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Upper Franconian and Lower Trempealeauan Cambrian Trilobites and Brachiopods, Wilberns Formation, Central Texas

By

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UPPER FRANCONIAN AND LOWER TREMPEALEAUAN CAMBRIAN TRILOBITES AND BRACHIOPODS, WILBERNS FORMATION, CENTRAL TEXAS[1]

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ABSTRACT—Forty-three species of trilobites belonging to 28 genera, 12 species of brachiopods belonging to 8 genera, and one species of gastropod are described from the Morgan Creek, Point Peak, and San Saba members of the Wilberns formation in the Llano uplift. Systematic descriptions include one new trilobite genus: *Stigmacephaloides* (type, *S. curvabilis, n.* sp.); six other new trilobite species: *Monocheilus truncatus, Rasettia magna, Parabolinoides granulosus, Conaspis masonensis, C. testudinatus, Keithiella scrupulosa;* one new brachiopod genus: *Pseudodicellomus* (type, *P. mosaicus*); two new brachiopod species: *Billingsella rhomba, B. texana;* and one new brachiopod subspecies: *Billingsella corrugata inornata.* Neotypes are designated for *Angulotreta microscopica* (Shumard) and *Billingsella coloradoensis* (Shumard). Four trilobite genera are placed in synonymy: *Meeria* Frederickson (with *Idahoia), Minkella* Lochman & Hu (with *Saratogia), Bernia* Frederickson (with *Parabolinoides), Bemaspis* Frederickson (with *Taenicephalus).* All illustrations are stereographic.

INTRODUCTION

AN EXPLANATION is necessary for why a paper that appears under joint authorship should be written in the first person singular. The core of the fossil material treated here was the subject of a doctoral thesis submitted at the University of Minnesota in 1953 by Ellinwood, who studied under my supervision. Collections from the Wilberns formation had been made by Virgil E. Barnes and others prior to 1947, by Barnes and myself in the summer of 1947, and by Ellinwood in 1949–50 while employed by the Texas Bureau of Economic Geology as Barnes' field assistant. Although acceptable as a thesis, Ellinwood's manuscript, especially the plates, was not ready for publication, and because of his duties with the California Company he had been unable to accomplish the necessary changes as late as 1958.

In the meantime investigations at the Master of Arts level by Alexander (1956), Jansen (1957) and Winston (1957) at The University of Texas added new collections and new information, particularly with respect to the Cambrian-Ordovician boundary. Especially important was a doctoral study of Franconian and Trempealeauan faunas in Montana and Wyoming by Grant (1958), the result of which was to modify much of Ellinwood's generic taxonomy.

By this time Barnes' investigation of pre-

[1] Ten of the plates in this paper were paid for by the University Research Institute, University of Texas.

Ellenburger Paleozoic rocks in central Texas was well advanced, and it became necessary that the post-*Elvinia* Franconian and Trempealeauan taxa be described and illustrated if I were to prepare a biostratigraphic and paleocologic analysis in collaboration with him. Consequently in the summer of 1959 I undertook the preparation of this paper. The late Trempealeauan and early Canadian faunas of the Wilberns formation have been studied by Don Winston and Harry Nicholls, and their paper should appear soon after this one.

Because, except for the descriptions of a few new taxa credited to Ellinwood, this text is completely new, because all of the figures are new, and because all final taxonomic decisions have been mine alone, I have assumed senior authorship and written in the first person.

Finally, a word needs to be said about the relationship between this paper and one being prepared simultaneously by Grant. A number of Ellinwood's manuscript species turned up in Grant's collections from Montana and Wyoming, and it was he who changed a number of Ellinwood's generic assignments and suggested that several of Frederickson's (1949) genera belonged in synonymy. This created the problem of how proper credit was to be allocated in print. We agreed that this paper should precede his, that I should establish Ellinwood's species and assign them generically as Grant had done, but that I should leave to Grant the defense of his own generic concepts. This I have tried to do.

In fairness to Ellinwood, it should be mentioned that he recognized, as new, several species later described by Lochman & Hu (1959).

The collections from central Texas that form the basis for this study were obtained from the upper half of the Morgan Creek limestone, the Point Peak siltstone, and the lower part of the San Saba limestone, all members of the Wilberns formation (Bridge, Barnes & Cloud, 1947; Cloud & Barnes, 1948). Biostratigraphically the taxa described here constitute the faunas of the *Conaspis* through *Rasettia* (=*Platycolpus*)-*Scaevogyra* zones of the Cambrian Correlation Chart (Howell and others, 1944), and therefore are assignable to the upper Franconian and lower Trempealeauan Stages of the Croixan Series.

The sole purpose of this paper is to provide descriptions and stereographic illustrations of the fossil species so far identified from the interval mentioned above. Their detailed stratigraphic distribution and local zonation will be fully documented in a study of the pre-Ellenburger Paleozoic strata of central Texas being prepared for publication by Barnes and Bell. Consequently occurrences of the species are reported here only in terms of the standard zones, and precise locality information is given only for the figured specimens.

ACKNOWLEDGMENTS

Thanks are extended to Virgil E. Barnes and John T. Lonsdale of the Texas Bureau of Economic Geology for their encouragement and financial assistance in support of this project, to G. Arthur Cooper, Preston E. Cloud, and A. R. Palmer for providing specimens from the U. S. National Museum, to Shell Oil Company and the University of Minnesota for providing graduate fellowships and assistantships, and to the Geology Foundation of The University of Texas for financial support in the summer of 1959. Richard A. Robison photographed the specimens and constructed the plates while a Research Assistant appointed by The University of Texas Research Institute.

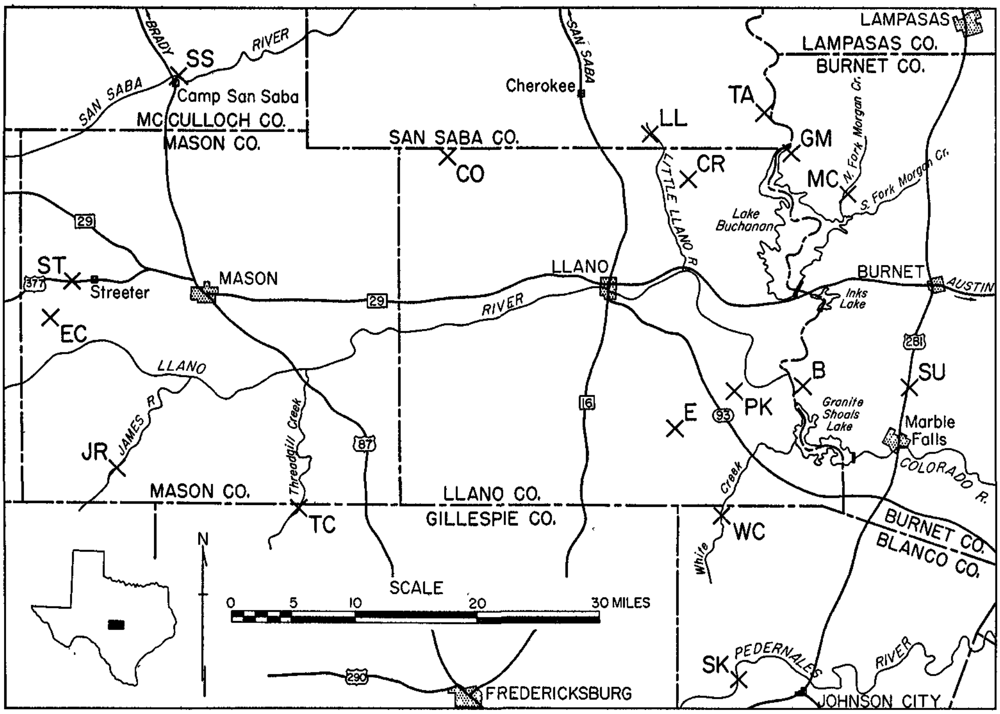
LOCALITIES

Most of the fossils illustrated in this paper were collected from measured sections whose approximate positions are shown in text-fig. 1. The more detailed descriptions that follow include positions of member-boundaries within the Wilberns formation. Sections are listed in alphabetical order according to their code designations.

(*B*) *Backbone Ridge section.*—West side of Backbone Ridge on east bank of Colorado River approximately 2 miles downstream from Kingsland, western Burnet County. Base of section is *Irvingella* coquinite; top of Morgan Creek member at approximately B-82; top of Point Peak member at approximately B-280 feet.

(CO) *Cold Creek section.*—Prominent knob on west side of Cold Creek, approximately one mile north of where it crosses Texas ranch road 386 between Field Creek and Valley Spring, northwestern Llano County. Base of section is *Eoorthis* coquinite; top of Morgan Creek member at approximately CO-78; top of Point Peak member at approximately CO-218.

(*CR*) *Carter ranch section.*—About 4 miles airline north of Lone Grove and 3/4 mile east of



TEXT-FIG. *1*—Map of central Texas showing location of measured sections of the Wilberns formation B—Backbone Ridge, CO—Cold Creek, CR—Carter Ranch, E—East Canyon, EC—Eckert's Crossing, GM—Gray Mountain, JR—James River, LL—Little Llano, MC—Morgan Creek, PK—Packsaddle Mountain, SK—Klett-Walter, SS—Camp San Saba, ST—Streeter, SU—Sudduth, TA—Tanyard, TC—Threadgill Creek, WC—White Creek.

Little Llano River, northeastern Llano County. Base of Section is base of Hickory sandstone; top of Morgan Creek member at approximately CR-780; top of Point Peak member at approximately CR-940.

(*E*) *East Canyon section.*—South end of Riley Mountains, about 13 miles airline southeast of Llano, and about 0.45 mile west of road between Click and State Highway 71, southeastern Llano County. Base of section is base of Hickory sandstone; top of Morgan Creek member at approximately E-790; top of Point Peak member at approximately E-903.

(EC) Eckert's Crossing section.—Bed of Leon Creek downstream from crossing near Ed Eckert ranch headquarters, about 6 miles airline southwest of Streeter, western Mason County. Section includes 40 feet of Morgan Creek member, and 71 feet of Point Peak member; boundary at EC-40.

(*GM*) *Gray Mountain section.*—South side of Gray Mountain, Goodrich ranch near north end of Lake Buchanan, northwestern Burnet County. Base of Gray Mountain segment of Goodrich ranch composite section is base of Wilberns formation at approximately GM-465; top of Morgan Creek member at approximately GM-618.

(*JR*) *James River section, upstream segment.*—Along James River on Jeffords-James River ranch, southwestern Mason County. Base of section is near base of Lion Mountain member of the Riley formation; top of Morgan Creek member at approximately JR-204; top of Point Peak member at approximately JR-392.

(*LL*) *Little Llano River section.*—Near Little Llano River about 4 miles airline southeast of Cherokee, and just north of Llano County line, southern San Saba County. Base of section is at base of Hickory sandstone; top of Morgan Creek member at approximately LL-746; top of Point Peak member at approximately LL-885.

(*MC*) *Morgan Creek section.*—Wilberns segment on north fork of Morgan Creek, about 2 miles from Lake Buchanan, western Burnet County. Base of section is at base of Hickory sandstone; top of Morgan Creek member at approximately MC-736; top of Point Peak member at approximately MC-850.

(*PK*) *Packsaddle Mountain section.*—Top of Packsaddle Mountain, a prominent landmark about 14 miles airline southeast of Llano, southeastern Llano County. Base of section is *Eoorthis* coquinite. This is USNM locality 68.

(*SK*) *Klett-Walker section.*—Along east bank of

Pedernales River on Klett and Walker ranches, about 5 miles airline west of Johnson City, western Blanco County. (Originally called Scott Klett section.) Base of section is at unconformable contact of Precambrian granite and Cap Mountain member of Riley formation; top of Morgan Creek member at approximately SK-267; top of Point Peak member at approximately SK-292.

(*SS*) *Camp San Saba section.*—North side of San Saba River near Camp San Saba, about 18 miles airline north of Mason, southern McCulloch County. Base of section is in Welge member of Wilberns formation; top of Morgan Creek member at approximately SS-123; top of Point Peak member at approximately SS-217.

(*ST*) *Streeter section.*—Along south side of U. S. Highway 377 about 1.3 miles west of Streeter, western Mason County. Base of section is at a fault in Hickory sandstone; top of Morgan Creek member probably at ST-581.

(*SU*) *Sudduth section.*—Along west side of U. S. Highway 281 about 4 miles north of Marble Falls, southern Burnet County. Base of section is at base of Morgan Creek member; top of Morgan Creek member at approximatejy SU-126.

(*TA*) *Tanyard section.*—Directly across the Colorado River from the Tanyard, extreme south eastern San Saba County. Base of section is *Irvingella* coquinite ; top of Morgan Creek member at approximately TA-80; top of Point Peak member at approximately TA-216.

(*TC*) *Threadgill Creek section.*—Upper segment along Threadgill Creek, straddling Mason-Gillespie County line. Base of composite Threadgill Creek section is at base of Hickory sandstone; top of Morgan Creek member at approximately TC-1025; top of Point Peak member at approximately TC-1179.

(*WC*) *White Creek section.*—Along east side of White Creek, northwestern Blanco County. Base of section is near base of Hickory sandstone; top of Morgan Creek member at approximately WC-968; top of Point Peak member at approximately WC-1079.

SYSTEMATIC DESCRIPTIONS

Familes of trilobites are arranged alphabetically under each order, genera alphabetically under each family, and species alphabetically under each genus. Morphologic terms for trilobites are those of the Treatise (Harrington, Moore, & Stubblefield, 1959). Specimens belonging to the Bureau of Economic Geology (BEG) are stored at The University of Texas. A notation such as E-840 means that the specimen was collected from 840 feet above the base of the East Canyon measured section. In the lists of figured specimens, *width* means maximum measured or estimated width when referring to any pygidium or to an agnostid cephalon, but it means measured or estimated width across the palpebral lobes when referring to a non-agnostid cranidium. For brachiopods, *width* means maximum measured width of the figured specimen.

Phylum ARTHROPODA
Class TRILOBITA
Order AGNOSTIDA Kobayashi, 1935
Family AGNOSTIDAE M'Coy, 1849
Genus HOMAGNOSTUS Howell, 1935
HOMAGNOSTUS TUMIDOSUS (Hall & Whitfield)
Pl. 51, figs. 1–4

Agnostus tumidosus HALL & WHITFIELD, 1877, p. 231, pl. 1, fig. 32.
Geragnostus cf. *G. tumidosus* (Hall & Whitfield) PALMER, 1955a, p. 719, pl. 76, figs. 4,6.
Geragnostus tumidosus (Hall & Whitfield) PALMER, 1955b, p. 89, pl. 19, figs. 3,4; pl. 20, figs. 1–3,12,15.
Homagnostus tumidosus (Hall & Whitfield) PALMER, 1960, p. 63, pl. 4, figs. 1,2.

Homagnostus tumidosus was first reported from central Texas by Palmer (1955a) from the lower part of the *Aphelaspis* zone, and is here recorded from the *Elvinia* zone.

Figured specimens.—

	Zone	*BEG Number*	*Width*
Pl. 51, fig. 1 (cephalon)	*Elvinia*	34836	2.1 mm.
2 (pygidium)	"	34837	2.3
3 "	"	34838	•2.8
4 (cephalon)	"	34839	2.2

? HOMAGNOSTUS sp.
Pl. 51, figs. 5,6

Associated with specimens of *Homagnostus tumidosus* and *Pseudagnostus communis* in the *Elvinia* zone are a few pygidia that are characterized by a posteriorly expanded axis that extends to the marginal furrow. They have morphological affinities with *Kormagnostus* and *Pseudagnostus,* and I arbitrarily assign them with a query to *Homagnostus.*

The pygidia resemble species of *Homagnostus* in having the entire axial furrow distinctly impressed, but no described species of *Homagnostus* has an axial lobe that extends to the marginal furrow. They resemble *Pseudagnostus communis* in having a posteriorly expanded axis that extends to the marginal furrow, but by definition *Pseudagnostus* has no effaced posterior axial furrow. Nearly identical pygidia from the *Coosella* zone have been assigned by Palmer

(1955a, pl. 76, fig. 10) to *Kormagnostus,* but so far no cephalon with the characters of *Kormagnostus* has been obtained from the *Elvinia* zone in central Texas.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 51, fig. 5 (pygidium)	*Elvinia*	34840	2.1 mm.
6 "	"	34841	2.1

Family PSEUDAGNOSTIDAE Whitehouse, 1936

Genus PSEUDAGNOSTUS Jaekel, 1909

PSEUDAGNOSTUS COMMUNIS (Hall & Whitfield)

Pl. 51, figs. 7–21

Agnostus communis HALL & WHITFIELD, 1877, p. 228, pl. 1, figs. 28,29.

Pseudagnostus communis (Hall & Whitfield) PALMER, 1955a, p. 720, pl. 76, figs. 1–3; 1955b, p. 94, pl. 19, figs. 16, 19–21; pl. 20, figs. 4–11, 14; 1960, p. 61, pl. 4, figs. 3,4; RASETTI, 1961, p. 109, pl. 23, figs. 13–17.

Pseudagnostus josepha (Hall) FREDERICKSON, 1949, p. 362, pl. 72, fig. 17.

Pseudagnostus prolongus (Hall & Whitfield) PALMER, 1955b, pl. 19, fig. 18; LOCHMAN & Hu, 1959, p. 412, pl. 57, figs. 7–16.

Pseudagnostus convergens Palmer, LOCHMAN & Hu, 1959, p. 412, pl. 57, figs. 1–6.

No one has searched systematically for agnostids in central Texas, and specimens have been discovered during the processing of collections of larger trilobites. Consequently the available material leaves much to be desired with respect to geographic and stratigraphic distribution.

In my opinion only one species of *Pseudagnostus* is present in the *Aphelaspis, Elvinia, Conaspis,* and *Ptychaspis-Prosaukia* faunas of central Texas. Morphologically it ranges from one end-member (pl. 51, figs, 8,10,16–18) with clearly incised axial, medial, and glabellar furrows, through continuous gradations to another end-member (pl. 51, figs. 9,13,14,19–21) in which furrows are absent on exteriors and faint on internal molds. There seems to be no correlation between furrow-depth and either size or stratigraphic position, and I assume that differences are related either to sex or to normal variation. A similar situation seems to have been encountered by Lochman & Hu (1959, pl. 57, figs. 1–16), although they interpreted it differently.

Specimens with clearly incised furrows are indistinguishable from those assigned to *P. communis by* Palmer (1955a, 1955b, 1960) in his recent clarification of that species, but he reports no gradation to faint furrows, and all of his specimens are from the *Aphelaspis* and *Dunderberia* faunas. Smooth or nearly smooth cephala are indistinguishable from those of *P. prolongus* (Hall & Whitfield), but Palmer (1960, p. 61) finally concluded that the species lacks spines on the pygidium. Thus in central Texas there seems to occur a species in part like *P. communis,* but with greater morphologic variability and a higher stratigraphic position. For the present it seems best to assign the name *P. communis,* although in fact it may be a different species.

Probably in fact this species is *P. josepha* (Hall), a name that holds priority over all others, and it has been so identified by previous workers in Texas. However, the central Texas species has a spinose pygidium, and *P. josepha* is said to be non-spinose. The latter claim may be true, but the facts can't be ascertained. The pygidial spines of *P. communis* are tiny, and I have rarely seen one preserved on an internal mold, even in fine-grained limestone. Inasmuch as *P. josepha* in its type area (Upper Mississippi Valley) invariably is preserved as molds in medium-grained sandstone, it is not surprising that spines, if present, have never been described.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 51, fig. 7 (cephalon)	*Elvinia*	34842	2.6 mm.
8 "	*Pty.-Pro.*	34843	2.3
9 "	"	34844	2.9
10 "	"	34845	3.1
11 "	*Elvinia*	34846	3.6
12 "	*Pty.-Pro.*	34847	3.9
13 "	"	34848	4.4
14 "	"	34849	4.6
15 (pygidium)	"	34850	3.0
16 "	"	34851	3.0
17 "	"	34852	3.4
18 "	"	34853	3.6
19 "	"	34854	4.0
20 "	"	34855	3.9
21 "	"	34856	4.2

Order PTYCHOPARIIDA Swinnerton, 1915

Family ANOMOCARIDAE Poulson, 1927

Genus MONOCHEILUS Resser, 1937

MONOCHEILUS TRUNCATUS Ellinwood, n. sp.

Pl. 52, figs. 1–3

Cranidium quadrate, moderately convex. Glabella flatly convex, sides curved and tapering, slightly expanded medially, frontal margin rounded-truncate, width at base and length approximately equal. Glabellar furrows absent or posterior pair faintly impressed. Axial furrow moderately impressed, stronger in front than at sides of glabella. Occipital furrow shallow, straight. Occipital ring moderately wide, flattened. Frontal area short, flatly convex, anterior margin broadly curved. Marginal furrow absent or faintly impressed. Fixigenae very narrow, horizontal. Palpebral lobes broad, gently curved, almost as long as glabella. Palpebral furrow crescentic, complete. Posterior limbs smooth, very narrow. Anterior course of facial suture immediately in front of palpebral lobes closely approaches axial furrow, then diverges slightly for a short distance and swings sharply in toward sagittal line.

Librigenae and pygidium unknown.

Remarks.—This species combines characters of *M. anatinus* (Hall) and *M. micros* (Walter), and is stratigraphically higher (lower Trempealeauan). From the former it differs in its quadrate, more truncate glabella and longer palpebral lobes, but has a similar short frontal area; from the latter it differs in its proportionally shorter frontal area and greater size, but other proportions are similar,

Figured specimens.—

	Zone	BEG Number	Width
Pl. 52, fig. 1 (cranidium, holotype)	low. Tremp.	34857	10.2 mm.
2 (cranidium)	"	34858	7.2
3 "	"	34859	5.3

Family DIKELOCEPHALIDAE Miller, 1889
Genus BRISCOIA Walcott, 1924
BRISCOIA sp.
Pl. 52, figs. 5,6

The *Plectotrophia* limestone bed (Bridge, Barnes & Cloud, 1947, p. 116) in the Point Peak siltstone member of the Wilberns formation is characterized by fairly abundant fragments of large dikelocephalid trilobites. Thus far no complete cranidia or pygidia have been collected, and naming the species does not seem advisable. The tapered glabella and nonspinose pygidial margin. accord with the definition of *Briscoia,* but the few small specimens available on which these features can be seen do not constitute an adequate sample of the dikelocephalid remains in the *Plectotrophia* bed.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 52, fig. 5 (cranidium)	Pty.-Pro.	34861	20.0 mm.
6 (pygidium)	"	34862	7.8

Family DOKIMOCEPHALIDAE Kobayashi, 1935
Genus SULCOCEPHALUS Wilson, 1948
SULCOCEPHALUS CANDIDUS (Resser)
Pl. 52, fig. 4

Talbotina candida RESSER, 1942, p. 107, pl. 21, figs. 27,28.
Talbotina ulrichi RESSER, 1942, p. 107, pl. 21, fig. 26.
Sulcocephalus candidus (Resser) WILSON, 1948, p. 31, pl. 8, figs. 1,2; WILSON & FREDERICKSON 1950, p. 896, pl. 1, figs. 4,5.
Sulcocephalus benesulcatus WILSON, 1948, p. 31, pl. 8, figs. 3–5; WILSON & FREDERICKSON, 1950, p. 896.

A single specimen of this species is illustrated because it was collected in association with *Eoorthis remnicha* and *Parabolinoides,* riot an uncommon occurrence at the *Elvinia-Conaspis* zone boundary. I can see no justification for Wilson's *S. benesulcatus.*

Figured specimen.—

	Zone	BEG Number	Width
Pl. 52, fig. 4 (cranidium)	Conaspis	34860	7.4 mm.

Family ELVINIIDAE Kobayashi, 1935
Genus DRUMASPIS Resser, 1942

Resser (1942, p. 28) simultaneously created the genus *Drumaspis* and 14 new species, of which *D. walcotti* is the type. As usual, such things as size, normal variation, preservation, and stratigraphic position were not considered in naming the "species," and probably several of them are synonyms.

In central Texas *Drumaspis* is represented by two species that, except for an intermediate zone of overlap or gradation, are consistently segregated biostratigraphically. Possibly this represents evolution in place, but is by no means certain. A similar situation has been reported by Grant in Minnesota (1953) and Montana (1958). No attempt is made here to treat the matter statistically; all three areas should be included in such a study, the object of which would be to *explain* the empirical fact of similar gradational stratigraphic distribution.

The range of *Drumaspis* falls within the *Ptychaspis-Prosaukia* zone.

DRUMASPIS DECKERI Resser
Pl. 52, figs. 10–12,15

Drumaspis deckeri RESSER, 1942, p. 31, pl. 5, figs. 14–16.

This, the stratigraphically higher of the two species of *Drumaspis* in central Texas, is especially characterized by its smooth surface (except occipital ring, which carries faint ridges and granules), quadrate glabella, and its posterior pair of glabellar furrows that are slightly curved posteriorly toward the midline and connected across the glabella. It overlaps with or grades to *D, texana* in the lower part of its range, and poorly preserved specimens (particularly internal molds) cannot with certainty be assigned to either species.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 52, fig. 10 (cranidium)	*Pty.-Pro.*	34868	3.8 mm.
11 "	"	34869	6.5
12 "	"	34870	8.0
15 (pygidium)	"	34871	6.5

DRUMASPIS TEXANA Resser
Pl. 52, figs. 7–9,13,14

Drumaspis texana RESSER, 1942, p. 32, pl. 5, figs. 27–30.
Drumaspis osella RESSER, 1942, p. 32, pl. 5, figs. 17–20.

This, the stratigraphically lower of the two species of *Drumaspis* in central Texas, is especially characterized by its coarsely ridged and granulated surface, relatively tapered glabella, and its posterior pair of glabellar furrows that are strongly curved posteriorly toward the midline, but are not connected across the glabella. In the zone of overlap with or gradation to *D. deckeri*, specimens of *D. texana* have a faintly granulated surface and a faint trace of connection of the posterior glabellar furrows.

Pygidia are rare, and those that have been assigned to species on the basis of stratigraphic association are too few to provide a basis for morphologic distinction.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 52, fig. 7 (cranidium)	*Pty.-Pro.*	34863	4.0 mm.
8 "	"	34864	5.0
9 "	"	34865	9.5
13 (pygidium)	"	34866	6.2
14 "	"	34867	12.5

Family IDAHOIIDAE Lochman, 1956
Genus COMANCHIA Frederickson, 1950
COMANCHIA AMPLOOCULATA (Frederickson)
Pl. 52, figs. 16–18

Ptychopleurites amplooculata FREDERICKSON, 1948, p, 803, pl. 123, figs. 9–11; WILSON, 1949, p. 42–43, pl. 10, fig. 4, pl. 11, figs. 8,9.
Comanchia amplooculata (Frederickson) WILSON & FREDERICKSON, 1950, p. 900, pl. 1, figs. 6,7.

This species is especially characteristic of the top of the *Elvinia* zone—the so called *Irvingella major* interval—but the specimens illustrated here all occur with *Eoorthis remnicha* and *Parabolinoides* in the very base of the *Conaspis* zone.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 52, fig. 16 (cranidium)	*Conaspis*	34872	3.0 mm.
17 (cranidia & pygidia)	"	34873	—
18 (cranidium)	"	34874	3.5

Genus IDAHOIA Walcott, 1924

Idahoia WALCOTT, 1924, p. 58; GRANT, 1958, p. 431; LOCHMAN-BALK, 1959, p. 252; LOCHMAN & Hu, 1959, p. 420.
Meeria FREDERICKSON, 1949, p. 358; LOCHMAN-BALK, 1959, p. 252; LOCHMAN & Hu (as subgenus of *Idahoia*), 1959, p. 419.

Until Grant (1958) concluded that *Saratogia* was an important Franconian genus, it had been progressively stripped of all but its type species after Walcott defined *Idahoia*. Lochman, not entirely independently, reached a similar conclusion, but her concept of *Saratogia* (Lochman & Hu, 1959, p. 420) differs considerably from that of Grant as evidenced by her creation of *Idahoia* (*Meeria*) *modesta* and the new genus *Minkella*, both of which exhibit characters attributed to *Saratogia* by Grant. I have no place in this debate, and will merely follow Grant, who will defend his position in a paper soon to appear.

In essence *Idahoia* is distinguished from *Saratogia* by the association of three features: (1) length of frontal area is half or more than half that of glabella plus occipital ring, (2) glabellar and occipital furrows are absent or faint, and (3) slope of anterior border (sag.) is nearly parallel to crest (sag.) of glabella, never strongly upsloping. The last feature is on occasion difficult to ascertain because of distortion produced by compaction.

The status of *Meeria* Frederickson is uncertain to say the least, and it cannot be settled until Oklahoma material from both *Conaspis* and *Ptychaspis-Prosaukia* faunas is studied. Grant (1958, p. 433) inspected the holotype of *Meeria lirae,* the type species, and concluded that it belonged to *Idahoia* and was conspecific with what Ellinwood (1953, p. 49) had described in manuscript as a new species of *Idahoia* from central Texas. Frederickson's (1949, pl. 72, figs. 3–6) illustrations leave much to be desired, but both figures of the holotype clearly show the presence of some sort of ridged ornament on the occipital ring, whereas Frederickson describes the test as smooth. Lochman-Balk (1959) recognized *Meeria* as a distinct genus in the Treatise, and Lochman & Hu (1959) treat it as a subgenus of *Idahoia,* but the new species they assign to it is in my opinion a *Saratogia.*

IDAHOIA LIRAE (Frederickson)
Pl. 53, figs. 1–12

Meeria lirae FREDERICKSON, 1949, p. 358, pl. 72, figs. 3–6; LOCHMAN-BALK, 1959, fig. 202.2.

At the very base of the *Ptychaspis-Prosaukia* zone in central Texas is a highly variable group of trilobites that seems to include within it the specific concept labeled *Meeria lirae* by Frederickson (1949, p. 358). Unfortunately Frederickson's illustrated specimens are few and poor, and he does not identify individual collections of his material in such a way that one can with certainty determine what specimens are actually associated in the rock. Moreover, Frederickson's holotype (pl. 72, figs. 3,4), an obviously crushed specimen, is the only one of the three illustrated that displays what is described as both a generic and specific feature: pits (fossulae) in the axial furrow at the anterolateral corners of the glabella. The two paratypes differ from the holotype in having frontal areas that are slightly more than half the length (sag.) of the glabella plus occipital ring, whereas the holotype has a frontal area decidedly less than half that length—in this instance regarded as an exception to the general rule, or the result of distortion. One paratype (pl. 72, fig. 5) conforms to what in central Texas I am calling *Idahoia lirae* var. A. Incidentally, although Frederickson reports this species from the *Taenicephalus* subzone, all illustrated specimens are from a locality (6) from which *Taenicephalus* itself is *not* reported.

The variable group of trilobites from central Texas that is here called *Idahoia lirae* may or may not constitute a valid paleontologic species, but the morphologically somewhat different specimens that are incorporated under the name are physically associated at locality after locality, and range through no more than 10 feet of strata. A "splitter" could with little difficulty distinguish three species: one (pl. 53, figs. 1–3) with occipital *spine* and anterior border furrow present; a second (pl. 53, figs. 4–7) with or without occipital *node,* but with anterior border furrow present; and a third (pl. 53, figs. 10–12) with anterior border furrow very faint to absent. For the present I prefer to regard the presence or absence of an occipital spine as a sexual feature (Lochman & Hu, 1959, p. 414–416), and to treat the group without distinct anterior border furrow as an informal variant. Frederickson described and illustrated only specimens without occipital spines.

As implied by Frederickson (1949, p. 358)—although I find this to be true only of *small* unspined cranidia—there are specimens low in the range of the species whose assignment to this species or to *Taenicephalus* is uncertain. Perhaps there is a phylogenetic gradation between the two, but much more and much better material than is now available will be necessary before evidence can be substituted for intuition.

The affinities of this species are subject to debate. Grant (1958) and I prefer to assign it to *Idahoia,* as did Ellinwood (1953), because it commonly has a spinose or nodose occipital ring, relatively faint glabellar furrows, a frontal area that is almost always slightly more than one-half the length (sag.) of glabella plus occipital ring, an anterior border furrow that is absent to wide and shallow, and a border that is at most gently upsloping relative to the preglabellar field. Frederickson (1949), Lochman-Balk (1959), and Lochman & Hu (1959) assign it to *Meeria* (of which it is the type species), which Frederickson thought closely related to *Taenicephalus,* and Lochman & Hu treat as a subgenus of *Idahoia*, Symptomatic of *Meeria's* migrant character is a footnote in the Treatise (Lochman-Balk, 1959, p. 252): "Transferred to Idahoiidae at request of Lochman-Balk after earlier assignment of genus by her to Parabolinoididae."

Figured specimens.—

	Zone	BEG Number	Width
Pl. 53, fig. 1 (cranidium)	Pty.-Pro.	34878	8.7 mm.
2 "	"	34879	6.0
3 "	"	34880	7.5
4 "	"	34881	2.4
5 "	"	34882	4.0
6 "	"	34883	4.2
7 "	"	34884	8.0
8 "	"	34885	8.8
9 "	"	34886	13.0

IDAHOIA LIRAE (Frederickson), var. A, Bell
Pl. 53, figs. 10–12

Meeria lirae FREDERICKSON, 1949, pl. 72, fig. 5.

Specimens assigned to this variant are invariably associated with both spined and nodose specimens of the species, and differ from them only in having a frontal area on which preglabellar field and anterior border are but faintly if at all differentiated. If differentiated, the ratio of preglabellar field to anterior border is about 3 or 4:1. The frontal area is short for the species, being slightly less than one-half the length of glabella plus occipital ring.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 53, fig. 10 (cranidium)	Pty.-Pro.	34887	6.3 mm.
11 "	"	34888	6.5
12 "	"	34889	8.0

IDAHOIA WISCONSENSIS (Owen)
Pl. 52, figs. 19–21

Crepicephalus ? wisconsensis OWEN, 1852, Tab. 1, fig. 13.
Idahoia wisconsensis (Owen) BELL, FENIAK, & KURTZ, 1952 (part), p. 189, pl. 37, figs. 3b,c, 3e,f.
Idahoia latifrons (Shumard) BERG, 1953, p. 566, pl. 60, fig. 11.
Not *Idahoia wisconsensis* (Owen) BERG, 1953, p. 566, pl. 61, fig. 11; LOCHMAN & Hu, p. 417, pl. 59, figs. 12–32.

This species, as restricted by Grant (1958, p. 437) is stratigraphically consistent in its occurrences and is characterized by a preglabeller field—anterior border ratio that ranges from near 3:1 to 4:3 upward, and is 2:1 in the middle part of its stratigraphic range. It occurs in the middle of the *Ptychaspis-Prosaukia* zone, mostly above but slightly overlapping with *Saratogia fria* in Texas and Montana. If I am right in feeling that Walcott (1916, p. 197) assigned *Saratogia hera* to the proper genus after all, stratigraphic distribution of *Idahoia* is also similar in the upper Mississippi Valley.

Most of the specimens illustrated by Lochman & Hu (1959, pl. 59, figs. 12–32) are far from convincing; they seem to me indistinguishable from the illustrations of *Saratogia fria* immediately above them on the plate. Even Lochman & Hu find it "surprising that most of the cranidia are small size" (the largest is 8 mm. long), whereas commonly in Texas, Montana, and the upper Mississippi Valley cranidia are 20–25 mm. long.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 52, fig. 19 (cranidium)	Pty.-Pro.	34875	18.0 mm.
20 "	"	34876	17.0
21 "	"	34877	8.5

Genus SARATOGIA Walcott, 1916

Saratogia WALCOTT, 1916, p. 195–196; LOCHMAN-BALK, 1959, p. 252; LOCHMAN & Hu, 1959, p. 420–421.
Minkella LOCHMAN & HU, 1959, p. 414.

The situation with respect to *Saratogia, Idahoia, Meeria,* and *Minkella* is briefly outlined under the heading of *Idahoia*. Grant will discuss it more fully in the near future. Three species of *Saratogia* are recognized in central Texas; they commonly occur together and range through the middle part of the *Ptychaspis-Prosaukia* zone.

SARATOGIA AMERICANA (Lochman & Hu)
Pl. 54, figs. 1–5

Minkella americana LOCHMAN & Hu, 1959, p. 414–416, pl. 58, figs. 1–20.

This species, superficially quite different in contour from *Saratogia fria*, is in several ways remarkably similar to that species, with which it commonly occurs. *S. americana* is characterized by its strong longitudinal and transverse convexity, its slightly tapered glabella whose width across the base is equal to its length, its short frontal area, its strongly downsloping and convex preglabellar field, its sharply upturned anterior border, its short occipital spine or node, and its surface ornament, in which is evident its similarity to *S. fria.* The whole of the occipital ring, occipital spine, posterior limbs, and the posterior half of the glabella are covered with irregular ridges; the fixigenae are smooth, and the palpebral furrow, except on small specimens, is indistinct to absent; the preglabellar field is smooth or covered with low ridges with a longitudinal alignment; the anterior border has transverse Bertillon ridges; seemingly there are no pits in the anterior border furrow.

Saratogia americana is very similar to the species described as *Idahoia* (*Meeria*) *modesta* by Lochman & Hu (1959, p. 420, pl. 59, figs. 33–45), and it is surprising that they did not compare the two. In my opinion they differ at most specifically, and both conform to the definition of *Saratogia* adopted by Grant (1958). A comparison is made under *Saratogia modesta.*

Figured specimens.—

	Zone	BEG Number	Width
Pl. 54, fig. 1 (cranidium)	*Pty.-Pro.*	34899	7.0 mm.
2 "	"	34900	8.5
3 "	"	34901	8.0
4 "	"	34902	7.3
5 (pygidium)	"	34903	11.0

SARATOGIA FRIA Lochman & Hu
Pl. 53, figs. 13–21

Saratogia fria LOCHMAN & Hu, 1959, p. 422, pl. 59, figs. 1–11.

The material from Texas, which had been recognized as a new species under another name by Ellinwood (1953, p. 48), is seemingly identical in all respects to that described from Idaho by Lochman and Hu, and it turns out that surface ornament is perhaps the most diagnostic feature of the species. It should also be pointed out that their statement (1959, p. 422) "preglabellar field ½ the glabellar length (sag.)" is not true, a fact that is evident from their own figures. Rather, the preglabellar field is more nearly 1/3 the glabellar length (sag.), whereas the frontal area is less than ½ the glabellar length (sag.) plus occipital ring.

Surface ornament on the cranidium is complex. The occipital ring, occipital spine, posterior limbs, and preoccipital glabellar lobes are coarsely granulated; the rest of the glabella (except for furrows, which are smooth) is covered with a complex pattern of low ridges; the fixigenae are smooth, and the palpebral furrow, except on small specimens, is indistinct to absent; the anterior border and most of the preglabellar field is covered with a Bertillon pattern of distinct ridges with a transverse alignment; the anterior third of the preglabellar field has widely spaced low ridges with a longitudinal alignment; and the broad anterior border furrow is somewhat puckered along its deepest part.

Most of the surface pattern is not present on internal molds, but one part is, and can be seen on two of Lochman and Hu's illustrations (pl. 59, figs. 6,7). Particularly on large weathered molds (pl. 53, fig. 16), strong caecal venations with a predominantly longitudinal alignment cover most of the preglabellar field, and a single row of widely spaced nodes (indicating pits on the underside of the test) extend most of the length of the anterior border furrow.

A few specimens without occipital spines (pl. 53, figs. 19, 20) are included in this species because in almost every other way they are similar. The only other differences are that the occipital ring is irregular ridged rather than granulated, and the palpebral furrow is clearly evident.

One among several poorly preserved pygidia that may belong to *S. fria* is illustrated (pl. 53, fig. 21). Its transversely elliptical shape and strongly concave border seem characteristic; its surface is coarsely granulate and irregularly ridged.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 53, fig. 13 (cranidium)	*Pty.-Pro.*	34890	6.5 mm.
14 "	"	34891	5.6
15 "	"	34892	7.0
16 "	"	34893	18.0
17 "	"	34894	16.0
18 "	"	34895	11.0
19 "	"	34896	7.4
20 "	"	34897	8.0
21 (pygidium)	"	34898	14.0

SARATOGIA MODESTA (Lochman & Hu)
Pl. 54, figs. 6–8

Idahoia (Meeria) modesta LOCHMAN & Hu, 1959, p. 420, pl. 59, figs. 33–45.

The cranidia of *Saratogia modesta* and *S. americana,* which commonly but apparently not universally occur together in central Texas, are very similar, and poorly preserved specimens are difficult to place. *S. modesta* seems to differ from *S. americana* consistently in only three respects: (1) its glabella is more nearly parallel-sided, tends to be more broadly rounded anteriorly, and has fainter glabellar furrows; (2) its preglabellar field is less convex and is proportionally longer with respect to the anterior border; and (3) its occipital ring bears at most a faint node. Although not visibile in their illustrations, Lochman & Hu describe surface ornament of granules and irregular ridges that essentially duplicates their description of *S. americana.* Perhaps it is pertinent to point out that if *S. modesta* is compared with the five cranidia interpreted by Lochman and Hu as male individuals of *S. americana,* most of the differences listed above no longer apply.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 54, fig. 6 (cranidium)	*Pty.-Pro.*	34904	9.5 mm.
7 "	"	34905	14.5
8 "	"	34906	14.5

Genus WILBERNIA Walcott, 1924

WILBERNIA DIADEMATA (Hall)
Pl. 54, figs. 9,10

Conocephalites diadematus HALL, 1863 (part), p. 167, pl. 7, fig. 36; pl. 8, fig. 21.
Wilbernia diademata (Hall) RESSER, 1937, p. 28; NELSON, 1951, p. 782, pl. 109, figs. 8,11,12.

This species, though not abundant in central Texas, seems to be persistently restricted to a few feet of strata in the vicinity of the boundary between the *Conaspis* and *Ptychaspis-Prosaukia* zones. It is characterized by its large size, a preglabellar field-anterior border ratio of approximately 1:2, and a parallel-sided to slightly tapered glabella.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 54, fig. 9 (cranidium)	*Pty.-Pro.*	34907	25.0 mm.
10 "	"	34908	10.3

WILBERNIA EXPANSA Frederickson
Pl. 54, figs. 11,12

Wilbernia expansa FREDERICKSON, 1949, p. 362, pl. 72, figs. 13–16; BELL, FENIAK, & KURTZ, 1952, p. 187, pl. 32, figs. 3a–c.

This species is not particularly abundant in central Texas, but it is present through a long stratigraphic interval that contains most of the *Conaspis* and *Ptychaspis-Prosaukia* zones. It is characterized by its concave frontal area and faint anterior border furrow (papillate on internal molds) that is almost tangent to front of the glabella.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 54, fig. 11 (cranidium)	*Conaspis*	34909	17.0 mm.
12 "	*Pty.-Pro.*	34910	25.0

WILBERNIA HALLI Resser
Pl. 54, figs. 13–18

Conocephaltes diadematus HALL, 1863 (part), pl. 7, figs. 37,38.
Wilbernia halli RESSER, 1937, p. 28; NELSON, 1951, p. 777, pl. 107, figs. 17,19; BELL, FENIAK, & KURTZ, 1952, p. 188, pl. 32, figs. 5a,b.

This species is moderately common at most localities in central Texas, and is confined to an interval of 15–25 feet in the upper part of the *Conaspis* zone. It is characterized by its tapered glabella, preglabellar field-anterior border ratio between 2:1 and 1:2, strongly incised glabellar and axial furrows, strongly convex preglabellar field and flat to slightly convex anterior border, and surface ornament consisting of a complex ridge and pit pattern similar to that of *Taenicephalus.*

Upward within the stratigraphic range of this species there is a progressive change from 2:1 to 1:2 in the preglabellar field-anterior border ratio, and the surface ornament becomes more subdued. Stratigraphically lowest specimens with strong ornament and short anterior border are referred to an informal variant.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 54, fig. 13 (cranidium)	*Conaspis*	34911	9.5 mm.
14 "	"	34912	9.5
15 (pygidium)	"	34913	7.9

WILBERNIA HALLI Resser, var. A, Ellinwood
Pl. 54, figs. 16–18

Until more is known about the stratigraphic distribution of morphotypes within *W. halli,* I prefer not to place this variant within reach of rules of zoological nomenclature, but for stratigraphic purposes its separation from the rest of the species in central Texas is convenient. It is characterized by a preglabellar field-anterior border ratio that ranges from 2:1 toward but does not include 1:1, and by strong surface ornament. It is stratigraphically low within the range of the species.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 54, fig. 16 (cranidium)	Conaspis	34914	7.0 mm.
17 "	"	34915	7.5
18 (pygidium)	"	34916	12.0

WILBERNIA PERO (Walcott)
Pl. 54, figs. 19–21

Conocephalites diadematus HALL, 1863 (part), pl. 8, fig. 18.
Ptychoparia pero WALCOTT, 1890, p. 274, pl. 21, fig. 6.
Wilbernia pero (Walcott) WALCOTT, 1924, p. 60, pl. 13, fig. 4; 1925, p. 124, pl. 15, figs. 22,23; FREDERICKSON, 1949, p. 362, pl. 72, figs. 7–9; NELSON, 1951, p. 782, pl. 109, fig. 13; LOCHMAN & Hu, 1959, p. 422, pl. 60, figs. 15–18.
Wilbernia cf. *W. pero* (Walcott) BELL, FENIAK, & KURTZ, 1952, p. 195, pl. 34, figs. 5a-c.

This, the type species of *Wilbernia,* is characterized by its parallel-sided, flatly convex glabella, and by an anterior border that is more than twice as long (sag.) as the preglabellar area. From *W. expansa* it differs in having a convex rather than concave anterior border.

Wilbernia ranges through all but the basal part of the *Conaspis* zone in central Texas, and through at least the lower half of the *Ptychaspis-Prosaukia* zone. Stratigraphically upward occur *W. halli, W. diademata,* and *W. pero,* with little or no overlap among them, whereas *W. expansa* seems to have a range essentially coincident with that of the genus.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 54, fig. 19 (cranidium)	Pty.-Pro.	34917	14.0 mm.
20 (pygidium)	"	34918	16.8
21 (cranidium, holotype)	"	(USNM 23859)	—

Family ILLAENURIDAE Vogdes, 1890
Genus ILLAENURUS Hall, 1863
ILLAENURUS QUADRATUS Hall
Pl. 55, figs. 1–3

Illaenurus quadratus HALL, 1863, p. 176, pl. 7, figs. 52–57; NELSON, 1951, p. 783, pl. 110, fig. 11 (synonymy to date).

The cranidium of this species is longer than it is wide (exclusive of the palpebral lobes), has parallel to slightly divergent anterior facial sutures, and the eyes are situated posterior to the midline of the cranidium.

Illaenurus has been collected thus far from successive stratigraphic levels in only one measured section in central Texas. Through the 28-foot interval the anterior facial sutures seem to change progressively from parallel (pl. 55, fig. 1) to slightly divergent anteriorly (pl. 55, fig. 2). Grant (1958) will elaborate on this seemingly phylogenetic situation in *Illaenurus* in a future publication.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 55, fig. 1 (cranidium)	low. Tremp.	34919	6.0 mm.
2 "	"	34920	8.1
3 (pygidium)	"	34921	15.0

Family KOMASPIDIDAE Kobayashi, 1935
Genus CHARIOCEPHALUS Hall, 1863

Lochman (1953, p. 893–896; 1959, p. 295,297) places *Chariocephalus* and *Dartonaspis* in different families (Elviniidae and Komaspididae, respectively), regards them as members of parallel lineages, and explains their morphologic similarity as the result of convergent evolution. A species of each occur together in central Texas, although *Dartonaspis* extends much higher stratigraphically than does *Chariocephalus.* Specimens are rare and almost always fragmentary, and to the man in the field similarities between the two are far more evident than are the differences. They are similar in size and in most features of the cranidium, even to the extent that both have deep pits (fossulae) in the axial furrow at the antero-lateral corners of the glabella. They seem to differ only in the configuration of the fixigenae, and in that the glabella of *Chariocephalus* narrows anteriorly whereas that of *Dartonaspis* expands. Either or both may have been derived from *Drumaspis,* which occurs stratigraphically much lower in central Texas.

CHARIOCEPHALUS WHITFIELDI Hall
Pl. 55, figs. 7,8

Chariocephalus whitfieldi HALL, 1863, p. 175, pl. 6, figs. 49–51; pl. 10, fig. 20; BELL, FENIAK, & KURTZ, 1952, p. 188, pl. 37, figs. 4a-d.

There seem to be no significant differences between specimens from central Texas and Minnesota. The species differs from *Dartonaspis wichitaensis* in having narrow (tr.) fixigenae, short (exsag.) palpebral lobes that are situated opposite the anterior third of the glabella, and a glabella whose sides are parallel or slightly convergent anteriorly.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 55, fig. 7 (cranidium)	*Pty.-Pro.*	34925	19.5 mm.
8 "	"	34926	27.0

Genus DARTONASPIS Miller, 1936
DARTONASPIS WICHITAENSIS (Resser)
Pl. 55, fig. 6

Chariocephalus wichitaensis RESSER, 1942, p. 10, pl. 2, figs. 1–8.

The fragmentary character of the material thus far collected in central Texas permits no comment on the phylogenetic. position of *Dartonaspis*. The assignment to *D. wichitaensis* is arbitrary, it being the best illustrated of several probably synonymous "species" described from Oklahoma by Resser. It differs from *Chariocephalus whitfieldi*, with which it can occur, in its wide (tr.) crescentic fixigenae, long (exsag.) palpebral lobes, and anteriorly expanding glabella.

Figured specimen.—

	Zone	BEG Number	Width
Pl. 55, fig. 6 (cranidium)	*Pty.-Pro.*	34924	25 mm.

Genus IRVINGELLA Ulrich & Resser *in* Walcott, 1924
IRVINGELLA MAJOR Ulrich & Resser
Pl. 55, figs. 4,5

Irvingella major Ulrich & Resser, *in* WALCOTT, 1924, p. 58, pl. 10, fig. 3; 1925, p. 98, pl. 15, figs. 26–29; FREDERICKSON, 1949, p. 353; pl. 69, figs. 5–7; GAINES, 1951, p. 609, pl. 1, figs. 1–32.
Irvingella, agrestis RESSER, 1942, p. 17, pl. 3, figs. 4–6.
Irvingella bacca RESSER.1942, p. 20, pl. 3, figs. 34–36.
Irvingella accincta RESSER, 1942, p. 21, pl. 3, figs. 37–39.
Irvingella abrupta RESSER, 1942, p. 21, pl. 3, figs. 40–45.

Irvingella, a common constituent of the *Elvinia* fauna, occurs most abundantly in a thin coquinite bed, essentially the *Irvingella major* zone of Wilson & Frederickson (1950), that immediately underlies *Eoorthis remnicha* and the *Conaspis* zone. Diligent search is invariably rewarded by a few specimens associated with *Eoorthis remnicha* and other elements of the *Conaspis* fauna, indicating the conformable character of the zonal boundary. The species is included here primarily to illustrate the coquinite and a specimen associated with *Eoorthis remnicha* and *Parabolinoides hebe* 2 feet above it.

Resser (1942) described 22 species of *Irvingella, 8* of them from the coquinite in central Texas. Since then 8 from Oklahoma have been placed in synonymy with *I. major* by Frederickson (1949), and 4 from central Texas have suffered the same fate at the hands of Gaines (1951). We have studied the type specimens of *I. agrestis, I. bacca, I. accincta* and *I. abrupta* from the central Texas coquinite, and place them too in synonymy with *I. major.*

Figured specimens.—

	Zone	BEG Number	Width
Pl. 55, fig. 4 (cranidium)	*Conaspis*	34922	9.0 mm.
5 (coquinite)	*Elvinia*	34923	—

Family LECANOPYGIDAE Lochman, 1953
Genus RASETTIA Lochman, 1953
RASETTIA MAGNA Ellinwood, n. sp.
Pl. 55, figs. 9–10

Cranidium (minus posterior areas) elongate, strongly convex longitudinally, less so transversely. Glabella elongate, moderately convex, slightly tapering, broadly rounded in front. Glabellar furrows absent to faintly impressed. Axial furrow moderately impressed. Occipital furrow shallow, does not quite reach axial furrow. Occipital ring flat. Frontal area downsloping, one-seventh length of cranidium. Preglabellar field narrow to absent. Anterior border distinctly elevated, flat, Bertillon ornamented, parallel-sided for most of length (tr.). Fixigenae narrow, horizontal. Palpebral furrow arcuate, complete. Posterior areas large, length (tr.) ¾ that of occipital ring. Anterior course of facial suture in front of eyes straight, then swinging almost at right angles toward axial line.

Pygidium transversely elliptical, flatly convex. Axis more distinct on small specimens than on large ones, consists of 2 axial rings and terminal axial piece; axial furrow shallow. Pleural region gently convex and smooth except for anterior pleural furrow. Border not differentiated.

Remarks.—*Rasettia magma* attains a comparatively large size; several fragmentary cranidia measure two inches in length. It is distinguished from other species of the genus by its proportionally wider (sag.) anterior border that displays little or no curvature across the frontal area. However. *R. eatoni* (Whitfield) has never been adequately illustrated and *R. oklahomensis* (Resser) and *R. wichitaensis* (Resser) are poorly described and illustrated; any or all of these species may be conspecific with *R. magna* and each other.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 55, fig. 9 (cranidium, holotype)	low. Tremp.	34927	26.5 mm.
10 (pygidium)	"	34928	48.0

Family PARABOLINOIDIDAE Lochman, 1956

Genus ORYGMASPIS Resser, 1937

ORYGMASPIS FIRMA Frederickson

Pl. 55, fig. 16; pl. 56, fig. 1

Orygmaspis firma FREDERICKSON, 1949, p. 359, pl. 71, figs. 15–18.

Whether this deserves the rank of species is moot. The only significant difference between it and *O. llanoensis,* with which it usually occurs, is the presence of an anterior border furrow—which produces the convex anterior border referred to by Frederickson. A blunt glabella is not restricted to specimens with a furrow (pl. 55, figs. 11,12). Most of the cranidia of *O. firma* from central Texas, which are rare relative to cranidia of *O. llanoensis,* are more quadrate than are those of the type species, but Frederickson's figured specimens do not display this characteristic.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 55, fig. 16 (cranidium)	*Conaspis*	34933	6.5 mm.
Pl. 56, fig. 1 "	"	34934	11.5

ORYGMASPIS LLANOENSIS (Walcott)

Pl. 55, figs. 11–15

Ptychoparia llanoensis WALCOTT, 1890, p. 272, pl. 21, figs. 3–5; 1899, p. 458, pl. 64, fig. 4 (holotype designated).

Orygmaspis llanoensis (Walcott) RESSER, 1937, p. 21; FREDERICKSON, 1949, p. 359, pl. 71, figs, 19–22; LOCHMAN-BALK, 1959, figs. 202. 12a,b.

Orygmaspis llanoensis, which is confined to the lower part of the *Conaspis* zone in central Texas (in association with *Wilbernia halli),* is characterized primarily by its smooth frontal area without anterior border furrow, and by fixigenae without palpebral furrows. On exfoliated specimens—and almost all of them are—a thin ridge crosses the frontal area transversely and bears a single row of pustules. Occasionally a specimen from which the test has not been exfoliated seems to have the frontal area differentiated into preglabellar field and anterior border by a ridge, but apparently this results from compaction.

Most of the few specimens that have not been entirely exfoliated seem to have a smooth test. However, one small specimen (pl. 55, fig. 15) displays a strong pitted ornament on occipital ring and fixigenae. This may be a common or universal feature and account for exfoliation; the rough surface would adhere to the matrix, and only abraded tests would part from it readily.

Lochman-Balk (1959, fig. 202. 12b) illustrates a tail for this species. Although she credits Resser as the source of the illustration, it is an idealized duplicate of the only photograph of a tail assigned to this species so far published, that by Frederickson (1949, pl. 71, fig. 22). Among the more than 40 collections of *Orygmaspis llanoensis* so far obtained from central Texas, no tail similar to this one has been found. (See *Parabolinoides hebe.*)

Figured specimens.—

	Zone	BEG Number	Width
Pl. 55, fig. 11 (cranidium, holotype)	*Conaspis*	(USNM 23857)	—
12 (cranidium)	"	34929	9.8 mm.
13 "	"	34930	5.0
14 "	"	34931	20.0
15 "	"	34932	5.5

Genus PARABOLINOIDES Frederickson, 1949

Parabolinoides FREDERICKSON, 1949, p. 360; LOCHMAN-BALK, 1959, p. 272.

Bernia FREDERICKSON, 1949, p. 357; LOCHMAN-BALK, 1959, p. 272.

Grant (1958, p. 465) concluded that *Parabolinoides* and *Bernia* are congeneric, and he will discuss the matter in a future publication. I agree, and point out that the ambiguity of *Bernia* is indicated by Lochman's

(1959, p. 272) description of it in the Treatise; she emphasizes none of the features regarded by Frederickson (1949, p. 360) as differentiating it from *Parabolinoides.* The type and only species of *Bernia, B. obtusa,* is here assigned to *Parabolinoides;* it may be either a valid species distinguished by a short frontal area, or an end-member of *P. hebe.* Because it has not been identified in central Texas, no comment is appropriate here.

PARABOLINOIDES CONTRACTUS Frederickson
Pl. 56, fig. 12

Parabolinoides contractus FREDERICKSON, 1949, p. 311, pl. 71, figs. 4,5,8 (not figs. 6,7); BERG, 1953, p. 564, pl. 59, fig. 3.

No more than a couple of cranidia from central Texas conform to *P. contractus* as defined by its holotype, whose length of frontal area is more than half length of the glabella. Frederickson did not regard the ratio between length of frontal area and length of glabella as a specific character, and consequently placed no limits on it. If, as I suspect, the only significant difference between *P. hebe* and *P. contractus* is in this ratio, and furthermore that a complete gradation exists between the two, then a purely arbitrary separation must be made. I have chosen to use 1:2 as the critical ratio; in other words, I have assigned to *P. contractus* those cranidia whose length of frontal area is half or more than half that of glabella. By this criterion, one of Frederickson's (1949, pl. 70, fig. 8) paratypes of *P. hebe* approaches the critical ratio more closely than does one of his paratypes (pl. 71, figs. 6,7) of *P. contractus;* in both the ratio is slightly less than 1:2.

The single cranidium of *P. contractus* figured by Berg (1953, pl. 59, fig. 3) conforms to the definition adopted here, but Berg did not make his assignment on this basis.

As pointed out by Grant (1958, p. 470), Berg (1953, p. 564) placed *P. expansa* Nelson in synonymy with *P. contractus* solely on stratigraphic grounds, and simultaneously (p. 565) described a species morphologically identical to *P. expansa* under the name of *P. palatus.* By the simple criterion of ratio between length of frontal area and length of glabella adopted here, the two species from Minnesota and Wisconsin conform to *P. contractus.* However, they differ from *P. contractus* in the topographic profile of the frontal area along the longitudinal axis, probably a perfectly valid distinction in this instance.

Figured specimen.—

	Zone	*BEG Number*	*Width*
Pl. 56, fig. 12 (cranidium)	*Conaspis*	34945	11.3 mm

PARABOLINOIDES GRANULOSUS Ellinwood, n. sp.
Pl. 56, figs. 13–18

Crandium nearly quadrate. Glabella convex, elevated above fixigenae, slightly tapered, bluntly rounded anteriorly. Glabellar furrows distinct, the posterior and middle pairs strong and directed backward, the anterior pair straight and faint or absent. Axial furrow moderately impressed. Occipital furrow deep and narrow, bowed slightly across axis of glabella and bent forward at lateral extremities. Occipital ring broad, flatly convex. Frontal area horizontal, about one-half length of glabella. Preglabellar field convex laterally, flat or depressed anterior to glabella. Anterior border furrow *recurved at axial line* along elevated anterior border. Anterior border convex, expanded posteriorly at center and tapered laterally. Preglabellar field-anterior border ratio about 1:1 along axial line. Fixigenae narrow, horizontal. Palpebral lobes small and situated opposite lobe between anterior and middle glabellar furrows. Palpebral furrow faint. Eye ridge prominent, straight. Posterior areas broadly triangular with gently convex anterior margin; posterior border furrow broad, shallow. Anterior courses of facial sutures slightly divergent in front of palpebral lobes. Surface ornament consists of strong vermiform ridges and granules over all of cranidium except furrows; tendency toward longitudinal alignment on preglabellar field, and transverse alignment on anterior border.

Pygidium transversely elliptical. Axis consists of articulating half-ring, 2 axial rings, and terminal axial piece. Pleural region without border furrow. Probably 4 pairs of marginal spines as in *P. hebe,* but not known with certainty. Surface ornament of coarse granules covers entire pygidium except spines, where granules are fine.

Remarks.—*Parabolinoides granulosus* differs from all other described species of *Parabolinoides* in its ridged and granular surface ornament, its flat or depressed preglabellar field anterior to glabella, and its sharply convex anterior border whose posterior margin is sharply recurved at the axial line. *P. granulosus* invariably occurs with *P. hebe* and is restricted in 10 sections to one foot or less of strata in the lower part of the range of that species.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 56, fig. 13 (cranidium)	*Conaspis*	34946	1.7 mm.
14 "	"	34947	4.0
15 "	"	34948	7.6
16 (cranidium, holotype)	"	34949	7.8
17 (cranidium)	"	34950	6.7
18 (pygidium)	"	34951	10.8

PARABOLINOIDES HEBE Frederickson
Pl. 56, figs. 6–11

Parabolinoides hebe FREDERICKSON, 1949, p. 361, pl. 70, figs. 7,8; pl. 71, figs. 1–3; BERG, 1953, p. 564, pl. 59, figs. 2,4.

This species is abundant and confined to the basal 4 feet of the *Conaspis* zone in central Texas. In more than a dozen sections it has been collected from immediately below *Orygmaspis*, with which seemingly it does not occur but from which it may be separated by as little as 6 inches.

Parabolinoides hebe is characterized by a moderately long (sag.) frontal area that ranges from 1/3 to ½ length of the glabella. Preglabellar field and anterior border are usually subequal, but there is some variability in this ratio as well as in the topography of both parts of the frontal area. How much convexity and concavity is induced or modified by compaction is not known, but almost certainly is significant.

Frederickson (1949, p. 362) and others to the contrary notwithstanding, there is no significant difference in the course of the facial suture anterior to the palpebral lobes in this species and in *P. contractus*, the type species. The longer the frontal area and the less convex it is transversely, the greater the apparent divergence of the facial sutures. *P. contractus* is based on a holotype (Frederickson, 1949, pl. 71, figs. 4,5) whose frontal area is flat and whose length (sag.) is greater than ½ that of the glabella; consequently its facial sutures apparently diverge more strongly than do those in any other figured specimen. But a paratype (pl. 71, figs. 6,7) of *P. contractus* whose frontal area is slightly less than ½ length of the glabella, and is convex, has facial sutures apparently no more strongly divergent than are those of a paratype (pl. 70, fig. 7) of *P. hebe* whose frontal area is proportionally considerably shorter. Inability to evaluate flattening by secondary compaction makes apparent divergence of facial sutures an unreliable character.

This raises the question of whether or not *P. hebe* and *P. contractus* are reasonable paleontologic species. Apparently they occur together in two sections in Oklahoma, and *P. hebe* occurs alone at two others, but Frederickson gives no indication of relative number of specimens assigned to each. Berg (1953, p. 564) reports *P. contractus* rare and *P. hebe* common in the *Eoorthis* subzone of Wisconsin, and the same is true in central Texas. This suggests that *P. contractus* is a name applied to a rare end-member variant, characterized by a longer than usual frontal area, and with little or no stratigraphic or geographic usefulness. The final decision must be based on biostratigraphic studies in Oklahoma and should take into account that a very similar species (*P. palatus* Berg, 1953, p. 556, 565) does have stratigraphic meaning in Wisconsin.

Frederickson (1949, p. 361, pl. 71, figs. 9, 10) illustrates one poor pygidium assigned to *P. contractus*, and neither illustrates nor describes one for *P. hebe*. In central Texas, where *P. hebe* is common and specimens assignable to *P. contractus* are almost nonexistent, the associated type of pygidium is that of Pl. 56, figs. 10,11. It has 4 pairs of marginal spines, the pair nearest the axis being very short and easily overlooked. It is, in fact, a pygidium identical to that illustrated by Frederickson (1949, pl. 71, fig. 22) and Lochman-Balk (1959, fig. 202. 12b) as belonging to *Orygmaspis llanoensis*. But *Parabolinoides hebe* and *Orygmaspis* do not occur together in central Texas.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 56, fig. 6 (cranidium)	*Conaspis*	34939	7.2 mm.
7 "	"	34940	6.9
8 "	"	34941	9.0
9 "	"	34942	4.7
10 (pygidium)	"	34943	20.0
11 "	"	34944	14.2

Genus STIGMACEPHALOIDES
Ellinwood, n. gen.

Cranidium elongate, moderately convex transversely, strongly convex longitudinally. Anterior margin broadly rounded. Glabella slightly elongate, moderately convex, slightly tapering, rounded-truncate. Glabellar furrows faint or absent. Axial furrow distinct but not strong. Occipital furrow stronger than axial furrow, gently bowed at the axial line and curved forward at the extremities, not reaching axial furrow. Occipital ring broad, flatly convex, expanded in middle. Frontal area steeply downsloping, approximately one-third length of cranidium. Preglabellar field flatly convex, continuing downslope of cranidium, slightly wider than anterior border. Anterior border furrow shallow, straight across middle of frontal area, extremities bent slightly forward to anterior corners of cranidium. Anterior border flatly convex, downsloping, broadest along axial line. Fixigenae narrow opposite palpebral lobes, downsloping anteriorly. Palbebral lobes narrow, about one-third length of glabella, smooth, bowed, situated on midline of glabella. Palpebral furrow curved, complete but faint. Posterior areas long (tr.), narrow, with broad curved posterior border furrow. Anterior course of facial suture divergent in front of palpebral lobes.

Librigenae flatly convex, with elevated, convex, border.

Type species.—*Stigmacephaloides curvabilis* Ellinwood, n. sp.

Remarks.—This genus is characterized by its smooth cranidium, sharply downsloping in front. It differs from the genus *Stigmacephalus* primarily in this respect. *Stigmacephalus flexifrons* Feniak (Bell, Feniak, & Kurtz, 1952) and *S. oweni* var. A, Nelson (1951) appear intermediate in character between the two genera, and could be included in either. Feniak's species from the *Ptychaspis striata* teilzone is the highest occurrence of *Stigmacephalus* recorded in *Minnesota,* and may indicate an evolutionary trend leading to *Stigmacephaloides.*

STIGMACEPHALOIDES CURVABILIS
Ellinwood, n. sp.
Pl. 56, figs. 2–5

All that is known of the type species is contained in the generic description. It occurs in three sections high in the *Ptychaspis-Prosaukia* zone.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 56, fig. 2 (cranidium, holotype)	*Pty.-Pro.*	34935	17.0 mm.
3 (cranidium)	"	34936	9.5
4 "	"	34937	6.4
5 (fixigena)	"	34938	—

Genus TAENICEPHALUS Ulrich & Resser *in* Walcott, 1924

Taenicephalus Ulrich & Resser *in* WALCOTT, 1924, p. 59; 1925, p. 116.
Bemaspis FREDERICKSON, 1949, p. 357; LOCHMAN-BALK, 1959, p. 306.

Grant (1958, p. 474) was the first to conclude that *Bemaspis gouldi,* the type and only species of *Bemaspis,* was in fact a species of *Taenicephalus,* although Ellinwood (1953, p. 37) referred to specimens that were intermediate between *Bemaspis gouldi* and *Taenicephalus shumardi.*

TAENICEPHALUS GOULDI (Frederickson)
Pl. 57, figs. 1–9

Bemaspis gouldi FREDERICKSON, 1949, p. 357, pl. 71, figs. 11–14,

The cranidium of *Taenicephalus gouldi* is broader than it is long if measured across the large palpebral lobes that lack palpebral furrows. This feature alone distinguishes it from all other described species of *Taenicephalus.* In addition, the absence of fossulae and occipital node, and the tendency for the preglabellar field to be flatter and shorter (sag.), distinguish *T. gouldi* from *T. shumardi.*

The pygidium, which has not been previously described, is transversely elliptical, has an articulating half-ring, 3 axial rings, and a terminal axial piece, a narrow rim-like border, and granular surface ornament. The fixigena has a faint lateral border furrow, a narrow lateral border, and fairly strong vermiform ridges radiating outward from the eye.

T. gouldi has been collected thus far from 8 sections in central Texas. In each of them it is confined to a few inches of strata immediately above the highest occurrence of *Parabolinoides hebe,* and at least 5 feet below the lowest occurrence of *Taenicephalus shumardi.*

Figured specimens.—

	Zone	BEG Number	Width
Pl. 57, fig. 1 (cranidium)	*Conaspis*	34955	6.0 mm.
2 "	"	34956	8.0
3 "	"	34957	9.5
4 "	"	34958	5.5
5 "	"	34959	6.0
6 "	"	34960	5.0
7 "	"	34961	4.2
8 (pygidium)	"	34962	11.7
9 (libragena)	"	34963	—

TAENICEPHALUS SHUMARDI (Hall)
Pl. 57, figs. 10–21

Conocephalites shumardi HALL, 1863, p. 154, pl. 7, figs. 1,2; pl. 8, fig. 32.
Taenicephalus shumardi (Hall) WALCOTT, 1924, p. 59, pl. 13, fig. 1; 1925, p. 117, pl. 17, figs. 15–17; WILSON, 1951, p. 652, pl. 95, figs. 21–23, 25; BERG, 1953, p. 565, pl. 59, figs. 11–14.
Taenicephalus texanus RESSER, 1942, p. 104, pl. 21, figs. 8–12.
Taenicephalus wichitaensis RESSER, 1942, p. 105, pl. 21, figs. 13–17; FREDERICKSON, 1949, p. 362, pl. 72, figs. 1,2.

Grant (1958, p. 478–479) has attempted the only restrictive diagnosis of this species that is based on study of material from several areas. It involves three simple ratios and does not take into account surface ornament, a feature whose importance has been recently emphasized by Palmer (1960, p. 57–58), but which is not preserved on specimens from the type area (Berg, 1953, pl. 59, figs. 11–14). The diagnostic proportions suggested by Grant are: (1) axial length (sag.) of cranidium greater than width (tr.) across palpebral lobes, (2) width (tr.) of glabella just anterior to occipital furrow at least as great as axial length (sag.) of glabella, and (3) preglabellar field at least as wide (sag.) as anterior border. It is on the basis of these proportions that *T. texanus* and *T. wichitaensis* are placed in synonymy with *T. shumardi.*

In central Texas *T. shumardi* occurs most abundantly and consistently through a 5-foot interval roughly 10–15 feet above the base of the *Conaspis* zone. Specimens from this epibole of the species are illustrated on Plate 57, figures 10–14,16,18 and 20. Sporadic collections of specimens assignable to *T. shumardi* have been obtained through as much as an additional 25 feet (pl. 57. figs. 15, 17,19,21) of section, and with them occur specimens (pl. 56, figs. 19–21) whose assignment to this species, or even to *Taenicephalus,* is equivocal; they seemingly have some attributes of the Idahoiidae. Further study of larger and more closely spaced collections through this interval at numerous places in central Texas conceivably could demonstrate a phylogenetic sequence of species grading from *Taenicephalus* to *Idahoia* or *Saratogia.*

In addition to the proportions mentioned above, "typical" cranidia from the *T. shumardi* epibole are characterized by a surface ornament of vermiform ridges and granules over all but the cranidial furrows. There is a tendency toward longitudinal orientation of ridges on the preglabellar field, the bottom of the anterior border furrow is puckered, and the anterior border has scattered circular pits. Because the palpebral furrow is not complete, a true palpebral lobe is not differentiated. On some internal molds the bottom of the anterior border furrow is puckered, but otherwise there is no evidence of surface ornament.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 57, fig. 10 (cranidium)	*Conaspis*	34964	7.5 mm.
11 "	"	34965	10.2
12 "	"	34966	6.6
13 "	"	34967	10.1
14 "	"	34968	4.2
15 "	"	34969	4.0
16 "	"	34970	3.8
17 "	"	34971	6.3
18 "	"	34972	7.2
19 (pygidium)	"	34973	6.2
20 "	"	34974	12.8
21 "	"	34975	6.1

TAENICEPHALUS sp.
Pl. 56, figs. 19-21

High in the range of *Taenicephalus* and low in the range of *Idahoia* and *Saratogia* are occasional specimens, usually small, whose systematic position is equivocal. Three such specimens are illustrated here. Each has relatively large crescentic palpebral lobes, ordinarily regarded as an idahoiid rather than a taenicephaliid character, but which *may* characterize early moults of *Taenicephalus.* The occipital node is stronger than normal for *Taenicephalus,* but surface ornament is more nearly taenicephaliid than idahoiid. The ratio of length (sag.) of preglabellar field to length (sag.) of anterior border (2:1 to 1:2) is seemingly highly variable, for no stratigraphic pattern is clear and the character of the anterior border furrow changes consistently with the change in ratio.

Almost certainly these specimens are not *T. shumardi,* but until more empirical data are available with respect to stratigraphic distribution of morphotypes, nothing will be gained by assignments to new species or to genera other than *Taenicephalus.*

Figured specimens.—

	Zone	BEG Number	Width
Pl. 56, fig. 19 (cranidium)	*Conaspis*	34952	3.1 mm.
20 "	"	34953	3.4
21 "	*Pty.-Pro.?*	34954	2.5

Family PLETHOPELTIDAE Raymond, 1925
Genus LEIOCORYPHE Clark, 1924
LEIOCORYPHE OCCIPITALIS Rasetti
Pl. 59, fig. 4

Leiocoryphe occipitalis RASETTI, 1944, p. 245, pl. 38, fig. 4.

Three specimens from one locality are assigned to this species. They are small, strongly convex, have a distinct occipital furrow, and lack any trace of palpebral lobes.

Figured specimen.—

	Zone	BEG Number	Width
Pl. 59, fig. 4 (cranidium	low. Tremp.	35000	4.0 mm.

Genus PLETHOMETOPUS Ulrich *in* Bridge, 1931
PLETHOMETOPUS CONVEXUS (Whitfield)
Pl. 59, figs. 5,6

Illaenurus convexus WHITFIELD, 1878, p. 66; 1882, p. 203, pl. 4, figs. 3,4 (not fig. 5).
Plethometopus convexus (Whitfield) Ulrich *in* BRIDGE, 1931, p. 221, pl. 19, figs. 29–31.

Two cranidia from the same locality are illustrated here. They differ considerably, that of fig. 5 being broader and blunter anterior to the eyes, has a longer (sag.) occipital ring projected into a node rather than a spine, and lacks any sign of axial furrow. The specimen of fig. 6 is very like that illustrated by Ulrich *in* Bridge (1931) on Plate 19, fig. 30. This amount of difference would by some authors (Ulrich *in* Bridge, 1931, p. 222; Rasetti, 1944, p. 251) call for assignment to different species.

Species of *Plethometopus* have been created on the basis of differences in size, proportions, and distinctness of furrows—but with little or no biostratigraphic control. So far as published information is concerned, all described species *could* be artificially created nomenclatorial synonyms. Unfortunately, sufficient biostratigraphic data are as yet not available in central Texas to support a rational taxonomy, and for the moment I am assigning the few specimens from the *Rasettia-Scaevogyra* faunule to the first-described mid-continent species.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 59, fig. 5 (cranidium)	low. Tremp.	35001	9.3 mm.
6 "	"	35002	8.0

Genus STENOPILUS Clark, 1924
STENOPILUS PRONUS Raymond
Pl. 59, figs. 7–9

Stenopilus pronus RAYMOND, 1924, p. 420, pl. 13, figs. 6,7; RASETTI, 1944, p. 257, pl. 39, fig. 19; RASETTI, 1959, p. 385, pl. 53, figs. 20–24.

As with the closely similar and probably genetically gradational genus *Plethometopus, Stenopilus* is burdened with species whose distinctions are subtle differences in proportions and longitudinal convexity—all unsupported by biostratigraphic control. In central Texas there seem to be two stratigraphically separated assemblages of *Stenopilur,* one a lower Trempealeauan elongate form here assigned to *S. pronus,* the other an upper Trempealeauan quadrate form assigned to *S. latus* Ulrich. Much more biostratigraphic information would be desirable, but apparently *S. pronus* is confined to the *Rasettia-Scaevogyra* faunule.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 59, fig. 7 (cranidium)	low. Tremp.	35003	10.5 mm.
8 "	"	35004	8.0
9 "	"	35005	7.5

Family PTYCHASPIDIDAE Raymond, 1924
Genus CONASPIS Hall, 1863
CONASPIS MASONENSIS Ellinwood, n. sp.
Pl. 58, figs. 1–9

Crandium quadrangular in outline, very convex longitudinally and transversely. Glabella tapered, conico-truncate, greatest height at about midpoint, strongly convex longitudinally and transversely. Middle and posterior pairs of glabellar furrows faintly impressed, directed backward. Axial furrow deeply impressed, fossulae distinct, deeper on internal molds. Occipital furrow narrow and deep across axial line, curved forward at extremities. Occipital ring broad and convex. Frontal area biconvex, downsloping, length slightly more than one-third that of glabella. Preglabellar field convex. Anterior border furrow deep, straight. Anterior border widest (sag.) at middle, about equal in width to preglabellar field, anterior edge pointed. Fixigenae one-third width (tr.) of glabella and horizontal opposite palpebral lobes, downsloping sharply anteriorly and posteriorly. Palpebral furrow faint but complete. Eye ridges faint. Posterior areas stout, triangular, anterior edge convex. Anterior course of facial suture in front of eye is convex outward.

Librigenae with elevated and flat border extended into long genal spine.

Pygidium semicircular. Axis strongly convex and tapered, consists of articulating half-ring, 4 axial rings, and terminal axial piece. Pleural region strongly convex laterally. Pleural and interpleural furrows strong, extend almost to margin. Border narrow, flat, not bounded by furrow.

Remarks.—*Conaspis masonensis* is distinguished from other species of the genus by its strongly convex and relatively long and narrow glabella with only faint furrows, and by its relatively long frontal area.

This species occurs prolifically at two localities and less abundantly at a third, all on the west side of the Llano Uplift in central Texas. Its stratigraphic position is about 45 feet above the base of the *Conaspis* zone in what is as yet the no-mans-land of associated taenicephaliids and idahoiids.

Figured specimens.—

	Zone	*BEG Number*	*Width*
Pl. 58, fig. 1 (cranidium)	*Pty.-Pro.?*	34976	4.1 mm.
2 "	"	34977	6.4
3 (cranidium, holotype)	"	34978	7.0
4 (cranidium)	"	34979	9.5
5 (pygidium)	"	34980	7.6
6 (cranidium)	"	34981	7.0
7 "	"	34982	6.5
8 (librigena)	"	34983	—
9 (pygidium)	"	34984	3.5

CONASPIS TESTUDINATUS
Ellinwood, n. sp.
Pl. 58, figs. 10–13

Cranidium quadrangular in outline, very convex transversely and longitudinally. Glabella strongly inflated, steeply downsloping in front, slightly tapered, smoothly rounded to rounded-truncate in front, unevenly but strongly pustulose on the outer surface. Glabellar furrows moderately impressed, anterior pair short and faint, middle pair recurved, posterior pair recurved and faintly connected. Axial furrow strongly impressed at the sides, fainter across front of glabella. Occipital furrow deep, curved forward at lateral extremities. Occipital ring narrow, widest along axial line, coarsely pustulose; occipital node present. Frontal area down-sloping, length (sag.) one-third to one-fourth that of glabella, smooth. Preglabellar field narrow, flatly convex. Anterior border furrow distinct, straight to slightly curved. Anterior border convex, width (sag.) at least twice that of preglabellar field, broadest along axial line. Fixigenae narrow, upsloping, coarsely pustulose, Palpebral furrows deep, straight, complete. Ocular ridges faint. Posterior areas triangular, border furrows broader than occipital furrow. Anterior courses of facial sutures divergent to convergent anterior to palpebral lobes. There is surprisingly little variability among cranidial features.

Libragenae and pygidium unknown.

Remarks.—There is no appreciable difference between this species and *Conaspis perseus* except for the coarse pustulose surface on *C. testudinatus.* Evidently the ornament is entirely surficial, and internal molds (pl. 58, fig. 13) are remarkably like those of *C. perseus* (Berg, 1953, pl. 60. figs. 5–7), So far as I know *C. perseus* and other species described from the arenaceous strata of Minnesota and Wisconsin have been illustrated exclusively by internal molds, but this has been only because squeezes from external molds are indistinguishable from natural internal molds. Certainly the many students of Cambrian trilobites in the upper Mississippi Valley would not all have failed to notice a surface ornament as spectacular as that of *C. testudinatus;* it surpasses even that of *Ptychaspis granulosa*

(Nelson, 1951, pl. 110, fig. 8; Bell, Feniak, & Kurtz, 1952, pl. 35, 1a,b).

Conaspis testudinatus thus far has been collected from 7 measured sections in central Texas. It occurs through a foot or two of strata above *Taenicephalus gouldi* and either below or with the lowest occurrence of *T. shumardi*.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 58, fig. 10 (cranidium)	*Conaspis*	34985	4.0 mm.
11 (cranidium, holotype)	"	34986	4.5
12 (cranidium)	"	34987	5.0
13 "	"	34988	4.7

Genus PTYCHASPIS Hall, 1863
PTYCHASPIS BULLASA Lochman & Hu
Pl. 58, figs. 14–17

Ptychaspis bullasa LOCHMAN & Hu, 1959, p. 422, pl. 58, figs. 21–42.

Cranidia from central Texas seem to be identical in every respect to those described by Lochman & Hu. Not mentioned by them, but evident on their and our illustrations, is the fact that neither the occipital ring nor the preoccipital glabellar lobes carry granules.

Specimens of *Ptychaspis bullasa,* invariably fragmentary, are exceedingly rare in any given collection, but they have been obtained from 9 measured sections in central Texas. The species seems to be restricted to a 15-foot interval from 50–65 feet above the base of the *Conaspis* zone, and by current definition, of course, occurs in the *Ptychaspis-Prosaukia* zone.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 58, fig. 14 (cranidium)	*Pty.-Pro.*	34989	4.6 mm.
15 "	"	34990	3.5?
16 "	"	34991	9.0
17 "	"	34992	23.0

Genus KEITHIELLA Rasetti, 1944
KEITHIELLA SCRUPULOSA Ellinwood, n. sp.
Pl. 58, figs. 19–21

Cranidium quadrate, moderately convex. Glabella convex, elongate, parallel-sided to slightly tapering, truncate in front, anterior third downsloping. Surface finely but unevenly pustulose. Glabellar furrows strongly impressed, directed backward, posterior pair complete, second pair short, anterior pair faint. Axial furrow strong at sides, merging with anterior border furrow in front of glabella. Occipital furrow straight, as strong as posterior glabellar furrow. Occipital ring narrow, flattened. Frontal area short, consisting of a deep, broad, slightly curved anterior border furrow and an elevated anterior border; border widest (sag.) medially. Fixigenae broad, convex, elevated opposite middle of glabella, downsloping toward anterior lateral corners of cranidium. Palpebral lobes small, situated behind mid-line of glabella on elevated part of fixigenae. Eye ridges present, trending obliquely forward across fixigenae. Posterior areas incomplete but appear to be broadly triangular and directed slightly backward. Anterior course of facial suture slightly divergent in front of palpebral lobes.

Librigenae and pygidium unknown.

Remarks.—The palpebral lobes and posterior limbs are poorly preserved on the exfoliated specimens in the single Texas collection. Rasetti's generic diagnosis need only be emended to include forms with eye ridges, if this species is assigned to *Keithiella.*

Keithiella scrupulosa, n. sp., differs from the type species, *K. cylindrica* (Billings), in having a proportionally wider (sag.) and medially expanded anterior border, more prominent anterior border furrow, and somewhat less elevated fixed cheeks. Its strong and continuous anterior border furrow distinguishes it from all other species assigned to the genus by Rasetti.

Figured specimens.—

	Zone	BEG Number	Widtn
Pl. 58, fig. 19 (cranidium)	low. Tremp.	34994	5.6 mm.
20 "	"	34995	6.0
21 (cranidium, holotype)	"	34996	6.6

? KEITHIELLA sp.
Pl. 58, fig. 18

Three specimens of this species have been collected from 25 feet of strata in one measured section, at about the same stratigraphic level as the one occurrence of *Keithiella scrupulosa* Ellinwood, n. sp. The best specimen is illustrated, and on it the central parts of both fixigenae are destroyed. The specimen is exfoliated, and illustrates all that is known of the morphology of the species. It differs from *K. scrupulosa* in having a greatly expanded and pointed anterior border, a wide, deep, and strongly curved anterior border furrow with a row of granules along its anterior edge, and in having an occipital node.

These differences may, in the opinion of some, place the species in another genus, but considering the small amount of morphologic and stratigraphic information presently available, it seems most convenient to assign it tentatively to *Keithiella.*

Figured specimen.—

	Zone	BEG Number	Width
Pl. 58, fig. 18 (cranidium)	low. Tremp.	34993	5.5 mm.

Family SAUKIIDAE Ulrich & Resser, 1930
Genus PROSAUKIA Ulrich & Resser, 1933

Saukiid trilobites are extremely rare in pre-middle Trempealeauan strata of central Texas, and all specimens so far recovered are fragmentary. The only saukiid genus present seems to be *Prosaukia,* and assignments to species are tentative.

PROSAUKIA cf. P. CURVICOSTATA
Ulrich & Resser
Pl. 59, fig. 1

Prosaukia curvicostata ULRICH & RESSER, 1933, p. 145, pl. *25,* figs. 1–7; NELSON, 1951, p. 778, pl. 110, figs. 6,16,18; RAASCH, 1951, p. 142 (synonymy to date).

Three fragmentary cranidia from three localities at the same level in high Franconian strata are assigned tentatively to this species on the basis of the convex and curved anterior border.

Figured specimen.—

	Zone	BEG Number	Width
Pl. 59, fig. 1 (cranidium)	Pty.-Pro.	34997	8.0 mm

PROSAUKIA cf. P. TUBERCULATA
Ulrich & Resser
Pl. 59, figs. 2,3

Prosaukia tuberculata ULRICH & RESSER, 1933, p. 159, pl. 28, fig. 5; DECKER, 1945, p. 39, pl. 9, fig. 14; BERG, 1951, p. 106, pl. 3, figs. 2–4; RAASCH, 1951, p. 143,149 (synonymy to date).

This species is essentially a tuberculate *Prosaukia misa.* Several specimens have been obtained from Point Peak siltstone at the graptolite locality described by Decker, and one each from two other localities at approximately the same stratigraphic level —which is below that of *Prosaukia* cf. *P. curvicostata.*

Figured specimens.—

	Zone	BEG Number	Width
Pl. 59, fig. 2 (cranidium)	Pty.-Pro.	34998	8.0 mm.
3 "	"	34999	18.0

Order and Family Uncertain
Genus ELLIPSOCEPHALOIDES
Kobayashi, 1935
ELLIPSOCEPHALOIDES SILVESTRIS
Resser
Pl. 59, figs. 10–12

Ellipsocephaloides silvestris RESSER, 1942, p. 64, pl. 11, figs. 1–3; pl. 12, fig. 7.
Ellipsocephaloides nitela RESSER, 1942, p. 66, pl. 11, fig. 13; pl. 12, figs. 1–3.
Chariocephalus whitfieldi Hall, DECKER, 1945, p. 39, pl. 9, fig. 15.

This species is characterized by a faint anterior border furrow that outlines a narrow anterior border, which is slightly elevated along the axial line. It is distinguished from the type species, *E. curtus* (Whitfield), by its decidedly narrower fixigenae, and from *E. gracilis* Feniak by its nearly equidimensional glabella.

E. curtus and *E. gracilis* (Bell, Feniak, & Kurtz, 1952, p. 188) are the only two species of *Ellipsocephaloides* whose biostratigraphic positions relative to each other are known. Unfortunately the genus is rare and specimens are poorly preserved in central Texas. Proportions of flattened specimens in siltstone (pl. 59, fig. 12) are difficult to compare with those of convex specimens in limestone (pl. 59, figs. 10,11), and more than one species may be represented. The choice of the name *E. silvestris* is quite arbitrary, for until biostratigraphic data are available for Resser's (1942) 11 new "species," the number of synonyms among them will remain unknown. The biostratigraphic position of the Texas specimens is more nearly that of *E. gracilis* than that of *E. curtus.*

Figured specimens.—

	Zone	BEG Number	Width
Pl. 59, fig. 10 (cranidium)	Pty.-Pro.	35006	2.8 mm.
11 "	"	35007	4.0
12 "	"	35008	4.8

Genus TAENICEPHALINA Rasetti, 1945
TAENICEPHALINA GLOBULA
Lochman & Hu
Pl. 59, figs. 13–15

Taenicephalina globula LOCHMAN & Hu, 1959, p. 424, pl. 57, figs. 34–43.

The material from central Texas is meager, consisting currently of nine specimens from three localities, and the preservation is not good. Similarities to the specimens from Idaho illustrated by Lochman and Hu are striking, even to the unusual circumstance that cranidia commonly are cracked along the anterior border furrow (compare their pl. 57, fig. 43 with our pl. 59, fig. 14).

Figured specimens.—

	Zone	BEG Number	Width
Pl. 59, fig. 13 (cranidium)	*Pty.-Pro.*	35009	3.6 mm.
14 "	"	35010	4.5
15 "	"	35011	4.0

Phylum MOLLUSCA
Class GASTROPODA
Genus SINUELLA Knight, 1947
SINUELLA MINUTA Knight
Pl. 59, figs. 16–21

Sinuella minuta KNIGHT, 1947, p. 9, pl. 2, figs. 2a-g.

This one species of gastropod is included because apparently it is ubiquitous throughout at least the *Ptychaspis* subzone, though rarely recorded. The fragmentary silicified shell here illustrated (pl. 59, figs. 19,20), clearly shows the surface ornament of sinuous ridges that almost invariably is absent from glauconitic steinkerns, the almost universal form of preservation (cf. Knight, 1947, pl. 2, figs. 2a–g). Contrary to Knight's statement, there is no evidence to suggest that the species has more than 3 or 4 whorls.

Possibly *S. minuta* is synonymous with *Euomphalus ? vaticinus* Hall (1863, p. 136, pl. 6, fig. 29), but at present there is no way to make a decision one way or the other.

Knight reports that the holotype and 20 other specimens were collected by Walcott in 1885 from Potatotop Hill, 7 miles northwest of Burnet, Texas. The hill now known as Potatotop consists of Hickory sandstone and Cap Mountain limestone. So far as is known, *Sinuella minuta* is confined to the upper half of the Morgan Creek limestone, and the nearest Morgan Creek limestone from which the specimens could have been collected is about 8 miles northwest of Burnet, on the fringe of the Morgan Creek area proper.

Figured specimens.—

	Zone	BEG Number	Width (max.)
Pl. 59, fig. 16	*Pty.-Pro.*	35012	1.7 mm.
17	"	35013	2.1
18	"	35014	3.1
19	"	35015	1.4
20	"	35015	—
21	"	35016	0.6

Phylum BRACHIOPODA
Class INARTICULATA
Order ATREMATA
Genus PSEUDODICELLOMUS Bell, n. gen.

Shell similar to that of *Dicellomus*, being phosphatic, thick, and constructed of three units: surface unit thin, impunctate, separates easily from rest of shell, and has pitted surface ornament in only known species; middle unit thick, composed of numerous thin laminae that are sharply inclined to surface of shell at their peripheries, impunctate, and have surfaces marked only by faint radial striations; inner unit a thick laminated and spongy layer, apparently easily destroyed, that bears muscle scars and pallial marks. Interareas oboloid: pedicle groove deep, short, widely triangular, and bounded by narrow propareas; brachial interarea consists of broad, shallow groove bounded by almost imperceptible propareas. Pallial and muscle patterns oboloid and much like those of *Dicellomus*, insofar as they have been determined.

Type species.—*Dicellomus mosaica* Bell, 1941.

Remarks.—When I restudied the genus *Dicellomus* (Bell, 1944, p. 148) it became evident that *D. mosaicus* did not belong in it. For almost 20 years I have avoided defining a monotypic genus, that nomenclatorial necessity and paleontologic headache, but no related species have turned up. Therefore the new genus is of necessity here proposed, but I have no idea which of its attributes, other than its impunctate shell, will turn out to be generically important. It differs from all known species of *Dicellomus* also in its excessively thick and spongy shell under the visceral areas of both valves. The genus may well have evolved from the Dresbachian *Dicellomus*.

PSEUDODICELLOMUS MOSAICUS (Bell)
Pl. 60, figs. 1–7

Dicellomus nanus (Meek & Hayden) WALCOTT, 1912 (part), pl. 53, figs. 3,3c-d.

Dicellomus mosaica BELL, 1941, p. 216, pl. 29, figs. 4–9.

Although hundreds of free valves have been etched from limestone both in Montana and Texas since this species was proposed, surprisingly little can be added to the original description. The only error, an important one as it turned out, was the belief that the laminae of the middle shell were pitted (punctate). They are not, a fact that by itself removes the species from *Dicellomus*.

Most valves are incomplete, both inner and outer units of the shell tending to separate from the middle layer. All additional information now available concerning internal features of both valves is evident on the accompanying illustrations. The fantastically thick inner unit of the shell under the visceral areas of both valves is especially distinctive. What can be seen of the pattern of muscle scars is not strikingly different from that in *Dicellomus,* among the species of which there is considerable variation. An exfoliated valve, except that it is impunctate, is virtually indistinguishable from *Dicellomus pectanoides* (Whitfield).

The velvety surface ornament is produced by pits so tiny that any type of coating obliterates them, and they cannot be seen in oblique light on an uncoated specimen. They must be viewed at high magnification (ca. × 50) by reflected light, a situation that produces photographic problems that I have not solved satisfactorily (pl. 60, fig. 7).

Pseudodicellomus mosaicus is abundant in the *Conaspis* zone and rare in the *Ptychaspis-Prosaukia* zone in central Texas, and because small fragments of its pitted surface layer can be identified in cuttings, in practice it can be used as an index to the upper half of the Morgan Creek limestone in the subsurface adjacent to the Llano Uplift.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 60, fig. 1 (pedicle)	*Conaspis*	35017	5.2 mm.
2 "	"	35018	5.4
3 "	*Pty.-Pro.*	35019	6.2
4 (brachial)	*Conaspis*	35020	5.3
5 "	"	35021	6.8
6 "	"	35022	6.7
7 (pedicle)	"	35023	—

Order NEOTREMATA
Genus ANGULOTRETA Palmer, 1955
Pl. 61, figs. 1–3

Angulotreta PALMER, 1955a, p. 769, pl. 91, figs. 1–10.

When Palmer proposed this genus, he assigned to it two new species. One, *A. postapicalis,* is as yet known with certainty from only one locality in the Dresbachian *Cedarina-Cedaria* zone. The type species, *A. triangularis,* occurs widely in the Dresbachian *Aphelaspis* zone, where it underlies *Apsotreta expansa* of the *post-Aphelaspis* (*Dunderbergia*) zone. Where the Dresbachian-Franconian disconformity is not present, as in the subsurface south of the Llano uplift, and in the western United States, *Apsotreta* grades morphologically upward into *Linnarssonella* of the *Elvinia* zone. Finally, in the *Conaspis* zone of central Texas appears a third species of *Angulotreta,* referred to here as *Angulotreta microscopica* (Shumard).

In discussing *Angulotreta,* Palmer failed to point out that the fundamental difference between it and *Prototreta* and *Homotreta* (Bell, 1941, p. 221, 230), which probably should be regarded as synonyms, is that in *Angulotreta* the apical process of the pedicle valve lies along the anterior slope, whereas in *Prototreta* and *Homotreta* it lies along the posterior slope.

Palmer (1955a, p. 769) reports that the position of the internal pedicle opening within the apical process of *Angulotreta triangularis* "is not marked by a ring as in *A. postapicalis,*" but this is not true. Although commonly this delicate structure is destroyed during etching, it is on occasion preserved, as demonstrated by a topotype and two other specimens illustrated here (pl. 61, figs. 1–3). Consequently, as described, the two species differ only in the position of the apical pits: posterior to the pedicle opening in *A. postapicalis,* opposite the pedicle opening in *A. triangularis.* This is, however, a somewhat variable feature, and more occurrences of *A. postapicalis* would be desirable in order to isolate the characters, if any, that distinguish these stratigraphically somewhat distant species.

ANGULOTRETA MICROSCOPICA (Shumard)
Pl. 60, figs. 8–19

Discina microscopica SHUMARD, 1861, p. 221.
Acrotreta microscopica (Shumard) WALCOTT, 1912, p. 693, pl. 67, figs. 1,1a-o.

Shell stout for the genus. Pedicle valve moderately high, proconical to cataconical; narrow deltoid pseudointerarea or intertrough present. Brachial valve subcircular in outline.

Pedicle interior: Apical process moderately to strongly developed, sides parallel or expanding anteriorly; internal pedicle opening within a ring or collar at apex of valve. Apical pits lateral to or slightly anterior to pedicle opening.

Brachial interior: Median septum broad and low posteriorly, narrow and keel-like anteriorly, with highest point near front of valve; septum digitate in some valves in lower part of stratigraphic range.

Remarks.—"Typical" pedicle valves of this species are distinguished easily from "typical" pedicle valves of *A. triangularis* by being stouter and in having a strongly developed apical process whose sides are parallel or anteriorly divergent. However, juvenile, thin, or poorly preserved valves may be individually unassignable to either species; the two species are sufficiently similar that population variabilities overlap. I know of no way to dependably distinguish between brachial valves of the two species except that "typical" valves of *A. microscopica* are somewhat thicker.

The assignment of Shumard's name to this species is the result solely of stratigraphic deduction. He published a brief description of *Discina microscopica* without illustration in 1861, recorded the locality as "near the sources of Morgan's creek, Burnet county," and said it was associated with *Arionellus* (now *Tricrepicephalus*) *taxanus* and *Orthis* (now *Billingsella*) *coloradoensis*. Obviously he had collected both from the Cap Mountain limestone and the Morgan Creek limestone, but his specimens were lost long ago.

Palmer (1955a) described all the known acrotretoid species from the Cap Mountain limestone as new, and only one from the Morgan Creek limestone fits Shumard's description. Therefore by process of elimination. Shumard's concept of *Discina microscopica* included the species described here, and there seems to be no point in ignoring his name. Judging from the list of associated trilobite species, Walcott (1912) illustrated from Texas only specimens from the Morgan Creek limestone. The specimens, however, being exteriors, are indistinguishable from the species of *Angulotreta* described by Palmer. Consequently the specimens from the base of the *Conaspis* zone in the Morgan Creek section, illustrated here as pl. 60, figs. 13, 16 are designated as neotypes of *Angulotreta microscopica* (Shumard).

Angulotreta microscopica is abundant in the *Conaspis* zone and rare in the *Ptychaspis-Prosaukia* zone.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 60, fig. 8 (pedicle)	*Conaspis*	35024	—
9 "	"	35025	1.2 mm.
10 "	"	35026	1.7
11 "	"	35027	1.7
12 "	"	35028	1.8
13 (pedicle, neotype)	"	35029	1.5
14 (pedicle)	"	35032	1.3
15 (brachial)	"	35031	1.2
16 (brachial, neotype)	"	35030	1.5
17 (brachial)	"	35033	1.7

ANGULOTRETA MICROSCOPICA (Shumard), var. DIGITALIS, Bell, n. var. Pl. 60, figs. 18,19.

Some brachial valves from the basal *Conaspis* zone, low in the range of this species, have a digitate median septum, and for stratigraphic convenience are here isolated as an informal variant. This situation exactly parallels that in *Angulotreta triangularis* Palmer (1955a, p. 770), and makes me suspect that ecologic zonation is involved here. In neither species has it been possible thus far to distinguish two types of pedicle valves.

The meaning of digitation is unknown, but its presence in *A. microscopica* reinforces Palmer's (1955a, p. 769) suggestion that my names *Prototreta* and *Homotreta* (Bell, 1941, p. 221, 230) may apply to only one genus. If so, the stratigraphic relationships in Montana seem to be reversed: nondigitate valves occur low in the longer range of digitate ones.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 60, fig. 18 (brachial)	*Conaspis*	35034	1.4 mm.
19 "	"	35035	1.7

Genus CERATRETA Bell, 1941
CERATRETA HEBES Bell
Pl. 61, figs. 10–15

Ceratreta hebes BELL, 1941, p. 233, pl. 29, figs. 10–17.

Supplementary description.—Pedicle valve proconical, bluntly terminated, with deep intertrough and large slit-like foramen posterior to the apex. Apical process a strong ridge located at apex and extending primarily along posterior slope. Pedicle tube extends from foramen through apical process almost parallel to posterior slope before emerging as internal pedicle opening about half way between apex and posterior margin.

Brachial valve moderately convex, transversely subelliptical, with large concave median groove. Strong median septum is highest, almost spike-like on some specimens, in anterior third of valve. Cardinal scars very pronounced at postero-lateral corners just inside propareas.

Both valves sturdy and with distinct growth lines.

Remarks.—Additional information derived from etched valves from Montana and Texas calls for one correction in the original description: The pedicle foramen is large and slit-like, not minute, and occupies at least the apical third of the intertrough. Internal features can now be illustrated completely, but they are just about as originally described.

Ceratreta hebes is strikingly similar, except for size, to the species that Walcott (1912, pl. 81, figs. 4-4e) illustrated as *Keyserlingia buchi* from Esthonia; they could well be congeneric. *C. hebe* is restricted in Texas to the basal *Conaspis* zone, commonly associated with *Eoorthis* and *Angulotreta microscopica* var. *digitalis,* n. var.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 61, fig. 10 (pedicle)	*Conaspis*	35045	1.6 mm.
11 "	"	35046	1.7
12 (brachial)	"	35047	1.8
13 (pedicle)	"	35048	1.7
14 "	"	35049	1.9
15 "	"	35050	2.3

Genus LINNARSSONELLA Walcott, 1902

LINNARSSONELLA GIRTYI Walcott

Pl. 61, figs. 4–9

Linnarssonella girtyi WALCOTT, 1902, p. 602; 1912, p. 666, pl. 79, figs. 1,1a-r.
Linnarssonella elongata, BELL, 1941, p. 235, pl. 31, figs. 15–19, text-figs. 8–10.

This lower Franconian species is included for three reasons: (1) to report that apparently it is ubiquitous within the *Elvinia* zone of North America, and restricted to it; (2) to illustrate it stereographically for the first time; and (3) to rid the literature of an unnecessary name I proposed 20 years ago.

L. girtyi is rather variable in form, ranging from nearly subcircular to the elongate morphotype I described as a new species in 1941. Stratigraphically controlled etched material from the upper Mississippi Valley, Missouri, Oklahoma, Texas, Montana and Wyoming shows no stratigraphic or geographic patterns in variability, and names for the various morphotypes seem pointless. Evidently the species evolved directly from *Apsotreta expansa* Palmer of the underlying *Dunderbergia* fauna.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 61, fig. 4 (brachial)	*Elvinia*	35039	1.5 mm.
5 "	"	35040	1.7
6 "	"	35041	1.9
7 (pedicle)	"	35042	1.5
8 "	"	35043	1.8
9 "	"	35044	2.1

Class ARTICULATA

Superfamily ORTHACEA

Genus BILLINGSELLA Hall, 1892

BILLINGSELLA COLORADOENSIS (Shumard)

Pl. 62, figs. 1–10

Orthis coloradoensis SHUMARD, 1860, p. 627.
Billingsella coloradoensis (Shumard) WALCOTT, 1912 (part), p. 751–752, text-figs. 5,66, pl. 85, figs. 1,1c,1e,1f,1i, 1k,1s.1v (synonymy to date).

Original description.—"Shell small, compressed, subcircular or subquadrate, gently convex, slightly transverse, and a little the widest at the cardinal margin; front more strongly rounded than the sides. Dorsal valve a little more convex than the ventral, greatest convexity near the beak; sinus rather deep, well defined, commencing at the beak and gradually widening to the front, where its width is equal to about one-third the transverse diameter of the shell; beak small, pointed, scarcely passing beyond the cardinal margin; area narrow, foramen triangular, moderately wide. Ventral valve having a slightly raised, but rather broad mesial elevation, which is most prominent near the beak, and in some specimens its lateral margins are bounded by a raised line; beak small, not prominent, passing a little beyond the cardinal edge. Surface of valves neatly ornamented with very fine, closely crowded, concentric lines, crossed by about thirty rounded radiating striae, which are sometimes simple and sometimes bifurcated.

The dimensions of the largest specimens I have seen are, length, 0.50; width, 0.58; but most of the specimens before me are about one-third smaller. The radiating striae are occasionally nearly obsolete, but the concentric always distinct."

The original description is repeated here because it, Shumard's (1861, p. 221) statement that this species and *Discina microscopica* occur together, and the species listed in his measured section "five miles N.W. of the town of Burnet" (Shumard, 1861, p. 216) constitute the only available evidence for deciding what he intended *Orthis coloradoensis* to be. Shumard did not figure the species, his types have long since been lost, and no neotype has been designated.

Combining the evidence provided by Shumard with the stratigraphic facts of life as they apply to brachiopods in central Texas leads to the inevitable conclusion that the specimens described by him were collected from the upper half of the Morgan Creek member of the Wilberns formation. Stated biostratigraphically, they must have come from the *Conaspis* zone or the *Ptychaspis* subzone, and on the basis of Shumard's description, almost certainly from the lower *Conaspis* zone.

Valves of *Billingsella* are abundant throughout the *Conaspis* zone and common through the rest of the Morgan Creek limestone above it. Specimens as a rule are poorly preserved because of intrastratal solution, and details of surface ornament—which seem to be somewhat variable—are difficult to ascertain. Low in the *Conaspis* zone pedicle valves are almost invariably subcircular to subquadrate, usually equidimensional, and occasionally somewhat transverse; this is the configuration described by Shumard. Furthermore, they have a "rather broad mesial elevation, which is most prominent near the beak"; this is the faint pedicle fold so characteristic of earliest *Billingsella* and illustrated here (pl. 62, figs. 1,3,5,6), by Ulrich & Cooper (1938, pl. 7, fig. 15), and by Bell (1941, pl. 35, figs. 6–8,19). Consequently this type of shell, characterized also by having radial costellae dominant over concentric fila, is thought to be the one described by Shumard as *Orthis coloradoensis,* and the pedicle valve from Morgan Creek illustrated on pl. 12, fig. 1, is here designated the neotype.

Billingsella coloradoensis grades upward into an elongate species described here as *B. texana,* n. sp. Neither the morphologic nor stratigraphic details of this transition are adequately known; apparently it occurs in the vicinity of the boundary between the *Conaspis* and *Ptychaspis-Prosaukia* zones, but not at the same level everywhere. Only comparatively well preserved pedicle valves can be assigned to one or the other of the two species, and no clear distinctions are evident in the brachial valves.

Most of the distinctions described by Ulrich & Cooper (1938, p. 75) between *B. coloradoensis* and *B. perfecta* are erroneous; they probably were making a comparison with *B. corrugata inornata,* n. subsp. The only distinctions that seem to hold are that *B. perfecta* has a more prominent fold and a stronger tendency toward convex posterior margins in the pedicle valve. Franconian orthids of the upper Mississippi Valley have never been analyzed stratigraphically, and *Billingsella pepina* (Hall) is still not understood. Possibly when *Billingsella* ultimately is monographed, the names *coloradoensis, pepina,* and *perfecta* will be applied to geographic subspecies.

I can see no evident differences between *Billingsella rectangulata* Cooper (1952, p. 3, pl. 1, figs. 1–15), based on silicified material from the Signal Mountain formation of Oklahoma, and *B. coloradoensis* as it is defined here. However, supposedly the two are stratigraphically far apart, and until something is known of the biostratigraphy of *Billingsella* in Oklahoma I hesitate to place the former in synonymy.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 62, fig. 1 (pedicle, neotype)	*Conaspis*	35057	11.0 mm.
2 (pedicle)	"	35058	11.0
3 (brachial)	"	35059	9.5
4 (pedicle)	"	35060	14.0
5 "	"	35061	16.5
6 "	*Pty.-Pro.*	35062	11.5
7 "	"	35062	11.5
8 "	"	35063	8.0
9 (brachial)	"	35064	11.0
10 "	"	35064	11.0

BILLINGSELLA CORRUGATA INORNATA
Ellinwood, n. subsp.
Pl. 63, figs. 1–9

This subspecies differs from *Billingsella corrugata* as described by Ulrich & Cooper (1938, p. 73) in having a less corrugated surface ornamentation (the lamellar growth lines are less elevated), and in having a narrower sulcus in the brachial valve. Details of the interior and the variation of outline are similar. Both in Texas and Oklahoma the shells attain a large size and many specimens are alate. Inasmuch as the specific name calls attention to the corrugated exterior surfaces, a subspecific name is employed here to emphasize the differences between populations in the two areas.

Ulrich & Cooper described and illustrated *B. corrugata* with specimens from Oklahoma, but they mention its presence in central Texas. Almost certainly they refer to this subspecies, for it is the only large, alate, transverse *Billingsella* in the area.

Large, silicified shells of *B. corrugata inornata* are abundantly exposed on bedding surfaces throughout central Texas, and have been referred to as "Big Bill" or "alate *Billingsella*" by geologists working in the area. Its association with silicified shells of *Plectotophia* constitutes an easily recognized interval in the upper part of the Point Peak member. Biostratigraphically it occurs through a thin interval high in the *Prosaukia* subzone, above *Billingsella texana* and below *B. rhomba.*

Figured specimens.—

	Zone	BEG Number	Width
Pl. 63, fig. 1 (pedicle, holotype)	Pty.-Pro.	35078	15.5 mm.
2 "	"	35078	15.5
3 (pedicle)	"	35079	15.0
4 "	"	35080	12.5
5 "	"	35081	21.0
6 "	"	35082	15.5
7 "	"	35083	14.0
8 (brachial)	"	35084	15.5
9 "	"	35084	15.5

BILLINGSELLA RHOMBA Ellinwood, n. sp.
Pl. 61, figs. 16–21

Outline quadrate to transversely subrectangular. Hinge line equal to or slightly less than medial width of shell. Cardinal extremities rounded or slightly mucronate. Anterior commissure gently sulcate to emarginate. Profile plano-convex. Surface parvicostellate, growth lamellae increase in strength marginally. Shell thick for the genus.

Pedicle valve strongly convex, outline quadrate to subquadrate. Posterior margins straight, apical angle 130 to 140 degrees. Anterior margin straight or slightly emarginate. Median fold very faint. Interarea long in proportion to width, flat, orthocline, transversely striated. Pseudodeltidium flatly convex, thick, covers about one-third of the delthyrium; apical callosity well developed, perforate except in gerontic valves. Adductor track large, distinct. Pallial trunks straight, strongly impressed, divergent anteriorly.

Brachial valve flat or slightly convex. Outline transversely subrectangular. Posterior margin straight. Sulcus slightly to moderately developed. Interarea short, flat, anacline. Chilidium rarely preserved, evidently very thin. Brachiophores stout, short. Cardinal process a short narrow plate. Median ridge low, broad, extends anteriorly beyond middle of valve and expands.

Remarks.—*Billingsella rhomba* is characterized by its subquadrate outline, strongly convex and thick pedicle valve, small pseudodeltidium and strong apical callosity in adult valves, and flat brachial valve with strong median ridge. In almost all of these respects it differs from any described species of *Billingsella.*

B. rhomba is known from 5 localities in the northwest half of the Llano uplift; it occurs as silicified shells in limestone beds near the top of the Point Peak member and near the base of the San Saba member. This makes it the highest species of the genus stratigraphically in central Texas, and places it high in the Franconian or low in the Trempealeauan. It is the "small species of *Billingsella*" mentioned by Cloud & Barnes (1948, p. 193).

Figured specimens.—

	Zone	BEG Number	Width
Pl. 61, fig. 16 (pedicle)	Pty.-Pro.?	35051	9.5 mm.
17 (shell)	"	35052	10.0
18 (pedicle, holotype)	"	35053	9.3
19 (pedicle)	"	35054	10.4
20 (brachial)	"	35055	9.1
21 "	"	35056	8.9

BILLINGSELLA TEXANA Bell, n. sp.
Pl. 62, figs. 11–21

Outline of pedicle valve elongate elliptical to slightly pear-shaped, length decidedly greater than width, and greatest width anterior to midline. Narrow sharp fold usually present, faint to absent posteriorly, highest and widest anteriorly; concentric fila sharply flexed posteriorly on fold, creating a narrowly emarginate anterior commissure. Concentric fila commonly rugose in anterior half of valve, dominant over radial costellae. Brachial valve indistinguishable from that of *B. coloradoensis* except possibly for having stronger concentric fila. Interiors of both valves typical of *Billingsella.*

Remarks.—This species almost certainly grades into *B. coloradoensis,* and their separation in the zone of gradation is arbitrary. Low in the range of *B. texana* pedicle valves are longer than wide, but a fold is not present; in outline they resemble *B. perfecta pyriformis* Bell. (1941, pl. 35, figs. 22–24). Stratigraphically upward the fold becomes progressively more prominent, and valves with strong folds are characteristic of high *Conaspis* zone and much of the *Ptychaspis* subzone. Almost all silicified valves of *Billingsella* from the Morgan Creek limestone of central Texas belong to *B. texana.*

One feature of this species—the pseudodeltidium—deserves special mention. Although data are as yet inadequate, for the structure is rarely seen in calcitic material, there seem to be two types of pseudodeltidia present in what I am calling *B. texana:* one, in a calcitic valve (pl. 62, fig. 13) and some silicified valves (pl. 62, figs, 15,16) is like that in *B. perfecta* (Ulrich & Cooper, 1938, pl. 7, figs. 11,18,20,21; Bell, 1941, pl. 35, figs. 1–5,10–14), and the other, in silicified valves (pl. 62, figs. 17,18), has a blunt apex elevated above the plane of the interarea. Unfortunately, information about the pseudodeltidium of *B. coloradoensis ss.* is virtually nonexistent, but presumably it is like that of *B. perfecta.* Until much more is known about the stratigraphic distribution of these two kinds of pseudodeltidia, I hesitate to assign taxonomic meaning to them.

The only previously illustrated specimens that may conform to this species are from Minnesota (Walcott, 1912, pl. 85, figs. 1d, 1n), but until something is known of *Billingsella pepina* and its associates, I hesitate to place the specimens in the synonymy of *B. texana.*

Figured specimens.—

		Zone	BEG Number	Width
Pl. 62, fig.	11 (pedicle)	*Conaspis*	35067	9.5 mm.
	12 "	"	35068	12.2
	13 "	"	35069	9.3
	14 (brachial)	"	35070	9.0
	15 (pedicle)	?	35071	10.7
	16 "	?	35072	11.6
	17 "	*Pty.-Pro.*	35073	7.2
	18 "	"	35074	11.8
	19 (pedicle, holotype)	"	35075	10.0
	20 (brachial)	"	35076	10.8
	21 "	"	"	"

Genus EOORTHIS Walcott, 1908
EOORTHIS REMNICHA (Winchell)
Pl. 63, figs. 10–15

Orthis remnicha WINCHELL, 1886, p. 317, pl. 2, fig. 7.
Eoorthis remnicha (Winchell) WALCOTT, 1912, p. 786, pl. 91, figs. 1,1a-j,11-s, pl. 92, figs. 2,2a-d, 3,3a-e; BELL, 1941, p. 254, pl. 36, figs. 14–23; LOCHMAN & Hu, 1960, p. 810, pl. 95, figs. 51–53
Orthis (Plectorthis) remnicha texana WALCOTT, 1905, p. 270.
Eoorthis remnicha texana (Walcott) WALCOTT, 1912, p. 787, pl. 92, figs. 4,4a-f,4g?.
Eoorthis texana (Walcott) SCHUCHERT & COOPER, 1932, p. 51.

Wherever authentic *Eoorthis remnicha* is known it almost invariably occurs as coquinoid accumulations of valves through a short stratigraphic interval at the base of the *Conaspis* zone. Such is the situation in central Texas, where the "*Eoorthis* bed," a foot or two thick, is essentially continuous throughout the Llano Uplift. The species is somewhat variable in shell contour, but its primary specific characteristic is the coarse costation, each costa becoming larger anteriorly, and additional costae originating by intercalation. On perfectly preserved valves fine costellae can be seen on the primary costae. Dental plates are strong, and the cardinal process usually is absent but may consist of a small low plate.

Attempts to distinguish subspecies on the basis of shell contour, presence or absence of a sulcus in either Valve, or details of shell costation have all failed to isolate groups of shells with either stratigraphic or geographic significance. One such attempt was that by Walcott in establishing *Eoorthis remnicha texana,* which Schuchert and Cooper elevated to the rank of species; it is here placed in synonymy with *E. remnicha,* and its holotype is illustrated (pl. 63, fig. 12).

The type specimens of *Eoorthis remnicha* were collected by N. H. Winchell in September, 1885. Six small slabs of ferruginous and glauconitic dolomite at The University of Minnesota bear in red paint the number 6070, and the catalogue contains the notation "2–6′ below surface, Brush street at corner of Main, Red Wing, Minnesota." Faint traces of a ribbed brachiopod are visible on the slabs, but only one specimen is good enough to be photographed; it is illustrated here (pl. 63, fig. 15), and designated the holotype. The only reason that these specimens are known to belong to the species that today we call *Eoorthis remnicha* is that they came from the Birkmose member of the Franconia formation (Berg, 1954), which in the vicinity of Red Wing contains the base of the *Conaspis* zone. Identifiable specimens from the Birkmose near Hudson, Wisconsin, also are illustrated here (pl. 63, fig. 14).

Figured specimens.—

	Zone	BEG Number	Width
Pl. 63, fig. 10 (brachial)	*Conaspis*	35086	19.0 mm.
11 "	"	35087	21.0
12 (pedicle)	"	(USNM 52369a)	25.0
13 "	"	35089	20.0
14 (brachials)	"	35090	—
15 (pedicle holotype)	"	(Minn. 6070)	11.0

EOORTHIS INDIANOLA (Walcott)
Pl. 63, figs. 16,17; pl. 64, figs. 1–8

Orthis (Plectorthis) indianola WALCOTT, 1905, p. 264.
Eoorthis indianola (Walcott) WALCOTT, 1912, p. 780, pl. 94, figs. 1t,1u,2,2a-h.
Orthis (Plectorthis) wichitaensis WALCOTT, 1905, p. 271.
Eoorthis wichitaensis (Walcott) WALCOTT, 1912, p. 790, pl. 94, figs.1,1a-o,1u.
Orthis (Plectorthis) wichitaensis laeviusculus WALCOTT, 1905, p. 272.
Eoorthis wichitaensis leaviusculus (Walcott) WALCOTT, 1912, p. 701, pl. 94, figs. 1p-s.
Eoorthis remnicha (Winchell) WALCOTT, 1912 (part), pl. 91, fig. 1k.

Associated with and immediately below *Eoorthis remnicha,* wherever it occurs in abundance, are coquinoid accumulations of orthid valves that differ from *E. remnicha* externally be being about half as large, in having a variable pattern of costellae rather than large costae, and in tending toward sulcation of one or both valves. With respect to ribbing there seem to be two end members. One, typified by the holotype pedicle valve of *E. wichitaensis* (Walcott, 1912, pl. 94, fig. 1), is characterized by regular costellae of equal size that expand very little anteriorly. The other, typified by the holotype pedicle valve of *E. indianola* (Walcott, 1912, pl. 94, fig. 2), is characterized by widely spaced coarse costellae between each pair of which are several fine costellae. There seems to be complete gradation between these two end members, and no stratigraphic or geographic isolation of either. Surprisingly, in choosing for illustration brachial valves of his two species, Walcott (1912, pl. 94) associated brachial valves with alternating coarse and fine ribs with the evenly libbed type specimen of *E. wichitaensis,* and associated evenly ribbed brachial valves, which are less common, with the unevenly ribbed type of *E. indianola.* To my knowledge any association must be arbitrary and deductive; there has never been any empirical documentation of how these invariably isolated valves are paired. And, of course, intermediate and equivocal valves are not illustrated at all.

Because, in my opinion, we are dealing with a highly variable species group whose component parts we do not as yet comprehend, I prefer to refer to it collectively as *Eoorthis indianola,* a name chosen solely on the basis of page priority. Other names are placed in synonymy, but will be available as our knowledge increases.

The assignment to *Eoorthis* is made largely by default, for internal characters of this small orthid are virtually unknown. The shell is thin, apparently invariably nonsilicified in Oklahoma and central Texas, and does not separate cleanly either internally or externally from the enclosing matrix. The result is a state of preservation from which it is most difficult to determine external and, particularly, internal features. Obviously this state of affairs discourages the establishment of a new genus.

A situation that exists in Montana and Wyoming, and that may in time affect the disposition of *E. indianola,* deserves comment. I wish that I were as confident of the validity, importance, and susceptibility to positive identification of my genus *Ocnerorthis* as is Miss Lochman (Lochman & Hu, 1960, p. 797, 802). The genus was created in 1941 from two plano-convex species whose pedicle valves differ greatly internally, and whose brachial valves are similar in having a long, low, anteriorly-expanding, internal median ridge. Each species was known from a single locality, where at least some of its valves were silicified, and almost nothing was known of the precise stratigraphic position of either. The two were placed in the same genus solely on the basis of having similar flat brachial valves; the pedicle valves are very much alike externally, and remarkably like the holotype of *Eoorthis wichitaensis.*

Contributing also to this confused situation is *Otusia sandbergi* (Winchell), original types or topotypes of which are unknown, and whose western "representatives" described by Walcott (1912, p. 769) and myself (Bell, 1941, p. 251) are, in my opinion, probably related at no more than the subspecific level to the species group I am here calling *Eoorthis indianola.* I see no way out of this dilemma until silicified material becomes available from several localities, especially in Oklahoma and Texas.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 63, fig. 16 (pedicle, holotype)	*Conaspis*	(USNM 52343b)	7.5 mm.
17 (coquinite)	"	(USNM 52343)	—
Pl. 64, fig. 1 (brachial)	"	35092	7.5
2 (pedicle)	"	35093	5.2
3 "	"	35094	7.5
4 "	"	35095	6.0
5 (3 pedicles)	"	35096	—
6 (brachial)	"	35097	8.5
7 (pedicle)	"	35098	8.5
8 "	"	35099	7.5

Superfamily SYNTROPHIACEA
Genus HUENELLA Walcott, 1908
HUENELLA ABNORMIS (Walcott)
Pl. 64, figs. 14–17

Syntrophia abnormis WALCOTT, 1905, p. 289.
Huenella abnormis (Walcott) WALCOTT, 1912, p. 805, pl. 103, figs. 2,2a-m; SCHUCHERT & COOPER, 1932, p. 160, text-figs. 24a-c; BELL, 1941, p. 254, pl. 36, figs. 1,2.
Huenella texana (Walcott) ULRICH & COOPER, 1938, pl. 41, figs. 20,29; SHIMER & SHROCK, 1944, pl. 114, fig. 15.
Syntrophia texana laeviusculus WALCOTT, 1905, p. 294.
Huenella texana laeviusculus (Walcott) WALCOTT, 1912, p. 808.

Both Walcott (1912, p. 806) and I (Bell, 1941, p. 254) implied or stated the opinion that *H. abnormis* and *H. texana* intergraded, but that we recognized two species because one end member (*H. abnormis*) was confined essentially to Montana and Wyoming, and the other (*H. texana*) to Texas. Probably neither surmise is correct; both derived from inadequate collections and lack of biostratigraphic information.

Although more data are desirable and will be acquired in central Texas, the following conclusions are indicated: (1) specimens of *H. abnormis* are more abundant than are those of *H. texana;* (2) *H. abnormis* occurs abundantly in a thin interval low in the *Conaspis* zone, and *H. texana* occurs through an ill-defined interval high in the *Conaspis* zone; (3) *H. abnormis* is characterized primarily by a circular outline in plan view, the posterolateral margins being broadly curved, and secondarily by smooth or faintly costate flanks, and smooth or costate fold and sulcus. Seemingly the most common shell has smooth flanks and either no or two costae on fold and sulcus.

Occasional specimens of *H. abnormis* occur with common specimens of *H. texana* high in the *Conaspis* zone, but the reverse seems not to be true. In other words, there is a mixing of, but not a gradation between, the two species. The concept of gradation came from two sources: exclusive emphasis on costation, and the belief that the two were stratigraphically equivalent but geographically separate.

Huenella texana laeviusculus, which Walcott never illustrated, is almost certainly *H. abnormis;* it is best buried in synonymy.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 64, fig. 14 (pedicle)	*Conaspis*	35105	7.8 mm.
15 (brachial)	"	35106	8.5
16 (pedicle)	"	35107	10.0
17 (brachial)	"	35108	8.0

HUENELLA TEXANA (Walcott)
Pl. 64, figs. 18–20

Camarella sp. ? SHUMARD, 1861, p. 221.
Syntrophia texana WALCOTT, 1905, p. 294.
Huenella texana (Walcott) WALCOTT, 1912, p. 808, pl. 103, figs. 1,1a-i; SCHUCHERT & COOPER. 1932, p. 160, text-figs. 24d-e; CLOUD & BARNES, 1948, pl. 38, figs. 39–41 (topotypes).

This, the type species, is characterized by its transversely subquadrate outline in plan view, the posterolateral angles ranging from broadly rounded to acute and even alate, and by its completely costate surface. Some valves (pl. 64, fig. 18) have both alate and rounded posterolateral angles. The most common form has three costae on fold and sulcus that are of the same strength or a little stronger than are those on the flanks. On badly exfoliated shells the costae on the flanks are faint.

Huenella texana, occurs high in the *Conaspis* zone.

Figured specimens.—

	Zone	BEG Number	Width
Pl. 64, fig. 18 (pedicle)	*Conaspis*	35109	12.0 mm.
19 (brachial)	"	35110	7.0
20 (pedicle)	"	35111	7.0

Genus PLECTOTROPHIA Ulrich & Cooper, 1936

PLECTOTROPHIA ALATA (Walcott)

Pl. 64, figs. 9–13

Syntrophia alata WALCOTT, 1905, p. 290; 1912, p. 799, pl. 103, figs. 3,3a-e.

Plectotrophia alata (Walcott) ULRICH & COOPER, 1938, p. 197, pl. 40, figs. 1–4,8; CLOUD & BARNES 1948, p. 448, pl. 38, figs. 27–29.

Plectotrophia alata has been adequately described by Ulrich & Cooper (1938, p. 197), and additional illustrations are provided here. It occurs, commonly silicified and associated with *Billingsella corrugata inornata,* n. subsp., through a thin calcitic interval

(Text continues on page 421)

EXPLANATION OF PLATE 51

FIGS. *1–4*—*Homagnostus tumidosus* (Hall & Whitfield). All ×8. *1,4,* Mold and test of cephala, (BEG 34836) from E-840, (BEG 34839) from GM-516. *2,3,* Molds of pygidia, (BEG 34837) from E-823, (BEG 34838) from E-823.5.

5,6—*?Homagnostus* sp. Both ×8. Molds of pygidia, (BEG 34840) from E-823.5, (BEG 34841) from GM-516.

7–21—*Pseudagnostus communis* (Hall & Whitfield). All ×5. *7,11,14,* Small, medium, and large cephala with furrows moderately impressed, (BEG 34842) from E-823.5, (BEG 34846) from E-823.5, (BEG 34849) from MC-721. *8,10,12,* Small, medium, and large cephala with strongly impressed furrows, (BEG 34843) from E-932, (BEG 34845) from SS-109, (BEG 34847) from E-932 *9,13,* Small and large cephala with furrows faint or absent, (BEG 34844) from CR-745, (BEG 34848) from SK-266. *15,* Medium pygidium with furrows faintly impressed, (BEG 34850) from WC-968, *16–18,* Medium pygidia with furrows strongly impressed, (BEG 34851) from SS-109, (BEG 34852) from SU-104, (BEG 34853) from E-932. *19–21,* Moderately large pygidia with furrows faint or absent, (BEG 34854) from MC-721, (BEG 34855) from LL-728, (BEG 34856) from SK-233.

EXPLANATION OF PLATE 52

FIGS. *1–3*—*Monocheilus truncatus* Ellinwood, n. sp. *1,* Internal mold of large mold of large holotype cranidium, ×2 (BEG 34857) from SS-307.5. *2,3,* Internal molds of medium and small cranidia, ×3 (BEG 34858), ×4 (BEG 34859) from SS-307.5.

4—*Sulcocephalus candidus* (Resser). Cranidium preserving test, ×2½ (BEG 34860) from TC-934.5.

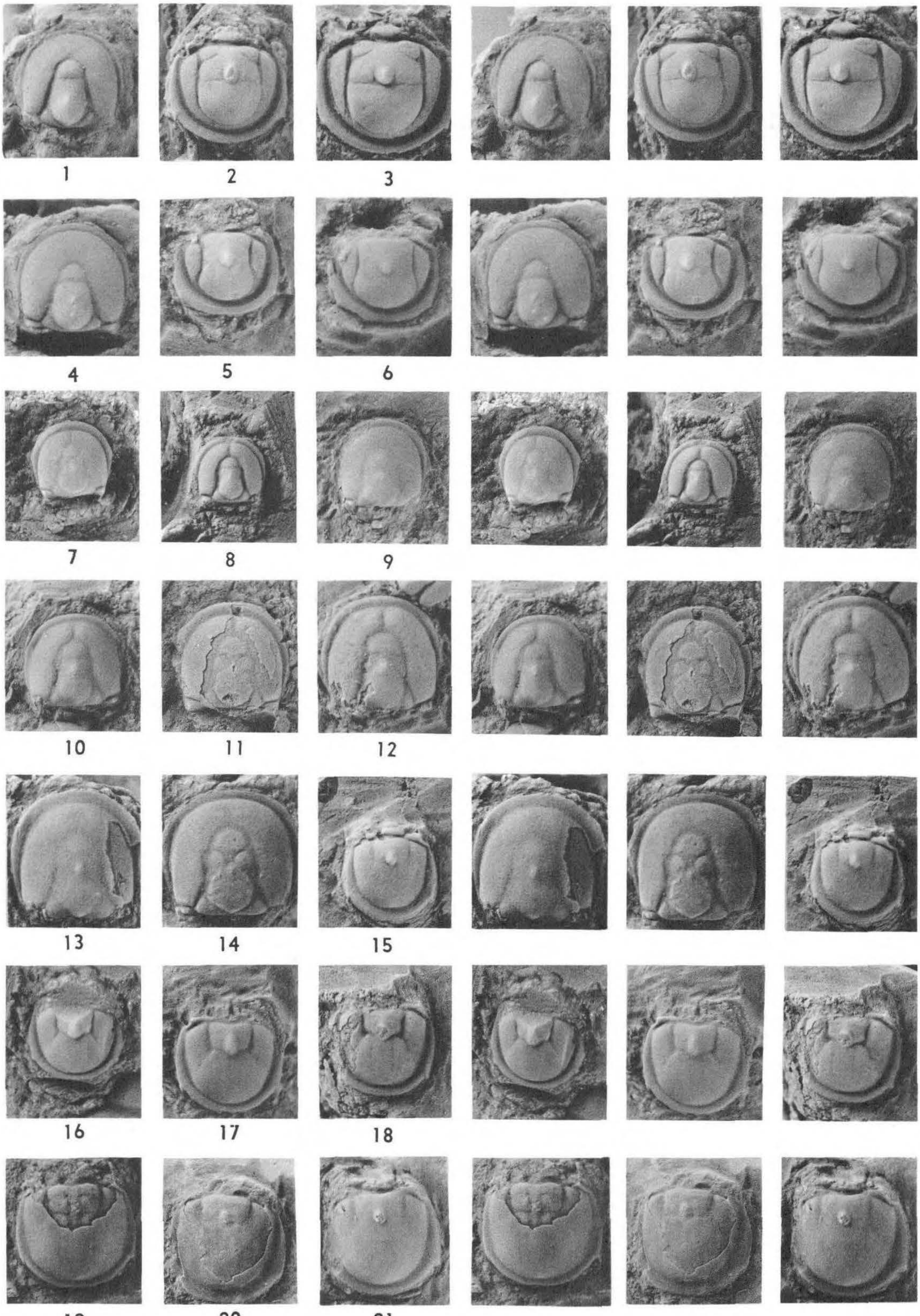
5,6—*Briscoia* sp. *5,* Rubber cast of incomplete small cranidium, ×1¼ (BEG 34861) from JR-284.5. *6,* Rubber cast of small pygidium, ×3 (BEG 34862) from JR-284.5.

7–9,13,14—*Drumaspis texana* Resser, *7–9,* Small, medium, and large cranidia with granulated tests preserved, ×5 (BEG 34863) from CR-765, ×3½ (BEG 34864) from MC-721, ×2 (BEG 34865) from CO-52. *13,14,* Small and large pygidia with tests preserved, ×3 (BEG 34866) from MC-721, ×2 (BEG 34867) from CO-60.

10–12,15—*Drumaspis deckeri* Resser. *10,11,* Small and moderately large cranidia with tests preserved, ×5 (BEG 34868) from JR-195.5, ×3 (BEG 34869) from JR-202. *12,* Internal mold of large cranidium, ×2 (BEG 34870) from SK-266. *15,* Medium pygidium with test preserved, ×3 (BEG 34871) from SK-264.

16—18—*Comanchia amplooculata* (Frederickson). *16,* Fragmentary cranidium on valve of *Eoorthis remnicha,* ×4 (BEG 34872) from B-1.5. *17,* Cluster of cranidia and pygidia, ×3

(Explanations of Plates 52–54 continue on page 417 following Plate 64)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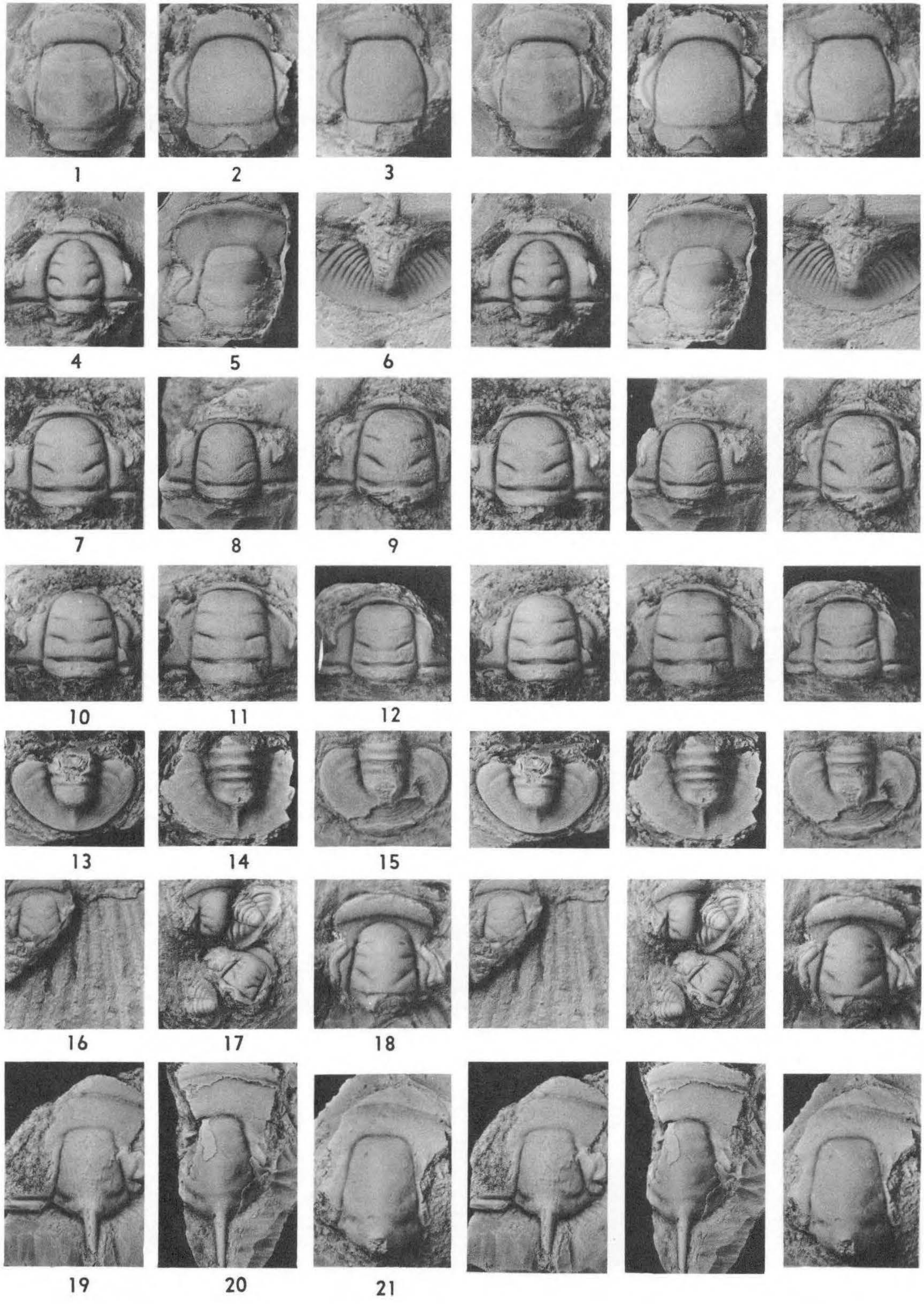
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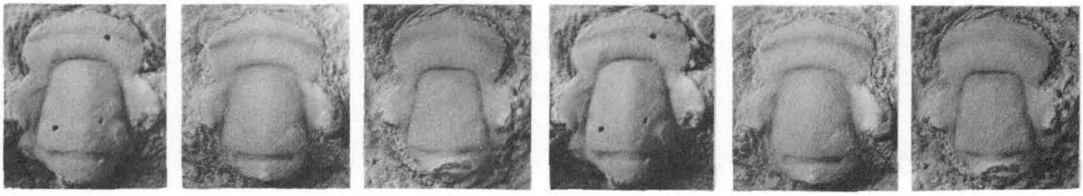

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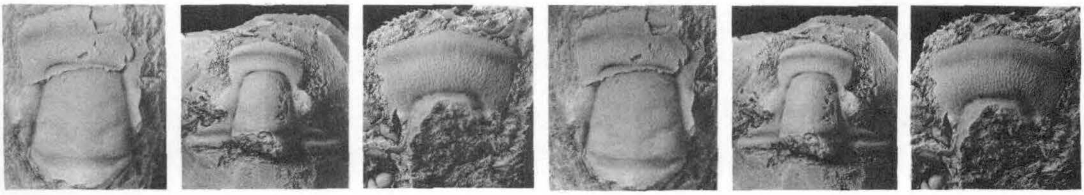

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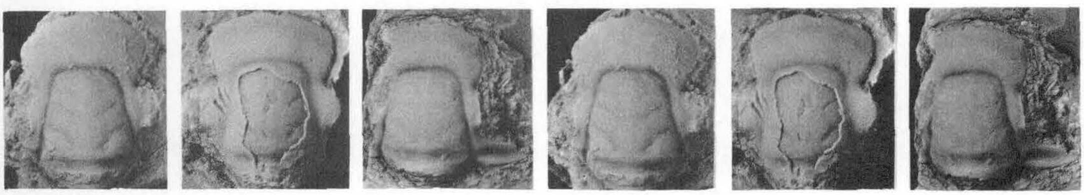

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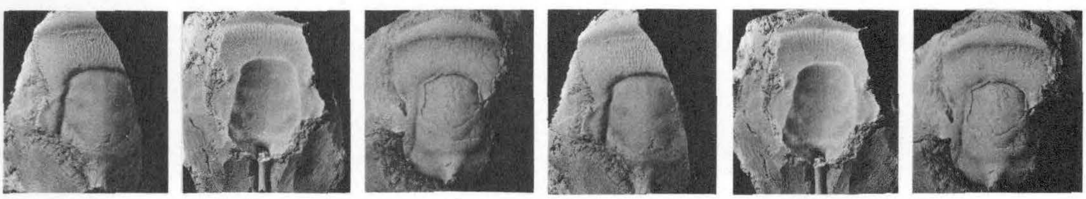

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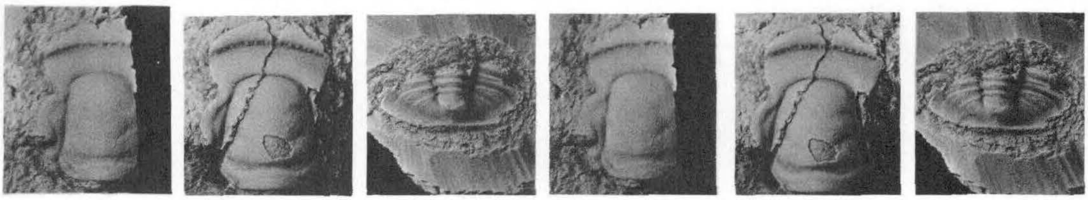

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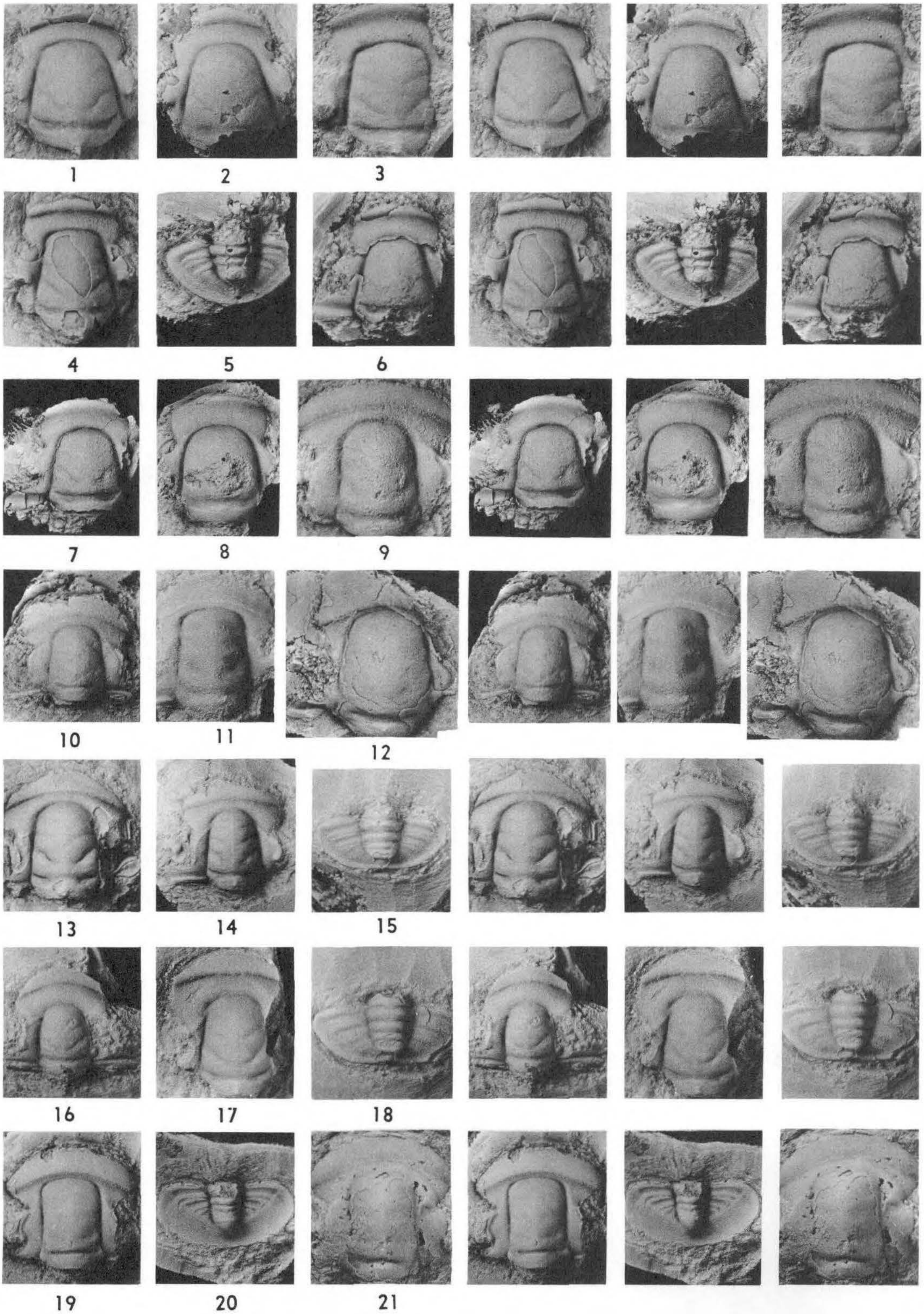
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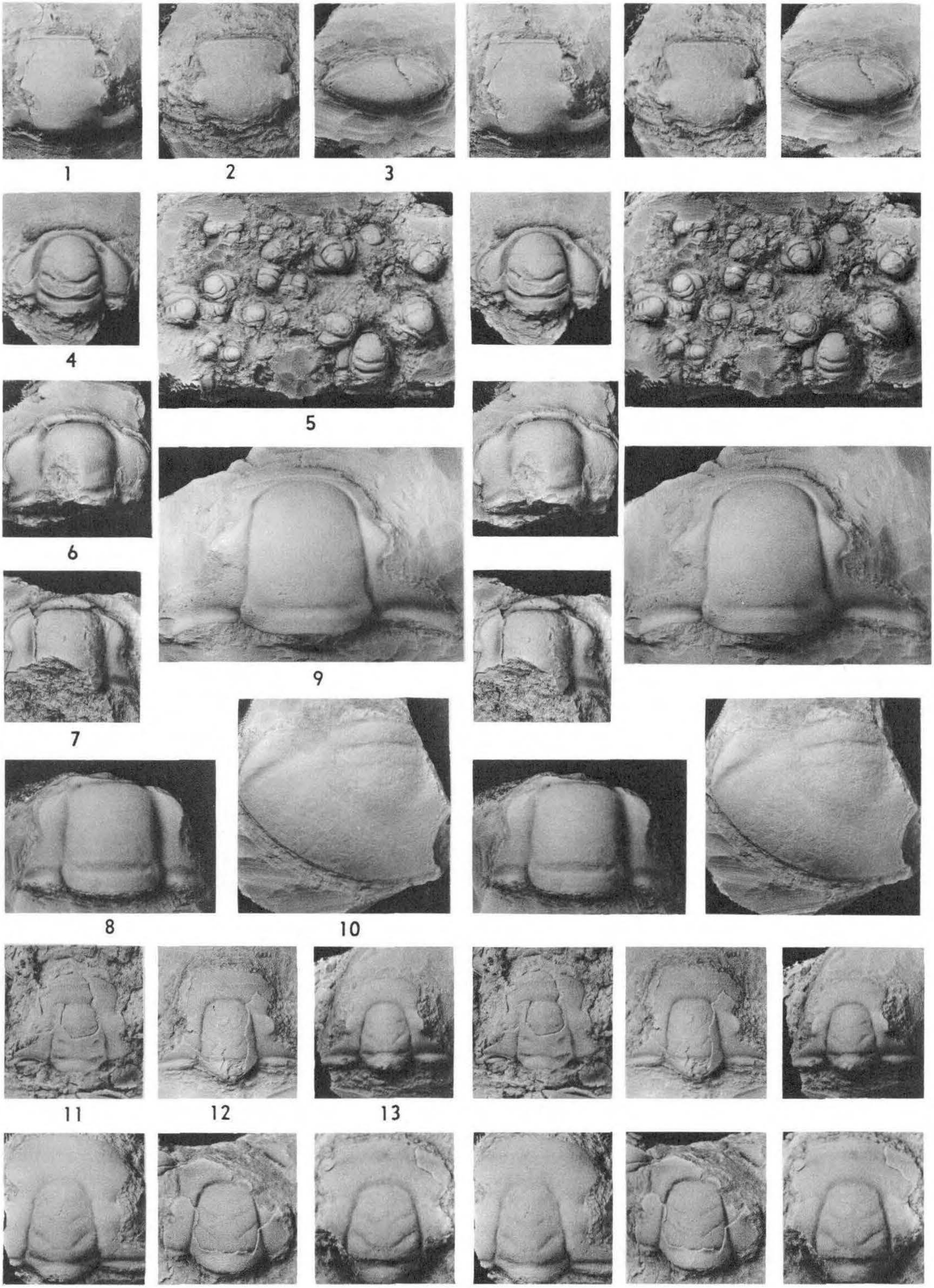
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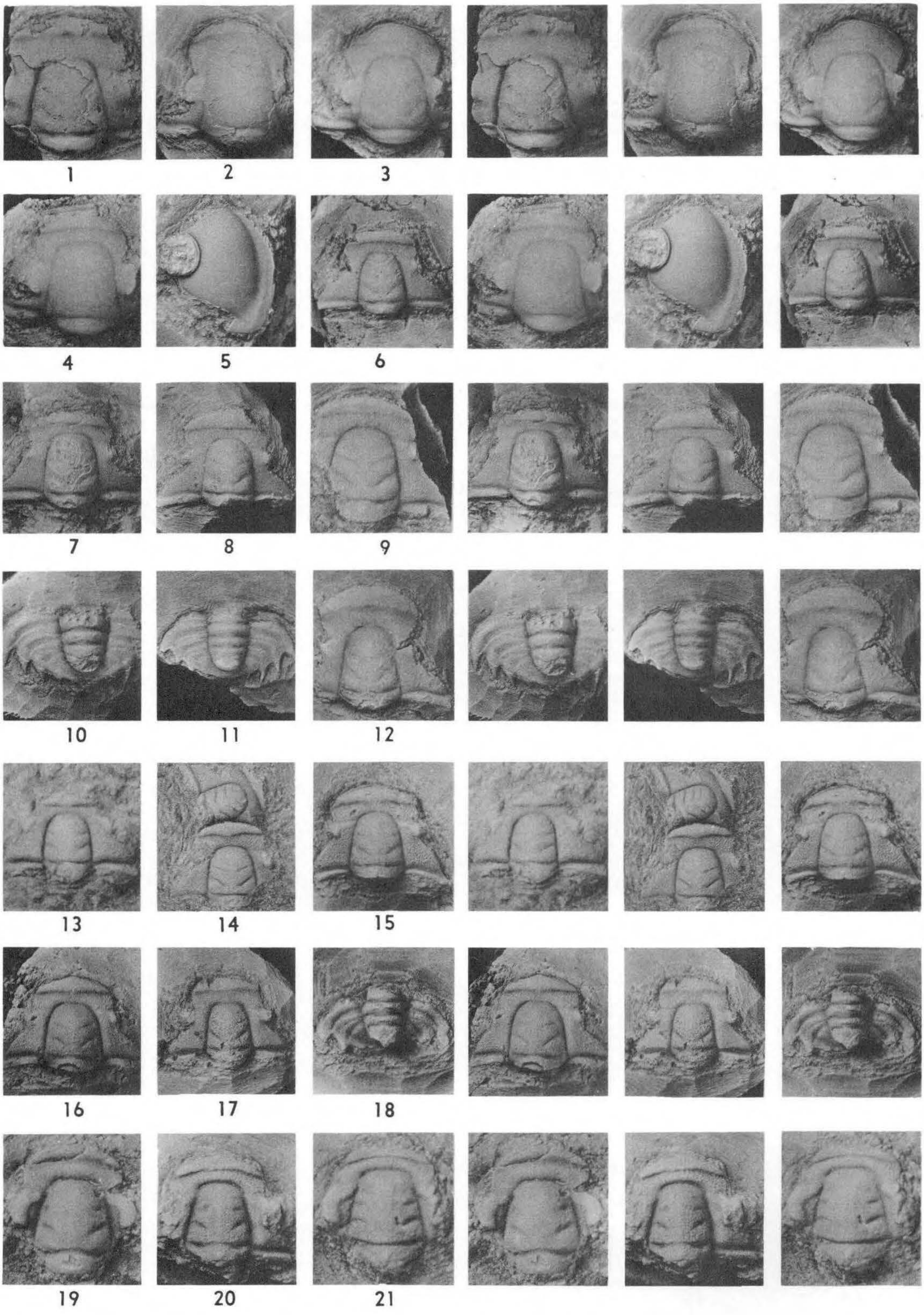
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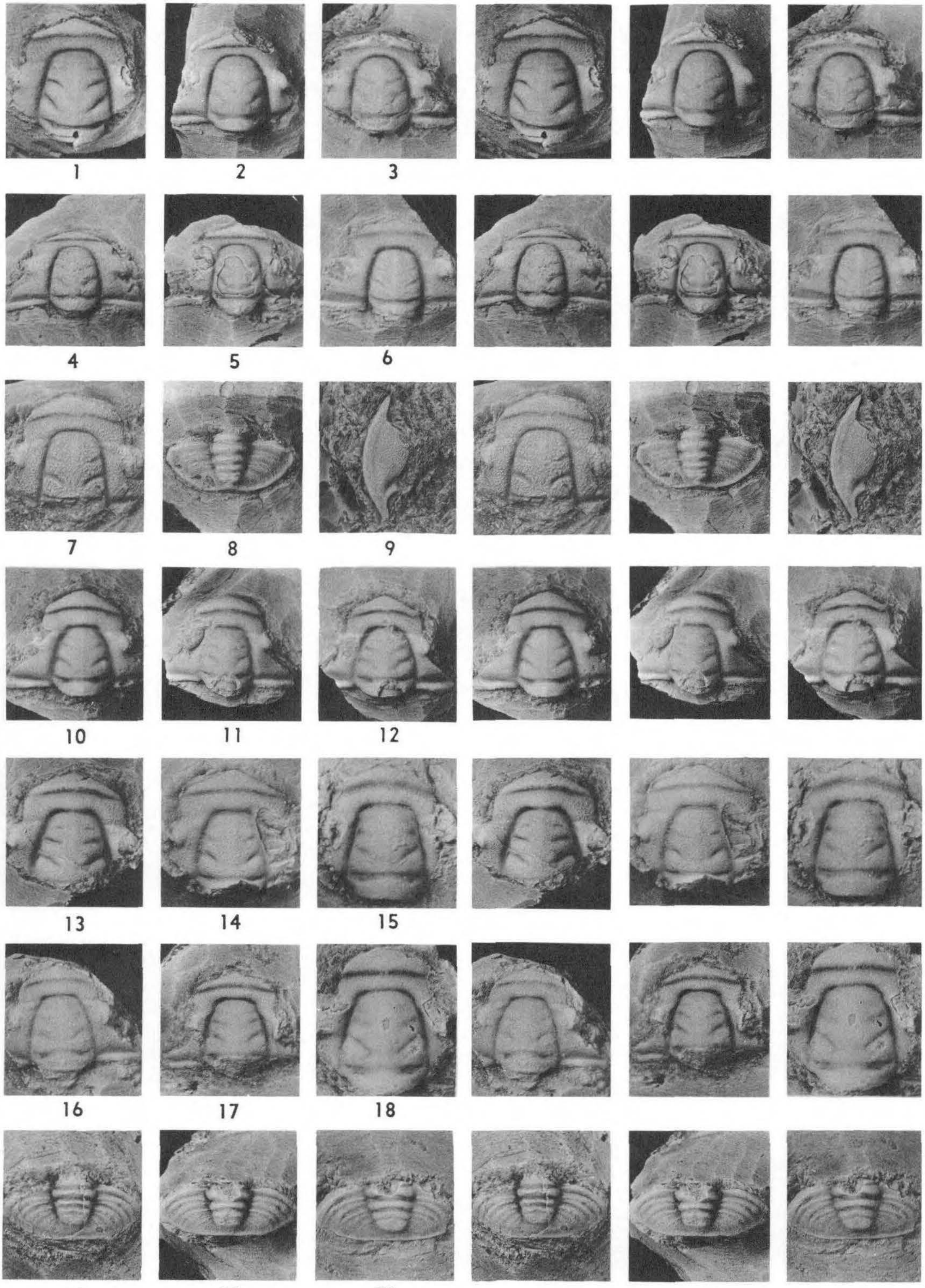
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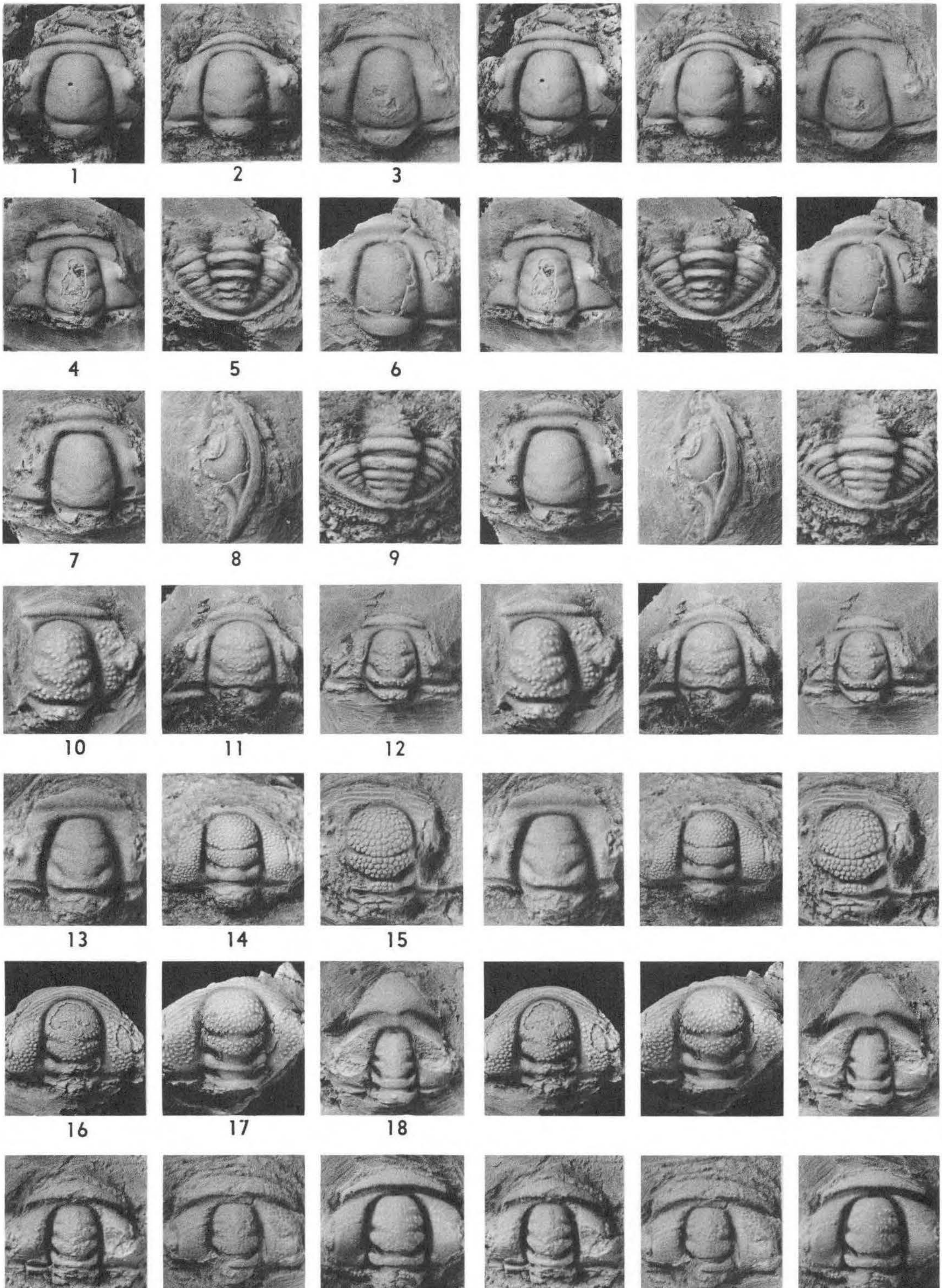
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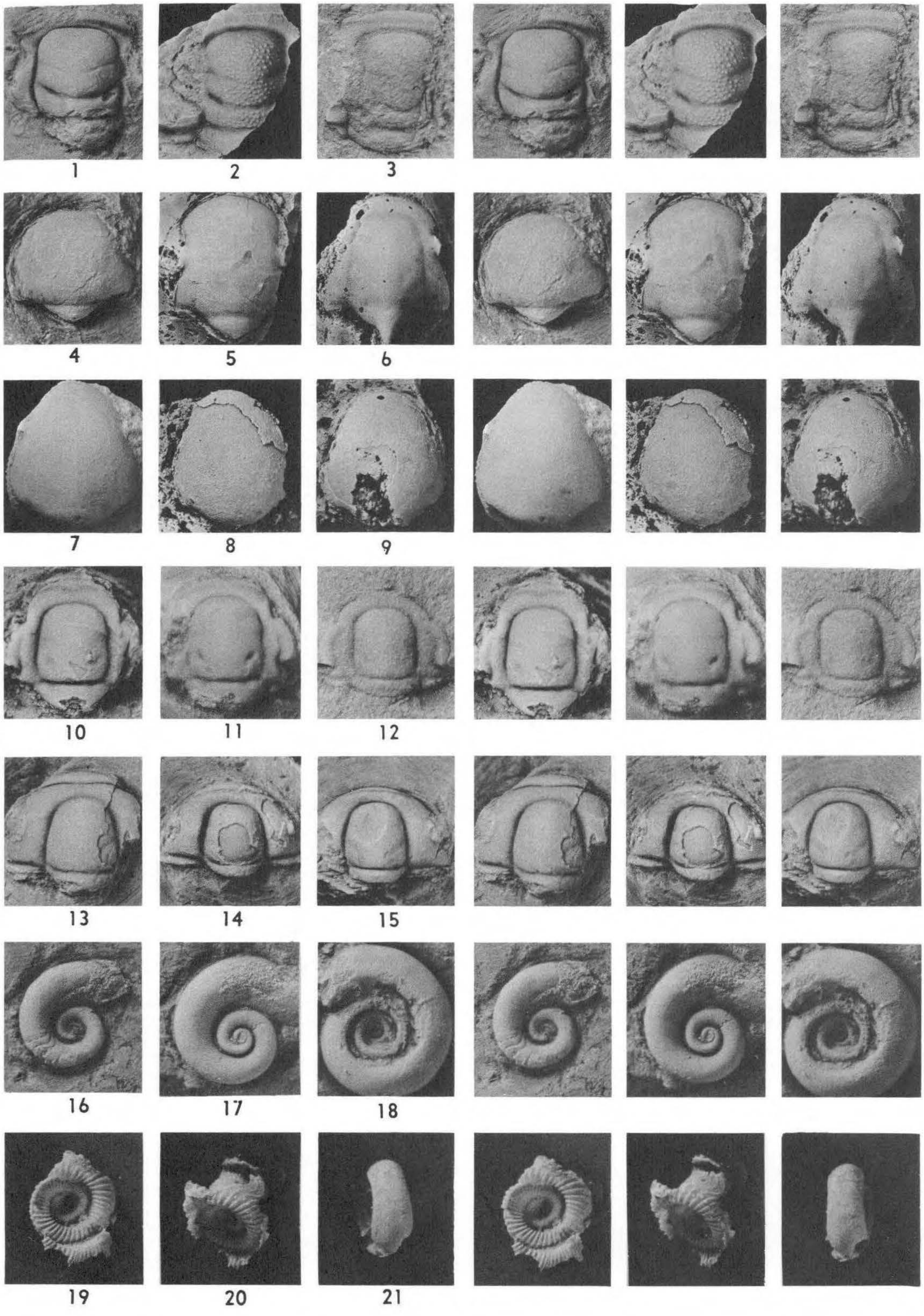
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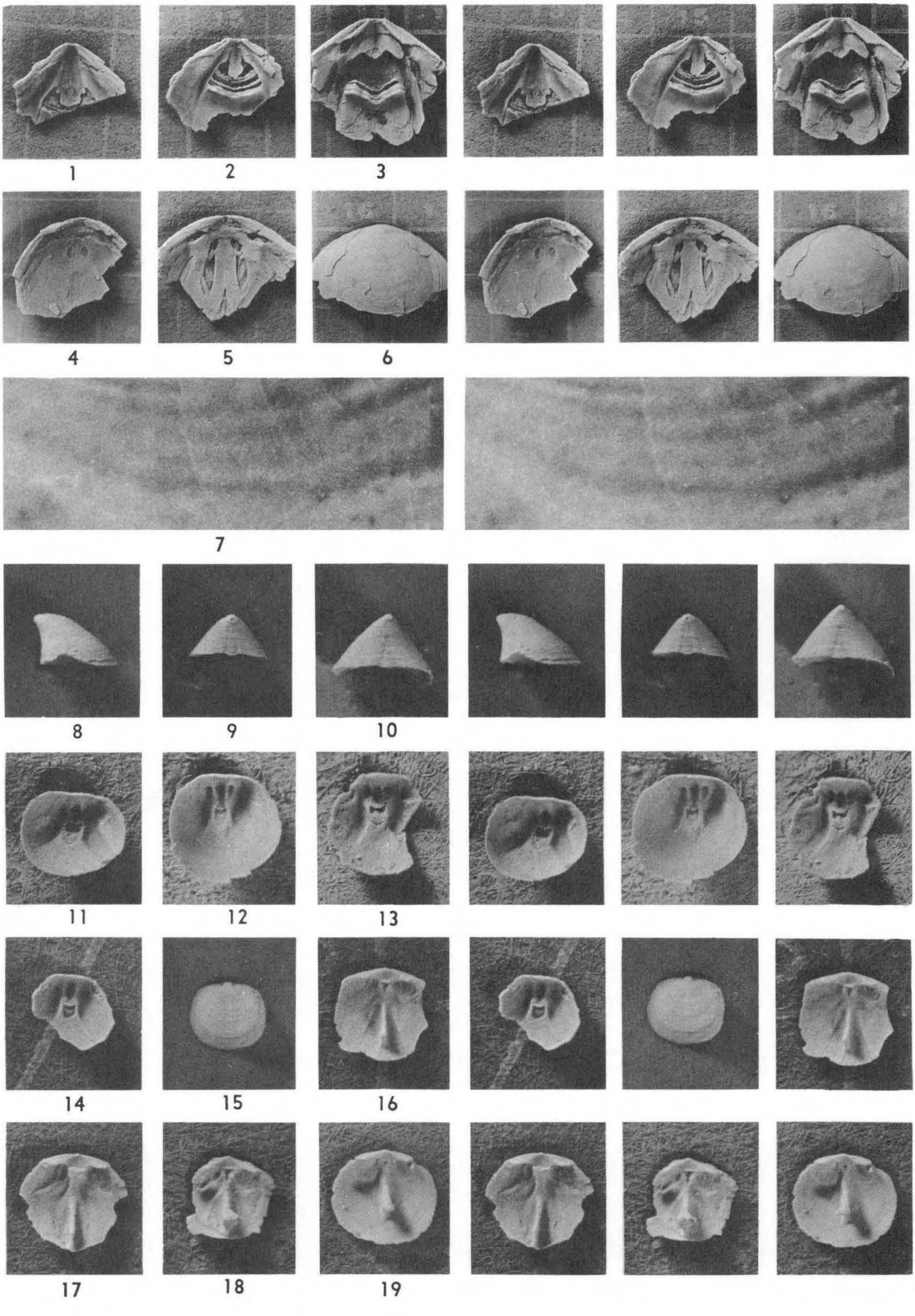
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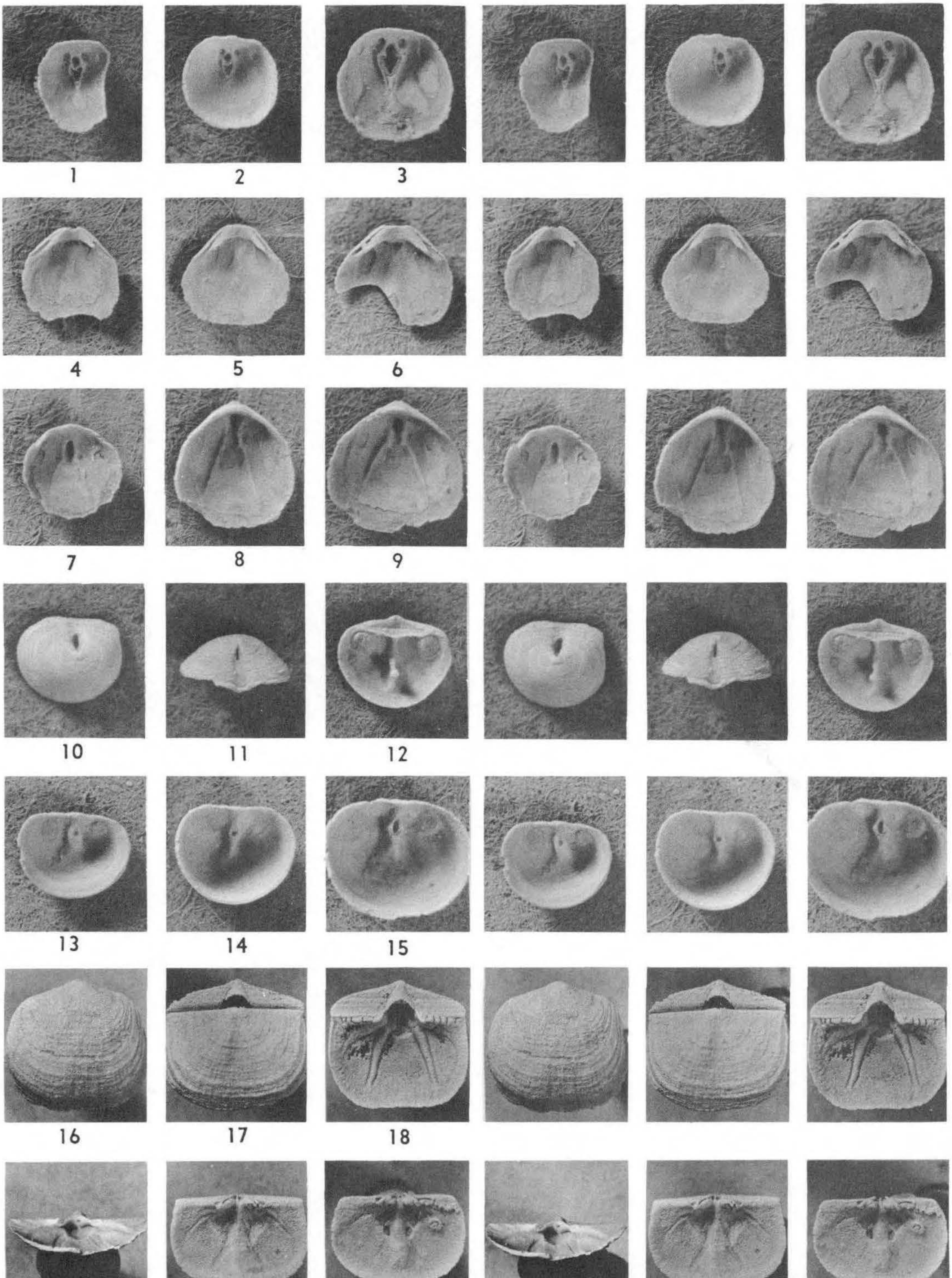
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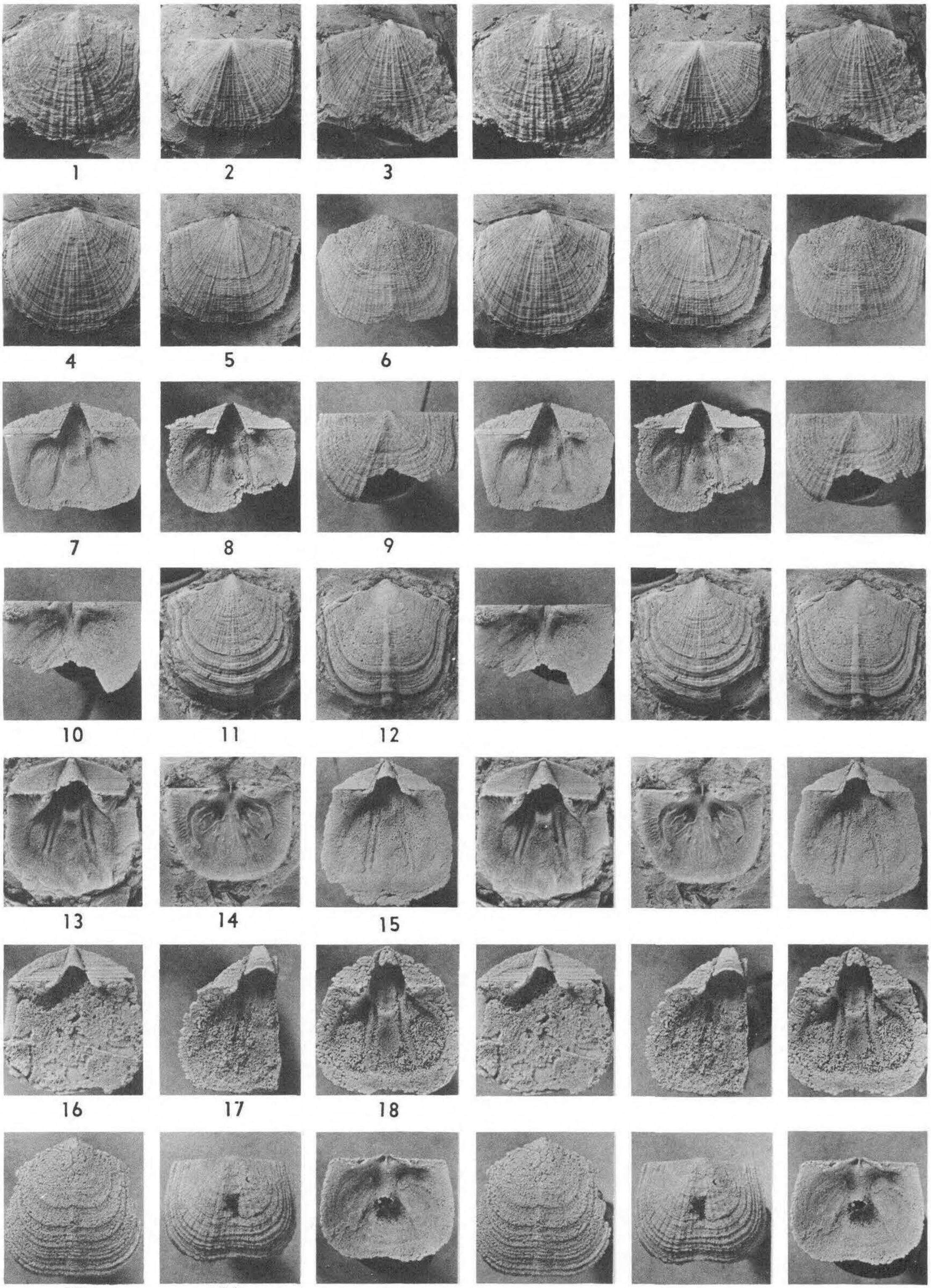
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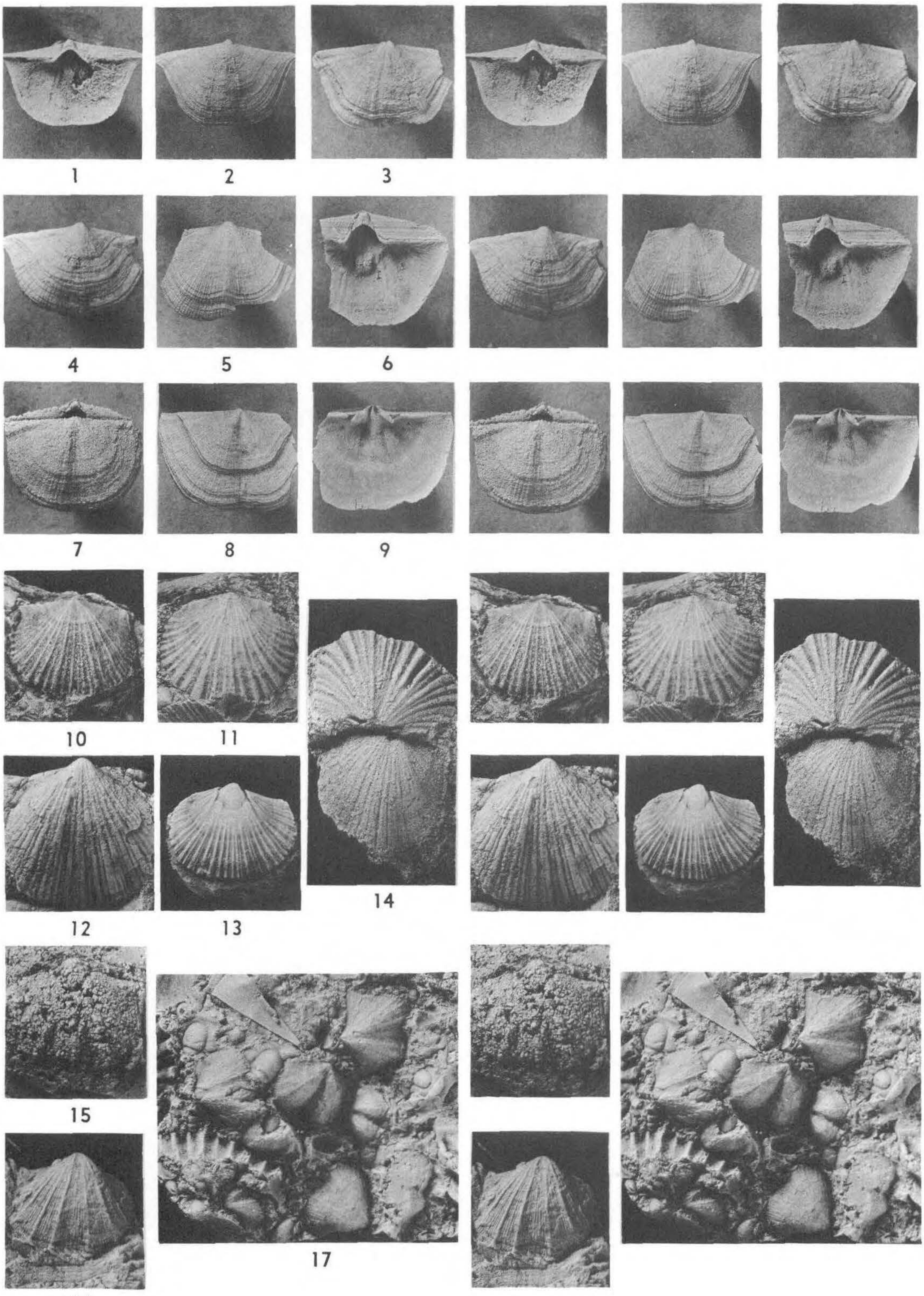
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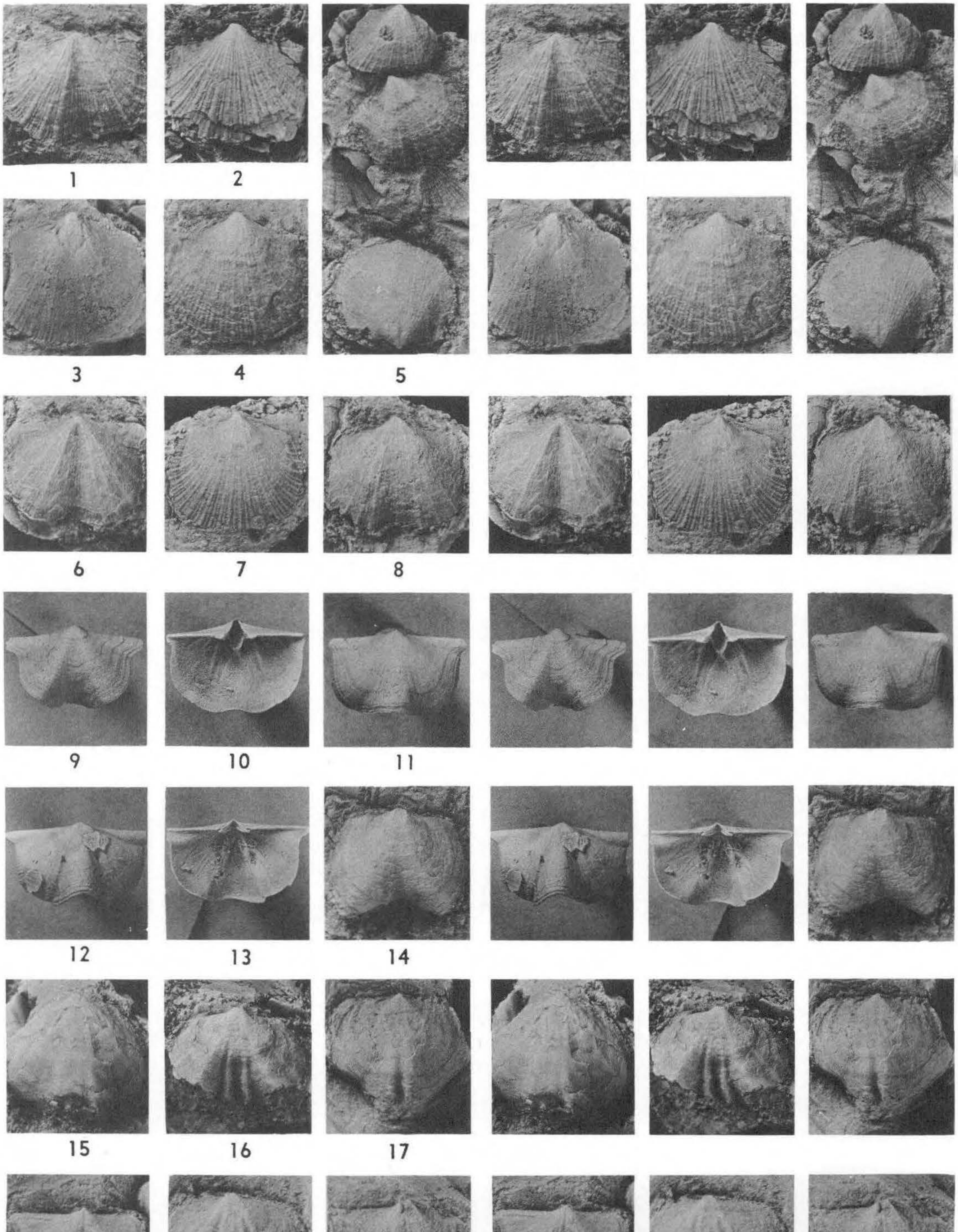
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(BEG 34873) from WC-889. *18,* Large cranidium with test preserved, ×6 (BEG 34874) from WC-889.

19–21—Idahoia wisconsensis (Owen). *19,20,* Large cranidia with tests preserved at least in part, ×1 (BEG 34875) from TC-1029, ×1 (BEG 34876) from SK-266. *21,* Internal mold of small cranidium, ×2½ (BEG 34877) from JR-210.

EXPLANATION OF PLATE 53

FIGS. *1–9—Idahoia, lirae* (Frederickson). *1–3,* Internal molds of moderately large cranidia with occipital spines, ×1½ (BEG 34878) from EC-20.5, ×2½ (BEG 34879) from SK-232, ×2 (BEG 34880) from SK-232. *4,* Very small cranidium with smooth occipital ring and with test preserved, ×8 (BEG 34881) from LL-719. *5,6,* Small cranidia with tests preserved, one with occipital node, ×4 (BEG 34882) from JR-173, ×4 (BEG 38883) from 41-1.5 (approximately equivalent to MC-707, but on South Fork of Morgan Creek). *7,8,* Moderately large cranidia with at least parts of tests preserved, fossulae and anterior border furrows well developed, ×2½ (BEG 34884) from TA-56, ×1½ (BEG 34885) from GM-594. *9,* Internal mold of fragmentary large cranidium showing venation of preglabellar field, ×1½ (BEG 34886) from JR-173.

10–12—Idahoia lirae (Frederickson) var. A, Bell. *10,11,* Completely and partly exfoliated moderately large cranidia, ×3 (BEG 34887, 34888) from TC-983. *12,* Internal mold of moderately large cranidium with tiny occipital node, ×2 (BEG 38889) from MC-706.

13–21—Saratogia fria Lochman & Hu. *13–15,* Medium cranidia with tests preserved, ×3 (BEG 34890) from WC-968, ×2½ (BEG 34891) from WC-968, ×2 (BEG 34892) from JR-188. *16,17* Internal mold and interior of large cranidia showing strong venation of preglabellar field, ×1-2/3 (BEG 34893) from JR-189, ×1 (BEG 34894) from TC-1017. *18,* Moderately large cranidium with most of test preserved, ×1-2/3 (BEG 34895) from SS-109. *19,20,* Medium cranidia with tests preserved, and without occipital spines, ×2¼ (BEG 34896) from WC-950, ×2¼ (BEG 34897) from MC-718. *21,* Pygidium with test preserved, ×1¼ (BEG 34898) from TC-1003.

EXPLANATION OF PLATE 54

FIGS. *1–5—Saratogia americana* (Lochman & Hu). *1,2,* Cranidia with tests preserved, ×2½ (BEG 34899) from MC-712, ×2½ (BEG 34900) from WC-950. *3,* Rubber cast of somewhat flattened cranidium, ×2½ (BEG 34901) from ST-578. *4,* Cranidium with test preserved, showing venation of preglabellar field, ×2½ (BEG 34902) from JR-169. *5,* Pygidium with test preserved, ×2 (BEG 34903) from ST-541.

6–8—Saratogia modesta (Lochman & Hu). *6,* Moderately large cranidium with test partly preserved, ×1¾ (BEG 34904) from MC-721. *7,8,* Internal molds of large cranidia, showing variation in outline of glabella, ×1¼ (BEG 34905) from MC-721, × 1¼ (BEG 34906) from SS-120.

9,10—Wilbernia diademata (Hall). Internal molds of large and medium cranidia, ×1 (BEG 34907) from SS-94.5, ×1½ (BEG 34908) from EC-21.5.

11,12—Wilbernia expansa Frederickson. Medium and large cranidia with tests at least partly preserved, ×1¼ (BEG 34909) from WC-912, ×1 (BEG 34910) from SS-120.

13–15—Wilbernia halli Resser. *13,* Cranidium with test preserved, ×2 (BEG 34911) from TC-946.*14,* Internal mold of cranidium, ×1½ (BEG 34912) from SS-67.*15,* Small pygidium with test preserved, ×2½ (BEG 34913) from LL-682.

16–18—Wilbernia halli Resser, var. A, Ellinwood, *16,17,* Cranidia with tests preserved, ×2 (BEG 34914) from CO-7, ×2½ (BEG 34915) from SS-60. *18,* Pygidium with test preserved, ×2 (BEG 34916) from MC-667.

19–21—Wilbernia pero (Walcott). *19,* Internal mold of cranidium, ×1¼ (BEG 34917) from JR-233. *20,* Internal mold of pygidium, ×1¼ (BEG 34918) from JR-233. *21,* Holotype cranidium, ×1 (USNM 23859) from USNM loc. 70, Morgan Creek.

EXPLANATION OF PLATE 55

FIGS. *1–3—Illaenurus quadratus* Hall. *1,2,* Cranidia with parallel and anteriorly divergent facial sutures, ×2½ (BEG 34919) from JR-357, ×2 (BEG 34920) from JR-374.5. *3,* Pygidium, ×1¼ (BEG 34921) from JR-369.5.

4,5—Irvingella major Ulrich & Resser. *4,* Internal mold of cranidium associated with *Eoorthis remnicha,* ×2½ (BEG 34922) from MC-661. *5,* Coquinite, ×1 (BEG 34923) from MC-659.

6—Dartonaspis wichitaensis (Resser), Internal mold of large cranidium, ×1 (BEG 34924) from MC-827.

7,8—*Chariocephalus whitfieldi* Hall. Internal molds of large cranidia, ×1 (BEG 34925) from MC-844, ×1 (BEG 34926) from MC-827.

P, *10*—*Rasettia magna* Ellinwood, n. sp. *9,* Internal mold of large holotype cranidium, ×1 (BEG 34927). *10,* Internal mold of large incomplete pygidium, ×1 (BEG 34928), both from 86T-13-14C, Squaw Creek Quadrangle (Barnes, 1952a), San Saba member, stromatolitic bioherm facies.

11–15—*Orygmaspis llanoensis* (Walcott). *11,* Holotype cranidium with most of test preserved, ×2 (USNM 23857) from USNM loc. 68, Packsaddle Mountain. *12,13,* Medium and small cranidia with all or part of tests preserved, ×1½ (BEG 34929) from LL-682, ×2½ (BEG 34930) from LL-682. *14,* Internal mold of large cranidium, ×1 (BEG 34931) from LL-682. *15,* Small cranidium with part of pitted test preserved, ×3 (BEG 34932) from TC-944.5.

16—*Orygmaspis firma* Frederickson. Internal mold of small cranidium, ×3 (BEG 34933) from CO-5.

EXPLANATION OF PLATE 56

FIGS. *1*—*Orygmaspis firma* Frederickson. Moderately large cranidium with most of test preserved. ×1-3/4 (BEG 34934) from CO-5.

2–5—*Stigmacephaloides curvabilis* Ellinwood, n. gen., n. sp. *2-4,* Large, medium, and small cranidia with tests preserved, ×1 (BEG 34935, holotype), ×1¾ (BEG 34936), ×2½ (BEG 34937), all from WC-1069. *5,* Medium librigena with test preserved, ×2½ (BEG 34938) from WC-1069.

6–11—*Parabolinoides hebe* Frederickson. *6,7,* Cranidia with tests preserved, ×1½ (BEG 34939) from ST-478, ×2 (BEG 34940) from CO-1. *8,* Internal mold of cranidium, ×1½ (BEG 34941) from TA-2. *9,* Small cranidium with ornamented test preserved, ×3½ (BEG 34942) from SS-46.5. *10,* Pygidium with test preserved only on tips of spines, ×1¼ (BEG 34943) from JR-122. *11,* Pygidium with test preserved, ×1½ (BEG 34944) from JR-122.

12—*Parabolinoides contractus* Frederickson. Cranidium with test preserved, ×1¼ (BEG 34945) from TC-935.5.

13–18—*Parabolinoides granulosus* Ellinwood, n. sp. *13,* Very small cranidium with test preserved, ×8 (BEG 34946) from LL-672. *14,* Small cranidia with tests preserved, ×3 (BEG 34947) from CO-0. *15,16,* Adult cranidia with tests preserved, ×1¾ (BEG 34948) from SS-46.5, ×1-3/4 (BEG 34949, holotype) from MC-661. *17,* Internal mold of medium cranidium, ×2 (BEG 34950) from SS-47. *18,* Pygidium with test preserved, ×2 (BEG 34951) from LL-672.

19–21—*Taenicephalus* sp. Small cranidia with tests preserved, ×6 (BEG 34952) from TA-35, ×6 (BEG 34953) from TC-975, ×8 (BEG 34954) from JR-169.

EXPLANATION OF PLATE 57

FIGS. *1–9*—*Taenicephalus gouldi* (Frederickson). *1,2,* Medium and large cranidia with test preserved, ×3 (BEG 34955), ×2 (BEG 34956), both from SK-204. *3,* Internal mold of large cranidium, ×1¾ (BEG 34957) from SK-204. *4,5,* Medium cranidia with tests preserved, ×2½ (BEG 34958) from PK-1, ×2¼ (BEG 34959) from TC-939. *6,7,* Small cranidia, the first an internal mold, the second with coarsely granulate test preserved, ×3 (BEG 34960), ×4 (BEG 34961), both from TC-939. *8,* Pygidium with test preserved, ×1¾ (BEG 34962) from TC-939. *9,* Small librigena with ornamented test preserved, ×4 (BEG 34963) from JR-126.3.

10–21—*Taenicephalus shumardi* (Hall). *10–13,* Medium and large cranidia with tests preserved, ×2 (BEG 34964) from SS-60, ×1¼ (BEG 34965) from JR-136, ×2 (BEG 34966) from TC-944.5, ×2 (BEG 34967) from TA-12. *14–16,* Small cranidia with tests preserved, ×4 (BEG 34968) from TA-12, ×4 (BEG 34969) from TA-35, ×4 (BEG 34970) from WC-898. *17,18,* Medium cranidia with tests preserved, ×2¼ (BEG 34971) from ST-511, ×2½ (BEG 34972) from SK-213. *19,21,* Small pygidia with tests preserved, ×3½ (BEG 34973) from LL-691, ×3½ (BEG 34975) from TA-42. *20,* Large pygidium with test preserved, ×1-3/4 (BEG 34974) from SK-213.

EXPLANATION OF PLATE 58

FIGS. *1–9*—*Conaspis masonensis* Ellinwood, n. sp. *1,2,* Small and medium cranidia with tests preserved, ×5 (BEG 34976), ×2½ (BEG 34977), both from JR-169. *3,4,* Medium and large cranidia with tests preserved, ×2½ (BEG 34978, holotype), ×1½ (BEG 34979), both from JR-169. *5,* Medium pygidium with test preserved, ×2½ (BEG 34980) from JR-169. *6,7,* Partial and entire internal molds of medium cranidia, ×2½ (BEG 34981), ×2½ (BEG 34982), both from SS-90. *8,9,* Small librigena and pygidium with tests preserved, ×4 (BEG 34983), ×6 (BEG 34984), both from SS-90.

10–13—Conaspis testudinatus Ellinwood, n. sp. *10–12,* Cranidia with tests preserved, ×5 (BEG 34985) from TC-944.5, ×3½ (BEG 34986, holotype) from CO-7, ×2½ (BEG 34987) from LL-682. *13,* Internal mold of cranidium, ×4 (BEG 34988) from JR-126.

14–17—Ptychaspis bullasa Lochman & Hu. *14—16,* Small and medium cranidia with tests preserved, ×4 (BEG 34989) from WC-950, ×5 (BEG 34990) from LL-725, ×2¼ (BEG 34991) from LL-725. *17,* Large cranidium with test preserved, ×1 (BEG 34992) from SU-104.

18—?Keithiella sp. Incomplete internal mold of cranidium, ×3 (BEG 34993) from JR-374.5.

19–21—Keithiella scrupulosa Ellinwood, n. sp. Internal molds of cranidia, ×3 (BEG 34994, 34995, 34996—holotype), all from SS-307.5.

EXPLANATION OF PLATE 59

FIGS. *1—Prosaukia* cf. *P. curvicostata* Ulrich & Resser. Internal mold of medium cranidium, ×2½ (BEG 34997) from JR-284.5.

2,3—Prosaukia cf. *P. tuberculata* Ulrich & Resser. *2,* Internal mold of medium cranidium in limestone, ×2½ (BEG 34998) from TC-1105. *3,* Internal mold of large cranidium in shale, ×1¼ (BEG 34999) from 159T-5-50A, Decker's (1945) graptolite locality in Point Peak member on Honey Creek, Mason Co.

4—Leiocoryphe occipitalis Rasetti. Internal mold of small cranidium, ×4 (BEG 35000) from SS-307.5.

5,6—Plethometopus convexus (Whitfield). Internal molds of large cranidia in chert, ×1-3/4 (BEG 35001), ×2 (BEG 35002), both from MC-1065.

7–9—Stenopilus pronus Raymond. *7,* Internal mold of cranidium in limestone, ×1½ (BEG 35003) from 41-3.1, 35 feet above stromatolite bioherm at Camp San Saba Bridge, McCulloch County. *8,9,* Internal molds of cranidia in chert, ×2 (BEG 35004, 35005) from MC-1065.

10—12—Ellipsocephaloides silvestris Resser. *10,* Cranidium with test preserved, ×7 (BEG 35006) from PP-82, top of Morgan Creek limestone on Point Peak (Bridge, Barnes & Cloud, 1947, pl. 5, fig. 1). *11,* Internal mold of cranidium, ×5 (BEG 35007) from SS-120. *12,* Internal mold of cranidium in shale, ×4 (BEG 35008) from 159T-5-50A, associated with specimen of fig. 3.

13–15—Taenicephalina globula Lochman & Hu. Cranidia with tests all or in part preserved, ×5 (BEG 35009) from CR-745, ×4 (BEG 35010) from WC-968, ×5 (BEG 35011) from ST-X.

16–21—Sinuella minuta Knight. *16,17,* Side views of calcitic steinkerns, that of fig. *16* seemingly in part septate, ×10 (BEG 35012, 35013) from CR-743. *18,* Side view of glauconitic steinkern, ×9 (BEG 35014) from ST-X. *19,20,* Side and oblique views of silicified fragmentary shell showing sinuous growth ridges, ×10 (BEG 35015) from 16T-6-40A), near McDougals Crossing, North Grape Creek Quadrangle (Barnes 1952c). *21,* Dorsal view of second whorl, glauconitic steinkern, ×10 (BEG 35016) from 16T-6-40A, same as figs. *19,20.*

EXPLANATION OF PLATE 60

FIGS. *1–7—Pseudodicellomus mosaicus* (Bell). *1–3,* Pedicle interiors, ×3½ (BEG 35017) from CO-4, (BEG 35018) from TA-14, (BEG 35019) from MC-782. *4,5,* Brachial interiors, ×3½ (BEG 35020) from CO-7, (BEG 35021) from ST-478. *6,* Partly exfoliated brachial exterior, ×3½ (BEG 35022) from SS-50. *7,* Greatly magnified pitted surface of a pedicle valve, ×60 (BEG 35023) from 41-18.1, Morgan Creek member, south slope of Point Peak (Bridge, Barnes & Cloud, 1947, pl. 1).

8–17—Angulotreta microscopica (Shumard). All ×10. *8–10,* Side and posterior views of pedicle valves, (BEG 35024, 35025) from LL-671.5, (BEG 35026) from CO-0. *11–14,* Pedicle interiors, (BEG 35027, 35028) from SS-46.5, (BEG 35029, neotype) from MC-661.5, (BEG 35031) from LL-673. *15,* Brachial exterior, (BEG 35033) from LL-671.5. *16,17,* Brachial interiors, (BEG 35030, neotype) from MC-661.5, (BEG 35032) from LL-673.

18,19—Angulotreta microscopica (Shumard) var. *digitalis* Bell, n. var. Brachial interiors, ×10 (BEG 35034, 35035) from CO-0.

EXPLANATION OF PLATE 61

FIGS. *1–3—Angulotreta triangularis* Palmer. All ×10. Pedicle interiors showing partial or complete apical rings, (BEG 35036, 35037) from WC-767, (BEG 35038, topotype) from WC-751.

4–9—Linnarssonella girtyi Walcott. All ×10. *3–6,* Brachial interiors, (BEG 35039–41) from CR-674. *7–9,* Pedicle interiors, (BEG 35042–44) from CR-674.

10–15—Ceratreta hebes Bell. All ×10 and from MC-661.5. *10,11,* Apical and posterior views of pedicle valves, (BEG 35045, 35046). *12,* Brachial interior, (BEG 35047). *13–15,* Pedicle interiors, (BEG 35048–50).

16–21—Billingsella rhomba Ellinwood, n. sp. *16,* Pedicle exterior, ×2¼ (BEG 35051) from LL-886. *17,* Brachial view of whole shell, ×2¼ (BEG 35052) from LL-887. *18,* Pedicle interior, ×2¼ (BEG 35053, holotype) from LL-885, *10,* Pedicle interior tilted to show perforate apical callosity, ×2 (BEG 35054) from LL-885. *20,21,* Brachial interiors, ×2¼ (BEG 35055, 35056) from LL-885.

EXPLANATION OF PLATE 62

FIGS. *1–10—Billingsella coloradoensis* (Shumard). *1,* Pedicle exterior, ×2 (BEG 35057, neotype) from MC-665. *2,3,* Brachial and pedicle exteriors, ×2 (BEG 35058, 35059) from CO-5. *4,5*—Pedicle exteriors, ×1½ (BEG 35060) from TC-939, ×1¼ (BEG 35061) from TA-2. *6,7,* Exterior and interior views of silicified pedicle valve, ×2 (BEG 35062) from SK-233. *8,* Interior view of silicified pedicle valve, ×2 (BEG 35063) from SK-233. *9,10,* Exterior and interior views of silicified brachial valve, ×2 (BEG 35064) from SK-233.

11–21—Billingsella texana Bell, n. sp. *11,* Pedicle exterior, ×2 (BEG 35067) from TC-948. *12–14,* Pedicle exterior, pedicle interior, brachial interior, ×2 (BEG 35068), ×2¼ (BEG 35069–70), all from TC-944.5. *15,16,* Interior views of silicified pedicle valves, ×2 (BEG 35071–72) from 16T-5-66D, near top of Morgan Creek member, North Grape Creek Quadrangle (Barnes, 1952c). *17,18,* Interiors of silicified pedicle valves, ×2 (BEG 35073–74) from SK-260. *19,* Exterior view of silicified pedicle valve, ×2 (BEG 35075, holotype) SK-260. *20,21,* Exterior and interior views of a brachial valve, ×2 (BEG 35076) from SK-260.

EXPLANATION OF PLATE 63

FIGS. *1–9—Billingsella corrugata inornata* Ellinwood, n. subsp. *1,2,* Interior and exterior views of a silicified pedicle valve, ×1½ (BEG 35078, holotype) from 41-9.1 =86T-13-19F, Squaw Creek Quadrangle (Barnes, 1952a). *3,4,* Exterior views of silicified pedicle valves, ×1½ (BEG 35079), ×1-3/4 (BEG 35080), both from LL-829. *5,* Exterior view of large fragmentary silicified pedicle valve, ×1 (BEG 35081) from 41-9.1, see fig. 1. *6,* Interior view of silicified pedicle valve, ×1¼ (BEG 35082) from 86T-13-19F, see fig. 1. *7,* Brachial view of complete silicified shell, ×1½ (BEG 35083) from LL-844. *8,9,* Exterior and interior views of a silicified brachial valve, ×1½ (BEG 35084) from 86T-13-19G, Squaw Creek Quadrangle (Barnes, 1952a).

10–15—Eoorthis remnicha (Winchell). *10,* Brachial exterior associated with *Eoorthis indianola* and *Parabolinoides hebe,* ×1 (BEG 35086) from TA-0.6. *11,* Brachial exterior associated with *Eoorthis indianola* and *Parabolinoides hebe,* ×1 (BEG 35087) from 86T-1-9D, Willow City Quadrangle (Barnes, 1952b). *12,* Holotype pedicle valve of *Eoorthis remnicha texana* (Walcott, 1912, pl. 92, fig. 4), not recognized herein as a valid subspecies, ×1 (USNM 52369a) from USNM loc. 71, Cold Creek Canyon, Burnet Co., Texas. *13,* Internal mold of pedicle valve, ×1 (BEG 35089) from TC-935.25. *14,* Internal molds of two brachial interiors, ×1 (BEG 35090) from Birkmose member of Franconia formation, roadcut on State Highway 35, 2 miles north of Hudson, Wis. (Nelson, 1951, p. 770, loc. 3). *15,* Holotype internal mold of pedicle valve, ×2 (Minn. 6070) collected by N. H. Winchell (1885) from Birkmose member of Franconia formation at Red Wing, Minn.

16,17—Eoorthis indianola (Walcott). *16,* Holotype pedicle valve, ×3 (USNM 52343b) from USNM loc. 12k, Honey Creek limestone, Ardmore Quadrangle, Carter Co., Okla.; on reverse side of same piece of rock is a specimen of *Irvingella major*. *17,* Slab from type locality bearing pedicle and brachial valves (see Walcott, 1912, pl. 94) associated with *Eoorthis remnicha* and *Parabolinoides hebe,* ×2 (USNM 52343) from USNM loc. 12k, see fig. 16.

EXPLANATION OF PLATE 64

FIGS. *1–8—Eoorthis indianola* (Walcott). *1,2,* Brachial and pedicle exteriors, ×3, ×4 (BEG 35092–93) from LL-671.8. *3,4,* Pedicle internal mold and exterior, ×3, ×3½ (BEG 35094–95) from SS-46. *5,* Exteriors of three pedicle valves; the upper two resemble the holotype of *Eoorthis indianola,* the lower one resembles the holotype of *Eoorthis wichitaensis* (Walcott, 1912, pl. 94, fig. 1), ×2 (BEG 35096) from TA-0.8. *6,7,* Brachial and pedicle exteriors,

×2½ (BEG 35097–98) from CR-697. *8,* Brachial exterior, ×2½ (BEG 35099), from TC-934.5.

9–13—Plectotrophia alata (Walcott). *9,* Exterior view of silicified pedicle valve, ×1¼ (BEG 35100) from CR-815-820. *10,* Interior view of silicified pedicle valve, ×1½ (BEG 35101) from LL-817. *11,* Exterior view of silicified brachial valve, ×1½ (BEG 35102) from LL-817. *12,13,* Exterior and interior views of a silicified brachial valve, ×1½ (BEG 35103) from LL-817.

14–17—Huenella abnormis (Walcott). *14,* Pedicle exterior, ×2½ (BEG 35105) from SS-60. *15,* Partly exfoliated brachial exterior, ×2½ (BEG 35106) from 55-54. *16,* Pedicle exterior, ×2 (BEG 35107) from SS-60. *17,* Brachial exterior, ×2½ (BEG 35108) from SU-49.

18–20—Huenella texana (Walcott). *18,* Pedicle exterior with one alate and one rounded postero-lateral angle, ×1-3/4 (BEG 35109) from TC-975. *19,20,* Brachial and pedicle exteriors, ×3 (BEG 35110–11) from WC-917.

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high in the Point Peak siltstone member of the Wilberns formation; the interval is an important stratigraphic marker, has been mapped over long distances by Barnes, and has been discussed by Bridge, Barnes, & Cloud (1947) and by Cloud & Barnes (1948).

Hundreds of silicified valves have been obtained from dozens of localities, and almost without exception each valve shows by its growth lines that it was strongly alate during its younger stages. Commonly the degree of alation becomes somewhat subdued in the adult valve as relatively more shell material was added to the lateral and anterolateral margins than to the postero-lateral corners during the late stages of growth. This is the common type of valve, and conforms to the original and subsequent definition of *P. alata,*

At and in the vicinity of Point Peak a couple of collections contain a high percentage of valves that are not alate in any stage of their growth. This is the type of shell that Ulrich & Cooper (1938, p. 198, pl. 40, figs. 5–7,9–22) described as *Plectotrophia bridgei,* and is from the same area. What its status will turn out to be I do not know, but I suspect that at best it should be regarded as a geographically restricted subspecies of *P. alata.*

Figured specimens.—

	Zone	BEG Numbers	Width
Pl. 64, fig. 9 (pedicle)	Pty.-Pro.	35100	15.3 mm.
10 "	"	35101	13.8
11 "	"	35102	13.8
12 (brachial)	"	35103	14.8
13 "	"	"	"

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