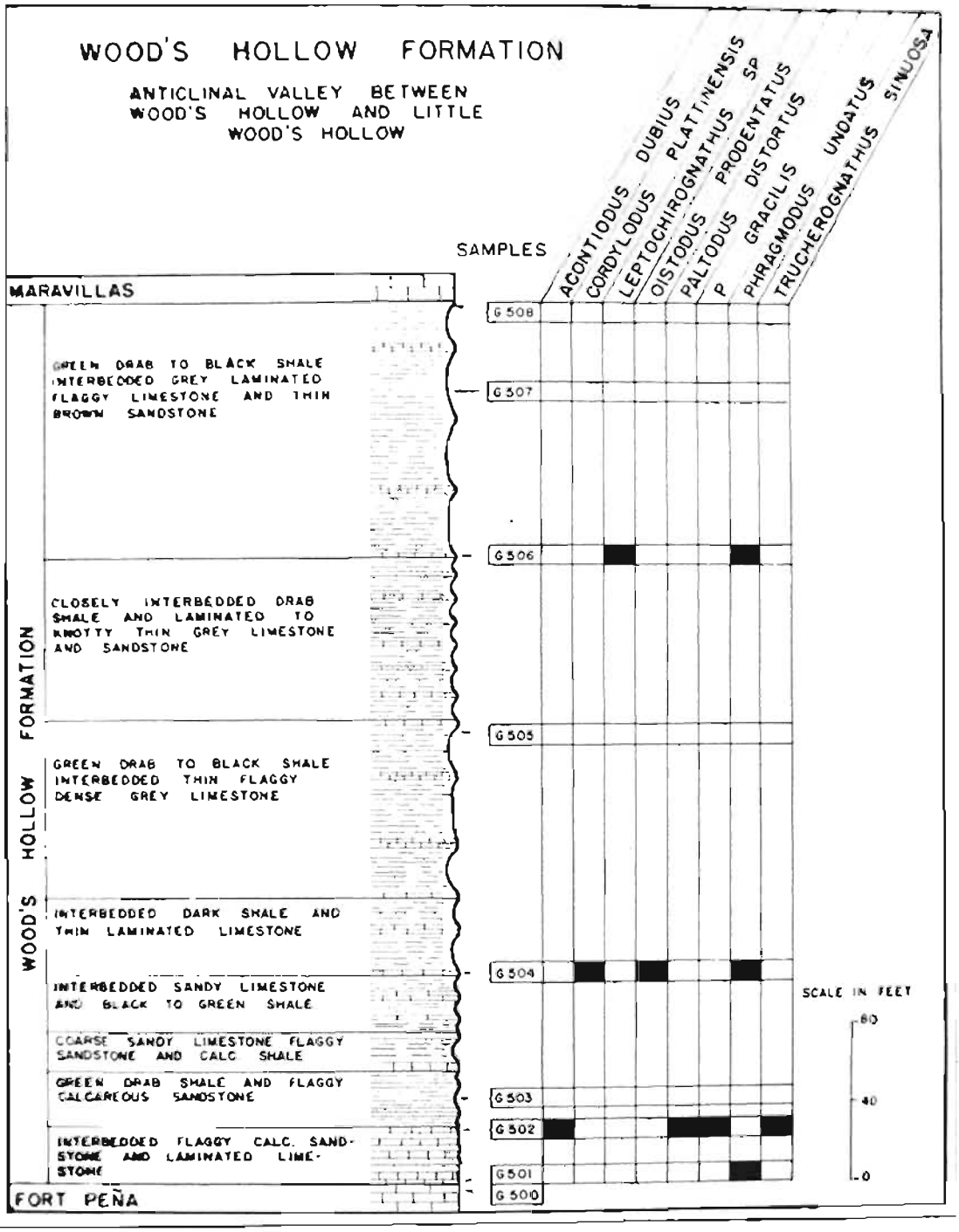
WOOD'S HOLLOW FORMATION
ANTICLINAL VALLEY BETWEEN WOOD'S HOLLOW AND LITTLE WOOD'S HOLLOW
SAMPLES
ACONTIODUS DUBIUS
CORDYLODUS PLATTINENSIS
LEPTOCHIRIOGNATHUS SP
OISTODUS PRODENTATUS
PALTODUS DISTORTUS
P GRACILIS
PHRAGMODUS UNDATUS
TRUCHEROGNATHUS SINUOSA
MARAVILLAS
WOOD'S HOLLOW FORMATION
GREEN DRAB TO BLACK SHALE INTERBEDDED GREY LAMINATED FLAGGY LIMESTONE AND THIN BROWN SANDSTONE
CLOSELY INTERBEDDED DRAB SHALE AND LAMINATED TO KNOTTY THIN GREY LIMESTONE AND SANDSTONE
GREEN DRAB TO BLACK SHALE INTERBEDDED THIN FLAGGY DENSE GREY LIMESTONE
INTERBEDDED DARK SHALE AND THIN LAMINATED LIMESTONE
INTERBEDDED SANDY LIMESTONE AND BLACK TO GREEN SHALE
COARSE SANDY LIMESTONE FLAGGY SANDSTONE AND CALC SHALE
GREEN DRAB SHALE AND FLAGGY CALCAREOUS SANDSTONE
INTERBEDDED FLAGGY CALC. SANDSTONE AND LAMINATED LIMESTONE
FORT PEÑA
G 508
G 507
G 506
G 505
G 504
G 503
G 502
G 501
G 500
SCALE IN FEET
80
40
0

FIGURE 5

Correlation.--Fossils are poorly preserved probably due, in part, to the severe folding to which the beds of the Wood's Hollow have been subjected. King[22] reported graptolites, bryozoans, trilobites, mollusks, and brachiopods and stated that "most of the fossils in the Wood's Hollow shale seem clearly to be of Middle Ordovician age and suggest that it be correlated with the Trenton. Some of the graptolites, however, such as Glossograptus echinatus, suggest a correlation with the Normanskill (Chazy), so that there is a possibility that the formation is older than Trenton. For the present the formation is classified as of Middle Ordovician age."

Stratigraphic relations.--The Wood's Hollow formation is separated distinctly from the overlying Maravillas limestones and chert by a sharp lithologic break from drab shales to dark gray, massive limestone. At some places the contact is marked by a basal conglomerate containing fragments of Wood's Hollow rocks.

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22. King, P. B., op. cit., (U. S. Geol. Survey Prof. Paper 187), pp. 35-36.

Maravillas Formation

General features.--The Maravillas formation, or Maravillas chert, was named by Baker and Bowman[23] for exposures in Maravillas Gap, in the Santiago Peak quadrangle, about 20 miles south of Marathon. The formation as originally described was said to include strata of both Trenton and Richmond age and to attain a thickness of 800 feet. It has since been decided that the formation is entirely upper Ordovician in age and that the thickness ranges from 100 to 400 feet. The original conception of 800 feet for the thickness of the formation was probably due to duplication of beds by folding.

The formation consists of interbedded dark gray limestone and black, dull to vitreous chert. Some of the limestone beds are petroliferous. A few beds of fine conglomerate and thin, black, indurated shale occur through the section.

Location of samples.--Limestone samples were collected from the cliff just east of the picnic grounds in the gap south of old Fort Pena Colorada[24] (Figure 6).

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23. Baker, C. L. and Bowman, W. F., op. cit., p. 87.
24. King, P. B., op. cit., p. 37; p. 38, Fig. 14; Pl. 5, Fig. B.

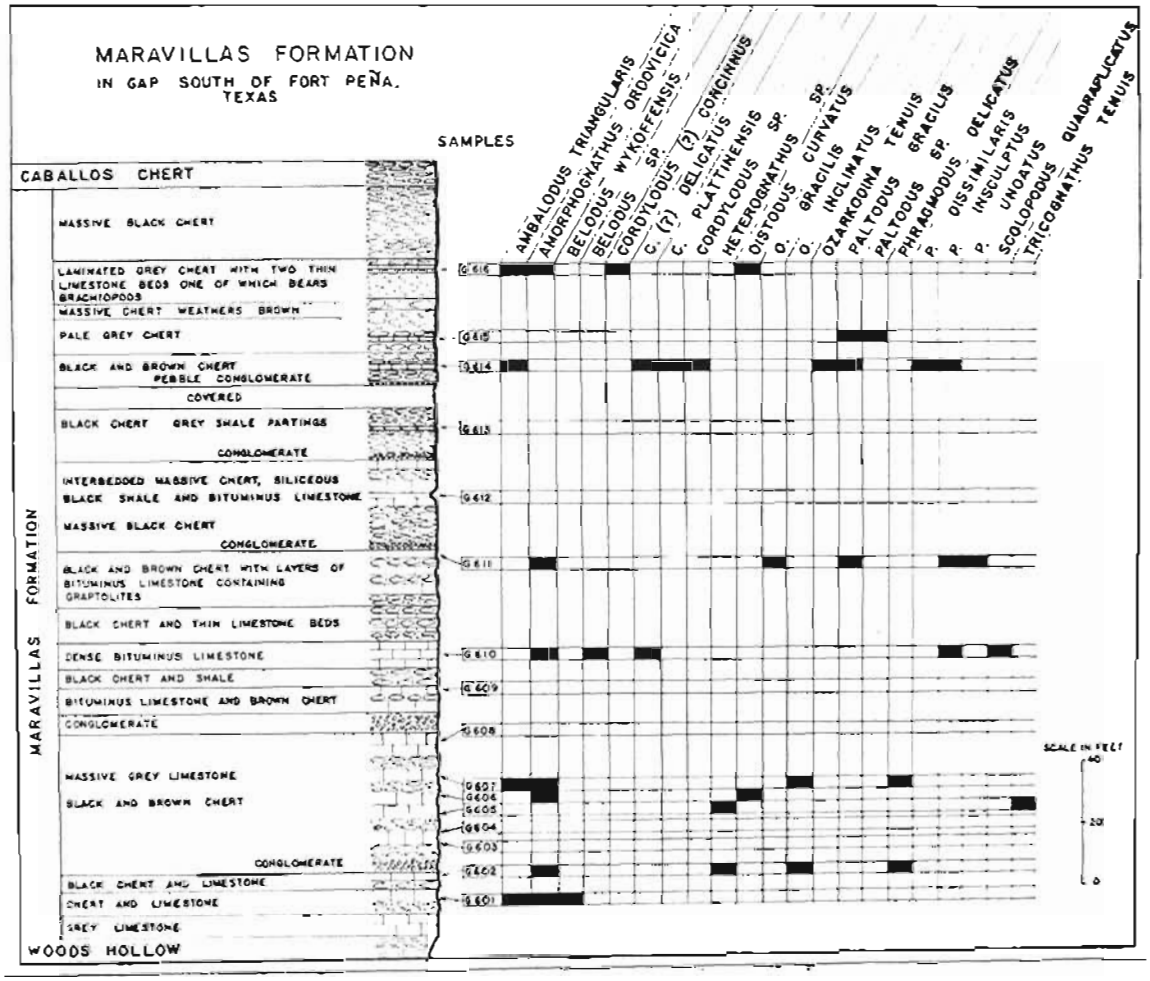
MARAVILLAS FORMATION
IN GAP SOUTH OF FORT PEÑA, TEXAS
SAMPLES
AMBALODUS TRIANGULARIS
AMORPHOGNATHUS ORDOVICICA
BELODUS WYKOFFENSIS
BELODUS SP.
COROLYLODUS SP.
C. (?) DELICATUS
C. (?) CONCINNUS
C. PLATTINENSIS
COROLYLODUS HETEROGNATHUS
DISTODUS SP.
D. GRACILIS CURVATUS
D. SP.
OZARKODINA INCLINATUS
PALTODUS TENUIS
PALTODUS GRACILIS
PHRAGMODUS SP.
P. P. P. DISSIMILARIS DELICATUS
INSCULPTUS
UNOATUS
SCOLOPODUS QUADRAPLICATUS
TRICOGNATHUS TENUIS
CABALLOS CHERT
MARAVILLAS FORMATION
MASSIVE BLACK CHERT
LAMINATED GREY CHERT WITH TWO THIN LIMESTONE BEDS ONE OF WHICH BEARS BRACHIOPODS
MASSIVE CHERT WEATHERS BROWN
PALE GREY CHERT
BLACK AND BROWN CHERT PEBBLE CONGLOMERATE
COVERED
BLACK CHERT GREY SHALE PARTINGS
CONGLOMERATE
INTERBEDDED MASSIVE CHERT, SILICEOUS BLACK SHALE AND BITUMINUS LIMESTONE
MASSIVE BLACK CHERT
CONGLOMERATE
BLACK AND BROWN CHERT WITH LAYERS OF BITUMINUS LIMESTONE CONTAINING GRAPTOLITES
BLACK CHERT AND THIN LIMESTONE BEDS
DENSE BITUMINUS LIMESTONE
BLACK CHERT AND SHALE
BITUMINUS LIMESTONE AND BROWN CHERT
CONGLOMERATE
MASSIVE GREY LIMESTONE
BLACK AND BROWN CHERT
CONGLOMERATE
BLACK CHERT AND LIMESTONE
CHERT AND LIMESTONE
GREY LIMESTONE
WOODS HOLLOW
G 616
G 615
G 614
G 613
G 612
G 611
G 610
G 609
G 608
G 607
G 606
G 605
G 604
G 603
G 602
G 601
SCALE IN FEET
40
20
0

FIGURE 6

Insoluble residues.--The residues consist of a few sponge spicules, some organic material, very small amber dolomite rhombohedrons, fine-grained, subrounded frosted quartz sand grains, small, angular, ropy to botryoidal grains of white chalcedony, and yellowish brown interstitial opaque silica (?).

Correlation.--The Maravillas has been variously correlated with the Richmond and the Trenton formations. King[25] has indicated a Cincinnattian age for these beds.

Stratigraphic relations.--The contact of the Maravillas with the overlying Caballos novaculite is sharp and is marked in a few localities by conglomerate. Generally, however, the gray to buff colored cherts of the lower member of the Caballos overlie the vitreous to dull black cherts of the upper Maravillas.

Caballos Formation

General features.--The Caballos formation, or Caballos novaculite, was named by Baker and Bowman[26] in 1917 for the outcrops on Horse, or Caballos, Mountain in the south-central rectangle of the Monument

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25. King, P. B., op. cit., pp. 41-42.
26. Baker, C. L. and Bowman, W. F., op. cit., p. 93.

Springs quadrangle about 14 miles southeast of Marathon. As redefined by King[27] the formation consists of five members with an aggregate thickness ranging from 300 to 600 feet; three chert members, one at the base, one at the top and one in the middle, are separated by a lower novaculite member and an upper novaculite member. The white novaculites are the chief ridge-makers of the basin. In the northwest part of the region the novaculite beds give place to chert which contains some siliceous shale partings and a few thin limestone beds. The cherts are varicolored and banded in dull white, black, brown, green, and pale blue. The novaculites are white to cream colored, vitreous to subvitreous to porcelaneous with usually indistinct bedding planes and in most places are shattered.

Location of samples.--No samples were collected from the Caballos formation.

Correlation.--According to King[28] "the Caballos novaculite is so strikingly similar to the Arkansas novaculite of Oklahoma and Arkansas, not only in lithology but in the character of the members and their stratigraphic behavior, that there is a strong presumption

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27. King, P. B., op. cit., pp. 47-48.
28. Idem., p. 52.

that the two are of the same age. The Arkansas novaculite has yielded fossils of Middle Devonian and Upper Devonian age. Until further evidence is obtained, the Caballos novaculite may best be classified as Devonian (?)."[29] Baker has recently found evidence in the San Andres Mountains of New Mexico which suggests a lower Mississippian age for the Caballos novaculite of that area.

Stratigraphic relations.—The Tesnus formation overlies the Caballos novaculite with distinct unconformity. In the southeastern part of the basin, in the Rough Creek area, the Tesnus overlaps the whole sequence of Caballos chert and novaculite which are folded into a steep anticline. Commonly, however, the differences in folding and the overlap are not pronounced. The variance in thickness of the upper chert beds and the presence of thin, silicified, chert conglomerates at the base of the Tesnus indicate an erosional break between the two formations.

Tesnus Formation

General features.—The Tesnus formation is the oldest Carboniferous formation in the Marathon region.

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29. Baker, C. L., Probable lower Mississippian age of Caballos Novaculite, New Mexico: Am. Assoc. Petroleum Geologists Bull., vol. 24, pp. 1679-1681, 1940

It was named by Baker and Bowman[30] for the exposures of sandstone and shale near Tesnus station on the Southern Pacific Railroad east of Haymond and about 15 miles east-southeast of Marathon. The formation is composed of a great thickness of interbedded brownish green, fine-grained sandstones and arkoses and black and olive drab shales with some chert and conglomerate beds near the base. In the northwestern part of the area the formation is about 300 feet thick and is composed mostly of black shale with a few beds of sandstone. In the southeastern part of the basin the formation exceeds 6500 feet in thickness and is made up mostly of sandstone and arkose.

Location of samples.--Samples of Tesnus shale were collected from the area of the outcrops 15 miles east of Marathon and from the section between East and West Bourland Mountains.[31] Calcareous shale and argillaceous limestone samples were collected near Three Mile Hill, or about 18 miles south of Marathon.

Correlation.--King[32] reported that, according to Dr. David White, plant remains from the Tesnus indicate

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30. Baker, C. L. and Bowman, W. F., op. cit., p. 101.
31. King, P. B., op. cit., p. 59.
32. Idem., p. 61.

that the formation is undoubtedly Pennsylvanian in age, possibly middle Pottsville, broadly Westphalian, younger than the Jackfork sandstone of Oklahoma, and probably older than Atoka. Foraminifera found by Bruce Harlton are reported to be identical with microfossils from the Caney shale in Oklahoma.

Stratigraphic relations.--The contact between the Tesnus and the Dimple formations is marked by a transition zone of interbedded limestones and shales.

Dimple Formation

General features.--The formation was named by Udden[33] for the exposures of moderately thick limestone beds which form the Dimple Hills, 20 miles northeast of Marathon. The formation is composed of beds of dark gray, granular limestone interbedded with shale. The upper and lower portions are particularly shaley where the transition zones grade into the clastic sediments of the Haymond above and the Tesnus below. The formation ranges from 300 to 1000 feet in thickness and the contacts are drawn at the highest and lowest limestone beds.[34]

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33. Udden, J. A., Baker, C. L., and Bose, Emil, Review of the Geology of Texas: Texas Univ. Bull. 44, 1st ed., p. 46, 1916.
34. King, P. B., op. cit., p. 62.

Location of samples.--Samples of the Dimple formation were collected from the Dimple Hills (Figure 7) and from the road cut on U. S. Highway 90, 15 miles east of Marathon (Figure 8).

Insoluble residues.--The residues from the Dimple limestones contain large single and branching sponge spicules, ostracod shells and silicified tests of foraminifera, numerous grains of chalcedony which occurs in spongy masses or cements the sponge spicules, small amber dolomite rhombohedrons, subrounded, frosted quartz sand grains, small grains of glauconite, small pyrite cubes, and some organic material.

Correlation.--King[35] stated that "foraminifera (other than fusulinids) are reported by Harlton from shales interbedded with the limestone layers of the Dimple Hills and of the exposures 18 miles east of Marathon. ... Harlton correlates the microfauna studied by him with that of the Marble Falls and Wapanucka limestones." Megafossils from several localities were identified by Cirty who in summarizing the collection stated: "The fossils in the Dimple suggest a Pottsville age. At all events, they apparently must represent an

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35. King, P. B., op. cit., p. 62.

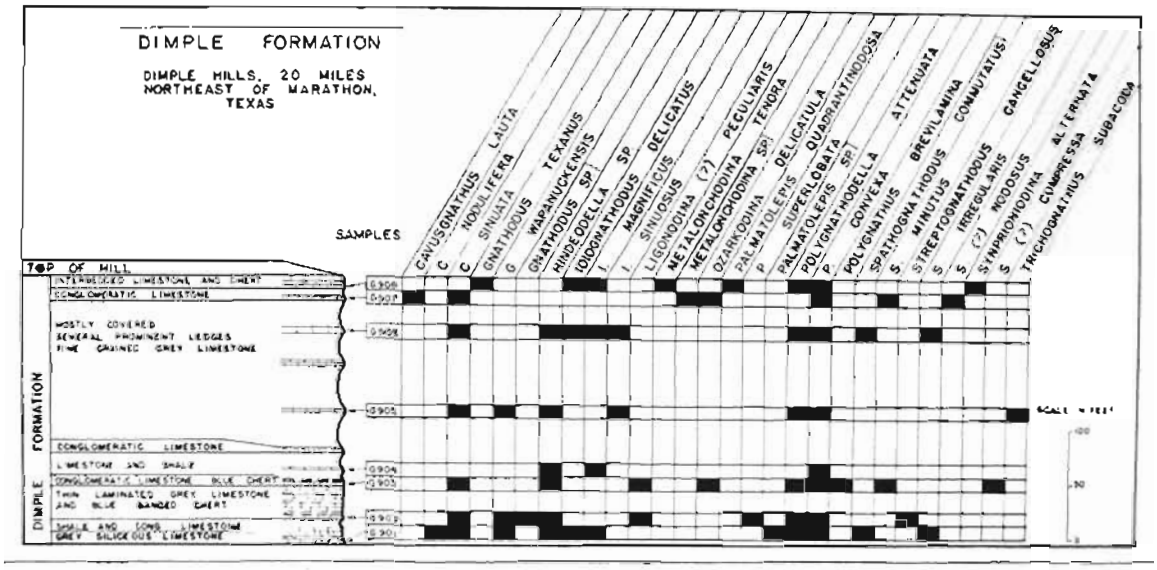
DIMPLE FORMATION
DIMPLE HILLS, 20 MILES NORTHEAST OF MARATHON, TEXAS
SAMPLES
TOP OF HILL
DIMPLE FORMATION
INTERBEDDED LIMESTONE AND CHERT
CONGLOMERATIC LIMESTONE
MOSTLY COVERED
SEVERAL PROMINENT LEDGES
FINE GRAINED GREY LIMESTONE
CONGLOMERATIC LIMESTONE
LIMESTONE AND SHALE
CONGLOMERATIC LIMESTONE BLUE CHERT
THIN LAMINATED GREY LIMESTONE AND BLUE BANDED CHERT
SHALE AND LOWER LIMESTONE
GREY SILICEOUS LIMESTONE
CAVUSGNATHUS
NODULIFERA
SINUATA
GNATHODUS
TEXANUS
WAPANUCKENSIS
HINDEODELLA SP.
IOIOGNATHODUS SP.
MAGNIFICUS
DELICATUS
SINUOSUS
LIGONODINA (?)
METALONCHODINA
PECULIARIS
TENORA
OZARKODINA
PALMATOLEPIS SP.
DELICATULA
QUADRANTINODOSA
SUPERLOBATA
POLYGNATHODELLA SP.
CONVEXA
ATTENUATA
POLYGNATHUS
SPATHOGNATHODUS
BREVILAMINA
MINUTUS
COMMUTATUS
STREPTOGNATHODUS
CANCELLOSUS
IRREGULARIS
NODOSUS
SYMPRIONIODINA
ALTERNATA
COMPRESSA
TRICHOGNATHUS
SUBACOLA

FIGURE 7

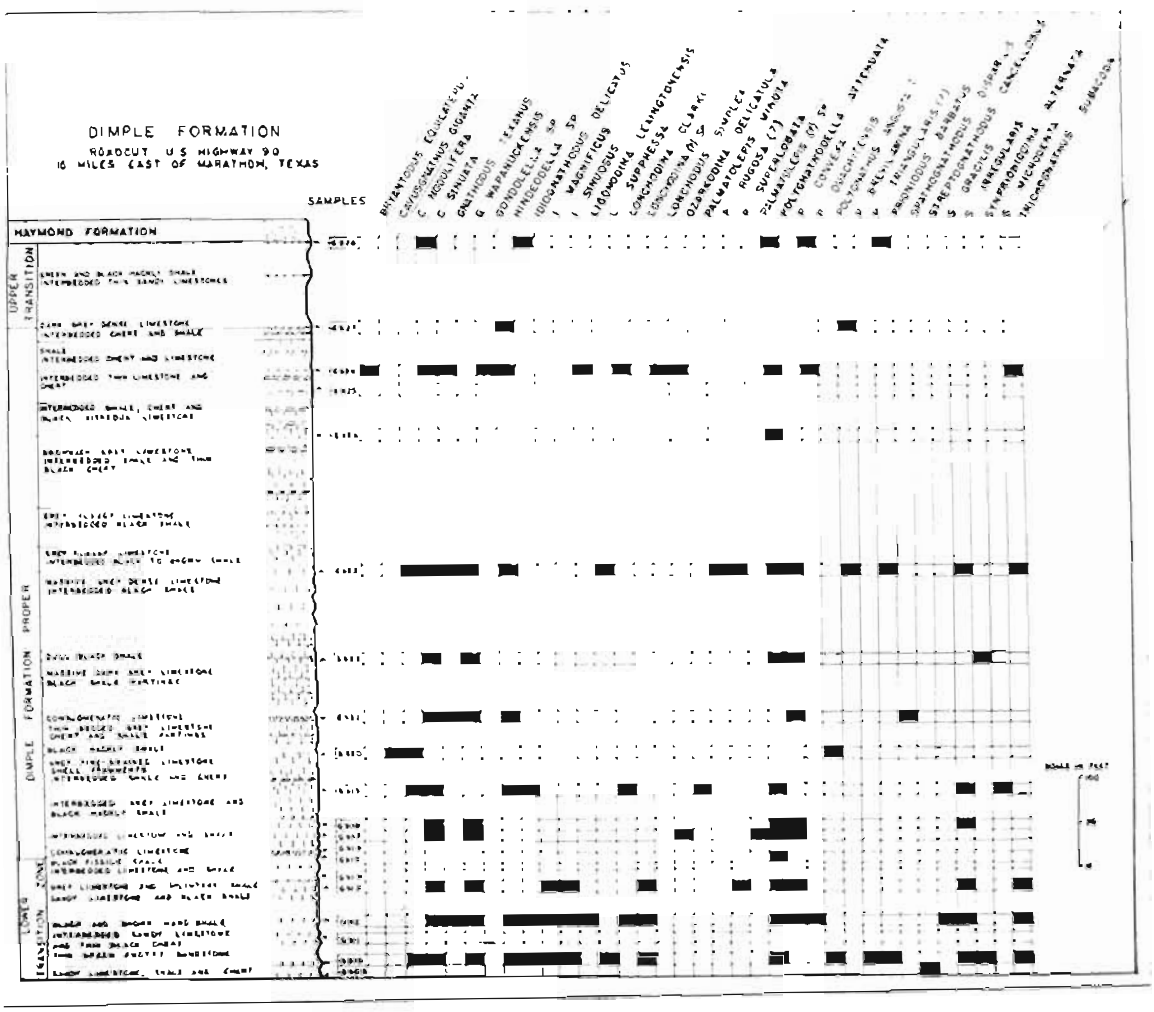
DIMPLE FORMATION
ROADCUT U.S. HIGHWAY 90
16 MILES EAST OF MARATHON, TEXAS
SAMPLES
HAYMOND FORMATION
UPPER TRANSITION
DIMPLE FORMATION PROPER
LOWER TRANSITION ZONE

FIGURE 8

unusual facies if the horizon from which they came is regarded as post-Pottsville."[36]

Stratigraphic relations.--The contact between the Dimple formation and the Haymond formation is apparently everywhere conformable. The two are separated by a transition zone of interbedded shale and limestone.

Haymond Formation

General features.--The Haymond formation was named by Baker[37] in 1916 for the exposures of sandstone and shale in the syncline near Haymond station about 17 miles east-southeast of Marathon. The formation consists of approximately 3,000 feet of massive beds of sandstone and arkose interbedded with carbonaceous shales a fraction of an inch to several inches in thickness. Near the middle and upper portions of the formation there is a boulder bed member made up of a complex group of interstratified thick bedded sandstone and shale, massive arkose, and boulder-bearing mudstone, all of which may be locally as much as 900 feet in thickness. There are a maximum of five mudstone layers, each ranging from 25 to 150 feet in thickness.

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36. King, P. B., op. cit., p. 64.
37. Udden, J. A., Baker, C. L. and Bose, Emil, op. cit., p. 46.

The boulders are generally of older rocks and may be as much as 180 feet across.

Location of samples.—Three samples of weathered Haymond shale and two of weathered calcareous sandstone were collected in the syncline southeast of Haymond.

Correlation.—King[38] reported that fossil plants from several localities have been determined by Dr. David White to be definitely of Pennsylvanian age and may possibly be correlated with those of upper Pottsville age, and that fusulinids collected by Sellards and Baker indicate an early Pennsylvanian age for the Haymond formation.

Stratigraphic relations.—The Haymond formation is apparently conformable with the overlying Gaptank as the immediate base of the Gaptank appears to be gradational and contains no basal conglomerate. Conglomerate beds in the overlying Gaptank are several hundred feet above the base of the formation.

Gaptank Formation

General features.—The name "Gaptank Formation" was given by Udden in 1916 to the exposures at Gap Tank in Stockton Gap, 23 miles northeast of Marathon.[39]

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38. King, P. B., op. cit., pp. 71-72.
39. Udden, J. A., Baker, C. L., and Bose, Emil, op. cit., p. 47.

The original definition included strata of Permian age now known as the Wolfcamp formation. These were separated by subsequent work and the formation name now includes only those Pennsylvanian rocks which overlie the Haymond formation.[40]

The Gaptank formation is exposed only on the northern flank of the Marathon region. According to King[41] "the Gaptank is the youngest Pennsylvanian formation in the area and the last to be involved in the Marathon disturbance. It is the only member of the series that contains fossils in any abundance. It is somewhat more variable in lithology than the formations below and consists of sandstones and shales, with interbedded conglomerates and limestone. The conglomerate fragments are derived from the Maravillas chert, the Caballos novaculite, and the Dimple limestone, which are thousands of feet lower in the section than the base of the Gaptank. They indicate the rise of local folds in the Marathon geosyncline in the middle part of Gaptank time." The formation has a thickness of about 1,800 feet.

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40. Sellards, E. H., Pre-Paleozoic and Paleozoic Systems, in Geology of Texas, Pl. 1, Stratigraphy: Texas Univ. Bull. 3232, p. 148, 1933.
41. King, P. B., op. cit., p. 74.

Location of samples.—Several samples of shale and limestone were collected by Samuel Ellison from the exposures near Gap Tank.

Correlation.—The Gaptank formation is considered by King[42] to be approximately of Des Moines age.

Stratigraphic relations.—In the southwestern part of the Glass Mountains the Gaptank formation is separated from the overlying Wolfcamp formation by a marked angular unconformity. In the northeastern part the Wolfcamp rests disconformably on the Gaptank.

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42. King, P. B., op. cit., pp. 76-79.

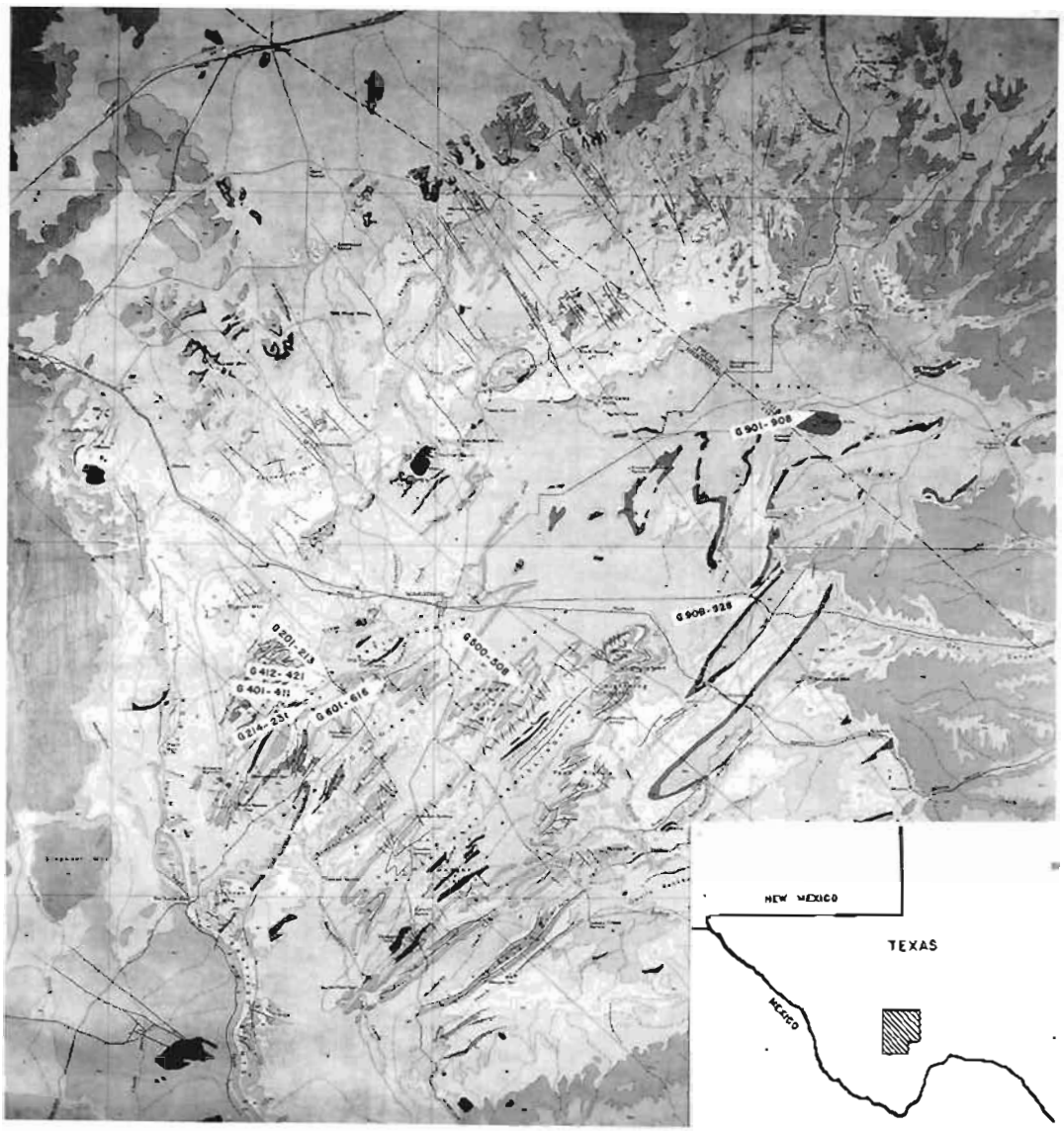

FIGURE 9

LOCATION OF SAMPLES AND INDEX MAP OF THE MARATHON REGION

(Map copied from, King, P. B., Geology of the Marathon Region, Texas: U. S. Geol. Survey Prof. Paper 187, pl 23, 1937)

DISCUSSION OF CONODONT FAUNAS

General Features

Conodonts occur abundantly in the Ordovician and Pennsylvanian limestones in the Marathon region but are scarce in beds of other ages.

The Ordovician strata contain a group of closely related faunas passing from the simpler types in the older rocks to the more complex types in the younger rocks. The chief characteristic of these faunas is the presence of many simple cone-type conodonts. A great variety of bladed and bar-like forms occur, but the development of complexity apparently culminates in the earliest platform types in the Maravillas limestone. These specialized forms were apparently short lived and are important as a means of distinguishing faunas.

A profusion of platform types, like Gnathodus, Cavusgnathus, and Polygnathodella, occurs in the Dimple formation and nothing comparable to these forms is found in the Ordovician. The differences between the Ordovician and Pennsylvanian faunas are clearly shown in the following table.

Distribution of Conodont Genera
in the Marathon Region

Genera	Formation					
	Dagger Flat	Marathon	Fort Pena	Wood's Hollow	Maravillas	Dimple
Acodus	■	■	■			
Acontiodus			■	■		
Ambalodus					■	
Amorphagnathus					■	
Belodus					■	
Bryantodina			■			
Bryantodus						■
Cavusgnathus						■
Cordylodus		■	■	■	■	
Drepanodus	■	■	■			
Gnathodus						■
Gondolella						■
Heterognathus		■	■	■	■	
Hindeodella						■
Idiognathodus						■
Leptochirognathus		■	■	■		
Ligonodina						■
Lonchodina						■
Lonchodus						■
Loxognathus			■			
Metalonchodina						■
Oistodus	■	■	■	■	■	
Ozarkodina			■	■	■	■
Palmatolepis						■
Paltodus		■	■	■	■	
Phragmodus			■	■	■	
Polygnathodella						■
Polygnathus						■
Prioniodus						■
Scolopodus	■	■				
Spathognathodus						■
Stereoconus		■				
Streptognathodus						■
Symprioniodina						■
Trichognathus					■	■
Truchorognathus				■		
Ulrichodina			■			

Cambrian

Dagger Flat formation.--Conodonts obtained from one limestone sample in this formation consisted of 14 broken specimens comprising four genera and five species, as follows:

Oistodus concavus Branson and Mehl

Oistodus sp.

Scolopodus quadraplicatus Branson and Mehl

Acodus sp.

Drepanodus sp.

The limestone in which the conodonts were found is of a distinctly different appearance than the typical Marathon and younger limestones, in that the weathered surface is quite sandy and of a chocolate brown color. It is possible, however, that the limestone belongs to the overlying Marathon formation and has been included in the upper Dagger Flat beds by folding and thrusting.

The conodonts obtained are similar to those which occur in the Jefferson City, Shakopee, and Oneota formations of the Mississippi Valley region.

Ordovician

Marathon formation.--Nine genera and 21 species of conodonts were found in the Marathon limestones. Figures 1 and 2 show their distribution within the formation.

The fauna is made up mainly of simple cone-type forms such as Drepanodus, Acodus, Paltodus, Scolopodus, and Oistodus. However, the complex denticulate blade and bar-type conodonts Cordylodus, Heterognathus, and Leptochirognathus make their appearance. One peculiar development is a posterior denticulate blade extension on a large main cone, exemplified by Oistodus extensus.

Many of the species found in the Marathon are also found in the Jefferson City formation of Missouri, but the Marathon fauna appears to be slightly younger because of the occurrence of the more complex forms.

Alsate formation.--Only four conodont fragments were found in the samples from this formation. Three of these appear to belong to the genus Cordylodus and one to the genus Acodus.

Fort Pena formation.--Twelve genera and 19 species of conodonts were obtained from the Fort Pena samples. Figures 3 and 4 show their distribution.

The fauna contains many simple cone-type conodonts such as Acodus, Drepanodus, Oistodus, and Paltodus. Oistodus prodentatus represents a development of additional denticles on the basic, simple cone. This species is similar to O. extensus but lacks the unusually long, compressed blade. The introduction of Loxognathus flabellata and Ozarkodina macrodentata gives the group a distinctive feature. Loxognathus flabellata is significant because it is not known from any other fauna in the Marathon region. The complex bladed and bar-type conodonts Phragmodus, Bryantodina, and Leptochirognathus appear but are also found in succeeding beds.

Many of the Fort Pena species are found elsewhere, ranging from the Shakopee into the Decorah. However, the assemblage is comparable to typical Plattin and Decorah faunas.

Wood's Hollow formation.—A small fauna consisting of seven genera and eight species was found in this formation. Figure 5 shows their distribution.

Except for the absence of Loxognathus flabellata, the fauna is similar to that found in the Fort Pena beds and, similarly, may be correlated with the Plattin and Decorah faunas.

Maravillas formation.—Ten genera and 18 species of conodonts were obtained from the Maravillas limestones. Figure 6 shows their distribution.

The distinctive feature of this group is the presence, in great abundance, of Amorphognathus and Ambalodus. These genera mark the earliest occurrence of platform types of conodonts in the Marathon region and are important because they are not known from any other fauna in the region. Other genera such as Cordylodus, Oistodus, Paltodus, Phragmodus, Scolopodus, Heterognathus, and Ozarkodina are found in these beds but are not significant because they occur in older formations.

In many respects this fauna is similar to that found in the Maquoketa shales of the Mississippi Valley.

Devonian (?)

Caballos formation.—No samples were collected by the writer from the Caballos formation. The conodonts collected by Miser[43] from the siliceous shales on East Bourland Mountain[44] are lost or misplaced. At the time the field work was in progress in 1940, the writer was

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43. King, P. B., op cit., (U. S. Geol. Survey Prof. Paper), p. 52.
44. Personal communication from P. B. King, February 27, 1941.

unaware of the collection from the Caballos formation and no consideration was given to the possibility of the occurrence of conodonts in these beds.

Pennsylvanian

Tesnus formation.--None of the shale or limestone samples collected from this formation yielded conodonts.

Dimple formation.--Eighteen genera and 46 species of conodonts were found in this formation. Figures 7 and 8 show their distribution.

Polygnathodella, Cavusgnathus, and Gnathodus are the most abundant and most characteristic genera of this fauna. The blade and bar-like genera Hindeodella, Ozarkodina, Bryantodus, Ligonodina, Lonchodina, Prioniodus, Spathognathodus, Synprioniodina, Metalonchodina, and Tricognathus are common throughout the formation. Streptognathodus and Idiognathodus appear abundantly. Palmatolepis and Polygnathus occur in several samples and one occurrence of Gondolella is noted. A few specimens of Leptochirognathus and Phragmodus were found in the lower transition zone.

The occurrence of the typical Devonian genera, Palmatolepis and Polygnathus, and the typical Ordovician genera, Leptochirognathus and Phragmodus is interpreted

as being due to the reworking of earlier assemblages and their inclusion in the typical lower Pennsylvanian faunas.[45] According to Branson and Mehl, this is called a stratigraphic admixture. The occurrence of Gondolella may be interpreted either as an infiltration from younger beds with deposition along the bedding plane, or as a downward extension of its geologic range.

The Dimple fauna is similar to those found in the Wapanucka formation and the lower Johns Valley shale of Oklahoma. Samples of Smithwick limestone and shale from central Texas, contributed by Dr. Preston E. Cloud, contained Polygnathodella and Cavusgnathus species identical to those found in the Dimple formation.

Haymond formation.--The samples of shale and calcareous sandstone from this formation contained no conodonts.

Gaptank formation.--None of the shale and limestone samples collected contained conodonts.

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45. Branson, E. B. and Mehl, M. G., The recognition and interpretation of mixed conodont faunas: Denison Univ. Bull., vol. XXXV, p. 197, 1940.

SYSTEMATIC DESCRIPTIONS

Genus ACODUS Pander, 1856

Acodus denticulatus Graves n. sp.

Plate I, figure 18

Base deeply excavated, triangular in outline, the long base of the triangle extends the base of the tooth posteriorly along its outer side and the obtuse apex of the triangle marks the position of a lateral keel on the blade of the tooth. Main cusp straight and inclined to the plane of the base at an angle of about 45 degrees. Cusp sharply keeled both anteriorly and posteriorly, and ornamented on the inner side by a distinct, more or less rounded carina; outer side plane to slightly convex bearing a faint carina; cross-section of tooth narrowly rhomboid. Posterior keel widens at junction of cusp and base to form three laterally compressed, sharp-pointed, short, discrete denticles.

Holotype.--Missouri School of Mines G223 (figured).

Remarks.--This species differs from Acodus delicatus Branson and Mehl in that it has three sharp denticles developed on the posterior keel, and has a relatively larger base.

Occurrence.--Marathon formation, Marathon region, Texas.

Acodus expansus Graves n. sp.

Plate I, figure 6

Base deeply excavated, lachrymiform in outline, offset posteriorly from the cusp; pit rounded at top. Tooth sharply recurved above the base so that extension of tip makes a low angle with the plane of the base, slender, laterally compressed with sharp, distinct, thin keels both anteriorly and posteriorly and extending from the base to the tip of the tooth. Ornamented laterally by a sharp carina which extends from the top of the slightly inflated base throughout the entire length of the cusp. Cross-section of tooth roughly rhomboid.

Holotype.--Missouri School of Mines G223 (figured).

Remarks.--This species differs from Acodus oneotensis Furnish in that the base is offset anteriorly, is lachrymiform rather than round in outline, and has prominent carinae on both sides of the tooth.

Occurrence.--Marathon formation, Marathon region, Texas.

Genus ACONTIODUS Pander, 1856

Acontiodus dubius Graves n. sp.

Plate II, figure 1

Base roughly triangular in outline, shallowly excavated. Tooth triangular in cross-section, with apex of triangle directed anteriorly, apparently straight and slightly inclined posteriorly from the axis normal to the plane of the base. Lateral margins of anterior face of cusp sharp edged; anterior face flat to slightly concave, having an indistinct median carina. Structure of tooth evenly laminar as shown by a broken edge of the base. Cusp laterally ornamented with a low but distinct carina on each side, parallel to the lateral margins and at about one-third the width of tooth from anterior edges.

Holotype.—Missouri School of Mines G502 (figured).

Remarks.—This species differs from Acontiodus abnormalis Branson and Mehl in that the tooth is commonly much larger and the lateral faces are less ornamented.

Occurrence.—Wood's Hollow formation, Marathon region, Texas.

Genus BRYANTODINA Stauffer, 1935

Bryantodina sinuosa Graves n. sp.

Plate II, figure 13

Blade thin, laterally compressed; anteriorly, denticles are laterally compressed, fused for most of their length, but have discrete termini; posteriorly, denticles are entirely fused forming a large, laterally compressed cusp. Basal part of blade bears a low flange its entire length; aboral side of blade shallowly grooved; lateral edges of aboral side of blade straight, except for a slight convex flare on inner margin forming a small cavity just anterior to the large fused denticle; outer side correspondingly concave just anterior to fused denticle giving a more or less sinuous outline to the aboral side of the bar.

Holotype.--Missouri School of Mines G414 (figured).

Remarks.--Bryantodina sinuosa differs from other species of Bryantodina in that the outline of the aboral surface is sinuous.

Occurrence.--Fort Pena formation, Marathon region, Texas.

Genus CORDYLODUS Pander, 1856

Cordylodus multidentatus Graves n. sp.

Plate I, figure 21

Oral bar straight, relatively thick, set with slightly compressed, somewhat posteriorly inclined, comparatively long, sharp-pointed, closely spaced but discrete denticles which are alternately large and small; the anterior large denticles are separated by two smaller denticles. Terminal denticle nearly erect, laterally compressed but with well rounded anterior margin and flat, sharp edged, posterior margin. The aboral extension of the terminal denticle bends posteriorly as it passes onto the sheath and continues nearly straight, forming an angle of about 45 degrees with the oral bar. The aboral extension of the terminal denticle bifurcates below the oral bar forming a heavy, rounded anterior keel separated from the sheath by a thin plate; laminae connecting the other limb of the aboral extension of the terminal denticle are nearly straight to slightly convex.

Holotype.--Missouri School of Mines G227 (figured).

Remarks.--Cordylodus multidentatus differs from other species of Cordylodus, mainly, in that it has a comparatively large number of denticles on the oral bar.

Occurrence.--Marathon formation, Marathon region, Texas.

Cordylodus quadratus Graves n. sp.

Plate I, figures 22, 25

Oral bar convex orally, relatively thick with convex sides, oral edge set with laterally compressed, wide sharp-pointed, discrete denticles on the posterior portion; at the junction of the oral bar and the terminal cusp, the oral denticles are smaller, six to eight in number, closely crowded, laterally compressed, in part fused, but with discrete termini. The terminal denticle is sharp edged, quadrate or roughly diamond-shaped in cross-section, with anterior and posterior keels; the anterior keel continues aborally to form a rather wide buttress anterior to the sheath; at midwidth on each side of the terminal denticle there is a high, sharp carina which forms a flange on the aboral extension of the terminal denticle. The terminal denticle extends a short distance posteriorly beneath the oral bar at an angle of about 30 degrees. The sheath laminae are narrow, extending from the flanges to the oral bar.

Holotype.--Missouri School of Mines G201 (figured). Paratype, Missouri School of Mines G323 (figured).

Remarks.--This species differs from Cordylodus multidentatus in that the oral bar is slightly curved, the denticles on the oral bar are more laterally compressed, the cross-section of the terminal denticle is roughly quadrate, the angle between the oral bar and the aboral extension of the terminal denticle is approximately 30 degrees.

Occurrence.--Marathon formation, Marathon region, Texas.

Genus DREPANODUS Pander, 1856

Drepanodus striatus Graves n. sp.

Plate I, figures 3, 12

Base slightly expanded posterierly, deeply excavated, the conical concavity as high as its basal length with the sharp apex near the anterior surface of cone; basal outline quadrate to subrounded. Tooth subrounded in upper part, slender, sharp-pointed, recurved with slight flexure near base; upper part nearly straight making a high angle with the plane of the base. The cusp is longitudinally ornamented with fine, parallel striae throughout its entire length; growth axis inconspicuous.

Holotype.—Missouri School of Mines G225 (figured). Paratype, Missouri School of Mines G223 (figured).

Remarks.—This species differs from Drepanodus arcuatus Branson and Mehl in that it lacks the faint keels, is less compressed laterally, and is longitudinally finely striated whereas the latter is smooth.

Occurrence.—Marathon formation, Marathon region, Texas.

Genus LOXOGNATHUS Graves n. gen.

Complex, denticulate bladed unit with a large denticle at the anterior end of an arched blade; basal portion of the main cusp expanded on the outer side into a thin, posteriorly curved, denticulate blade making an angle of about 60 degrees with the main blade; aboral portion extended into a pick-shaped anticusp. Aboral attachment scar largest under main denticle and extending as a groove on the two limbs. The denticles on the main limb are inclined anteriorly, closely oppressed and coalesced. Cross-section of the superior denticle is triangular, with sharp anterior and posterior edges and an outer keel.

Genotype.—Loxognathus flabellata.

Loxognathus flabellata Graves n. sp.

Plate II, figures 29, 31, 32

Denticulate blade composed of seven or more coalesced but distinct, subparallel denticles inclined to the base of the blade at an angle of about 45 degrees; blade joins the superior denticle at an angle of 90 degrees or less, forming a V-shaped notch with its apex upward. Cross-section of main cusp triangular with flat to slightly convex sides.

Genoholotype.—Missouri School of Mines G421 (figured). Paratypes, Missouri School of Mines G414 (figured).

Occurrence.—Fort Pena formation, Marathon region, Texas.

Genus OISTODUS Pander, 1850

Oistodus extensus Graves n. sp.

Plate I, figures 16, 28

Base deeply excavated, laterally compressed, elongate antero-posteriorly, with a long, laterally compressed, denticulate bar extending anteriorly, making a large obtuse angle with the vertical plane of the tooth; denticles on upper portion of bar compressed laterally, fused, inclined posteriorly to the plane of the base at a low angle; basal excavation of main cusp continues onto the base of

the bar as a shallow, narrow groove. Junction of bar and main cusp is wide, thick, inflated area. Tooth sharply recurved just above base so that main cusp is almost parallel to the plane of the base. Main cusp thin, short, sharply pointed, lenticular in cross-section.

Holotype.--Missouri School of Mines G201 (figured). Paratype, Missouri School of Mines G209 (figured).

Remarks.--This species is distinctly different from any previously described species, in that it has a long, laterally compressed, denticulate anterior bar extension. The general outline of the main cusp and the shape and position of the base are such that the specimens are placed in this genus.

Occurrence.--Marathon formation, Marathon region, Texas.

Oistodus prodentatus Graves n. sp.

Plate II, figures 6, 22, 23, 28

Outline of base markedly elongate because of its anterior and unusually long posterior extensions beyond the blade; extensions of base thin and straight; base flares conspicuously just posterior to its junction with the cusp; width less than one-quarter length of base. Anterior extension of base bears three to four laterally compressed, fused denticles which may have discrete termini.

Elongate excavation about same depth as the base width. Blade nearly straight its entire length, sharply bent back slightly anteriorly above excavation making an angle of about 45 degrees with the basal plane, long and slenderly tapering, sharp anterior and posterior edges, outer face flat to slightly convex laterally. Inner face strongly convex with slightly depressed margins, greatest width in most specimens slightly above the sharp posterior flexure.

Holotype.—Missouri School of Mines G413 (figured). Paratypes, Missouri School of Mines G504, G414, G407 (figured).

Remarks.—This species differs from Oistodus abundans Branson and Mehl in that it has a longer posterior extension of the base and has a denticulate anterior basal extension.

Occurrence.—Fort Pena and Wood's Hollow formations, Marathon region, Texas.

Genus OZARKODINA Branson and Mehl, 1933

Ozarkodina macrodentata Graves n. sp.

Plate II, figures 33, 35, 36

Base straight to slightly arched, broadly flexed antero-posteriorly. Aboral edge excavated by a narrow,

very shallow groove extending from the central cavity to near the extremities; attachment scar has slightly flaring, convex sides. Main denticle extremely long and about three times as wide as minor denticles, sharp edged, with one flat to slightly convex surface and one markedly convex surface which is depressed near the edges forming conspicuous keels, located slightly off center directly above the basal excavation, and inclined at an angle of about 60 degrees to the blade-like bar. Minor denticles subequal, inclined parallel to main denticle, laterally compressed, only partly fused, with discrete termini; two to three minor denticles anterior and three to five posterior to the main cusp.

Holotype.—Missouri School of Mines G414 (figured). Paratype, Missouri School of Mines G414 (figured).

Remarks.—This species differs from Ozarkodina typica Branson and Mehl in that it has fewer, relatively larger denticles, and is not as greatly arched.

Occurrence.—Fort Pena formation, Marathon region, Texas.

Genus CAVUSGNATHUS Harris and Hollingsworth, 1933

Cavusgnathus nodulifera Graves n. sp.

Plate VI, figure 4

Platform long, lanceolate, posteriorly pointed; inner and outer parapets ornamented with regularly spaced alternating nodes; outer row of nodes continues anteriorly as a thin blade with laterally compressed, short, sharp-pointed, discrete denticles; outer side of platform set with one or more (usually three) nodes which extend posteriorly from the junction of the blade and platform; oral surface of platform traversed by a deep, median, longitudinal trough, continuous the length of the platform; aboral attachment scar slender to moderately flaring.

Holotype.--Missouri School of Mines G923 (figured).

Remarks.--Cavusgnathus nodulifera differs from C. sinuata and C. lauta in that its parapets are of about equal elevation and in the development of the outer accessory nodes. The posterior development of the accessory lobes and a partial longitudinal and lateral fusion of the nodes on the main parapets with a corresponding partial filling of the median trough, may give rise to Gnathodus. The specimen shown on Plate VI, figure 6, possibly represents such a development.

Occurrence.--Dimple formation, Marathon region, Texas.

Cavusgnathus sinuata (Harris and Hollingsworth)

Plate VI, figures 1, 5, 7

Idiognathoides sinuata Harris and Hollingsworth, 1933, Am. Jour. Sci., 5th ser., vol. 25, p. 201, pl. 1, fig. 14.

Polygnathodella sinuata (Harris and Hollingsworth) Branson and Mehl, 1941, Jour. Paleontology, vol. 15, p. 105.

Harris and Hollingsworth's description:

"Tooth small, narrow, slender, acutely pointed anteriorly, concave anteriorly along margin of inside edge and posteriorly along margin of outside edge, the whole resulting in a sinuous outline, plate high and steep laterally, aboral face of plate channeled longitudinally with symmetrical curvature, greatest depth centrally, flanges prominent, concentrically ringed, posterior end of plate distinctly swinging downward and backward, especially noticeable along the ventral outline, anterior one-third of oral surface of plate flat and traversed by two or three short, low, transverse ridges, behind these are three or four hemi-transverse ridges gently sloping inwardly and downwardly from either side, thus defining the anterior limitation of a median channel which increases in depth posteriorly, marginal rims bordering either side of the channel steeply sloping inwardly and bearing eight to ten ill defined denticulations, rim of outside one-half of plate high, produced posteriorly to form the thin, straight, denticulate bar."

Revised description.--Platform long, lanceolate, posteriorly pointed, inner and outer parapets ornamented with regularly spaced nodes in alignment with each other

transversely; inner parapet commonly lower in elevation, particularly in the anterior portion, than the outer parapet; posterior one-third of platform may bear completely to partially fused nodes forming transverse ridges across the oral surface. Oral surface of platform traversed longitudinally by a deep median sulcus which becomes gradually more shallow as it approaches the posterior tip of the platform; sulcus may extend more than two-thirds the length of platform. Outer parapet is continued anteriorly into the thin blade bearing laterally compressed, subequal denticles rising only a short distance above the platform; aboral attachment scar slender, widely flaring on the inner side; sides of platform almost vertical.

Plesiotypes.--Missouri School of Mines C902, C926 (figured).

Remarks.--Cavusgnathus sinuata (Harris and Hollingsworth) differs from C. lauta in that the elevation of the parapets of the latter are about equal and the ornamentation is typically one of transverse ridges rather than nodes.

The dividing line between specimens placed here and those assigned to Polygnathodella ouachitensis is an arbitrary one, as specimens are known that show all

gradational forms from Cavusgnathus sinuata through Polygnathodella ouachitensis to P. attenuata and P. convexa. Those specimens having the longitudinal median trough extending posteriorly past the midpoint of the platform have been assigned to Cavusgnathus sinuata.

Occurrence.—Wapanucka formation, Oklahoma; Dimple formation, Marathon region, Texas.

Genus IDIOGNATHODUS Gunnell, 1931

Idiognathodus sinuosus Graves n. sp.

Plate VI, figure 22

Outline of platform in oral view, long, slender, sinuous, posteriorly pointed, greatest width near midlength; accessory lobes on inner margin mostly anterior to junction of blade and platform; transverse section of oral surface flat; oral surface ornamented with 10 to 14 parallel transverse ridges complete from one margin to the other, normal or slightly oblique to axis. Blade of average length ending abruptly against the first continuous transverse ridge; set off from the platform on either side by deep, laterally constricted sulci so that lateral margins of the anterior portion of the platform extend as free edges.

Holotype.--Missouri School of Mines G906 (figured).

Occurrence.--Dimple formation, Marathon region, Texas.

Genus LIGONODINA Ulrich and Bassler, 1926

Ligonodina (?) peculiaris Graves n. sp.

Plate IV, figure 17

Terminal fang laterally compressed with rounded anterior and posterior edges giving an elliptical cross-section outline near base but having a tendency to develop a sharper anterior edge in upper two-thirds. Antero-inferior process short, directed downward, inward, and slightly backward; denticles about four, the middle two offset and aligned in a plane at right angles to the plane of the process, rounded in cross-section, in general, directed upward and inward. Posterior bar wide, laterally compressed, at right angles to superior denticle; denticles small, round, node-like, widely separated, few in number. Aboral side of unit only shallowly excavated, with a small pit beneath the main cusp extending as a narrow groove along the base of the posterior bar.

Holotype.--Missouri School of Mines G903 (figured).

Occurrence.--Dimple formation, Marathon region, Texas.

Ligonodina suppressa Graves n. sp.

Plate IV, figure 16

Superior denticle long, straight to slightly recurved, lenticular in cross-section near the base, compressed in upper portion to a sharply pointed cross-section outline; inner surface of denticle smoothly convex; outer surface more sharply convex at midwidth but depressed along edges forming broad, almost imperceptible, grooves on outer surface. Base of cusp only slightly expanded and subcircular in outline; aboral cavity moderately deep with a deep pit beneath the superior denticle traversed by a groove extending along the aboral edge of the two limbs.

Holotype.—Missouri School of Mines G923 (figured).

Remarks.—Ligonodina suppressa differs from L. typa (Gunnell) and L. Lexingtonensis (Gunnell), mainly, in that the outer face of the superior denticle bears two shallow grooves.

Occurrence.—Dimple formation, Marathon region, Texas.

Genus POLYGNATHODELLA Harlton, 1933

Polygnathodella Harlton, 1933, Jour. Paleontology, vol. 7, p. 15.

Idiognathoides Harris and Hollingsworth, 1933, Am. Jour. Sci., vol. 35, pl. 1, fig. 14.

The following is the description of the genus Polygnathodella as revised by Branson and Mehl;[46] parenthetical expressions are additions by the writer to the revised description:

"Platform-like teeth with antero-posteriorly elongate oral surface, flat, (convex), shallowly (to deeply) trenched longitudinally, (or having a deep median, channel extending posteriorly from the anterior edge and dying out at a point near the center of the platform), with fine transverse corrugations (continuous across the plate or interrupted at the median channel); outer side of platform produced anteriorly into a free blade without vertical differentiation at the confluence of the blade and lateral margin; aboral side deeply excavated with lateral sides widely flared to produce a bilaterally asymmetrical cup, somewhat longer than wide, with lateral halves antero-posteriorly offset."

Genotype.— Polygnathodella ouachitensis Harlton.

Remarks.— The above additions have been made to the revised description of this genus because the genoholotype bears a short median trough and because of the development of a convex surface on the platform of Polygnathodella convexa Graves n. sp.

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46. Branson, E. B. and Mehl, M. G., New Carboniferous conodont genera: Jour. Paleontology, vol. 15, p. 103, 1941.

Polygnathodella attenuata (Harris and Hollingsworth) Branson and Mehl

Plate VI, figures 11, 13–15

Idiognathodus attenuata Harris and Hollingsworth, 1933, Am. Jour. Sci., 5th ser., vol. 25, p. 203, pl. 1, figs. 9a, b.

Polygnathodella attenuata (Harris and Hollingsworth) Branson and Mehl, 1941, Jour. Paleontology, vol. 15, p. 104.

Harris and Hollingsworth's description:

"Tooth small, narrow, slender, elongate, anteriorly sharply pointed, inner edge of plate straight, or very slightly concave, outer edge distinctly concave, strongly so around the posterior corner, thus causing the entire form to appear curved inwardly; plate approximately uniform in lateral height, in side view oral face flat and tending to undulate longitudinally in old age; oral platform of adult traversed by fifteen or sixteen low unbroken ridges, extreme posterior extremity of plate centrally channeled, the channel rims bearing six or seven denticles, the rim of outside half of plate produced posteriorly to form the thin denticulate bar."

Revised description.—Outline of platform in oral view long, width variable, and posteriorly acutely pointed; oral surface flat to slightly concave, ornamented with eight to 20 continuous transverse ridges; anterior margin of platform may have a short, median, shallow trough; in side view oral face flat to slightly concave

and tending to undulate longitudinally in old age; outer edge of platform continues anteriorly as the laterally compressed, denticulate blade; inner edge continues anteriorly as a free edge bearing four to eight short, transverse ridges, and separated from the blade by a deep, downward, anteriorly plunging trough which may continue posteriorly onto the platform for a short distance separating the first three platform ridges.

Plesiotypes.--Missouri School of Mines G906, G912, G917 (figured).

Remarks.--This species differs from P. ouachitensis in that the latter bears a longitudinal oral trough on the anterior half of the platform and has a concave oral surface. Polygnathodella attenuata is the typical Polygnathodella and may represent a climax in development in that the oral trough has almost completely disappeared.

Occurrence.--Wapanucka formation, Oklahoma; Dimple formation, Marathon region, Texas.

Polygnathodella convexa Graves n. sp.

Plate VI, figures 10, 12, 16

Platform long, lanceolate and posteriorly pointed to slipper-shaped. Oral surface markedly convex laterally and slightly convex longitudinally, bearing straight to posteriorly convex transverse ridges; outer edge of platform continues anteriorly as a thin, denticulate blade with laterally compressed, sharp pointed, discrete denticles; inner edge continues anteriorly a short distance forming a free edge traversed by two to seven short ridges, and separated from the blade by a deep, downward plunging sulcus which may continue posteriorly onto the platform as a shallow trough separating the transverse ridges on the anterior one-third of the platform. In some specimens the two transverse ridges just posterior to the terminus of the trough are bifurcated near the outer side of the platform.

Holotype.--Missouri School of Mines G907 (figured). Paratypes, Missouri School of Mines G908, G918 (figured).

Remarks.--Polygnathodella convexa differs from other species of Polygnathodella in that its oral surface is markedly convex both laterally and longitudinally.

This species probably represents a stage equal to P. attenuata in development from Cavusgnathus sinuata through Polygnathodella ouachitensis.

Occurrence.—Dimple formation, Marathon region, Texas.

Polygnathodella ouachitensis Harlton

Plate VI, figures 8, 9

Polygnathodella ouachitensis Harlton, 1933, Jour. Paleontology, vol. 7, p. 15, pl. 4, figs. 14a-c.

Idiognathodus corrugata Harris and Hollingsworth, 1933, Am. Jour. Sci., 5th ser., vol. 25, p. 202, pl. 1, figs. 8a, b.

Polygnathodella corrugata (Harris and Hollingsworth) Branson and Mehl, 1941, Jour. Paleontology, vol. 15, p. 105.

Harlton's description of Polygnathodella ouachitensis:

"Plate lanceolate in outline, posterior bar with denticles; oral surface with transversed distinct carinae; posterior bar connected with upper margin of oral surface. The carinae at lower oral surface coincide with the upper ones, posteriorly it has the tendency to incurve."

Harris and Hollingsworth's description of Idiognathodus corrugata:

"Plate flat, low, subsymmetrically lanceolate in oral view, becoming broader with age, in aboral view deeply concave with greatest depth at posterior end of plate, in side view oral face of plate flat, becoming slipper-shaped or undulating orally in old age;

plate widest immediately behind center, inner one-half of plate bending downward and inward posteriorly at an angle of approximately 20 degrees to form a distinct, short, posterior channel, nine to eleven low unbroken ridges extend subparallel across the anterior two-thirds of the plate, the first three or four of which arch forward at the margins; on the posterior end of the inner one-half of the oral face are approximately six to eight short, corrugated ribs; the posterior projecting bar is formed by the continuation of the outside one-half face of plate, it is thin, high, and coarsely denticulate."

Revised description.--Plate lanceolate to slipper-shaped in outline; oral surface flat to deeply concave, bearing a median trough from the anterior edge to about the midpoint of the platform, having six or more continuous transverse ridges on the posterior portion of the platform; the anterior portion of the platform bears six transverse ridges which are interrupted at the median trough. The outer side of the platform continues anteriorly as a laterally compressed, denticulate blade with sharp-pointed discrete termini; inner side of platform continues a short distance anteriorly as a free edge bearing three to five short transverse ridges, and separated from the blade by a deep, downward plunging continuation of the median, platform trough.

Plesiotypes.--Missouri School of Mines G926 (figured).

Remarks.--Polygnathodella ouachitensis is not the typical Polygnathodella even though it is the genotype.

The typical forms do not show the marked longitudinal oral trough and are only slightly concave to flat on the oral surface. It differs from P. convexa in that the latter has a convex oral surface. P. ouachitensis may represent the transition in form between Cavusgnathus and the more typical Polygnathodellas such as P. attenuata and P. convexa.

Occurrence.--Wapanucka formation and Johns Valley shale of Oklahoma; Dimple formation, Marathon region, Texas.

Genus STREPTOGNATHODUS Stauffer and Plummer, 1932

Streptognathodus irregularis Graves n. sp.

Plate VI, figures 17, 21, 24

Outline of platform in oral view, short, thin, posteriorly pointed, greatest width at anterior end; inner side of platform straight to slightly convex; outer side moderately convex; two accessory lobes with two to five nodes developed on each lobe; oral surface traversed by subequal ridges on each side of a shallow, inwardly curved eccentric median trough which terminates at both ends against complete transverse ridges. Blade median, thin, bearing laterally compressed, short, discrete denticles and set off from platform on either

side by deep sulci which terminate against the continuous transverse ridge on the anterior margin of the platform; lateral edges continue anteriorly as free edges bearing four to eight nodes.

Holotype.—Missouri School of Mines, G901 (figured). Paratypes, Missouri School of Mines G906, G910 (figured).

Occurrence.—Dimple formation, Marathon region, Texas.

Streptognathodus (?) nodosus Graves n. sp.

Plate V, figure 19

Outline of platform in oral view, long, slender, lanceolate, posteriorly pointed, greatest width near midlength; oral surface ornamented with parallel rows of nodes on either side of carina, nodes alternate in position with those of the carina. An accessory lobe consisting of a row of two to five nodes flanks each side of the platform; denticulate blade joins platform at a median position and continues as the central row of nodes; shallow sulci are continuous anteriorly on either side of the carina so that the oral surface of the anterior portion of the platform extends as free edges.

Holotype.—Missouri School of Mines G907 (figured).

Remarks.--This species has been referred to Streptognathodus rather than to Gnathodus because of the accessory lobes which occur on both sides of the oral surface.

Occurrence.--Dimple formation, Marathon region, Texas.

Genus SYNPRIONIODINA Ulrich and Bassler, 1926

Synprioniodina (?) compressa Graves n. sp.

Plate VI, figure 11

Two wide, blade-like bars in a common plane meet at an angle slightly greater than 90 degrees; both bars of equal length, widen perceptibly near the extremities, contain many subequal closely spaced, laterally compressed, denticles partly coalesced at junction with bar and inclined anteriorly at an angle of about 45 degrees; denticles on both bars parallel. A superior denticle about three times width of smaller denticles occupies central position at junction of bars. Pit directly beneath superior denticle laterally compressed, shallow, extending equal distances on the aboral side of each bar.

Holotype.--Missouri School of Mines G903 (figured).

Remarks.--The generic affinity of this species is in doubt because of the equal length of the bars and because it lacks the prominent median pit with flaring sides.

Occurrence.--Dimple formation, Marathon region, Texas.

EXPLANATION OF PLATE I

(All figures X40)

Figures 1, 7, 23 — Drepanodus arcuatus Branson and Mehl.
1, 7, Sample G218. 23, Sample G213.

2, 31, 34 — Oistodus pandus Branson and Mehl.
2, 34, Sample G203. 31, Sample G225.

3, 12 — Drepanodus striatus Graves n. sp.
3, Sample G223. 12, Holotype, Sample G225.

4, 11 — Cordylodus simplex Branson and Mehl.
Sample G227

5, 9 — Heterognathus idoneus Stauffer. Sample G227.

6 — Acodus expansus Graves n. sp. Holotype,
Sample G223.

8 — Oistodus curvatus Branson and Mehl.
Sample G218.

10 — Scolopodus quadraplicatus Branson and Mehl.
Sample G230.

13 — Drepanodus parallelus (?) Branson and Mehl.
Sample G213.

14 — Scolopodus pseudoquadratus Branson and Mehl.
Sample G223.

15, 17 — Oistodus fornicalus Stauffer.
15, Sample G203. 17, Sample G225.

16, 28 — Oistodus extensus Graves n. sp.
16, Holotype, Sample G201. 28, Sample G209.

Figure 18 — *Acodus denticulatus* Graves n. sp.
Holotype, Sample G223.

19 — *Paltodus distortus* Branson and Mehl.
Sample G209.

20 — *Leptochirognathus sp.* Branson and Mehl.
Sample G209.

21 — *Cordylodus multidentatus* Graves n. sp.
Holotype, Sample G227.

22, 25 — *Cordylodus quadratus* Graves n. sp.
22, Sample G223. 25, Holotype, Sample G201.

24 — *Cordylodus* (?) *spurius* Branson and Mehl.
Sample G227.

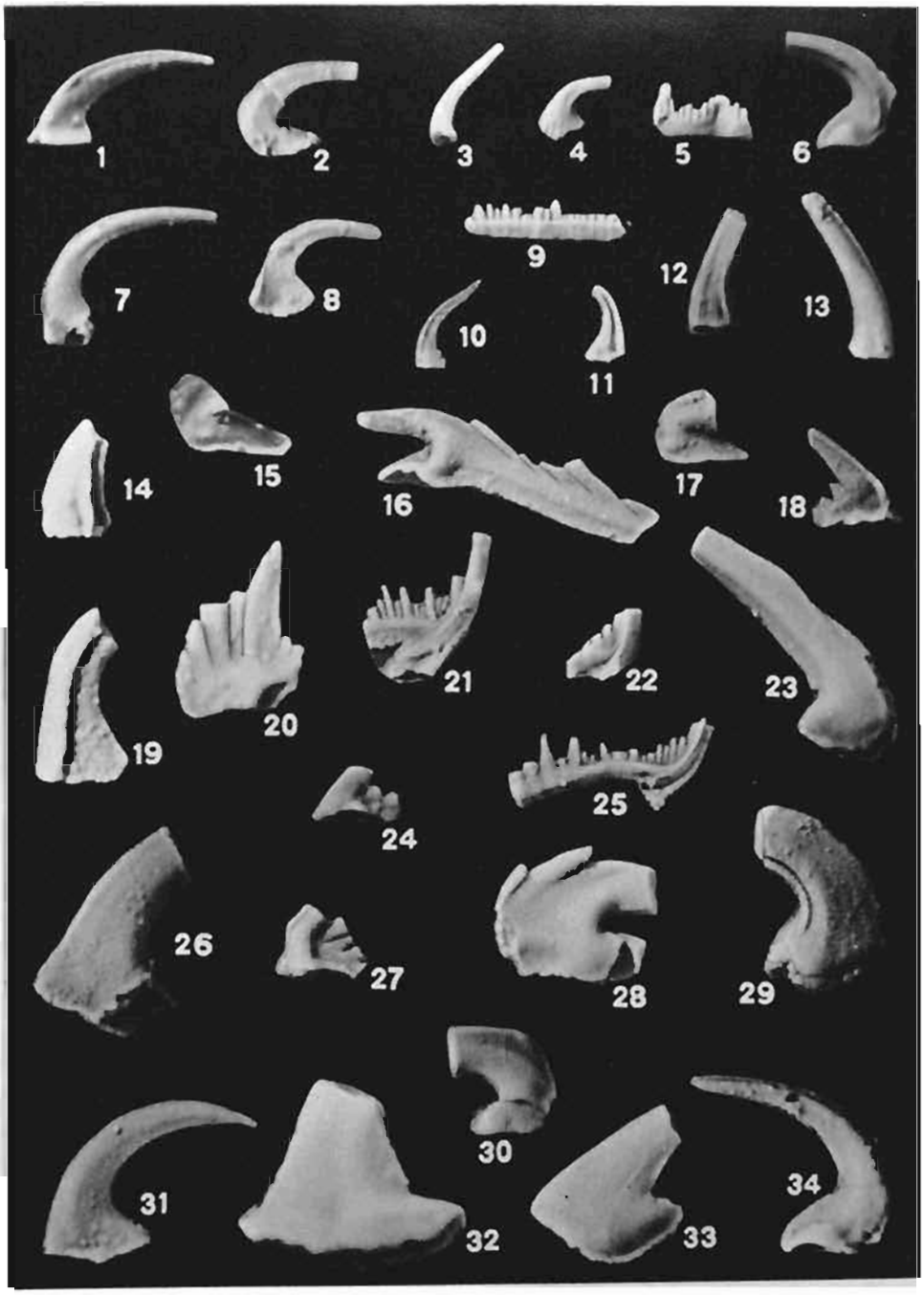
26, 30, 33 — *Oistodus gracilis* Branson and Mehl.
26, 33, Sample G209. 30, Sample G204.

27 — *Prioniodus* (?) *flexuosus* Branson and Mehl.
Sample G231.

29 — *Stereoconus robustus* Branson and Mehl.
Sample G209.

32 — *Oistodus suberectus* Branson and Mehl.
Sample G209.

PLATE I



CONODONTS OF THE MARATHON FORMATION

EXPLANATION OF PLATE II

(All figures X40)

Figures 1 -- *Acontiodus dubius* Graves n. sp. Holotype, Sample G502.

2, 9, 10 -- *Phragmodus undatus* Branson and Mehl. 2, Sample G504. 9, Sample G506. 10, Sample G501.

3 -- *Trucherognathus sinuosa* Branson and Mehl. Sample G502.

4 -- *Leptochirognathus* sp. Branson and Mehl. Sample G506.

5 -- *Paltodus gracilis* (?) Branson and Mehl. Sample G502.

6, 22, 23, 28 -- *Oistodus prodentatus* Graves n. sp. 6, Sample G504. 22, Sample G414. 23, Sample G407. 28, Holotype, Sample G412.

7 -- *Paltodus distortus* Branson and Mehl. Sample G502.

8 -- *Cordylodus plattinensis* Branson and Mehl. Sample G504.

11 -- *Ulrichodina* sp. Furnish. Sample G408.

12 -- *Drepanodus subarcuatus* Furnish. Sample G421.

Figures 13 -- Bryantodina sinuosa Graves n. sp.
Holotype, Sample G414.

14 -- Oistodus vulgaris Branson and Mehl.
Sample G414.

15, 18 -- Oistodus fornicalus Stauffer.
15, Sample G407. 18, Sample G414.

16 -- Oistodus inclinatus Branson and Mehl.
Sample G500.

17 -- Paltodus variabilis Furnish. Sample G414.

19, 20 -- Oistodus abundans Branson and Mehl.
19, Sample G421. 20, Sample G414.

21 -- Leptochirognathus sp. Branson and Mehl.
Sample G412.

24 -- Acontiodus sp. Sample G409.

25, 30 -- Cordylodus (?) spurius Branson and Mehl.
25, Sample G407. 30, Sample G406.

26 -- Phragmodus undatus Branson and Mehl.
Sample G412.

27 -- Dichognathus typica Branson and Mehl.
Sample G500.

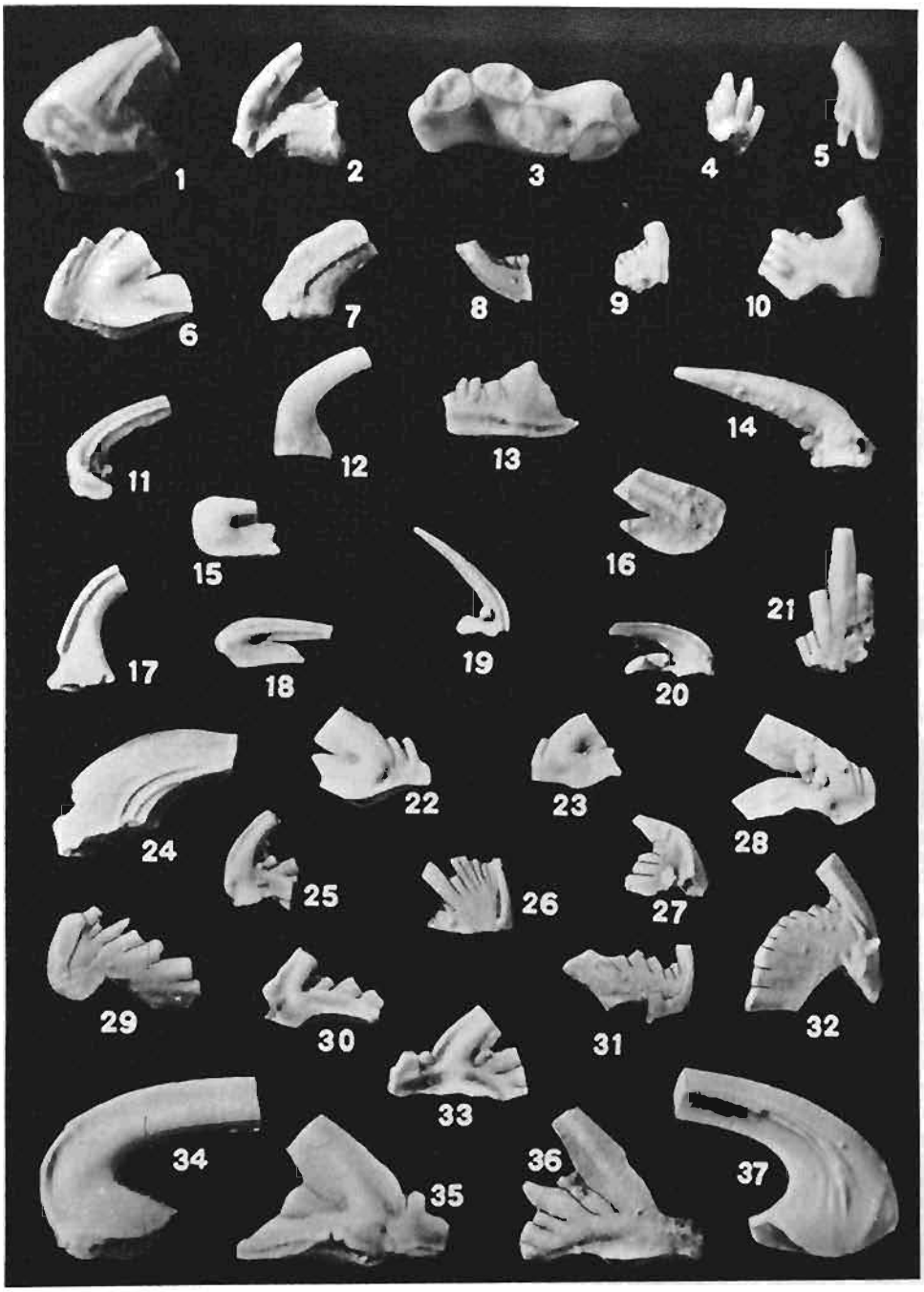
29, 31, 32 -- Loxognathus flabellata Graves n. sp.
29, Sample G414. 31, Holotype, Sample G421.
32, Senile specimen, Sample G414.

Figures 33, 35, 36 -- Ozarkodina macrodentata Graves n. sp. 33, 36, Sample G414. 35, Holotype, Sample G414.

34 -- Oistodus pandus Branson and Mehl. Sample G416.

37 -- Acodus bicostatus Branson and Mehl. Sample G414.

PLATE II



CONODONTS OF THE WOOD'S HOLLOW FORMATION - FIGS. 1-10

CONODONTS OF THE FORT PENA FORMATION - FIGS. 11-37

EXPLANATION OF PLATE III

(All figures X40)

Figures 1 — *Phragmodus insculptus* Branson and Mehl.
Sample G611.

2, 5 — *Scolopodus quadraplicatus* Branson and Mehl.
Sample G610.

3, 6 — *Ozarkodina tenuis* Branson and Mehl.
Sample G614.

4, 10, 22 — *Paltodus gracilis* Branson and Mehl.
4, Sample G614. 10, Sample G615.
22, Sample G611.

7, 8 — *Phragmodus undatus* Branson and Mehl.
Sample G611.

9 — *Phragmodus dissimilaris* Branson and Mehl.
Sample G614.

11 — *Cordylodus plattinensis* Branson and Mehl.
Sample G614.

12, 13 — *Phragmodus delicatus* Branson and Mehl.
Sample G602.

14 — *Belodus* (?) sp. Sample G610.

15 — *Cordylodus* (?) sp. Sample G614.

16 — *Oistodus gracilis* Branson and Mehl. Sample G611.

17, 21, 24, 27 — *Oistodus curvatus* Branson and Mehl.
17, Sample from vicinity of Heart Mountain.
21, Sample G606. 24, 27, Sample G616.

Figures 18 -- Oistodus inclinatus Branson and Mehl. Sample G607.

19, 20, 25 -- Heterognathus (?) sp. 19, Sample G602. 20, 25, Sample G605.

23 -- Cordylodus (?) delicatus Branson and Mehl. Sample G614.

26 -- Belodus wykoffensis Stauffer. Sample G601.

28 -- Trichognathus tenuis Branson and Mehl. Sample G605.

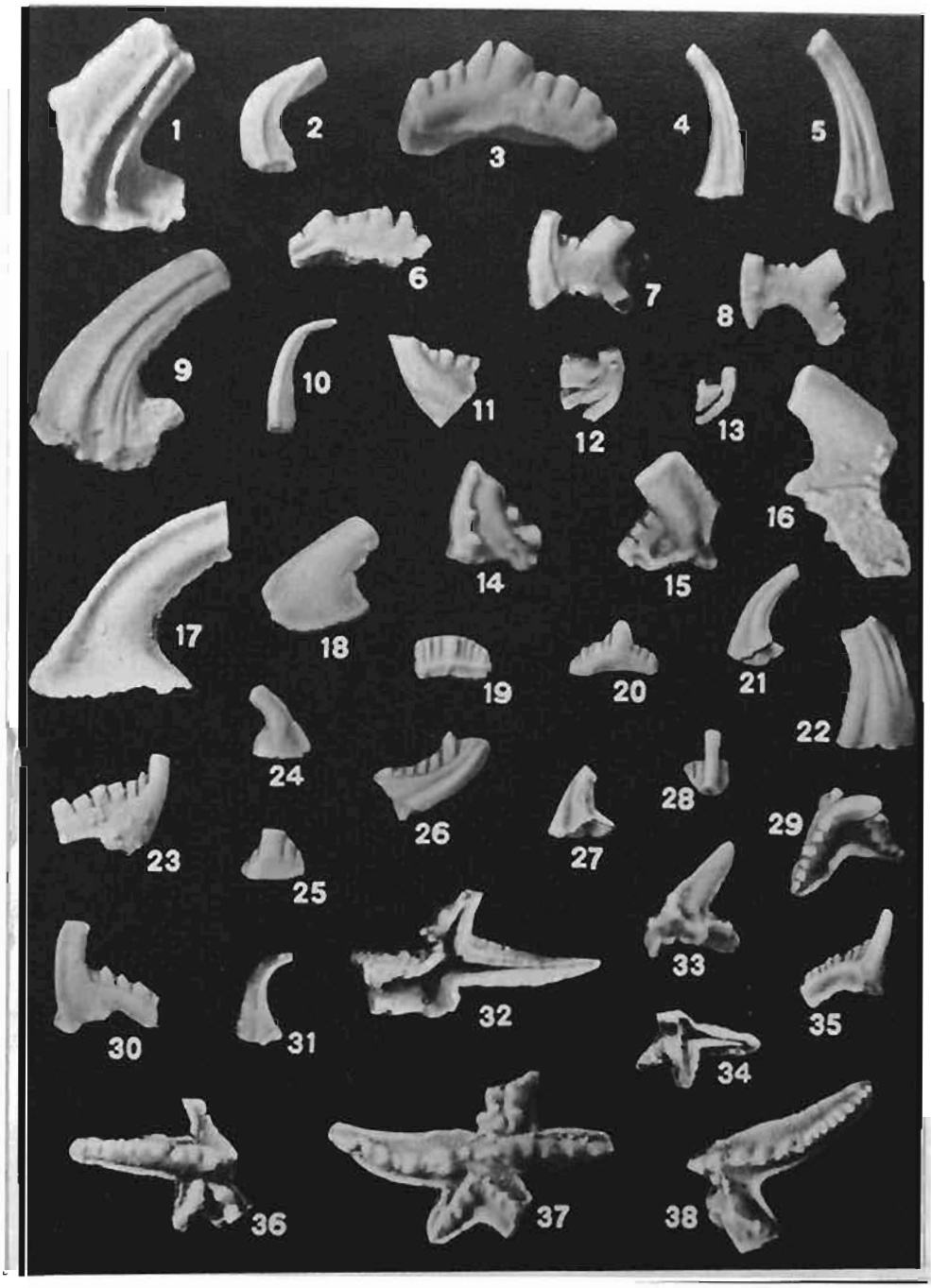
29, 33-35 -- Ambalodus triangularis Branson and Mehl. 29, 33, oral and lateral views, separate specimens, Sample G616. 34, aboral view, sample from vicinity Heart Mountain. 35, lateral view, Sample G614.

30 -- Cordylodus (?) concinnus Branson and Mehl. Sample G616.

31 -- Paltodus sp. Sample G615.

32, 36-38 -- Amorphognathus ordovicia Branson and Mehl. Sample from vicinity Heart Mountain. 32, aboral views. 36-38, oral views of separate specimens.

PLATE III



CONODONTS OF THE MARAVILLAS FORMATION

EXPLANATION OF PLATE IV

(All figures X40)

Figures 1 - 7 — Hindeodella sp. 1, Sample G904.
2, Sample G902. 3, 5, Sample G910.
4, Sample G903. 6, Sample G906. 7, Sample G901.

8 -- Symprioniodina alternata Ulrich and Bassler.
Sample G908.

9 — Metalonchodina tenora Ellison, Sample G908.

10 — Symprioniodina microdenta Ellison. Sample G919.

11 — Symprioniodina (?) compressa Graves n. sp.
Holotype, Sample G903.

12 - 14 — Ozarkodina delicatula (Stauffer and Plummer). 12, Sample G926. 13, Sample G917.
14, Sample G907.

15, 22 -- Lonchodina clarki (Gunnell).
Sample G912.

16 — Ligonodina suppressa Graves n. sp.
Holotype, Sample G923.

17 — Ligonodina (?) peculiaris Graves n. sp.
Holotype, Sample G903.

18 — Bryantodus equilaterus Branson and Mehl.
Sample G926.

19 — Trichognathus subacoda (Gunnell).
Sample G905.

Figures 20 -- Metalonchodina sp. Sample G907.

21 -- Lonchodus simplex Pander. Sample G926.

23, 24 -- Ligonodina lexingtonensis (Gunnell).

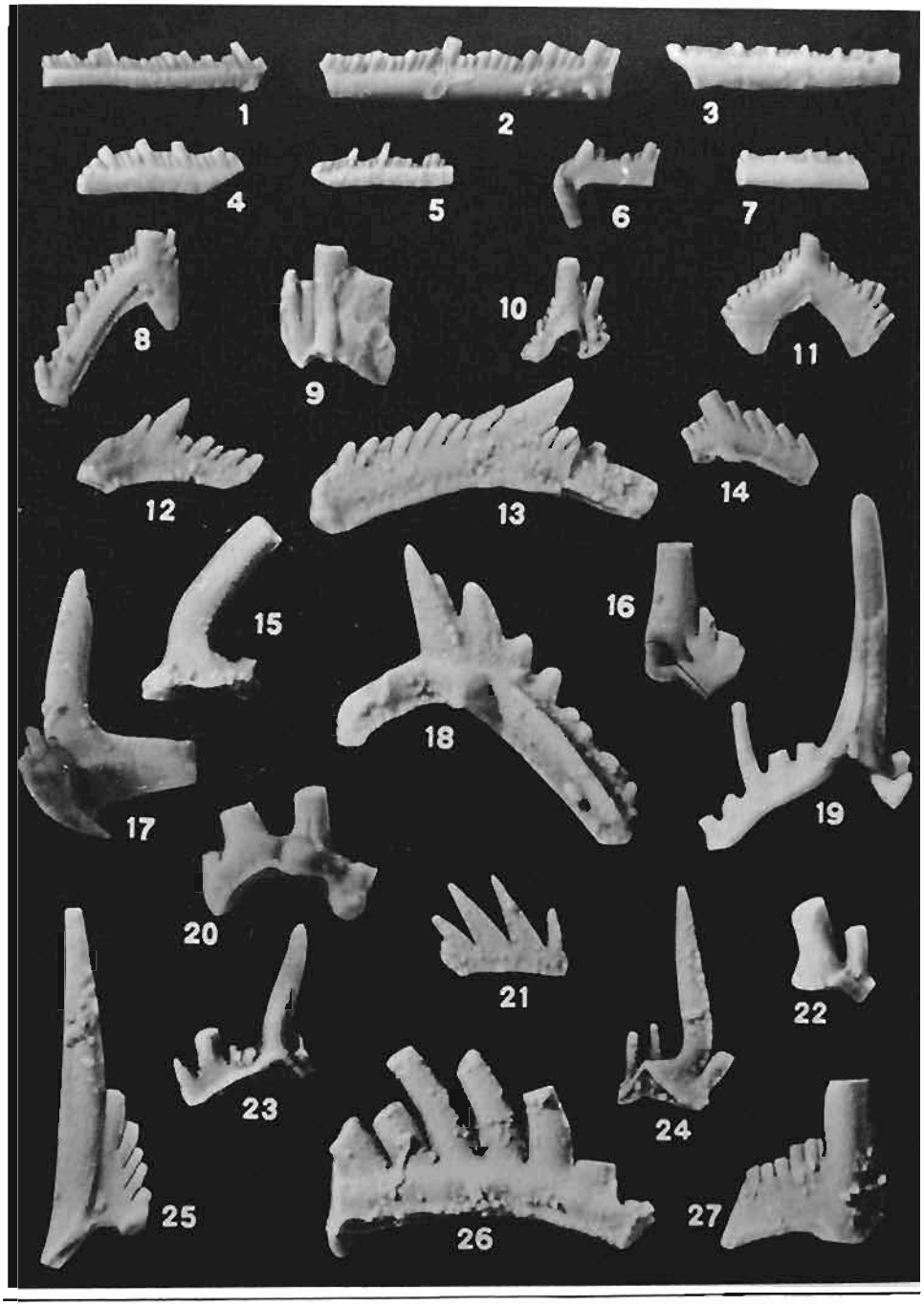
23, Sample G912. 24, Sample G926.

25, 27 -- Prioniodus barbatus Branson and Mehl.

25, Sample G923. 27, Sample G928.

26 -- Lonchodina (?) sp. Sample G910.

PLATE IV



CONODONTS OF THE DIMPLE FORMATION

EXPLANATION OF PLATE V

(All figures X40)

Figures 1, 3, 5 — Spathognathodus minutus (Ellison).

1,5, lateral views, Sample G903.

3, lateral view, Sample G907.

2 — Spathognathodus disparilis Branson and Mehl.

Oral view, Sample G921.

4, 6 — Spathognathodus commutatus Branson and Mehl. 4, Sample G901. 6, Sample G906.

7, 22 — Polygnathus brevilamina Branson and Mehl.

7, Sample G927. 22, Sample G923.

8 - 10, 12 — Gnathodus texanus Roundy.

8, 10, Sample G908. 9, Sample G912.

12, G926.

11 — Gnathodus sp. (immature specimen) Sample G902.

13 - 17 — Gnathodus wapanuckensis (Harlton).

13, Sample G918. 14, Sample G917.

15, 17, Sample G912. 16, Sample G902.

18 — Polygnathus triangularis (?) Branson and Mehl. Sample G910.

19 — Streptognathodus (?) nodosus Graves n. sp.

20 — Gondollela sp. Sample G926.

Figures 21 -- Polygnathus angusta Branson and Mehl. Sample G910.

23 -- Palmatolepis rugosa (?) Branson and Mehl. Sample G923.

24 -- Polygnathus sp. Sample G901.

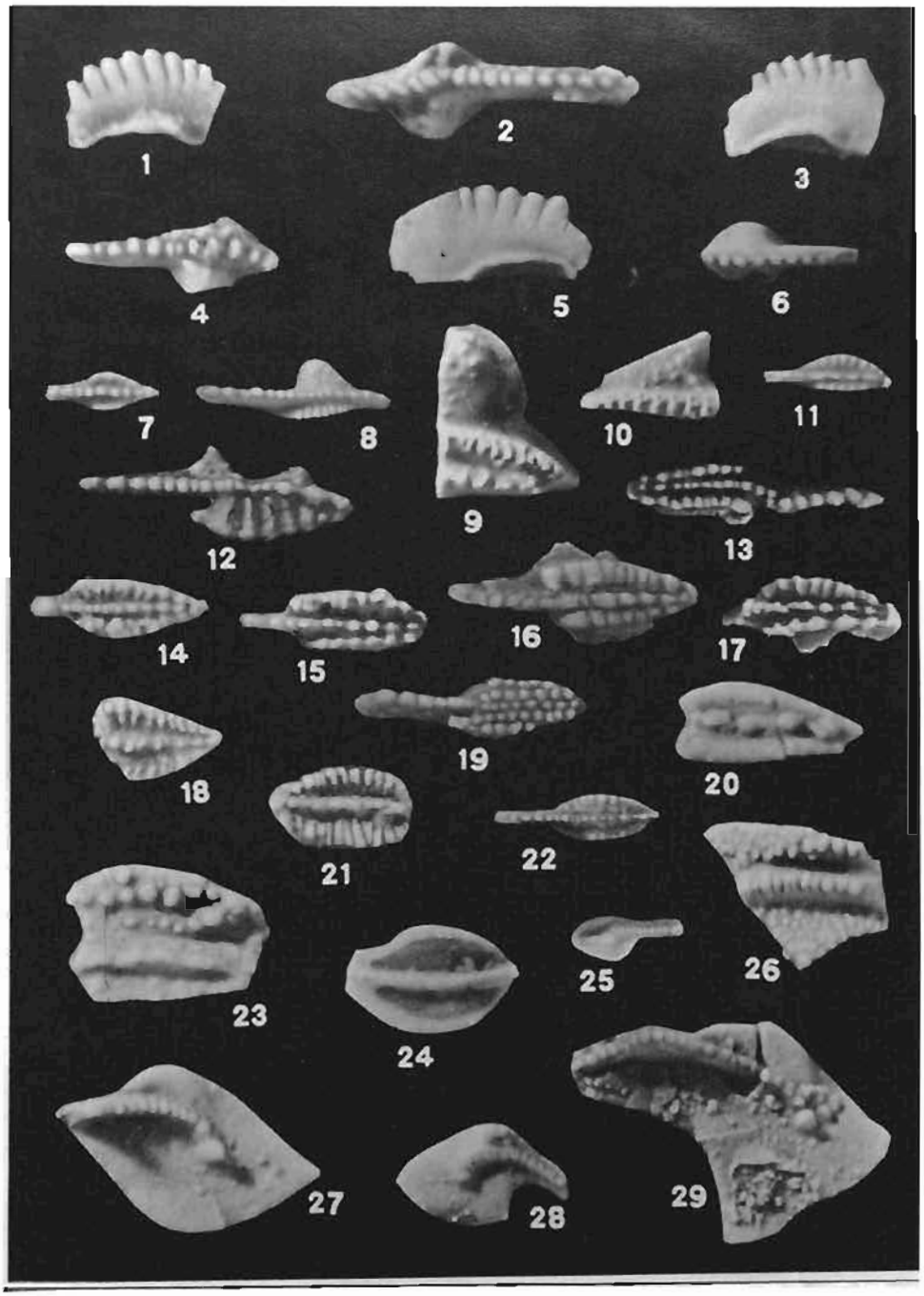
25 -- Palmatolepis minuta Branson and Mehl. Sample G919.

26 -- Palmatolepis (?) sp. Sample G917.

27, 29 -- Palmatolepis superlobata Branson and Mehl. 27, Sample G923. 29, Sample G902.

28 -- Palmatolepis quadrantinodosa Branson and Mehl. Sample G908.

PLATE V



CONODONTS OF THE DIMPLE FORMATION

EXPLANATION OF PLATE VI

(All figures X40)

Figures 1, 5, 7 — Cavusgnathus sinuata (Harris and Hollingsworth). 1, Sample G926. 5, 7, Sample G902.

2 — Cavusgnathus lauta Gunnell. Sample G907.

3 — Cavusgnathus giganta Gunnell. Sample G920.

4, 6 — Cavusgnathus nodulifera Graves n. sp. 4, Holotype, Sample G923. 6, senile specimen (identification questionable), Sample G919.

8, 9 — Polygnathodella ouachitensis Harlton. Sample G926.

10, 12, 16 — Polygnathodella convexa Graves n. sp. 10, Holotype, Sample G907. 12, Sample G906. 16, Sample G918.

11, 13 - 15 — Polygnathodella attenuata (Harris and Hollingsworth). 11, Sample G906. 13, Sample G917. 14, 15, Sample G912.

17, 21, 24 — Streptognathodus irregularis Graves n. sp. 17, Holotype, Sample G901. 21, immature specimen, Sample G910. 24, immature specimen, Sample G906.

Figures 18 -- Streptognathodus cancellosus (Gunnell).
Senile specimen, Sample G909.

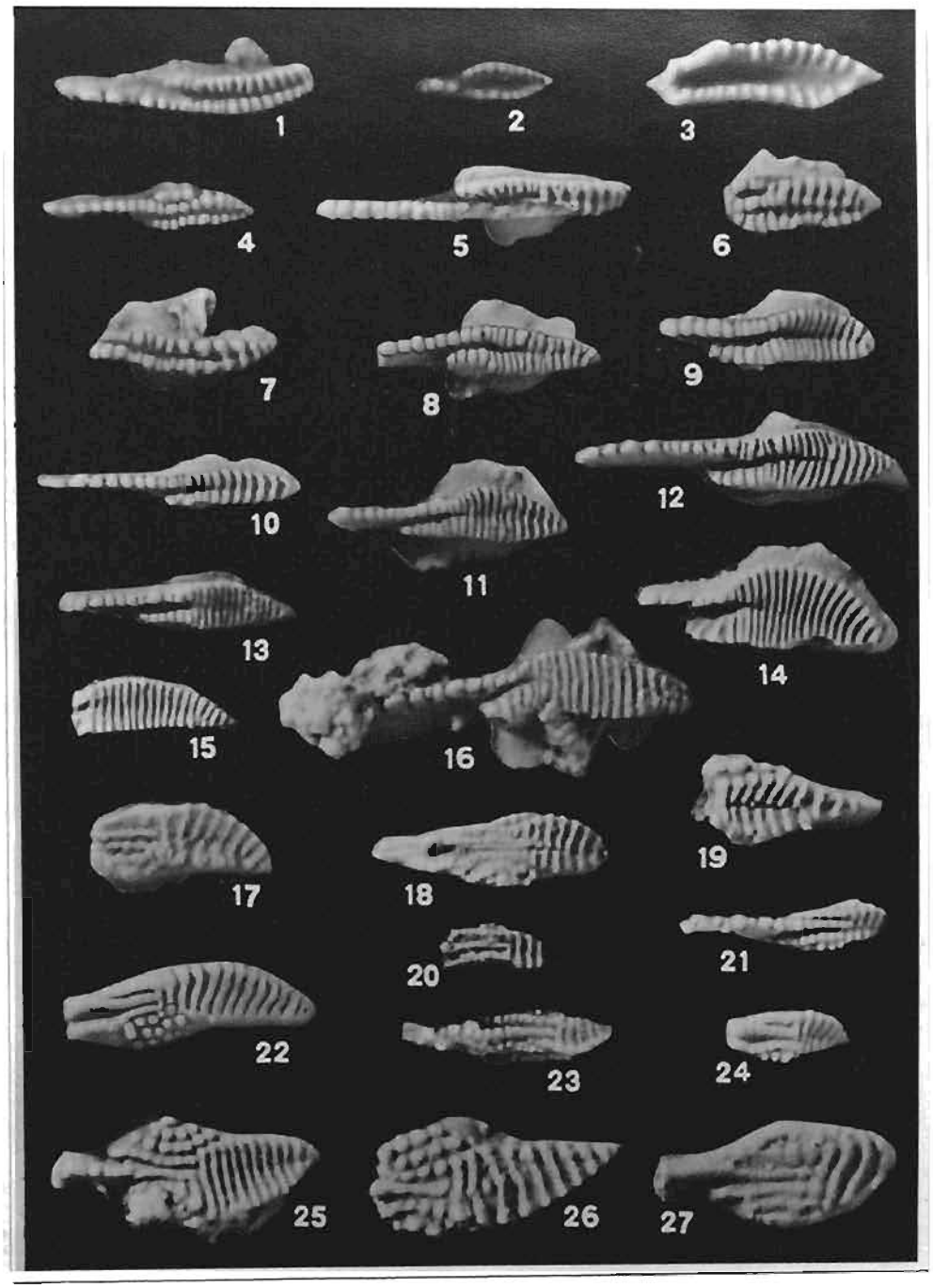
19 — Streptognathodus (?) sp. Sample G912.

20, 23 — Idiognathodus delicatus Gunnell.
Immature specimens, Sample G912.

22 — Idiognathodus sinuosus Graves n. sp.
Holotype, Sample G906.

25–27 -- Idiognathodus magnificus.
25, 26, Sample G912. 27, Sample G904.

PLATE VI



CONODONTS OF THE DIMPLE FORMATION

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