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LATE CAMBRIAN AND EARLIEST ORDOVICIAN TRILOBITES, TIMBERED HILLS AND LOWER ARBUCKLE GROUPS, WESTERN ARBUCKLE MOUNTAINS, MURRAY COUNTY, OKLAHOMA

JAMES H. STITT

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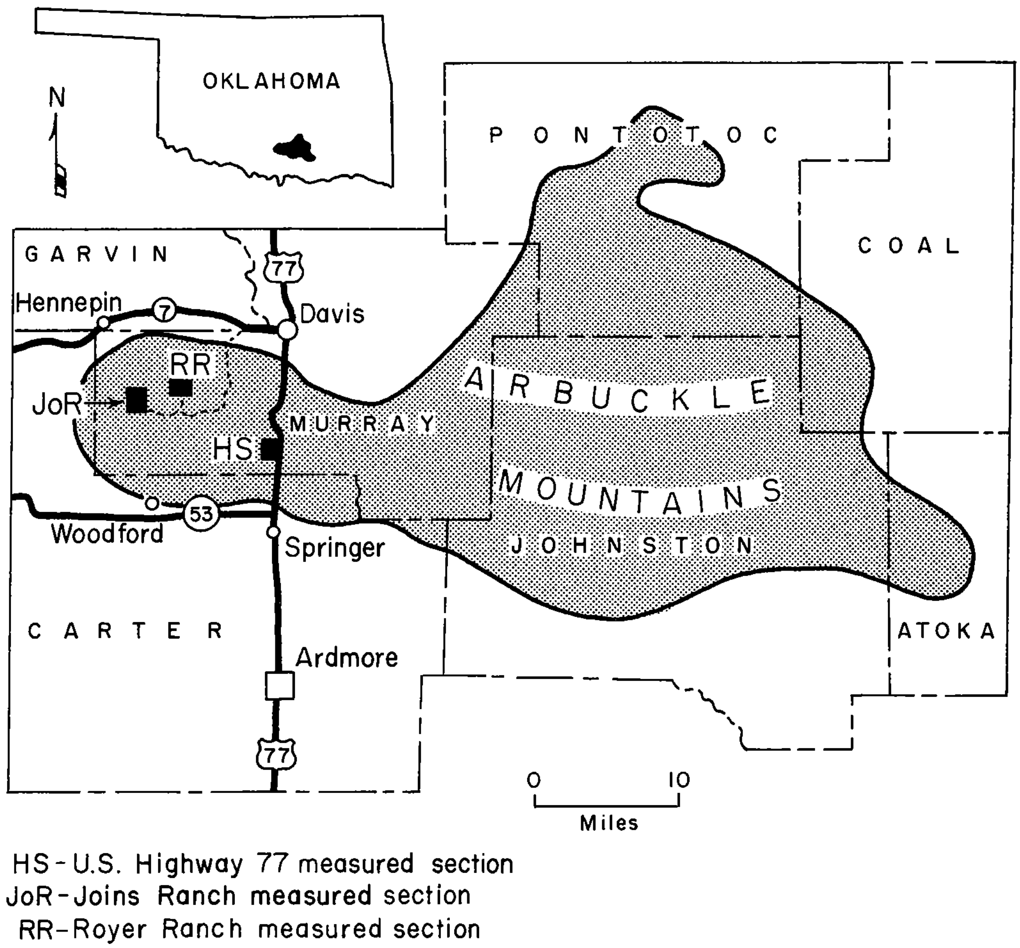

Figure 1. Index map showing outline of Arbuckle Mountains and locations of measured sections. Geology of areas inside boxes is shown in detail on maps accompanying measured sections.

LATE CAMBRIAN AND EARLIEST ORDOVICIAN TRILOBITES, TIMBERED HILLS AND LOWER ARBUCKLE GROUPS, WESTERN ARBUCKLE MOUNTAINS, MURRAY COUNTY, OKLAHOMA

JAMES H. STITT[1]

ABSTRACT—Trilobites were collected from each fossiliferous bed in three measured sections that constitute two composite sections through the Timbered Hills and lower Arbuckle Groups. Forty-four hundred prepared specimens, assigned to 99 species and 67 genera, include 2 new genera and new species of *Bynumina, Missisquoia, Morosa, Plethometopus, Plethopeltis,* and *Sulcocephalus.*

The Reagan Sandstone and overlying Honey Creek Limestone constitute the Timbered Hills Group. The oldest trilobites constitute the faunas of the *Elvinia, Taenicephalus,* and *Saratogia* Zones of the Upper Cambrian Franconian Stage. The *Elvinia* Zone occurs in the upper part of the Reagan and the lower part of the Honey Creek, the *Taenicephalus* Zone in the middle part of the Honey Creek, and the *Saratogia* Zone in the upper part of the Honey Creek and lower part of the overlying Fort Sill Limestone. A basal *Parabolinoides* Subzone is recognized in the *Taenicephalus* Zone. A basal *Idahoia lirae* Subzone and an overlying *Drumaspis* Subzone are recognized in the lower part of the *Saratogia* Zone.

Formations of the Arbuckle Group sampled for trilobites include the Fort Sill Limestone, Royer Dolomite, Signal Mountain Limestone, Butterly Dolomite, and basal McKenzie Hill Limestone (listed in ascending order). No trilobites were recovered from the Royer or Butterly Dolomite. Trilobites from the upper part of the Fort Sill and lower part of the Signal Mountain constitute the fauna of the *Saukia* Zone of the Upper Cambrian Trempealeauan Stage. The *Saukia* Zone is divided into four subzones: *Rasettia magna, Saukiella junia, Saukiella serotina,* and *Corbinia apopsis* (listed in ascending order).

Trilobites from the upper part of the Signal Mountain Limestone belong to the *Missisquoia* Zone, the lowest zone in the Lower Ordovician. Trilobites from the base of the McKenzie Hill Limestone belong to the *Symphysurina* Zone, the next highest zone in the Lower Ordovician. The Cambrian-Ordovician boundary lies within the Signal Mountain Limestone, not 400 feet higher at the base of the McKenzie Hill as previously believed.

The trilobites studied are similar to those of equivalent zones in central Texas. Abrupt faunal changes at the *Elvinia-Taenicephalus* and *Saukia-Missisquoia* Zone boundaries define the Ptychaspid Biomere, which has also been recognized in central Texas.

INTRODUCTION

The purpose of this investigation was to collect and describe the Late Cambrian and earliest Ordovician trilobites in the western Arbuckle Mountains, Murray County, Oklahoma, to chart the stratigraphic distribution of identified species, and to attempt to erect a biostratigraphic zonation.

The western Arbuckle Mountains are in Murray County in south-central Oklahoma (fig. 1). State Highways 7 and 53 provide access to the margins of the mountains, and U.S. Highway 77 cuts through them. County roads and pasture roads provide access to the interior part of the mountains.

The first geologic mapping in the Arbuckle Mountains was done by Taff (1902, 1903, 1904). His work was followed by a period of 50 years of paleontologic and stratigraphic work done without benefit of further and more detailed mapping. Persons making contributions during this time were Ulrich (1911, 1927, 1932), Walcott (1912a), Decker and Merritt (1928), Six (1929), Decker (1933, 1936, 1939a, 1939b, 1939c), Bridge (1936, 1937), and Ulrich and Cooper (1938). The emphasis on paleontology and the lack of understanding of the complex limestone-dolomite facies relationships in these rocks led to several stratigraphic misconceptions. Freder-

[1]Department of Geology, University of Missouri at Columbia, Columbia, Missouri.

ickson (1941, 1942, 1948a, 1948b, 1949, 1956) solved some of these problems and published descriptions and illustrations of the fauna of the Honey Creek Limestone. Ham (1951, 1955) mapped the Arbuckle Mountains in greater detail than anyone had previously, establishing the stratigraphic relationships among the lithic units recognized as formations. His cross section (1955, fig. 2) shows clearly the gradation from limestone in the west to dolomite in the east within the Timbered Hills and Arbuckle Groups that caused some of the earlier problems. Ham and others (1964), in their basement-rock study, changed several more long-standing concepts. Most important was their discovery that the rhyolites in the western Arbuckle Mountains and the Wichita Mountains are not Precambrian but probably Middle Cambrian.

Sections were measured with a 5-foot Jacob's staff and Brunton compass and were checked by Brunton-and-tape traverses. Each section was painted every 5 feet with a stripe of yellow paint, and the stripes were numbered every 25 feet above the base of the section. Every bed was sampled for fossils, and collections were bagged separately and labeled to correspond with the position of the bed above the base of the section. Rock samples were collected at least every 5 feet for lithologic study.

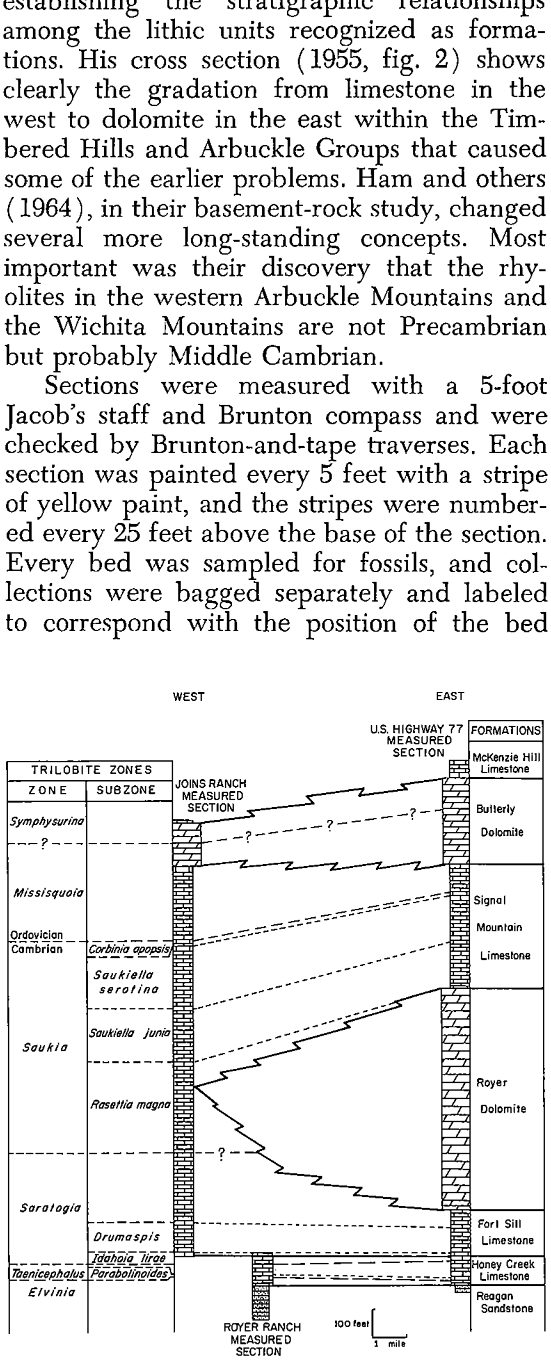

Figure 2. Relationship between formations and trilobite zones in Timbered Hills and lower Arbuckle Groups.

The fossils were prepared, identified, and described at The University of Texas at Austin from 1966 to 1968.

ACKNOWLEDGMENTS

I want to thank W. C. Bell, who suggested and supervised this investigation and who gave freely of his time, encouragement, and advice during its progress. I am most grateful to the late William E. Ham of the Oklahoma Geological Survey, who showed me the best areas for collecting, checked my field work, and read and criticized the manuscript. A. R. Palmer, Christina Lochman-Balk, K. P. Young, and A. J. Scott read and criticized the manuscript, and I thank them for suggested improvements. Discussion with J. R. Derby and R. A. Robison was also helpful.

I am indebted to Susan A. Longacre, who studied equivalent faunas from central Texas. Her willingness to discuss and compare our projects was of immeasurable benefit to me.

I thank Wayne Jolly for serving as my field assistant during the summer of 1964. The ranchers and foremen in the western Arbuckle Mountains were most generous in allowing me to collect fossils on their ranches.

For the loan of requested material I want to thank Porter Kier and G. A. Cooper of the U.S. National Museum, Copeland MacClintock of Yale's Peabody Museum of Comparative Zoology, René Bureau of Laval University in Quebec, Canada, and Patrick K. Sutherland of The University of Oklahoma. The Oklahoma Geological Survey provided aerial photographs of the collecting areas.

I want to thank the faculty of the Department of Geological Sciences of The University of Texas at Austin for providing a stimulating atmosphere for graduate work. Field work was supported by two National Science Foundation fellowships; work at The University of Texas at Austin was supported by a university fellowship and a National Defense Education Act Title IV Fellowship. I am grateful for these fellowships.

Very special thanks go to my wife, who was my field assistant in the summer of 1965, who typed and edited the original manuscript, and who lent her patience, understanding, and encouragement to my efforts.

Lithostratigraphy

Timbered Hills Group

Decker (1933, p. 55) proposed the term Timbered Hills Group to include the Reagan Sandstone, Cap Mountain Limestone, and Honey Creek Limestone. Ham (1949, p. 19-20) showed the Cap Mountain to be sandy, dolomitized Honey Creek. Consequently, the Timbered Hills Group is used here in the sense of Ham (1955, p. 4) and includes the Reagan Sandstone and Honey Creek Limestone.

Reagan Sandstone

As originally proposed by Taff (1902, p. 3; 1903, p. 3), the Reagan Sandstone included some limestone beds now recognized as the lower part of the Honey Creek Limestone. Ulrich (1911, p. 661) proposed the name Honey Creek Member for these and younger limestone beds and later (1932, p. 742-743) raised the Honey Creek to a formation. Since then the term Reagan Sandstone has been used for the reddish sandstone immediately overlying the basement igneous-rock complex.

The Reagan Sandstone is mostly brownish, fine- to coarse-grained, limonitic, glauconitic, feldspathic quartz sandstone. It is locally quartz cemented but normally is poorly cemented and is a slope former. Flattened phosphatic brachiopods and scarce trilobites occur in the upper part of the Reagan.

Thickness of the Reagan depends on the topography developed on the eroded igneous basement complex. A maximum thickness of 460 feet has been reported in the western Arbuckle Mountains (Ham, 1955, p. 10-11). The Reagan was sampled only where fossils were collected: the upper 112 feet in the Royer Ranch section and the upper 18 feet in the U.S. Highway 77 section.

The Reagan Sandstone is unconformable upon the Colbert Rhyolite but has a conformable and gradational boundary with the overlying Honey Creek Limestone.

Honey Creek Limestone

The Honey Creek Limestone is used here in the sense of Ham (1955, p. 4), who was first to map this lithologic unit in the western Arbuckle Mountains.

The Honey Creek is a gray, glauconitic trilobite pelmatozoan biosparite and biomicrite. Minor constituents include phosphatic and calcitic brachiopods, ferroan dolomite, and fine sand to silt-size quartz.

It is rather uniform in thickness and is present everywhere in the western Arbuckle Mountains above the Reagan Sandstone and below the Fort Sill Limestone. The Honey Creek is 102 feet thick in the Royer Ranch section and 101 feet thick in the U.S. Highway 77 section.

Where examined in the field, the Honey Creek Limestone has conformable and gradational boundaries with both the underlying Reagan Sandstone and the overlying Fort Sill Limestone. The glauconitic granular character of the Honey Creek distinguishes it in the field from the white micritic limestone of the Fort Sill.

Arbuckle Group

Decker (1933, p. 55) proposed the term Arbuckle Group to include, in ascending order, the Fort Sill Limestone, Royer Marble, Signal Mountain Limestone, Chapman Ranch Dolomite, McKenzie Hill Limestone, and Wolf Creek Dolomite. These formations were mapped in the western Arbuckle Mountains for the first time by Ham (1951, 1955). The Arbuckle Group, as now defined, consists of the Fort Sill Limestone, Royer Dolomite, Signal Mountain Limestone, Butterly Dolomite, McKenzie Hill Limestone, Cool Creek Limestone, Kindblade Limestone, and West Spring Creek Limestone.

Fort Sill Limestone

Ulrich (1932, p. 744) proposed the name Fort Sill Formation from exposures in the Wichita Mountains, and it is used here as defined by Ham (1955, p. 4).

The lower part of the Fort Sill Limestone is predominantly gray, very sparse trilobite biomicrite with lesser amounts of pelsparite and intrasparite. Minor constituents include sponge spicules, phosphatic, calcitic, and silicified brachiopods, dolomite, silt- to fine sand-size quartz, and glauconite. This lithology is the only one present at the U.S. Highway 77 section. In the Joins Ranch section the upper 168 feet of the Fort Sill is predominantly algal biomicrite, with lesser amounts of pelsparite, intrasparite, and trilobite biomicrite. *Cryptozoon*-type algal heads are common to abundant in the upper 100 feet of the Fort Sill at this locality.

The Fort Sill Limestone is 577 feet thick at the Joins Ranch section and thins eastward to only 154 feet at the U.S. Highway 77 section (fig. 2; Ham, 1955, fig. 2). This eastward thinning results from the dolomitization of the upper part of the Fort Sill; the dolomite is mapped as a part of the Royer Dolomite, which shows a corresponding eastward thickening.

The Fort Sill has a conformable and gradational boundary with the underlying Honey Creek Limestone. In the Joins Ranch section, where the Fort Sill has its maximum thickness in the Arbuckle Mountains, the top of the Fort Sill Formation is placed at the top of a thick stromatolitic limestone sequence. Its boundary with the overlying Signal Mountain Limestone is conformable. In the U.S. Highway 77 section the contact between the Fort Sill Limestone and the overlying Royer Dolomite is conformable and slightly irregular along strike because of the replacement nature of the dolomite.

Royer Dolomite

This formation was called the Royer Marble by Ulrich (1927, p. 28) and is used here as defined by Ham (1955, p. 4).

The Royer Dolomite is predominantly brown or gray, medium- to very coarsely crystalline dolomite. Lesser quantities of white, coarsely crystalline dolomite and grayish-brown, medium- to finely crystalline dolomite are present. At the U.S. Highway 77 section a 111-foot-thick limestone lens is present slightly above the middle of the Royer. Ham (1968, pers. comm.) observed on stained slabs and thin sections of Royer Dolomite the same textures that he found in the Fort Sill and Signal Mountain Limestones. He concluded from these observations and field relations that the Royer is dolomitized Fort Sill and Signal Mountain, and I agree with this interpretation.

The Royer Dolomite is not present in the Joins Ranch section but crops out just east of this section and expands rapidly eastward to a thickness of 752 feet in the U.S. Highway 77 section. This eastward thickening is accomplished mainly by dolomitization of the Fort Sill Limestone and, to a lesser extent, the Signal Mountain Limestone; both formations thin markedly in the same direction (fig. 2; Ham, 1955, fig. 2).

In the U.S. Highway 77 section the Royer has conformable boundaries with both the underlying Fort Sill and the overlying Signal Mountain. The boundaries are solely the result of dolomitization of limestone and are slightly irregular along strike.

Signal Mountain Limestone

Ulrich (1932, p. 746) named the Signal Mountain Formation from exposures in the Wichita Mountains, and it is used here as defined by Ham (1955, p. 4).

The Signal Mountain Limestone is composed of mixed calcarenites, calcirudites, and calcilutites. Trilobite biomicrite and intrasparite predominate, with lesser amounts of intramicrite, oösparite, oömicrite, and pelsparite. These lithologies occur in separate beds or mixed together in all combinations in single beds. Minor constituents include dolomite, glauconite, fine quartz sand, scarce sponge spicules, algal stromatolites, brachiopods, and gastropods.

The Signal Mountain Limestone is 735 feet thick in the Joins Ranch section, where it overlies the Fort Sill Limestone. In this section the Royer Dolomite is absent, and the overlying Butterly Dolomite is thinner than in the U.S. Highway 77 section. The Signal Mountain thins to the east (fig. 2; Ham, 1955, fig. 2) as the Royer and Butterly Dolomites thicken. In the U.S. Highway 77 section the Signal Mountain is only 414 feet thick.

In the Joins Ranch section the Signal Mountain is underlain by the Fort Sill Limestone; in the U.S. Highway 77 section the Royer Dolomite underlies the Signal Mountain. In both sections the boundaries are conformable. The Signal Mountain is conformably overlain everywhere by the Butterly Dolomite. The contacts between the Signal Mountain and the Royer and Butterly Dolomites are slightly irregular along strike because of the replacement nature of the dolomite.

Butterly Dolomite

The Butterly Formation was named by Decker (1939b, p. 1317), and the areal extent in the western Arbuckle Mountains was mapped by Ham (1951, 1955).

The Butterly Dolomite is predominantly brown, finely to coarsely crystalline, sandy dolomite. Lesser amounts of white, coarsely crystalline dolomite are present.

The Butterly Dolomite is 151 feet thick in the Joins Ranch section and thickens eastward to 286 feet in the U.S. Highway 77 section. This eastward thickening is accomplished by dolomitization of the highest part of the Signal Mountain and the lowest part of the McKenzie Hill (fig. 2; Ham, 1955, fig. 2).

The Butterly Dolomite overlies the Signal Mountain Limestone and underlies the McKenzie Hill Limestone. Both boundaries are conformable, although they are slightly irregular along strike because of the replacement nature of the dolomite.

McKenzie Hill Limestone

The McKenzie Hill Limestone was named by Decker (1933, p. 55; 1939b, p. 1318) from exposures in the Wichita Mountains and is used here as defined by Ham (1955, p. 1, 4).

This is the highest formation sampled, and only the basal beds were examined. Intrasparite, pelsparite, and sparse trilobite biomicrite are the dominant lithologies. Lesser constituents include rhombs, lenses, and beds of dolomite and scattered authigenic quartz sand. Algal stromatolites are locally conspicuous.

The McKenzie Hill Limestone overlies the Butterly Dolomite. Only the basal 7 feet in the Joins Ranch section and the basal 65 feet in the U.S. Highway 77 section were sampled.

The McKenzie Hill conformably overlies the Butterly Dolomite; the boundary is slightly irregular along strike because of the replacement nature of the dolomite.

DEPOSITIONAL HISTORY

The rocks sampled in this study are believed to have formed in shallow water on a broad and moderately rapidly subsiding shelf. The Reagan Sandstone is probably a nearshore deposit that accumulated upon a subsiding craton during transgression of a Late Cambrian (Franconian?) sea. As the area became completely inundated, shallow-water limestone, now called the Honey Creek, Fort Sill, and Signal Mountain Limestones, was deposited. That these beds of limestone were deposited in shallow water is indicated by (1) the variety of lithologies, (2) the abundance of sparry calcite cement, indicating bottom currents strong enough to remove mud, (3) numerous intraclastic and oölitic rocks, (4) algal "heads," oncolites, and other structures of probable algal origin, (5) cross-bedded pelsparites, and (6) a moderately abundant and diverse fauna (trilobites, brachiopods, gastropods, sponges, conodonts, and algae). These features characterize various modern shallow-water deposits, and I believe that the rocks under study were also deposited in shallow water.

The western Arbuckle Mountains was an area of moderately rapid accumulation and subsidence during the Late Cambrian and Early Ordovician. In the north and northeastern Arbuckle Mountains, the Reagan-Butterly interval is only one-half as thick (Ham, 1955, p. 1; fig. 2) as in the area of study.

Biostratigraphy

The trilobite zonation used here is the one that I feel is most useful in the western Arbuckle Mountains. The base of any particular zone is defined by the lowest occurrence of one or more distinctive and usually abundant taxa. The top of the zone is defined by the base of the next overlying zone. This follows the suggestion of Grant (1962, p. 976), and recent zonations of Upper Cambrian trilobites using this principle have been erected by Grant (1965), Winston and Nicholls (1967), and Longacre (1970).

Because Upper Cambrian trilobites have been studied in detail in many areas during the last century, a body of knowledge has accumulated through which locally useful zonations have been erected. Howell (1944) and Raasch (1952) proposed regional zonations that have been used in correlating faunal information from widely separated areas. Their zonations were based on faunas from the type area for the Upper Cambrian in the Upper Mississippi Valley, where trilobites are preserved in sandstone. As more areas outside the type area have been studied, the resulting lithofacies picture of the Upper Cambrian shows that the sandstone in the type area is surrounded by a broad belt of predominantly carbonate rocks, which in turn grade laterally into interbedded shale and limestone at what were probably the margins of the Late Cambrian craton. The distribution of some Late Cambrian trilobites seems to reflect to some extent the lithofacies pattern. Certain trilobite genera (e.g., *Conaspis, Ptychaspis, Prosaukia*) occur in abundance in the sandstone of the Upper Mississippi Valley and are scarce or nonexistent in most carbonate rocks. Other genera (e.g., *Elvinia, Irvingella, Taenicephalus*) occur in abundance in both sandstone and limestone, and still others (e.g., *Bayfieldia, Euptychaspis, Saratogia*) are more abundant in or even restricted to the carbonate areas. (For documentation of this, check the generic and specific *abundances* reported from various areas by Bell and others (1952), Bell and Ellinwood (1962), Berg (1953), DeLand and Shaw (1956), Grant (1962, 1965), Lochman and Hu (1959), Longacre (1970), Nelson (1951), Wilson (1948, 1949, 1951), Winston and Nicholls (1967), and this paper.)

I contend that a zonation based primarily on trilobites found in any one of the three major lithofacies will be completely suitable for that lithofacies only, and it will be less useful in areas where other lithofacies predominate. Longacre (1970, p. 6-12) recently proposed a zonation for the upper Franconian and Trempealeauan Stages, utilizing trilobite genera reported from both the sandstone and the carbonate lithofacies. This is not a zonation based solely on central Texas and southern Oklahoma trilobites, but one that incorporates faunal information published from various parts of the United States in the 25 years since the Cambrian Correlation Chart was synthesized. A small miracle would have been performed if Howell (1944) had established a zonation that correctly anticipated all of the faunal information and distributions that have been published since 1944. Alternate zonations have been proposed by Shaw (1954), Shaw and DeLand (1955), and Grant (1965), all working in areas outside the Upper Mississippi Valley. Cambrian paleontologists will never have a completely satisfactory zonation (or set of zonations) unless we continue to express our opinions about the usefulness of whatever zonation is currently recognized as "the best" or "the standard." How useful Longacre's zonation will be in the shale and limestone lithofacies in the western United States will be known soon, for work on equivalent faunas is currently in progress in the Great Basin.

The zonation I have erected for the western Arbuckle Mountains matches most closely the zonations established in central Texas by Wilson (1949), Winston and Nicholls (1967), and Longacre (1970). The abundant faunal elements and their stratigraphic ranges and associations are for the most part strikingly similar. Less similarity is present when comparing trilobites of the western Arbuckle Mountains with those reported from the Appalachian Mountains, Upper Mississippi Valley, Montana-Wyoming, and the Great Basin.

CAMBRIAN

FRANCONIAN STAGE

Trilobites from the Reagan Sandstone, Honey Creek Limestone, and lower part of the Fort Sill Limestone constitute the faunas of the *Elvinia, Taenicephalus,* and *Saratogia* zones of the Franconian Stage.

Elvinia ZONE

The following species constitute the fauna of the *Elvinia* Zone (pls. 9, 11, 12):

Apachia trigonis Frederickson
Burnetiella ectypa (Resser)
Camaraspis convexa (Whitfield)
Cliffia lataegenae (Wilson)
Comanchia amplooculata (Frederickson)
Deckera completa Wilson
Dellea suada (Walcott)
Dellea? *punctata* Palmer
Dokimocephalus curtus (Resser)
Dokimocephalus intermedius (Resser)
Elvinia roemeri (Shumard)
Homagnostus tumidosus (Hall and Whitfield)
Irvingella major Ulrich and Resser
Kindbladia wichitaensis (Resser)
Morosa? *bothra* Stitt, n. sp.
Morosa simplexa Stitt, n. sp.
Plataspella anatina (Resser)
Pseudagnostus communis (Hall and Whitfield)
Pterocephalia sanctisabae Roemer
Sulcocephalus candidus (Resser)
Sulcocephalus cereus Stitt, n. sp.
Sulcocephalus latus (Frederickson)
Xenocheilos minutum Wilson

Trilobites of the *Elvinia* Zone occur in at least the upper part of the Reagan Sandstone and in the lower part of the Honey Creek Limestone (fig. 2). In the Royer Ranch section, specimens of *Sulcocephalus latus, Sulcocephalus cereus,* and *Elvinia roemeri* were collected from fine-grained sandstone 42 to 45 feet below the top of the Reagan Sandstone. These collections establish the present base of the *Elvinia* Zone in the Arbuckle Mountains.

These specimens are the first trilobites ever found in the Reagan Sandstone. Previously the only faunal elements recovered from the Reagan were brachiopods that were usually too fragmented for specific identification (Frederickson, 1956, p. 490). Walcott (1912a, p. 175, 577) identified specimens of *Dicellomus politus,* a Dresbachian brachiopod, from the Reagan Sandstone in the Wichita Mountains, and this led to the conclusion that the Reagan was Dresbachian (Frederickson, 1956, p. 490). I borrowed Walcott's specimens, and they were examined by W. C. Bell. He reports that they are not *Dicellomus* (pers. comm.), thus removing the only evidence for a Dresbachian age of the Reagan.

Sulcocephalus cereus has been reported in association with *Elvinia roemeri, Camaraspis convexa,* and *Pterocephalia sanctisabae* from the Welge Sandstone Member of the Wilberns Formation in central Texas (Wollman, 1952, p. 18; Jansen, 1957, p. 150). The association in the Royer Ranch section of *S. cereus* with the *Elvinia* Zone taxa *Sulcocephalus latus* and *Elvinia roemeri* indicates that at least the upper 45 feet of the Reagan Sandstone in the Royer Ranch section is Franconian. Unfortunately no fossils were recovered from the coarser grained middle or lower parts of the Reagan; ground water and outcrop leaching have probably dissolved any fossils that might have been present. Whether or not the entire Reagan is Franconian is therefore impossible to tell at this time. I suspect that it is and that the Reagan was deposited as basal, nearshore sandstone during the same early Franconian transgression that deposited the Welge Sandstone in central Texas.

The top of the *Elvinia* Zone is defined by the base of the *Taenicephalus* Zone. A coquina dominated by specimens of *Irvingella major, Sulcocephalus candidus,* and *Comanchia amplooculata* occurs at the top of the *Elvinia* Zone. This coquina has wide regional distribution (Wilson and Frederickson, 1950) and is a distinctive marker of the top of the *Elvinia* Zone.

As can be seen from the range charts (pls. 9, 11, 12), the top of the *Elvinia* Zone is one of the two most abrupt faunal changes encountered in this study. Its significance will be discussed in the section on biomeres.

The *Elvinia* Zone in the western Arbuckle Mountains is equivalent to the *Elvinia* Zone in central Texas (Wilson, 1949, p. 29-30), Montana-Wyoming (Grant, 1965, p. 82), and the Upper Mississippi Valley (Nelson, 1951, p. 767, 769, table 1; Bell and others, 1952, p. 177, table 1); it is probably equivalent to the *Elvinia* Zone in the southern Appalachians (Wilson, 1951, p. 618, table 1) and the Great Basin (Palmer, 1965b, pl. 21).

Taenicephalus ZONE

The *Taenicephalus* Zone is characterized by the following species (pls. 9, 11, 12):

Conaspis testudinata Ellinwood
Croixana bipunctata (Shumard)
Orygmaspis llanoensis (Walcott)
Parabolinoides contractus Frederickson
Parabolinoides granulosus Ellinwood
Pseudagnostus communis (Hall and Whitfield)
Taenicephalus gouldi (Frederickson)
Taenicephalus shumardi (Hall)
Wilbernia expansa Frederickson
Wilbernia halli Resser

Most of these species make their first appearance in this zone and are restricted to it. *Pseudagnostus communis* and *Wilbernia expansa* range into the overlying *Saratogia* Zone. A few specimens of *Irvingella major, Sulcocephalus candidus,* and *Comanchia amplooculata,* common in a coquina at the top of the *Elvinia* Zone, occur at the base of the *Taenicephalus* Zone.

Trilobites of the *Taenicephalus* Zone occur in the middle part of the Honey Creek Limestone (fig. 2). The top of the zone is at the base of the overlying *Saratogia* Zone. A *Parabolinoides* Subzone is recognized at the base of the *Taenicephalus* Zone.

The *Taenicephalus* Zone is equivalent to the *Taenicephalus* Zone of Shaw (1954, chart 2), Shaw and DeLand (1955, p. 41), Grant (1965, p. 84), and Longacre (1970, p. 9-10). It is also equivalent to the *Conaspis* Zone of Howell (1944); Nelson (1951, p. 769, table 1); Bell and others (1952, p. 177, table 1); and Berg (1953, p. 556).

Parabolinoides Subzone.—This subzone is defined on the range of the genus *Parabolinoides* and contains three species, *Parabolinoides contractus, Parabolinoides granulosus,* and *Pseudagnostus communis.* This subzone defines the base of the *Taenicephalus* Zone and is 4.7 feet thick in the Royer Ranch section and 8 feet thick in the U.S. Highway 77 section (fig. 2).

Parabolinoides occurs at the base of the *Taenicephalus* (or *Conaspsis*) Zone in central Texas (Bell and Ellinwood, 1962, p. 400; Longacre, 1970, p. 10), Montana-Wyoming (Grant, 1965, p. 84), and the Upper Mississippi Valley (Berg, 1953, p. 556).

Saratogia ZONE

The *Saratogia* Zone is characterized by the following species (pls. 9-12):

Conaspis cf. *C. tumida* Kurtz
Dartonaspis wichitaensis (Resser)
Dikelocephalus sp. 1
Drumaspis idahoensis Resser
Drumaspis texana Resser
Ellipsocephaloides silvestris Resser
Idahoia lirae (Frederickson)
Pseudagnostus communis (Hall and Whitfield)
Rasettia capax (Billings)
Saratogia fria Lochman and Hu
Saratogia modesta (Lochman and Hu)
Stigmacephaloides curvabilis Ellinwood
Wilbernia diademata (Hall)
Wilbernia expansa Frederickson

Most of these species make their first appearance in this zone. The only exceptions are *Wilbernia expansa* and *Pseudagnostus communis,* which also occur in underlying zones. None of these species occurs in the overlying *Saukia* Zone of the Trempealeauan Stage, and only one genus, *Rasettia,* occurs in both the *Saratogia* and *Saukia* Zones.

Trilobites of the *Saratogia* Zone are present in the upper part of the Honey Creek Limestone and from the base to slightly above the middle of the Fort Sill Limestone (fig. 2). The top of the zone is at the base of the overlying *Saukia* Zone. An unfossiliferous interval of 41 feet occurs at the top of the *Saratogia* Zone in the Joins Ranch section. The absence of trilobites is probably related to the increased algal content of these rocks and their deposition in very shallow water or possibly even a supratidal environment.

Two subzones are recognized in the lower part of the *Saratogia* Zone: a basal *Idahoia lirae* Subzone and an immediately overlying *Drumaspis* Subzone (fig. 2). The upper part of the *Saratogia* Zone is characterized by (1) fewer specimens and (2) species with longer ranges than those characterizing either subzone.

The *Saratogia* Zone is equivalent to the *Idahoia* and *Ellipsocephaloides* Zones of central Texas (Longacre, 1970, p. 8, 10-11), the *Idahoia* and *Prosaukia* Zones of Grant (1965, p. 85-87), and the *Ptychaspis-Prosaukia* Zone of the Upper Mississippi Valley (Nelson, 1951, p. 769, table 1; Bell and others, 1952, p. 177, table 1; Grant, 1962, p. 974, table 2; Berg, 1953, p. 557).

Idahoia lirae Subzone.—This subzone is defined on the range of *Idahoia lirae,* which occurs in abundance at the base of the *Saratogia* Zone (fig. 2). Associated with *I. lirae* in this subzone are *Conaspis* cf. *C. tumida* and *Wilbernia diademata.*

The *Idahoia lirae* Subzone is equivalent to the *Idahoia lirae* Subzone in central Texas (Longacre, 1970, p. 10). It is probably equivalent to the lower part of the *Idahoia wyomingensis* Subzone of Montana - Wyoming (Grant, 1965, p. 86), the *Stigmacephalus oweni* faunule (Nelson, 1951, p. 769, table 1), and the *Psalaspis* zonule (Bell and others, 1952, p. 177, table 1; Grant, 1962, p. 973-978, table 2) in the Upper Mississippi Valley.

Drumaspis Subzone.—This subzone is defined on the range of the genus *Drumaspis. Drumaspis texana* occurs in the lower part of this subzone, and *Drumaspis idahoensis* makes its first appearance high in the range of *D. texana* and continues to the top of the subzone. Other trilobites making their first appearance in this subzone include *Ellipsocephaloides silvestris, Ptychaspis* sp. undet., *Saratogia fria,* and *Saratogia modesta* (pls. 9, 10, 12); of these only *Ptychaspis* sp. undet. and *Saratogia modesta* are restricted to the subzone.

The *Drumaspis* Subzone occurs in the lower part of the Fort Sill Limestone (fig. 2) and is equivalent to the upper part of the *Idahoia* Zone of central Texas (Longacre, 1970, p. 10) and the *Ptychaspis granulosa* and *Ptychaspis striata* zonules of Minnesota (Grant, 1962, p. 974, table 2).

TREMPEALEAUAN STAGE

Trilobites from the upper part of the Fort Sill Limestone and slightly more than the lower half of the Signal Mountain Limestone constitute the faunas of the *Saukia* Zone of the Trempealeauan Stage.

Saukia ZONE

The most abundant trilobites in this zone are species of *Rasettia, Stenopilus, Plethometopus, Idiomesus, Euptychaspis, Eurekia,* and *Bayfieldia.*

The *Saukia* Zone in the western Arbuckle Mountains is equivalent to the *Saukia* Zone of the Upper Mississippi Valley (Raasch, 1952, p. 148-149, chart 1). The base of the *Saukia* Zone in the western Arbuckle Mountains is slightly lower biostratigraphically than the base of this zone in central Texas, which probably extends down into the unfossiliferous Point Peak Siltstone (Longacre, 1970, p. 11). Otherwise the faunal similarity between these two areas is striking.

Previous attempts at zonation of this interval in the Arbuckle Mountains were frustrated by the long, overlapping ranges of the dominant genera and species (Frederickson, 1956, p. 500). Recent detailed work on this interval in central Texas by Winston and Nicholls (1967) and Longacre (1970) established a subzonation of the *Saukia* Zone that is applicable in the western Arbuckle Mountains. Winston and Nicholls divided this zone in central Texas into four subzones: Lower Trempealeauan, *Saukiella junia, Saukiella norwalkensis,* and *Corbinia apopsis* (listed in ascending order). Longacre recognized the same subzones but renamed the Lower Trempealeauan the *Saukiella pyrene* Subzone and changed the name *Saukiella norwalkensis* to *Saukiella serotina.*

I recognize four subzones in the *Saukia* Zone in the western Arbuckle Mountains. They are, in ascending order, the *Rasettia magna* Subzone, the *Saukiella junia* Subzone, the *Saukiella serotina* Subzone, and the *Corbinia apopsis* Subzone. The equivalence of these subzones to their counterparts in central Texas is indicated in the discussion of each subzone.

Rasettia magna Subzone.—The following species define this subzone and are confined to it (pls. 9, 10, 12):

Illaenurus quadratus Hall
Leiocoryphe occipitalis Rasetti
Monocheilus truncatus Ellinwood
Plethometopus convergens (Raymond)
Plethometopus granulosus Stitt, n. sp.
Rasettia magna Ellinwood
Saukiella pyrene (Walcott)
Spinacephalus frontis Stitt, n. sp.
Stenopilus pronus Raymond
Theodenisia microps (Rasetti)

In addition, *Bayfieldia binodosa* (Hall) and *Eurekia granulosa* Walcott make their first appearance in this subzone and also occur in the overlying *Saukiella junia* Subzone. *Bowmania pennsylvanica* Rasetti occurs in all four subzones of the *Saukia* Zone.

The base of the *Rasettia magna* Subzone is defined by the lowest occurrence of *Leiocoryphe occipitalis, Stenopilus pronus,* and *Theodenisia microps* (pls. 9, 12). The top of this subzone is the base of the overlying *Saukiella junia* Subzone.

The lower part of the *Rasettia magna* Subzone is equivalent to the *Illaenurus* Zone of Montana-Wyoming (Grant, 1965, p. 88), and at least the upper half of this zone in the western Arbuckle Mountains is equivalent to the *Saukiella pyrene* Subzone of central Texas (Longacre, 1970, p. 11-12).

Saukiella junia Subzone.—The following species make their first appearance in this subzone (pls. 9, 10, 12):

Acheilops masonensis Winston and Nicholls
Bayfieldia simata Winston and Nicholls
Bynumiella oklahomensis Resser
Bynumina vescula Stitt, n. sp.
Euptychaspis jugalis Winston and Nicholls
Euptychaspis typicalis Ulrich
Eurekia eos (Hall)
Idiomesus levisensis (Rasetti)
Magnacephalus smilus Stitt, n. sp.
Rasettia wichitaensis (Resser)
Saukia tumida Ulrich and Resser
Stenopilus latus Ulrich
Theodenisia sp. undet.
Triarthropsis limbata Rasetti
Triarthropsis marginata (Rasetti)

Only *Magnacephalus smilus, Saukia tumida, Theodenisia* sp. undet., and *Triarthropsis limbata* are confined to this subzone. All other species also occur in the overlying *Saukiella serotina* Subzone, and *Idiomesus levisensis, Stenopilus latus,* and *Triarthropsis marginata* also occur at the base of the *Corbinia apopsis* Subzone. *Bowmania pennsylvanica* occurs in the *Saukiella junia* Subzone, having made its first appearance in the underlying *Rasettia* *magna* Subzone, and extends into the base of the *Corbinia apopsis* Subzone.

The base of the *Saukiella junia* Subzone is defined by the lowest occurrence of *Saukia tumida, Triarthropsis limbata,* or *Euptychaspis typicalis* (pls. 10, 12). Its top is the base of the overlying *Saukiella serotina* Subzone.

The *Saukiella junia* Subzone of the western Arbuckle Mountains is equivalent to the *S. junia* Subzone of central Texas (Winston and Nicholls, 1967, p. 67, 69; Longacre, 1970, p. 12).

Saukiella serotina Subzone.—The following species make their first appearance in this subzone (pls. 9, 10, 12):

- *Bowmania americana* (Walcott)
- *Briscoia* cf. *B. hartti* (Walcott)
- *Briscoia llanoensis* Winston and Nicholls
- *Calvinella tenuisculpta* Walcott
- *Dikelocephalus* sp. 2
- *Euptychaspis kirki* Kobayashi
- *Heterocaryon tuberculatum* Rasetti
- *Keithiella* cf. *K. patula* Winston and Nicholls
- *Leiocoryphe platycephala* Kobayashi
- *Plethometopus armatus* (Billings)
- *Plethometopus obtusus* Rasetti
- *Saukiella serotina* Longacre
- *Theodenisia marcoui* (Raymond)

All of these species are confined to this subzone except *Plethometopus obtusus,* which also occurs in the overlying *Corbina apopsis* Subzone. In addition, the following species occur in the *Saukiella serotina* Subzone and the underlying *Saukiella junia* Subzone (pls. 9, 10, 12):

- *Acheilops masonensis*
- *Bayfieldia simata*
- *Bowmania pennsylvanica*
- *Bynumiella oklahomensis*
- *Bynumina vescula*
- *Euptychaspis jugalis*
- *Euptychaspis typicalis*
- *Eurekia eos*
- *Idiomesus levisensis*
- *Rasettia wichitaensis*
- *Stenopilus latus*
- *Triarthropsis marginata*

Thus, the *Saukiella serotina* Subzone with 26 species has the highest species diversity of any of the subzones in the interval studied. The same is true of this subzone in central Texas (Longacre, 1970, text-fig. 3).

The base of the *Saukiella serotina* Subzone is defined on the lowest occurrence of *Bowmania americana, Calvinella tenuisculpta,* or *Saukiella serotina* (pls. 9, 10, 12).

The *Saukiella serotina* Subzone of the western Arbuckle Mountains is equivalent to the *S. serotina* Subzone of central Texas (Longacre, 1970, p. 12; equals *Saukiella norwalkensis* Subzone of Winston and Nicholls, 1967, p. 69).

Corbinia apopsis Subzone.—The following species define this subzone and are confined to it (pls. 9, 10, 12):

- *Apatokephaloides clivosus* Raymond
- *Corbinia apopsis* Winston and Nicholls
- *Leiobienvillia leonensis* Winston and Nicholls

In addition, *Bowmania pennsylvanica, Idiomesus levisensis, Plethometopus obtusus, Stenopilus latus,* and *Triarthropsis marginata* extend into the base of this thin subzone.

The base of this subzone is defined by the three species that are confined to it. Its top is the base of the overlying Ordovician *Missisquoia* Zone.

The *Corbinia apopsis* Subzone of the western Arbuckle Mountains is equivalent to the *Corbinia apopsis* Subzone of central Texas (Winston and Nicholls, 1967, p. 69; Longacre, 1970, p. 12).

CAMBRIAN-ORDOVICIAN BOUNDARY

Ever since the work of Josiah Bridge (1936), the Cambrian-Ordovician boundary has been placed at the top of the Butterly Dolomite (e.g., Frederickson, 1956, p. 486). Palmer (*in* Müller, 1956, p. 1335) suggested that the boundary be placed in the upper part of the Signal Mountain Limestone because there he found specimens of the brachiopod genus *Apheoorthis,* which is associated with Ordovician trilobites in other parts of the United States (Palmer, 1968, pers. comm.). However, when I began field work in the summer of 1964, the Cambrian-Ordovician boundary was still placed at the top of the Butterly.

I was surprised to find known Ordovician trilobite genera, *Missisquoia* and *Symphysurina,* 254 feet below the top of the Signal Mountain in the Joins Ranch section and 91 feet below the top of the Signal Mountain in the U.S. Highway 77 section (fig. 2). James R. Derby (1967, pers. comm.) had also discovered that the Cambrian-Ordovician boundary occurred at this level in the Signal Mountain. In fairness to previous workers, I want to emphasize that most of the existing knowledge about Early Ordovician trilobites has been published since 1951 and was not known when Bridge, Decker, and Frederickson worked on the Arbuckle Group.

The trilobite faunas change abruptly at this boundary (pls. 10, 11, 12), and no mixing of Cambrian and Ordovician trilobites was observed. The lowest Ordovician trilobites occur 4 feet above the highest Cambrian trilobites in the Joins Ranch section and 8 feet above the highest Cambrian trilobites in the U.S. Highway 77 section. No evidence of erosion or interruption of sedimentation was observed in the Signal Mountain Limestone at this level. Therefore, I conclude that the Cambrian-Ordovician boundary lies within a completely conformable limestone sequence, with no apparent interruption of sedimentation and that the factors that caused the abrupt change in the trilobites, whatever they may be, have not left their imprint on the rocks in any obvious fashion.

The abrupt faunal change at the Cambrian-Ordovician boundary will be discussed further in the section on biomeres.

ORDOVICIAN

Trilobites from the upper part of the Signal Mountain Limestone and the base of the McKenzie Hill Limestone constitute the faunas of the *Missisquoia* and *Symphysurina* Zones of the Lower Ordovician Canadian Series (fig. 2). No stage nomenclature for this interval is currently in use in the literature, and none is proposed here.

Missisquoia ZONE

The following species define this zone (pls. 9, 10, 12):

- *Apoplanias rejectus* Lochman
- *Homagnostus reductus* Winston and Nicholls
- *Missisquoia depressa* Stitt, n. sp.
- *Missisquoia typicalis* Shaw
- *Plethopeltis arbucklensis* Stitt, n. sp.
- *Symphysurina brevispicata* Hintze

All of these species except S. *brevispicata* are confined to this zone.

The base of this zone is defined by the lowest occurrence of *Plethopeltis arbucklensis* and *Missisquoia depressa.* Its top lies somewhere in the unfossiliferous Butterly Dolomite.

The *Missisquoia* Zone of the western Arbuckle Mountains is equivalent to (1) all but the uppermost part of the *Missisquoia* Zone of central Texas (Winston and Nicholls, 1967, p. 72), (2) the fauna of the Highgate Formation described by Shaw (1951), and (3) the A Zone of the Williston Basin (Lochman, 1964b, p. 457-458; Winston and Nicholls, 1967, p. 72). In addition, the discovery of *Apoplanias rejectus* associated with Ordovician trilobites in the western Arbuckle Mountains suggests that Lochman and Wilson's (1967, p. 889-890) *Apoplanias rejectus* faunule, which they regarded as transitional between the Cambrian and Ordovician, is more properly placed in the Ordovician.

Symphysurina ZONE

At the base of the McKenzie Hill Limestone abundant specimens of *Symphysurina brevispicata* Hintze and *Hystricurus millardensis* Hintze were collected (pls. 9, 10, 12). This association is reported from the *Symphysurina* Zone of central Texas (Winston and Nicholls, 1967, p. 72), the B Zone of Ross (1951, p. 29), the *Symphysurina* (B) Zone of Hintze (1952, p. 6-8), and Zone B of Lochman (1964b, p. 458-460) and Lochman and Wilson (1967, p. 897, and table II-B, p. 895). As a future project I plan to collect higher in the McKenzie Hill to determine the complete fauna and extent of the *Symphysurina* Zone.

BIOMERES

Palmer (1965a, p. 149-150) defined the biomere as "a regional biostratigraphic unit bounded by abrupt nonevolutionary changes in the dominant elements of a single phylum." He documented this concept (1965b) with a study of the trilobites of the Pterocephaliid biomere in the Great Basin. The Pterocephaliid Biomere includes the faunas of the *Aphelaspis, Dicanthopyge, Dunderbergia,* and *Elvinia* Zones.

Longacre (1970, p. 2-3) has proposed the name "Ptychaspid Biomere" to include the faunas constituting the *Taenicephalus, Idahoia, Ellipsocephaloides,* and *Saukia* Zones in central Texas. The Ptychaspid Biomere is bounded at the bottom by the abrupt faunal change between the *Elvinia* and *Taenicephalus* Zones and at the top by a similarly abrupt change between the *Saukia* and *Missisquoia* Zones. These two abrupt changes also occur at the *Elvinia-Taenicephalus* and the *Saukia-Missisquoia* Zone boundaries in the western Arbuckle Mountains. I agree with Longacre that the faunas of the *Taenicephalus* to *Saukia* Zones constitute a second biomere, one that she has named after the Ptychaspididae, the only family of trilobites that is represented throughout this interval.

Palmer (1962, p. 8-9) demonstrated that in part of the Great Basin the lower boundary of the Pterocephaliid Biomere is time transgressive. Whether or not the boundaries of the Ptychaspid Biomere are diachronous is not yet apparent. Perhaps when the study of equivalent faunas in the Great Basin is completed, comparison with central Texas and the western Arbuckle Mountains will resolve this question.

Systematic Paleontology

Trilobites assigned to 20 families, 67 genera, and 99 species are described and illustrated. Families are listed alphabetically under each order, and genera are listed alphabetically under each family. Species are listed stratigraphically under each genus, the species that occurs lowest stratigraphically being described first.

Morphological terms used in the descriptions are those defined in Part O of the *Treatise on Invertebrate Paleontology* (Harrington and others, 1959, p. 117-126). Measurement of the width or length of morphologic features and the generic assignments to families follow the suggestions of the *Treatise* as emended by Palmer (1965b) and Longacre (1970), unless otherwise stated.

Synonymies are shortened wherever possible by referring to a readily available published article with a more complete listing of all citations for the taxon in question.

An indication of the abundance and occurrence of each species is listed after the taxonomic discussion. The terms scarce (1 to 21 specimens), common (22 to 50 specimens), or abundant (more than 50 specimens) indicate the total number of specimens in my collections that are assignable to a particular species. For more precision, the exact number of specimens can be tabulated from the occurrence data included with the measured sections.

Occurrences are arranged according to measured sections and are listed after the initials of the measured sections. The numbers given correspond to footages above the base of the section. Occurrences are grouped according to the zonal classification used here. Sections are listed in alphabetical order, with the following abbreviations:

HS—U.S. Highway 77 section
JoR—Joins Ranch section
RR—Royer Ranch section

At least one specimen of each identified species has been illustrated, using the techniques described by Grant (1965, p. 155).

The figured holotype and paratypes for all new species are stored with the School of Geology and Geophysics at The University of Oklahoma (OU). The other figured specimens are stored in the Geology Department of The University of Texas at Austin (UT).

Phylum Arthropoda Siebold and Stannius 1845

Class Trilobita Walch, 1771

Order Agnostida Kobayashi, 1935

Family Agnostidae McCoy, 1849

Genus *Homagnostus* Howell, 1935

Homagnostus tumidosus (Hall and Whitfield)

Pl. 2, fig. 6

Agnostus tumidosus Hall and Whitfield, 1877, p. 231, pl. 1, fig. 32.

Homagnostus tumidosus (Hall and Whitfield) Palmer, 1960, p. 63, pl. 4, figs. 1, 2 (synonymy to date); Bell and Ellinwood, 1962, p. 388, pl. 51, figs. 1-4.

Remarks.—Two pygidia assigned to this species occur in the *Irvingella major* coquina. They are characterized by their tumid, posteriorly expanded posterior part of the axial lobe that reaches nearly to the marginal furrow.

Occurrence.—Scarce at the top of the *Elvinia* Zone at RR 142.

Homagnostus reductus Winston and Nicholls

Pl. 8, fig. 9

Homagnostus reductus Winston and Nicholls, 1967, p. 72-73, pl. 13, figs. 20, 23.

Remarks.—Two incomplete cranidia are assigned to this species. They match fairly well the description given by Winston and Nicholls and have a faint vestigial preglabellar median furrow.

Occurrence.—Scarce near the base of the *Missisquoia* Zone at HS 1353; JoR 1063.

Family PSEUDAGNOSTIDAE Whitehouse, 1936

Genus *Pseudagnostus* Jaekel, 1909

***Pseudagnostus communis* (Hall and Whitfield)**

Pl. 2, figs. 4, 5

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

Pseudagnostus communis (Hall and Whitfield) KOBAYASHI, 1939, p. 157; PALMER, 1954, p. 720, pl. 76, figs. 1-3; BELL and ELLINWOOD, 1962, p. 389, pl. 51, figs. 7-21 (synonymy to date).

Remarks.—Agnostids assigned to this species fall within the paleontologic concept of *Pseudagnostus communis* as described and illustrated by Bell and Ellinwood (1962, p. 389, pl. 51, figs. 7-21). Most specimens from the Arbuckle Mountains have faintly impressed furrows, and the pygidia have a pair of small marginal spines. As pointed out by Bell and Ellinwood (p. 389), the only difference between *P. communis and P. josepha* (Hall) is that the pygidium of the latter has no marginal spines. *P. josepha* should be collected from the finer grained sandstones in the Upper Mississippi Valley near the type area to determine for certain whether or not it has marginal spines. The status of *Pseudagnostus sentosus* Grant, an agnostid of similar appearance and stratigraphic position, should also be included in this study.

Occurrence.—Common in the *Elvinia* Zone at RR 117, 120, 126, 127, 142. Scarce in the *Parabolinoides* Subzone at HS 44; RR 147. Abundant in the *Taenicephalus* Zone at HS 78, 81, 83, 84, 88, 93; RR 181, 183. Abundant in the *Idahoia lirae* Subzone at HS 110; JoR 2; RR 188, 193, 195, 198, 199, 202, 204, 205, 208, 210. Abundant in the *Drumaspis* Subzone at HS 124, 130, 138; JoR 7, 10, 16, 26, 60, 108. Abundant in the upper part of the *Saratogia* Zone at JoR 180, 217, 225, 283.

Order PTYCHOPARIIDA Swinnerton, 1915

Family ASAPHIDAE Burmeister, 1843

Subfamily SYMPHYSURININAE Kobayashi, 1955

Genus *Symphysurina* Ulrich *in* Walcott, 1924

***Symphysurina brevispicata* Hintze**

Pl. 8, figs. 19-21

Symphysurina brevispicata HINTZE, 1952, p. 236, pl. 3, figs. 9-17; LOCHMAN, 1964b, p. 464, pl. 63, figs. 1-16; WINSTON and NICHOLLS, 1967, p. 87, pl. 12, figs. 7-10, 15.

Remarks.—The definitive features of this species were described by Hintze (1952, p. 236). Pygidia from the Arbuckle Mountains are twice as wide as they are long, have a well-defined axis, and lack a pygidial spine. Scarce free cheeks have the short genal spine mentioned by Hintze. The smooth cranidium has a faint axial furrow, narrow anterior border ornamented by terrace lines, slightly divergent anterior facial sutures, and a glabellar node between the prominent, flat, furrowless palpebral lobes. *S. brevispicata* and *Hystricurus millardensis* occur abundantly together in a thin coquina at the base of the McKenzie Hill Limestone in the Joins Ranch section. Most of the specimens are crushed, presumably by compaction of the limestone.

Occurrence.—Scarce in the *Missisquoia* Zone at JoR 1137. Abundant at the base of the *Symphysurina* Zone at JoR 1468 (coquina).

Family AVONINIDAE Lochman, 1936

Genus *Xenocheilos* Wilson, 1949

***Xenocheilos minutum* Wilson**

Pl. 1, fig. 15

Xenocheilos minutum WILSON, 1949, p. 43, pl. 9, figs. 11-13.

Xenocheilos cf. *X. minutum* Wilson, BELL and others, 1952, p. 185, pl. 30, fig. 2.

Remarks.—This species is characterized by its sunken glabella and by its raised and rather flat preglabellar field and anterior fixigenae that form a platform immediately anterior to the glabella, then slope down rather steeply to the nearly flat border. Its small size and topography of the frontal area make it easily distinguishable from *Pterocephalia sanctisabae*. Three cranidia are assigned to this species.

Occurrence.—Scarce in the *Elvinia* Zone at RR 126, 127.

Family CATILLICEPHALIDAE Raymond, 1938

Genus *Acheilops* Ulrich *in* Bridge, 1931

***Acheilops masonensis* Winston and Nicholls**

Pl. 7, fig. 5

Acheilops masonensis WINSTON and NICHOLLS, 1967, p. 77-78, pl. 11, figs. 23-25.

Remarks.—This species was well described and illustrated by Winston and Nicholls (1967). Five incomplete cranidia from the Arbuckle Mountains are assigned to this species because they have no frontal area or anterior fixigenae, their glabellae are expanded anterior to the palpebral lobes only, and the palpebral lobes are close to the glabella. One specimen at the top of the range of *A. masonensis* has medium to coarse granules covering the entire cranidium, exclusive of the crandial furrows.

Occurrence.—Scarce in the middle of the *Saukiella junia* Subzone at HS 1120. Scarce in the upper part of the *Saukiella serotina* Subzone at HS 1326; JoR 1002, 1043.

Genus *Theodenisia* Clark, 1948

Theodenisia microps (Rasetti)

Pl. 7, fig. 1

Acheilus microps Rasetti, 1944, p. 237, pl. 36, fig. 39.

Theodenisia microps (Rasetti) Rasetti, 1954b, p. 607-609, text-fig. 3e; Rasetti, 1963, p. 1014, pl. 129, figs. 6-9.

Remarks.—As reported by Winston and Nicholls (1967, p. 77), the absence of a frontal area, the position of the palpebral lobes at or anterior to the glabellar midpoint, and the presence of small anterior fixigenae serve to separate species of *Theodenisia* from those of *Triarthropsis* and *Acheilops.*

Broad triangular posterior areas, small palpebral lobes slightly anterior to the glabellar midpoint, and an ornament of fine granules covering the entire cranidium (except cranidial furrows) distinguish *Theodenisia microps.*

Only four incomplete cranidia are assigned to this species; one (pl. 7, fig. 1) is twice as long (4 mm) as those previously figured by Rasetti.

Occurrence.—Scarce in the *Rasettia magna* Subzone at JoR 348, 475, 592.

Theodenisia marcoui (Raymond)

Pl. 7, fig. 4

Acheilus marcoui Raymond, 1924, p. 422-423, pl. 13, fig. 15; Rasetti, 1944, p. 235, pl. 36, figs. 31-35.

Theodenisia marcoui (Raymond) Rasetti, 1954b, p. 607-609, text-fig. 3c.

Remarks.—This species is distinguished by its narrow (exsag.) and wide (tr.) posterior areas, slightly anteriorly expanded glabella, lack of a frontal area, and moderately impressed glabellar furrows. Only four incomplete cranidia are assigned to this species.

Occurrence.—Scarce in the upper part of the *Saukiella serotina* Subzone at JoR 957, 983.

Theodenisia sp. undet.

Pl. 7, fig. 6

Remarks.—One specimen assignable to *Theodenisia* cannot be assigned with certainty to any of the established species of this genus. Rasetti (1944, 1945b, 1954b, 1963) illustrated most of the species of *Theodenisia* and listed the rest (1954b, p. 609). This specimen from the Arbuckle Mountains is clearly assignable to *Theodenisia* on the basis of its convex, anteriorly expanded glabella, its palpebral lobes centered at the glabellar midline, and its lack of a frontal area. The glabella and fixigenae are covered by fine granules and scattered medium-sized granules. In all other species of *Theodenisia* the palpebral lobes are fairly close to the glabella, but on this specimen from the Arbuckle Mountains each palpebral area is more than half as wide as the glabella (widths measured at glabellar midline). These unusually wide fixigenae preclude assignment of this specimen to any published species of *Theodenisia.*

Occurrence.—Scarce in the middle of the *Saukiella junia* Subzone at HS 1120.

Genus *Triarthropsis* Ulrich *in* Bridge, 1931

Triarthropsis limbata Rasetti

Pl. 7, fig. 3

Triarthropsis limbata Rasetti, 1959, p. 382-383, pl. 52, figs. 1-8.

Remarks.—This species is distinguished from other species of *Triarthropsis* by its rather flat (tr.) glabella and its broad frontal area. Two incomplete cranidia are assigned to it.

Occurrence.—Scarce in the lower part of the *Saukiella junia* Subzone at HS 1032, 1110.

Triarthropsis marginata (Rasetti)

Pl. 7, fig. 2

Acheilus? marginatus Rasetti, 1945b, p. 463, 465, pl. 60, figs. 9-13.

Triarthropsis marginata (Rasetti) Rasetti, 1954b, p. 606-607, text-fig. 2e.

Remarks.—This species is distinguished from other species of *Triarthropsis* by its convex, anteriorly rounded (but not pointed) glabella. Its frontal area is intermediate in width between *T. princetonensis* Kobayashi and *T. limbata* Rasetti. Three incomplete cranidia are assigned to this species, which occurs stratigraphically higher than *T. limbata* in the Arbuckle Mountains.

Occurrence.—Scarce in the upper part of the *Saukiella junia* Subzone at HS 1148, 1171. Scarce in the *Corbinia apopsis* Subzone at HS 1340.

Family Dikelocephalidae Miller, 1889

Genus *Briscoia* Walcott, 1925

Briscoia cf. *B. hartti* (Walcott)

Pl. 7, fig. 20

Conocephalites hartti Walcott, 1879, p. 130.
Dikelocephalus hartti (Walcott) Walcott, 1914, p. 368, pl. 63, figs. 1-7, 7a (synonymy to date).
Briscoia hartti (Walcott) Kobayashi, 1935a, p. 51; Winston and Nicholls, 1967, p. 73, pl. 10, fig. 9.

Remarks.—One incomplete cranidium is tentatively assigned to this species. Winston and Nicholls (1967, p. 73) summarized the cranidial characteristics of *B. hartti*. It is distinguished from *Briscoia llanoensis* by its parallel-sided glabella, fainter glabellar furrows, and the presence of a faint anterior border furrow. In the Arbuckle Mountains as in central Texas, *B. hartti* occurs stratigraphically lower than *B. llanoensis*.

Occurrence.—Scarce in the lower part of the *Saukiella serotina* Subzone at HS 1199.

Briscoia llanoensis Winston and Nicholls

Pl. 7, fig. 19

Briscoia llanoensis Winston and Nicholls, 1967, p. 73-75, pl. 10, figs. 1-3, 5.

Remarks.—This species is distinguished from *Briscoia* cf. *B. hartti* by its truncate, tapered glabella and its smooth concave frontal area. It is represented by five specimens in the Arbuckle Mountains collections.

Occurrence.—Scarce in the upper part of the *Saukiella serotina* Subzone at HS 1258, 1278; JoR 973, 997.

Briscoia? sp. undet.

Pl. 3, fig. 21

Remarks.—One pygidium is tentatively assigned to this genus. It has a prominent axis with at least three axial rings and a terminal piece. The well-impressed pleural and interpleural furrows die out before reaching the pygidial margin; pleural furrows are situated on anterior part of pleurae. At least two and probably four or five pairs of marginal spines are present. Internal mold ornamented by fine anastomosing ridges that have a roughly longitudinal alignment on the axis; on the pleurae the ridges are aligned at roughly right angles to the pleural furrows.

This fragmentary pygidium is most similar to pygidia illustrated by Kobayashi (1935a, pl. 10, figs. 8-12) in his description of *Parabriscoia elegans*, the type species of *Parabriscoia*. Palmer (1968, p. 58-60), in a well-reasoned discussion, tentatively placed *P. elegans* in *Briscoia*. I choose to follow Palmer in tentatively assigning this pygidium to *Briscoia*.

Occurrence.—Scarce in the upper part of the *Saratogia* Zone at JoR 283.

Genus *Dikelocephalus* Owen, 1852

Dikelocephalus sp. 1

Pl. 3, fig. 20

Remarks.—Several fragmentary cranidia are referred to this species. They have convex, parallel-sided glabellae, two or three pairs of moderately impressed, posteriorly directed glabellar furrows (posterior pair complete), and large palpebral lobes with arcuate, well-impressed palpebral furrows. The frontal areas are poorly preserved but appear to be concave.

These specimens are most like *D. freeburgensis* Feniak (*see* Bell and others, 1952, p. 195-196, pls. 35, 38), but the material is too fragmentary to make a confident species assignment.

Occurrence.—Scarce in the upper part of the *Saratogia* Zone at JoR 283.

Dikelocephalus sp. 2

Pl. 5, fig. 20

Remarks.—One small cranidium (3 mm in length) from the Trempealeauan of the Arbuckle Mountains is assigned to this species. The glabella is broadly convex, parallel-sided, and rounded anteriorly, with one pair of shallow glabellar furrows that connect across the axis. The palpebral furrows are moderately impressed, and the palpebral areas are posterior to midline of the glabella. The frontal area is slightly downsloping and poorly preserved. The strong granular ornament appears to be more pronounced than usual for *Dikelocephalus*.

Occurrence.—Scarce in the upper part of the *Saukiella serotina* Subzone at JoR 997.

Family ELVINIIDAE Kobayashi, 1935
(as emended by Palmer, 1962)

Subfamily DOKIMOCEPHALINAE Kobayashi 1935

Genus *Apachia* Frederickson, 1949
Apachia trigonis Frederickson

Pl. 2, fig. 8

Apachia trigonis FREDERICKSON, 1949, p. 346, pl. 70, figs. 14-17.

Remarks.—This species is characterized by its extremely tumid, conical glabella. Whether *Apachia convexa* DeLand (DeLand and Shaw, 1956, p. 546, pl. 65, figs. 4, 6) is really different from *A. trigonis* is questionable. Comparison of DeLand's stereo photographs of *A. convexa* with Frederickson's photographs of *A. trigonis* and my specimens of *A. trigonis* indicates that the occipital rings and fixed cheeks of these two species are equally convex. The character of the brim and border of *A. convexa* is difficult to determine because on the profile stereo photographs this area is hidden in shadows. At best these differences are slight. *A. trigonis* does appear to have a slightly more tumid conical glabella, but again this is a minor difference.

Occurrence.—Scarce in the *Elvinia* Zone at RR 126.

Genus *Burnetiella* Lochman, 1958
Burnetiella ectypa (Resser)

Pl. 1, fig. 9

Burnetia ectypa RESSER, 1942, p. 82, pl. 17, figs. 30-31.

Burnetiella ectypa (Resser) GRANT, 1965, p. 110, pl. 8, figs. 22, 24.

Remarks.—Specimens assigned to this genus are characterized by (1) a high, convex glabella and (2) the courses of their anterior facial sutures, which are strongly divergent anterior to the palpebral lobes and continue to be strongly divergent anterior of the anterior border furrow. This latter feature gives the anterior fixigenae and frontal area a very broad, fan-shaped appearance, and both features help distinguish *Burnetiella* from *Dokimocephalus*.

Frederickson (1949, p. 348) and Wilson (1951, p. 625) placed *B. ectypa* in synonymy with other species of *Burnetiella*. After examining the holotypes of *B. urania* and of the numerous species in this genus created by Resser (1942, p. 80-85), Grant (1965, p. 110-111) decided that *B. ectypa* differed from *B. urania* and listed several features that he felt could be used to recognize *B. ectypa*. Most of these features are gradational with features characteristic of *B. urania* (*see* Walcott, 1891, p. 274-275; Wilson, 1949, p. 32-33; 1951, p. 625-626). One difference that is consistent is the presence of granules on the anterior border of *B. ectypa* and their absence in this area on *B. urania* (reported both by Walcott in his original description and by Wilson, 1949, p. 32-33, in his supplementary description). Palmer (1965b, p. 21-22) found that ornament is an important feature in distinguishing species in many other genera in the Elviniidae. I think this is probably true for the genus *Burnetiella* also.

Occurrence.—Scarce in the *Elvinia* Zone at RR 126, 131, 133.

Genus *Deckera* Frederickson, 1949
Deckera completa Wilson

Pl. 1, fig. 16

Deckera completa WILSON, 1951, p. 634, pl. 90, figs. 10-17.

Remarks.—Two incomplete cranidia are assigned to this species on the basis of their keeled, arrowhead-shaped glabellae, elevated fixigenae that rise from the axial furrow at an angle greater than 25°, and the ornament of mixed fine and coarse granules that cover the cranidia (exclusive of cranidial furrows), *including* the glabellar slopes. The anterior border is broken, so the preglabellar field-anterior border ratio cannot be determined for either specimen.

Occurrence.—Scarce in the *Elvinia* Zone at RR 126, 133.

Genus *Dokimocephalus* Walcott, 1924
Dokimocephalus intermedius (Resser)

Pl. 1, fig. 7

Burnetia intermedia RESSER, 1942, p. 80, pl. 17, figs. 10-11.

Dokimocephalus intermedius (Resser) WILSON, 1951, p. 640, pl. 90, fig. 25 (synonymy to date); GRANT, 1965, p. 111, pl. 9, figs. 29, 32.

Remarks.—Wilson (1949, p. 37) has summarized the characteristics of this species. Species of *Dokimocephalus* differ from those of *Burnetiella* because they have a lower and less convex glabella and the anterior facial sutures are less divergent anterior to the palpebral lobes and begin to converge *at* the anterior border furrow.

Only four specimens have complete anterior borders. On these specimens the anterior margin tapers to a rounded point at the axial line. On all other specimens the anterior margin is broken, and all but three specimens have been arbitrarily assigned to *D. intermedius* because they are similar in all other aspects.

Three specimens appear to indicate strongly that the anterior margin extends forward into the spoon-shaped process characteristic of *Dokimocephalus curtus* (Resser). These specimens occur high in the stratigraphic range of *Dokimocephalus* and may indicate a stratigraphic trend toward elongation of the anterior margin in younger species. It is equally possible that if the anterior margins were preserved on all specimens, they would show a complete gradation from blunt to pointed to spoon-shaped, with no stratigraphic trend to this variation. *D. curtus* and *D. intermedius* are also remarkably similar in all other aspects (compare Frederickson's (1948b, p. 801) descriptions of these two species).

Occurrence.—Common in the *Elvinia* Zone at HS 32.5, 37; RR 126, 127, 131, 133, 134, 137, 138, 139, 140.

Dokimocephalus curtus (Resser)
Pl. 1, fig. 8

Burnetia curta RESSER, 1942, p. 83, pl. 17, figs. 28-29.
Dokimocephalus curta (Resser) FREDERICKSON, 1948b, p. 801, pl. 123, figs. 4-8.

Remarks.—Three specimens are assigned to this species because their anterior margins, although broken, suggest elongation into the spoon-shaped process illustrated for this species by Frederickson (1948b, pl. 123, figs. 4-6). The possible significance of this feature is discussed under *D. intermedius*. One specimen assigned to this species by Frederickson (1948b, pl. 123, figs. 7-8) cannot with certainty be assigned to *D. curtus* because the anterior margin is broken.

Occurrence.—Scarce in the *Elvinia* Zone at RR 137, 139.

Genus _Kindbladia_ Frederickson, 1948
Kindbladia wichitaensis (Resser)
Pl. 2, fig. 9

Berkeia wichitaensis RESSER, 1942, p. 92, pl. 15, figs. 31-33.
Kindbladia wichitaensis (Resser) FREDERICKSON, 1948b, p. 802-803, pl. 123, figs. 20-23; WILSON, 1951, p. 645, pl. 92, figs. 23-24 (synonymy to date); GRANT, 1965, p. 111, pl. 8, fig. 23.
Berkeia augustata RESSER, 1942, p. 93, pl. 15, figs. 34-39.
Berkeia retusa RESSER, 1942, p. 92, pl. 15, figs. 28-30.

Remarks.—This species is characterized by its evenly tapered, anteriorly round glabella, well-impressed cranidial furrows, narrow, elevated palpebral areas, and three shallow depressions in the anterior border furrow. It is distinguished from *K. affinis* (Walcott) by its greater preglabellar field-anterior border ratio and the presence of a short spine on the occipital ring. On most Arbuckle Mountains specimens the spine is not preserved and the occipital ring is broken in the center. The largest cranidia also have the highest glabellae. Ornament is as reported by Frederickson (1948b, p. 802).

Frederickson (1948b, p. 802) placed *Berkeia retusa* Resser and *Berkeia angustata* Resser in *Kindbladia* and considered them conspecific but different from *K. wichitaensis*. I believe these two nominal species (described from the Arbuckle Mountains only) are conspecific with *K. wichitaensis*. Resser (1942, p. 92) thought *B. retusa* was peculiar because its preglabellar area was wider than the anterior border and it had a slight swelling in the center of the preglabellar area. A characteristic of *Kindbladia*, and especially *K. wichitaensis*, is that the preglabellar field is wider (sag.) than the anterior border. The slight swelling in the center of the preglabellar area probably is related to the pointedness of the anterior border and the location of the three depressions in the border furrow. *Berkeia angustata* Resser (1942, p. 93) is supposed to have a relatively longer glabella than usual, a fact not borne out by measurements of the holotype as compared to the holotype of *K. wichitaensis*. I fail to find any difference between these two species and *K. wichitaensis*, and I place them in synonymy.

Occurrence.—Scarce in the *Elvinia* Zone at RR 113, 120, 126.

Genus _Plataspella_ Wilson, 1949
Plataspella anatina (Resser)
Pl. 1, fig. 10

Iddingsia anatina RESSER, 1942, p. 89, pl. 17, figs. 1, 2.

Plataspella anatina (Resser) WILSON, 1949, p. 42, pl. 9, figs. 20-22, 25, 26 (synonymy to date); FREDERICKSON, 1949, p. 355, pl. 68, figs. 10-13; WILSON, 1951, p. 647, pl. 92, fig. 6.

Remarks.—Although Bell and others (1952, p. 184) synonymized *Plataspella* with *Iddingsia,* Palmer (1960, p. 96) recognized *Plataspella* as a valid genus. I follow Palmer because a group of trilobites in my collections lacks conspicuous glabellar furrows, has nearly horizontal fixed cheeks and an occipital spine, and has an ornament different from that described for species of *Iddingsia* (*see* Palmer, 1960, p. 96; 1965b, p. 35). These specimens also fit the other criteria of *Plataspella* listed by Wilson (1951, p. 646). *P. anatina* has an ornament of anastomosing ridges and valleys with a roughly longitudinal orientation on the preglabellar field; this ornament is present on both the external surface and on internal molds. This appears to be the only ornamentation, although admittedly most of my specimens are internal molds.

Because *Plataspella* is similar to *Iddingsia,* I have placed it in the same subfamily, the Dokimocephalinae.

Occurrence.—Scarce in the *Elvinia* Zone at RR 113, 117, 126, 127.

Genus *Sulcocephalus* Wilson, 1948

Sulcocephalus cereus Stitt, n. sp.

Pl. 1, figs. 2, 3

Material available.—10 cranidia preserved as internal molds in fine-grained sandstone; several specimens well preserved, others in only fair condition.

Description. — Cranidium small (largest specimens less than 3 mm long), width greater than length, flatly convex as a whole, although glabella and fixigenae have moderate relief. Glabella moderately convex transversely, less so sagittally; length five-eighths to two-thirds of cranidial length and about equal to basal glabellar width; strongly tapered, bluntly rounded anteriorly. Two pairs of well-impressed, posteriorly directed glabellar furrows; a third pair of faintly impressed glabellar furrows present on some specimens. Axial furrow well impressed, very nearly converging with the anterior border furrow in front of glabella. Occipital ring slightly wider at axis, with a faint indication of a medial node. Frontal area one-fourth to one-fifth of cranidial length. Preglabellar field narrow, flat to downsloping, indistinctly defined between preglabellar furrow and anterior border furrow. Anterior border wider than preglabellar field, tapered laterally, very convex, giving it an upturned appearance. Anterior border furrow well impressed, gently curved forward at extremities. Fixigenae convex, width at palpebral areas about one-third of basal glabellar width. Palpebral lobes not well preserved but appear to be narrow and centered at about glabellar midlength. Palpebral furrow moderately impressed. Posterior areas incomplete, appear to be short (exsag.) and downsloping. Posterior border furrow well impressed. Anterior course of facial sutures slightly divergent.

Ornament impossible to determine because of state and type of preservation.

Pygidium and librigenae unknown.

Holotype.—OU 6504, plate 1, figure 2.

Paratype.—OU 6505, plate 1, figure 3.

Etymology.—*Cereus,* L., taper; referring to the arrowhead-shaped glabella of this species.

Remarks.—This species is assigned to the genus *Sulcocephalus* because of its deeply incised cranidial furrows, tapered glabella, convex fixigenae, and general similarity to established species in this genus. *S. cereus* is characterized by its strongly tapered glabella, convex fixigenae, narrow preglabellar field, and nearly straight anterior border furrow that curves gently forward at the extremities. *S. cereus* differs from *S. candidus* in having a more tapered glabella, in lacking the medial expansion of the anterior border, and in having the configuration of the anterior border furrow.

This species has been reported from the Welge Sandstone Member of the Wilberns Formation in central Texas by Wollman (1952) and Jansen (1957).

Occurrence.—Scarce at the base of the *Elvinia* Zone at RR 67.

Sulcocephalus latus (Frederickson)

Pl. 1, fig. 1

Berkeia lata FREDERICKSON, 1949, p. 347, pl. 68, figs. 17-19.

Remarks.—Eight cranidia from the Reagan Sandstone appear to match the description and illustration of this species given by Frederickson (1949, p. 347, pl. 68, figs. 17-19). The specimens are small (4 mm or less in length) and have the well-impressed cranidial furrows, prominent tapered glabella, and convex fixed cheeks characteristic of species of *Sulcocephalus*. *S. latus* is easily distinguished from *S. candidus* by its lack of a medially expanded anterior border and is distinguished from *S. cereus* by its distinct preglabellar field and posteriorly curved anterior border furrow.

Occurrence.—Scarce at the base of the *Elvinia* Zone at RR 67.

Sulcocephalus candidus (Resser)
Pl. 1, fig. 4

Talbotina candida Resser, 1942, p. 107, pl. 21, figs. 27, 28.
Sulcocephalus candidus (Resser) Wilson, 1948, p. 31, pl. 8, figs. 1, 2; Bell and Ellinwood, 1962, p. 390, pl. 52, fig. 4 (synonymy to date).
Berkeia sculptilis Resser, 1942, p. 93, pl. 16, figs. 1-4.
Sulcocephalus sculptilis (Resser) Wilson and Frederickson, 1950, p. 896-897, pl. 1, figs. 1-3.

Remarks.—This species is characterized by its moderately convex and tapered glabella, which stands well above the fixigenae and has three pairs of well-impressed furrows, its thickened anterior border that is expanded (sag.) at the axial line, and the granulated surface of the cranidium (exclusive of the cranidial furrows). *Sulcocephalus sculptilis* (Resser) appears to be identical to *Sulcocephalus candidus*.

Occurrence.—Common at the top of the *Elvinia* Zone at HS 38; RR 142. Scarce at the base of the *Parabolinoides* Subzone at HS 40.

Subfamily Elviniinae Kobayashi, 1935
Genus *Elvinia* Walcott, 1924
Elvinia roemeri (Shumard)
Pl. 1, fig. 11

Dikelocephalus roemeri Shumard, 1861, p. 220-221.
Crepicephalus (*Loganellus*) *unisulcatus* Hall and Whitfield, 1877, p. 216, pl. 2, fig. 22.
Ptychoparia matheri Walcott, 1912b, p. 268, pl. 44, figs. 15-17.
Elvinia roemeri (Shumard) Walcott, 1924, p. 56, pl. 11, fig. 3; Frederickson, 1949, p. 352, pl. 69, figs. 19-21; Palmer, 1960, p. 70-71, pl. 6, fig. 7; 1965b, p. 44, pl. 3, figs. 9, 11, 14, 16 (synonymy to date); Grant, 1965, p. 115, pl. 9, fig. 22 (synonymy to date).

Remarks.—This common species is characterized by its tapered, truncate glabella with one well-impressed transglabellar furrow, smooth external surface, wide fixigenae, and low convexity. Frederickson (1949) and Palmer (1960, 1965b) synonymized with *Elvinia roemeri* most of the species of *Elvinia* that Resser (1938, 1942) described, including the four new species from Oklahoma.

Occurrence. — Abundant in the *Elvinia* Zone at HS 32.5; RR 70, 113, 117, 120, 126, 127, 128, 131, 133, 134, 137, 138, 139, 140.

Genus *Irvingella* Ulrich and Resser *in* Walcott, 1924
Irvingella major Ulrich and Resser
Pl. 1, fig. 12

Irvingella major Ulrich and Resser *in* Walcott, 1924, p. 58, pl. 10, fig. 3; Bell and Ellinwood, 1962, p. 397, pl. 55, figs. 4, 5 (synonymy to date); Grant, 1965, p. 126-127, pl. 10, figs. 8, 9, 11; Palmer, 1965b, p. 48, pl. 6, figs. 9-15.

Remarks.—Palmer (1965b, p. 48) recently summarized the status and morphological variation of this species. It is characterized by its short frontal area, prominent convex glabella, and wide fixigenae. The distance between the palpebral furrows (measured on a line tangent to the anterior end of the glabella) is always greater than the basal glabellar width; this distinguishes *I. major* from its closest relative, *I. flohri*.

I. major is especially abundant in a thin coquina at the top of the *Elvinia* Zone. A few specimens of *I. major* were found in the *Eoorthis* coquina, which occurs from 4 to 22 inches above the *I. major* coquina and marks the base of the *Taenicephalus* Zone.

Occurrence. — Abundant in the *Elvinia* Zone, especially at the top, at HS 38 (coquina); RR 120, 126, 134, 142 (coquina). Scarce at the base of the *Parabolinoides* Subzone at HS 40.

Family Heterocaryontidae Hupé 1953 (as emended by Clark and Shaw, 1968)
Genus *Bowmania* Walcott, 1925
Bowmania pennsylvanica Rasetti
Pl. 7, fig. 10

Bowmania pennsylvanica Rasetti, 1959, p. 395-396, pl. 55, figs. 1-5.

Remarks.—This species has been well described and illustrated by Rasetti. It is distinguished from *Bowmania americana* by its blunt, anteriorly expanded glabella, more consistently granulated cranidial surface, and greater convexity, especially in the frontal area. *Bowmania sagitta* Winston and Nicholls is bluntly triangular anterior to the eyes, whereas *Bowmania pennsylvanica* is semicircular in outline. *B. pennsylvanica* has a convex (but not tumid) glabella and a posteriorly curved anterior border, which distinguishes it from *Heterocaryon tuberculatum*, although some specimens of the former have the pitted anterior border furrow characteristic of the latter. Some specimens of *B. pennsylvanica* have pits scattered around the granules.

Occurrence.—Scarce in the *Rasettia magna* Subzone at JoR 535. Scarce in the *Saukiella junia* Subzone at JoR 780. Scarce in the *Saukiella serotina* Subzone at HS 1199; JoR 830, 854, 876, 1002, 1003, 1043. Scarce in the *Corbinia apopsis* Subzone at JoR 1046.

Bowmania americana (Walcott)

Pl. 7, figs. 7-9

Arethusina americana WALCOTT, 1884, p. 62, pl. 9, fig. 27.
Bowmania americana (Walcott) WALCOTT, 1925, p. 73, pl. 15, figs. 15, 16; WINSTON and NICHOLLS, 1967, p. 89, pl. 10, fig. 18.

Remarks.—Winston and Nicholls have summarized the diagnostic characteristics of this species. Specimens from the Arbuckle Mountains show several kinds of ornamental patterns on the cranidium. The preglabellar field is usually covered by fine, irregular lines that give it a ropy, pitted appearance (pl. 7, fig 9). The flat, shelflike anterior border is either smooth or covered by a row of pustules. Coarse pustules are commonly scattered over the entire cranidium, and in a few specimens fine to medium granules occur between the pustules on the fixigenae. On one specimen (pl. 7, fig. 9), the anterior border comes to a point at the sagittal line, indicating a possible relationship with *Bowmania sagitta* Winston and Nicholls.

Occurrence.—Scarce in the *Saukiella serotina* Subzone at HS 1258, 1284; JoR 830, 906, 1003, 1022.

Genus *Heterocaryon* Raymond, 1937
Heterocaryon tuberculatum Rasetti

Pl. 7, fig. 11

Heterocaryon tuberculatum RASETTI, 1944, p. 241, pl. 36, fig. 55.
Heterocaryon cf. *H. tuberculatum* Rasetti, WINSTON and NICHOLLS, 1967, p. 76, pl. 11, figs. 15, 18.

Remarks.—This species can be distinguished from *Bowmania pennsylvanica* by its combination of tumid, anteriorly rounded glabella, sharply downsloping frontal area, straight anterior border, pitted anterior border furrow, and slotlike axial furrows formed between the glabella and the rapidly rising palpebral areas of the fixigenae. Perhaps the most characteristic feature of this species is the glabella, which is so enlarged that it obscures the dorsal view of the glabellar furrows and preglabellar furrow.

Occurrence.—Scarce in *Saukiella serotina* Subzone at HS 1188; JoR 854, 997, 1002, 1010.

Family ILLAENURIDAE Vogdes, 1890

Genus *Illaenurus* Hall, 1863
Illaenurus quadratus Hall

Pl. 4, fig. 14

Illaenurus quadratus HALL, 1863, p. 176, pl. 7, figs. 52-57; NELSON, 1951, p. 783, pl. 110, fig. 11 (synonymy to date); BELL and ELLINWOOD, 1962, p. 396, pl. 55, figs. 1-3; GRANT, 1965, p. 125, pl. 15, fig. 23.

Remarks.—Cranidia of this species are longer than wide (exclusive of palpebral lobes), anterior facial sutures are parallel to slightly divergent, and the eyes are situated posterior to midline of the cranidium. Collections from the Arbuckle Mountains are too small (5 specimens from 2 stratigraphic levels) to test the phylogenetic trends observed by Bell and Ellinwood (1962, p. 396) and Grant (1965, p. 124-125).

Occurrence.—Scarce in the lower part of the *Rasettia magna* Subzone at JoR 385, 388.

Family KINGSTONIIDAE Kobayashi, 1933

Genus *Bynumina* Resser, 1942
Bynumina vescula Stitt, n. sp.

Pl. 7, figs. 16-18

Available material. — 18 well-preserved cranidia of various sizes.

Description.—Cranidium small (less than 3 mm long), semicircular, moderately convex longitudinally, more strongly convex transversely. Glabella low, only faintly outlined on external surface by axial furrow, flatly convex, tapered anteriorly, rounded-truncate. Glabellar furrows faintly impressed, hardly visible on external surfaces of specimens less than 2 mm (sag.), more easily seen on exfoliated specimens. Three pairs of short glabellar furrows are close to, but not connected with, the axial furrow; posterior pair appears to connect across axis on exfoliated specimens. Axial furrow faintly impressed on external surface, absent on specimens less than 2 mm (sag.), moderately to well impressed on exfoliated specimens. Two pits present in axial furrow just posterior of anterolateral corners of glabella, best seen on exfoliated specimens. Occipital furrow deeply impressed laterally, only faintly impressed across axis on external surfaces. Occipital ring expanded posteriorly toward axis, small node near posterior margin at axis. Frontal area about one-fifth of cranidial length. Preglabellar field smooth, downsloping. Anterior border furrow faintly impressed, anterior border narrow, liplike. Fixigenae broad posteriorly, tapering evenly anteriorly. Palpebral lobes and palpebral furrows very faint, situated near anterior end of glabella.

Pygidium and librigenae unknown.

Holotype.—OU 6519, plate 7, figure 16.

Paratypes.—OU 6520, plate 7, figure 17; OU 6521, plate 7, figure 18.

Etymology.—*Vescula*, L., thin, weak, little. This species is very small, with weak cranidial furrows.

Remarks.—This species is assigned to *Bynumina* because of its small size and its cranidial furrows that are faint or absent on external surfaces but show distinctly on exfoliated specimens. *B. vescula* most closely resembles *Bynumina missouriensis* Resser, from which it differs in having a more posteriorly expanded occipital ring, straight rather than curved glabellar furrows, a more tapered glabella, and two distinctive pits in the axial furrow near the anterolateral corners of the glabella. *B. vescula* differs from *Bynumina* sp. undet. Grant, the only other described species of *Bynumina* from the Trempealeauan, chiefly in having a less convex, differently shaped glabella and less prominent glabellar furrows on exfoliated specimens. Grant (1965, pl. 15, fig. 17) illustrated an exfoliated specimen that can be compared with mine (pl. 7, figs. 17, 18).

Occurrence.—Scarce in the middle and upper part of the *Saukiella junia* Subzone at HS 1110, 1115, 1120; JoR 701. Scarce in the lower part of the *Saukiella serotina* Subzone at HS 1181, 1188, 1197, 1206, 1213, 1217, 1224; JoR 870, 880.

Genus *Bynumiella* Resser, 1942
Bynumiella oklahomensis Resser
Pl. 7. fig. 15

Bynumiella? oklahomensis Resser, 1942, p. 58, pl. 10, figs. 27-28.

Remarks.—Only two cranidia are assigned to this species; the one that is illustrated matches almost exactly the holotype illustrated by Resser (1942, pl. 10, figs. 27-28). Resser (1942, p. 58) was somewhat reluctant to assign this species to *Bynumiella* because "this species differs from typical forms in that the glabella tapers less rapidly and in the size and position of the eyes, which are far larger and situated much farther back than they should be for a *Bynumiella*." The axial furrow is also less well impressed than in other species of *Bynumiella*. However, the presence of a faint but complete axial furrow and palpebral lobes set off by distinct palpebral furrows precludes its assignment to *Plethometopus*. Species of *Plethopeltis* have deeper axial furrows and shorter frontal areas. This species does have the anteriorly pointed frontal area, posteriorly expanded occipital ring, complete axial furrow, and fixigenae characteristic of *Bynumiella* and on the basis of these criteria is assigned to it.

Occurrence.—Scarce in the *Saukiella junia* Subzone at HS 1060. Scarce at the base of the *Saukiella serotina* Subzone at JoR 830.

Family Lecanopygidae Lochman, 1953
Genus *Rasettia* Lochman, 1953
Rasettia capax (Billings)
Pl. 4, figs. 1, 4

Bathyurus capax Billings, 1860, p. 318, fig 20; *in* Logan and others, 1863, p. 238, fig. 271; 1865, p. 409-410, fig. 389.
Platycolpus capax (Billings) Raymond, 1913 (part), p. 63, pl. 7, fig. 20 (not fig. 21); Rasetti, 1944 (part), p. 250, pl. 39, figs. 10, 11 (not fig. 12).
Platycolpus oklahomensis Resser, 1942, p. 40-41, pl. 6, figs. 24, 25 (holotype) (not figs. 20, 21= *Rasettia wichitaensis* (Resser); not figs. 22, 23= *Rasettia magna* Ellinwood).
Rasettia magna Ellinwood *in* Bell and Ellinwood, 1962 (part), p. 397-398, pl. 55, fig. 10 (not fig. 9).

Remarks.—This is the lowest of three stratigraphically separated associations of cranidia and pygidia in the genus *Rasettia*. The cranidium of *Rasettia capax* is characterized by its smooth surface (except for a medial node on the occipital ring and the distinctive terrace lines on the anterior border), absence of a preglabellar field, and the sharply downsloping anterior part of the cranidium (including the anterior border). The anterior border furrow is moderately to deeply impressed.

The shape and ornament of the anterior

pleurae are the key to distinguishing the pygidia of *R. capax* (pl. 4, fig. 4) from those of *Rasettia magna* (pl. 4, fig. 5). The pleural margins are sharply bent posteriorly slightly more than half the distance across the anterior pleurae. This curved anterior edge is covered by terrace lines very similar to those on the anterior border of the cranidium. This is the only ornament on the pygidium, and it is not present on internal molds. Some specimens show a faint second pleural furrow.

This is essentially the same pygidium that was assigned to *R. magna* by Ellinwood (*in* Bell and Ellinwood, 1962, p. 397-398, pl. 55, fig. 10). This apparent association of *R. capax* and *R. magna* in Texas does not occur in the western Arbuckle Mountains, where the highest occurrence of *R. capax* is 174 feet below the lowest occurrence of *R. magna.*

I have examined the holotype and paratypes of *Platycolpus oklahomensis* Resser, and in my opinion the holotype (Resser, 1942, pl. 6, figs. 24, 25) is actually a specimen of *Rasettia capax.* Furthermore, I assign one of Resser's figured paratypes of *P. oklahomensis* (pl. 6, figs. 20, 21) to *Rasettia wichitaensis* and the other figured paratype (pl. 6, figs. 22, 23) to *Rasettia magna.*

Occurrence.—Common in the upper part of the *Saratogia* Zone at JoR 217, 254, 274, 283, 285, 294, 300, 307.

Rasettia magna Ellinwood

Pl. 4, figs. 2, 3, 5, 6

Rasettia magna Ellinwood, *in* Bell and Ellinwood, 1962 (part), p. 397-398, pl. 55, fig. 9 (not fig. 10).

Platycolpus oklahomensis Resser, 1942 (part), p. 40-41, pl. 6, figs. 22, 23 (not figs. 20, 21, 24, 25).

Remarks.—This species occurs stratigraphically above *Rasettia capax* and below *Rasettia wichitaensis.* The external surface of cranidia of *Rasettia magna* has a characteristic ornament of fine to medium granules (pl. 4, fig. 3) that cover the entire cranidium except for (1) occasional places along the axial furrow, (2) bare areas on the glabella opposite the eyes where glabellar furrows might be if there were glabellar furrows, and (3) the anterior border, which is covered by terrace lines. The granules are not present on internal molds, but the terrace lines are clearly present on the anterior border. A medial node, which is much harder to see among the granules on external surfaces, is on the occipital ring. Cranidia of *R. magna* have a narrow preglabellar field, and the anterior part of the cranidium is only gently downsloping (not sharply downsloping as in *R. capax*).

Pygidia of *R. magna* (pl. 4, fig. 5) do not have the sharp bend along the anterior edge of the pleural region that characterizes pygidia of *R. capax.* They have an articulating half ring, two axial rings, and a terminal axial piece that has two low nodes on the posterior end. Two and sometimes three pleurae are present on most specimens. On external surfaces (pl. 4, fig. 6), the axial rings and pleurae are covered by fine to medium granules, areas that are smooth in *R. capax.* Internal molds of *R. magna* are smooth.

Occurrence.—Abundant in the *Rasettia magna* Subzone at JoR 481, 487, 497, 510, 535, 539, 550, 561, 568, 592.

Rasettia wichitaensis (Resser)

Pl. 4, figs. 7, 8, 11

Platycolpus wichitaensis Resser, 1942, p. 41, pl. 6, figs. 26-29.

Platycolpus oklahomensis Resser, 1942 (part), p. 40-41, pl. 6, figs. 20, 21 (not figs. 22-25).

Available material.—8 cranidia, 24 pygidia, mostly well preserved, plus Resser's original material, including the holotype pygidium and paratype cranidium.

Description.—As pointed out by Bell and Ellinwood (1962, p. 398), this species had never been adequately described or illustrated. Both Resser's original material and specimens that I collected have been used in the following redescription.

Cranidium (minus posterior areas) quadrate, minutely pitted on internal molds (except for frontal area), strongly convex longitudinally, less so transversely. Glabella elongate, minutely pitted, indistinctly defined by faint axial furrow. Glabellar furrows absent. Small node present on axial line of glabella near posterior margin of cranidium. Occipital furrow absent, occipital ring not differentiated. Frontal area consists of anterior border only, preglabellar field absent. Anterior border sharply downsloping, covered by terrace lines, parallel sided for most of its length (tr.). Anterior border furrow moderately impressed. Fixigenae narrow, downsloping (tr.). Palpebral areas situated slightly posterior to midline of cranidium. Palpebral furrows curved, moderately impressed, palpebral lobes small. Posterior areas short (exsag.), width (tr.) half that of posterior part of glabella. Posterior border furrow divides posterior area in half. Anterior course of facial sutures in front of eyes straight to slightly diverging, gently curving adaxially after passing anterior border furrow.

Pygidium transversely elliptical and moderately convex. Axis broad and low, consisting of an articulating half ring, one faint axial ring, and a terminal axial piece. Axial furrows moderately to faintly impressed. Pleural region convex and smooth except for faintly impressed anterior pleural furrow. Anterior edge of pleural region covered by terrace lines near lateral margin of pygidium. Some specimens have two faint nodes on the terminal axial piece.

Holotype.—USNM no. 108695a, plate 4, figure 8.

Paratype.—USNM no. 108695b, plate 4, figure 7.

Remarks.—The quadrate shape (minus the posterior areas), absence of an occipital furrow, finely pitted cranidium, and faint, indistinct axial furrows serve to distinguish cranidia of *Rasettia wichitaensis* from those of *R. capax* and *R. magna*. *R. wichitaensis* is further distinguished from *R. magna* by the absence of a preglabellar field and a more sharply downsloping anterior border.

Pygidia of *R. wichitaensis* (pl. 4, figs. 8, 11) have a less convex, proportionally shorter axis than those of either *R. capax* or *R. magna*. The terrace lines on the anterior edge of the pleural region near the lateral margins also serve to distinguish *R. wichitaensis* from *R. magna*.

Stratigraphically this species is the highest of the three species of *Rasettia*. Its lowest occurrence is 117 feet above the highest occurrence of *R. magna*.

Occurrence.—Common in the middle and upper part of the *Saukiella junia* Subzone at HS 1087, 1171; JoR 709, 753, 755. Common in the *Saukiella serotina* Subzone at HS 1181, 1221, 1230, 1237; JoR 835, 896, 906, 973, 983, 1022.

Family Missisquoiidae Hupé, 1953

Genus *Missisquoia* Shaw, 1951

Missisquoia depressa Stitt, n. sp.

Pl. 8, figs. 5-8

Available material.—12 cranidia, 5 pygidia, mostly well preserved.

Description.—Cranidium wider than long, moderately convex longitudinally, nearly flat transversely. Glabella more convex longitudinally than transversely, nearly twice as long as wide, narrowest (tr.) at glabellar midlength, expanded anteriorly and posteriorly. Four pairs of glabellar furrows, posterior two pairs moderately impressed, slightly posteriorly directed. Second pair of furrows from anterior end of glabella actually impressed as a pair of pits. Anterior pair of glabellar furrows faintly impressed and together with the anterior notch give the front of the glabella a bilobed appearance. Axial furrow moderately impressed, deepest opposite anterior end of palpebral lobes, merging with anterior border furrow at anterior lateral corners of glabella. Occipital furrow moderately impressed, curved gently forward laterally. Occipital ring narrow, flatly convex. Frontal area downsloping, narrow, about one-eleventh of the glabellar length. Preglabellar field not differentiated. Fixigenae moderately convex (exsag.), flatly convex (tr.), width four-fifths of basal glabellar width. Palpebral lobes crescentic, centered at glabellar midlength. Palpebral furrows weakly impressed. Faint eye ridges present. Posterior areas wide (tr.), flatly convex (tr. and exsag.). Posterior border furrows moderately impressed, broader than axial or occipital furrows. Anterior course of facial sutures convergent.

External surface of glabella and fixigenae covered with extremely fine granules and less numerous, scattered, medium-sized granules.

Librigenae unknown.

Pygidium broadly triangular, width greater than length. Axis low, tapered posteriorly, consisting of articulating half ring, three faintly differentiated axial rings, and a terminal axial piece. Four or five pleurae with pleural furrows. Pleural field nearly flat close to axis, then downsloping to edge of pygidium. Downsloping border faintly differentiated by shallow border furrow, most apparent at posterior end of pygidium.

External surface of pygidium covered with extremely fine granules, and scattered medium-sized granules occur on the pleural fields and on the axis.

Holotype.—OU 6527, plate 8, figure 5.

Paratype.—OU 6528a, plate 8, figure 6; OU

6528b, plate 8, figure 7; OU 6528c, plate 8, figure 8.

Etymology.—*Depressus*, L., pressed down, low, flat; referring to the low glabella and general low convexity of this species.

Remarks.—This species falls within the concept of *Missisquoia* as defined by Shaw (1951, p. 108-109) and Winston and Nicholls (1967, p. 88), particularly in its small size and proportions of the cranidium, glabella, and pygidium and in the character and size of the frontal area. It differs from all previously described species of *Missisquoia* in being much flatter and less convex, especially the glabella and fixigenae. The highest occurrence of this species is 49 feet below the lowest occurrence of *Missisquoia typicalis* in the Joins Ranch section.

Occurrence.—Common at the base of the *Missisquoia* Zone at JoR 1058, 1059, 1063, 1065.

Missisquoia typicalis Shaw

Pl. 8, figs. 1-4

Missisquoia typicalis SHAW, 1951, p. 108-109, pl. 23, figs. 1-10; WINSTON and NICHOLLS, 1967, p. 88-89, pl. 13, figs. 2, 5-6, 10, 12, 15, 18.

Remarks.—This species has been well described and illustrated by Shaw (1951) and Winston and Nicholls (1967), and nothing new can be added from Arbuckle Mountain specimens. Cranidia (exclusive of cranidial furrows) of all sizes and larger pygidia are covered with an ornament of fine to medium granules (pl. 8, figs. 2, 4).

Occurrence.—Abundant in the lower and middle part of the *Missisquoia* Zone at HS 1409, 1420, 1422, 1425; JoR 1114, 1125, 1129, 1142, 1153, 1162, 1171, 1174, 1187, 1190, 1197, 1199, 1205, 1257.

Family OLENIDAE Burmeister, 1843

Genus *Leiobienvillia* Rasetti, 1954

Leiobienvillia leonensis Winston and Nicholls

Pl. 7, fig. 12

Leiobienvillia leonensis WINSTON and NICHOLLS, 1967, p. 75-76, pl. 11, figs. 16, 20, 21.

Remarks.—This species is characterized by its anteriorly expanded glabella, faint glabellar furrows, and occipital spine. One cranidium from my collections has been assigned to this species.

Occurrence.—Scarce in the *Corbinia apopsis* Subzone at HS 1334.

Family PARABOLINOIDIDAE Lochman, 1956 (as emended by Longacre, 1970)

Genus *Croixana* Nelson, 1951

Croixana bipunctata (Shumard)

Pl. 2, fig. 18

Arionellus bipunctatus SHUMARD, 1863, p. 101; HALL, 1863, p. 169, pl. 7, figs. 50, 51.
Croixana bipunctata (Shumard) NELSON, 1951, p. 775-776, pl. 107, figs. 10, 12 (synonymy to date); GRANT, 1965, p. 131, pl. 13, fig. 15 (synonymy to date).

Remarks.—This species is easily recognized by the deep pits on the anterolateral corners of the glabella and by its convex, triangular, undifferentiated frontal area. Other diagnostic features are given by Bell and others (1952, p. 185-186). Two cranidia from one collection are assigned to this species.

Occurrence.—Scarce in the *Taenicephalus* Zone at HS 78.

Genus *Idahoia* Walcott, 1924

Idahoia lirae (Frederickson)

Pl. 3, figs. 5-9

Meeria lirae FREDERICKSON, 1949, p. 358-359, pl. 72, figs. 3-6; LOCHMAN *in* Harrington and others, 1959, p. 252, fig. 202.2.
Idahoia lirae (Frederickson) BELL and ELLINWOOD, 1962, p. 392-393, pl. 53, figs. 1-12.

Remarks.—Since Frederickson (1949, p. 358-359, pl. 72, figs. 3-6) proposed *Meeria lirae*, this monotypic genus has been unable to stand alone. Although *Meeria* was recognized as a separate genus in the *Treatise* (Lochman *in* Harrington and others, 1959, p. 252), Lochman and Hu (1959, p. 419-420) decided it was a subgenus of *Idahoia* and assigned to *Meeria* a second species, *Idahoia* (*Meeria*) *modesta* (p. 420, pl. 59, figs. 33-45). Bell and Ellinwood (1962, p. 391-393) reviewed the problem and assigned *Meeria lirae* to *Idahoia*. They also assigned Lochman and Hu's *Idahoia* (*Meeria*) *modesta* to *Saratogia*. Grant (1965, p. 121) suggested that *Meeria* was a subgenus of *Saratogia*, although in his dissertation (Grant, 1958, p. 431-434) he placed *Meeria* in synonymy with *Idahoia*. Because this problem originated with material from Oklahoma, further collections and study of Oklahoma material were necessary to determine the actual status of this group of trilobites.

Grant (1965, p. 121) listed eight criteria by which *Idahoia* and *Saratogia* could be differentiated. On the basis of these criteria I have examined features on the better preserved specimens that could be assigned to *I. lirae,* and the results are shown in table 1. On only 12 specimens could all 8 features be determined, so most specimens contributed only partial data. On many specimens the occipital ring was broken (probably indicating the presence of a node or spine), and for this reason data on the character of the occipital furrow and the length of frontal area divided by length of glabella plus occipital ring are least numerous.

As can be seen from table 1, many of these trilobites have the glabellar furrows, fixed cheeks anterior to the palpebral lobes, anterior facial sutures, palpebral lobes, and anterior borders characteristic of *Idahoia.* The ornamented external surface is characteristic of *Saratogia.* The occipital furrow and ratio of frontal area to glabellar length less clearly indicate affinities with *Saratogia.*

As pointed out earlier, the occipital ring was broken on many specimens. Not uncommonly, specimens of species that have a spine have the central part of the occipital ring broken where the spine would have joined the occipital ring. Furthermore, specimens of *I. lirae* from central Texas that have a spine commonly exhibit an occipital furrow that is faint where it crosses the axis; in specimens without a spine, the occipital furrow is well impressed across the axis (Susan A. Longacre, pers. comm.). On many of my specimens the occipital ring is broken, which probably means that many of them had spines or nodes. Specimens of *I. lirae* from central Texas commonly have spines or nodes (*see* Bell and Ellinwood, 1962, p. 392). I believe that differential preservation of the occipital ring on specimens without spines, which are the same specimens that are likely to have a well-impressed occipital furrow, has occurred. This would bias the data on the character of the occipital furrow, making that feature appear to be more like *Saratogia* than it probably is.

As can be seen from table 1, the data on length of frontal area divided by length of glabella (measured to posterior of occipital ring) does not clearly place *I. lirae* in *Idahoia* or *Saratogia.* Grant (1965, p. 121) feels that this is the most important criterion that can be used to distinguish *Idahoia* from *Saratogia.* His specimens of *Saratogia* (p. 121) have frontal areas that range from slightly less than one-fifth to one-third as long as the glabella plus occipital ring. His specimens of *Idahoia* have frontal areas that are from more than one-half to two-thirds as long as the glabella plus occipital ring (p. 118-119). Specimens of *I. lirae* from the Arbuckle Mountains have frontal areas that are never much more or much less than one-half as long as the glabella plus occipital ring. With respect to this criterion, *I. lirae* is apparently more like species

TABLE 1.—SUMMARY OF MEASUREMENTS OF ALL SPECIMENS ASSIGNED TO *Idahoia lirae*

DIAGNOSTIC FEATURE	CHARACTERISTIC OF SPECIES OF IDAHOIA	CHARACTERISTIC OF SPECIES OF SARATOGIA	INTERMEDIATE
1. Glabellar furrows	36—absent to faint	21—visible to moderately impressed	0
2. Occipital furrows	16—shallow, faint across axis	19—well impressed, visible across axis	1
3. Fixed cheeks anterior to palpebral lobes	42—moderately wide	2—narrow	2
4. Outer surface	3—smooth	52—granular, brim striated	0
5. Anterior facial sutures	31—widely divergent	3—narrowly divergent	12
6. Palpebral lobes	40—elongate	1—large, flat, semicircular	0
7. Anterior border	47—flat to downsloping	1—upturned	0
8. Length of frontal area divided by length of glabella (measured to posterior of occipital ring)	12—greater than one-half	15—less than one-half	11—equals one-half

of *Idahoia* but has some affinities with species of *Saratogia.*

Idahoia lirae has a distinctive ornament (pl. 3, figs. 5-7) that, surprisingly, has not been described before. The cranidium is covered with irregular ridges and granules (except the cranidial furrows), and the downsloping preglabellar field has longitudinal ridges. Palmer (1960, p. 57-58) believed that ornament is important at the specific level but not important enough at the generic level to be used by itself to separate otherwise similar-looking trilobites. I believe that the presence of ornament on *I. lirae* is another indication that this species has some affinities to *Saratogia.*

That *Idahoia* and *Saratogia* are closely related has been apparent for some time (*see* Lochman and Hu, 1959, p. 421; Bell and Ellinwood, 1962, p. 391-392; Grant, 1965, p. 118, 120). I have reviewed the evidence that led me to conclude that *I. lirae* is in fact a species of *Idahoia,* but I believe it is more closely related to *Saratogia* than are other described species of *Idahoia.*

Two specimens of the pygidium associated with *I. lirae* are illustrated (pl. 3, figs. 8, 9). The outline of the pygidium is elliptical, with a high axis consisting of an articulating half ring, three axial rings, and a terminal axial piece. The whole axis has a rather broad, blunt appearance with a hint of two small nodes on the posterior corners of the terminal axial piece. Pleurae are moderately developed, dying out before reaching the margin, which has a small wirelike rim.

Occurrence.—Abundant in the *Idahoia lirae* Subzone at HS 98, 100, 102, 104, 107, 110, 112, 114, 121, 124; JoR 0, 2, 4, 7; RR 187, 188, 193, 195, 198, 199, 202, 204, 205, 207, 208, 210, 217.

Idahoia lirae (Frederickson), var. A, Bell

Pl. 3, fig. 4

Idahoia lirae (Frederickson), var. A, Bell, *in* Bell and Ellinwood, 1962, p. 393, pl. 53, figs. 10-12.

Remarks.—Five specimens from one collection are assigned to this variant. The anterior border furrow is very faint or absent, and the granular and ridged ornament is much more subdued. The frontal area is slightly less than one-half the length of the glabella (measured to the posterior of the occipital ring).

Occurrence.—Scarce in the *Idahoia lirae* Subzone at HS 112.

Genus *Orygmaspis* Resser, 1937
Orygmaspis llanoensis (Walcott)

Pl. 2, fig. 14

Ptychoparia llanoensis Walcott, 1891, p. 272, pl. 21, figs. 3-5.

Orygmaspis llanoensis (Walcott) Resser, 1937, p. 21-22; Grant, 1965, p. 133, pl. 12, figs. 4, 7 (synonymy to date).

Orygmaspis firma Frederickson, 1949, p. 359, pl. 71, fig. 15-18; Bell and Ellinwood, 1962, p. 398, pl. 55, fig. 16; pl. 56, fig. 1; Grant, 1965, p. 132-133, pl. 12, figs. 3, 5, 6.

Remarks.—Cranidia of *Orygmaspis* are distinguished from those of *Parabolinoides* by the more posterior position of the palpebral areas, lower convexity of the glabellae, much fainter glabellar furrows, and narrower posterior areas. Collections from central Texas (Bell and Ellinwood, 1962, p. 398, pl. 55, figs. 11-16; pl. 56, fig. 1), Montana and Wyoming (Grant, 1965, p. 132-133, pl. 12, figs. 3-7), and the Arbuckle Mountains all show complete gradation between specimens corresponding to the paleontologic concepts of *Orygmaspis llanoensis* and *Orygmaspis firma.* The chief difference between these two species centers around the presence (*O. firma*) or absence (*O. llanoensis*) of a moderately impressed anterior border furrow that would produce an anterior border. Bell and Ellinwood (p. 398) and Grant (p. 132-133) preferred to recognize both species; Grant reasoned that in this way the distinctive end members could be identified. In the Arbuckle Mountains, specimens that are assigned to these two species occur together throughout a 35- to 40-foot interval immediately above the range of *Parabolinoides.* The same situation occurs in central Texas (Bell and Ellinwood, 1962, p. 398; p. 400 in discussion of *P. hebe*). In Montana and Wyoming, *O. llanoensis* and *O. firma* have the same range (Grant, 1965, pl. 4), although there they occur with *Parabolinoides.*

Because these two nominal species grade into each other and have the same range in each of these three areas, I consider that these specimens belong to one variable species. I have assigned them to *O. llanoensis* and have placed *O. firma* (the junior name and scarcer of the two morphotypes) in synonymy.

Occurrence.—Abundant in the *Taenicepha-*

lus Zone at HS 50, 61, 70, 75; RR 150, 153, 156, 162, 181, 183.

Genus *Parabolinoides* Frederickson, 1949

Parabolinoides FREDERICKSON, 1949, p. 360-361; LOCHMAN *in* Harrington and others, 1959, p. 272; BERG, 1953, p. 564; BELL and ELLINWOOD, 1962, p. 398-399; GRANT, 1965, p. 133-134.

Bernia FREDERICKSON, 1949, p. 357; LOCHMAN *in* Harrington and others, 1959, p. 272.

Remarks.—Grant (1965, p. 133-135) and Bell and Ellinwood (1962, p. 398-400) recently discussed the problems associated with the genus *Parabolinoides*. The ratio of the length of the frontal area to the length of the glabella, the divergence of the anterior facial sutures, and the sagittal topographic profile of the frontal area are features used by them to distinguish species assigned to *Parabolinoides*. The variability of these features was studied on 211 cranidia from the Arbuckle Mountains that are assigned to this genus. As a result of this study I have concluded (1) that Grant was correct when he placed *Bernia* (Frederickson, 1949) in synonymy with *Parabolinoides*, (2) that *Parabolinoides hebe* Frederickson and *Parabolinoides expansus* Nelson should be placed in synonymy with *Parabolinoides contractus* Frederickson, and (3) that *Parabolinoides granulosus* Ellinwood is a valid species. Reasons for these decisions are given in the discussion of the species.

Parabolinoides palatus (Berg, 1953, p. 564-566, pl. 59, figs. 5, 8) probably is a valid species. Certainly it is different from the species of *Parabolinoides* found in the Arbuckle Mountains. Despite the similarity of Berg's descriptions of *P. palatus* and *P. expansus* (*see* Berg, 1953, p. 564, in discussion of *P. contractus*), examination of the paired stereographic photographs of *P. palatus* (Berg, 1953, pl. 59, figs. 5, 8) and *P. expansus* (Nelson, 1951, pl. 107, fig. 1) shows that *P. palatus* has a much more steeply downsloping frontal area than *P. expansus*. This plus the stratigraphic occurrence of *P. palatus* with *Taenicephalus shumardi*, which places it higher in the section than any species of *Parabolinoides* in Oklahoma or central Texas, leads me to believe that *P. palatus* is a valid species of *Parabolinoides*.

The status of *Parabolinoides cordillerensis* (Lochman) is less certain. So far this species has only been reported from Montana and Wyoming, and it may be a geographic variant of *P. contractus*, as suggested by Grant (1965, p. 134-135). Its pustulose marginal furrow indicates affinities with *Orygmaspis*, which probably is a descendant of *Parabolinoides*.

Parabolinoides contractus Frederickson

Pl. 2, figs. 11-13

Parabolinoides contractus FREDERICKSON, 1949, p. 361, pl. 71, figs. 4-10; GRANT, 1965, p. 134, pl. 10, figs. 20, 23-27 (synonymy to date).

Parabolinoides hebe FREDERICKSON, 1949, p. 361-362, pl. 70, figs. 7-8; pl. 71, figs. 1-3; BERG, 1953 (part), p. 564, pl. 59, fig. 2 (not fig. 4); BELL and ELLINWOOD, 1962, p. 400, pl. 56, figs. 6-11; GRANT, 1965, p. 135, pl. 10, fig. 19.

Bernia obtusa FREDERICKSON, 1949, p. 357-358, pl. 70, figs. 1-6; BERG, 1953, p. 559-560, pl. 59, fig. 1.

Parabolinoides expansus NELSON, 1951, p. 776, pl. 107, figs. 1, 3; GRANT, 1965, p. 135, pl. 10, figs. 18, 21-22 (synonymy to date).

Description.—Cranidium slightly elongate, moderately convex. Glabella elongate, parallel sided to slightly tapered, rounded anteriorly. Glabellar furrows distinct; the anterior pair straight to slightly posteriorly directed and faint or absent, the middle and posterior pairs posteriorly directed and moderately to well impressed. Axial furrow well impressed. Occipital furrow well impressed, bowed forward slightly at the axis, and curved forward at the lateral extremities. Occipital furrow usually dies out before reaching axial furrow. Occipital ring convex, broadest at axis where a conspicuous node occurs. Frontal area convex (tr.) and variable; length ranges from slightly less than one-fourth to slightly more than one-half of glabellar length; longitudinal profile ranges from a flat preglabellar field and an upsloping anterior border to a downsloping preglabellar field and a raised but flat anterior border. Preglabellar field and anterior border subequal along axial line. Anterior border furrow moderately impressed. Fixigenae moderately wide, narrowest at palpebral areas. Palpebral lobes small, situated opposite glabellar lobes between middle and anterior glabellar furrows. Palpebral furrow faint. Eye ridges faint, anteriorly directed. Posterior areas broadly triangular, gently convex. Posterior course of facial sutures straight to gently recurved posteriorly. Posterior border furrow broad, moderately impressed. Anterior course of facial sutures ranges from slightly to strongly divergent; amount of divergence not related to length of frontal area.

Pygidium transversely elliptical. Axis consists of an articulating half ring, two axial rings, and a terminal piece. Pleural region consists of three pairs of pleurae and the hint of a faint, discontinuous border furrow. The pleurae terminate in marginal spines, and a fourth pair of marginal spines is present near the axis. The spines become progressively shorter toward the axis.

Remarks.—Grant (1965, p. 133-134) discussed his reasons for placing *Bernia* in synonymy with *Parabolinoides*, and I agree with these. Measurement of the 211 cranidia from the Arbuckle Mountains that are assigned to *Parabolinoides* reveals that the frontal area ranges from less than one-fourth (*B. obtusa*) through one-third (*P. hebe*) to slightly more than one-half (*P. contractus*) (pl. 2, fig. 11) of the length of the glabella. Measurements of this feature distribute themselves along a continuous curve with no obvious breaks. The majority of the measurements fit most closely the ratio of *P. hebe*.

Similarly, the divergence of the facial sutures ranges from straight or slightly divergent (*B. obtusa, P. hebe*) to moderately divergent (*P. hebe*) to strongly divergent (*P. contractus, P. expansus*). Again, these measurements spread along a continuum with no obvious breaks, and the majority of the measurements fit the concept of *P. hebe*.

The sagittal topographic profile of the frontal area has been used by Grant and also by Berg (1953, p. 564-565) as an aid in distinguishing species of *Parabolinoides.* Observation of this feature on the Arbuckle Mountains specimens revealed that flat to slightly downsloping pregabellar fields (pl. 2, fig. 11) with raised but flat borders (*P. contractus, P. hebe*) merged with more strongly downsloping preglabellar fields (pl. 2, fig. 12) and flat borders (*P. expansus*). Again, no obvious break existed in the continuity of this variation.

If these various nominal species were useful stratigraphically, this might be a reason to continue to recognize them. However, in the Arbuckle Mountains these nominal species, if recognized separately, would all have the same short stratigraphic range at the base of the *Taenicephalus* Zone. The same situation exists in central Texas (Bell and Ellinwood, 1962, p. 400), in Minnesota and Wisconsin (Berg, 1953, p. 556, table 1), and in Montana and Wyoming (Grant, 1965, pl. 4). Because these morphotypes have been recognized in these various areas, the possibility that they are geographic variants of each other is eliminated. In short, no taxonomic, stratigraphic, or geographic reason seems to justify continuing to split this homogeneous but variable group of trilobites into artificial species. I have, therefore, placed *P. hebe* and *P. expansus* in synonymy with *P. contractus*, the type species of *Parabolinoides.*

The pygidia associated with cranidia of *P. contractus* (pl. 2, fig. 13) have been previously illustrated by Frederickson (1949, pl. 71, fig. 9) and Bell and Ellinwood (1962, pl. 56, figs. 10, 11).

Specimens are available that display the ontogeny of *P. contractus.* In the smallest specimens, the posterior and middle pairs of glabellar furrows are straight and connect across the axis, and the anterior pair is straight and almost connects. In successively larger meraspides, the anterior pair of glabellar furrows becomes fainter and curves posteriorly, the middle pair separates and begins to curve posteriorly, and the posterior pair separates and curves posteriorly.

Occurrence.—Abundant in the *Parabolinoides* Subzone at HS 40, 41, 42.5, 44, 48; RR 142.3, 145, 147.

Parabolinoides granulosus Ellinwood

Pl. 2, fig. 10

Parabolinoides granulosus Ellinwood, *in* Bell and Ellinwood, 1962, p. 399-400, pl. 56, figs. 13-18.
Parabolinoides hebe (Frederickson) Berg, 1953 (part), p. 564, pl. 59, fig. 4 (not fig. 2).

Remarks.—This species is characterized by its granular and ridged ornament, its flattened or depressed preglabellar field, and its anterior border that is expanded (sag.) at the axial line. Bell and Ellinwood (1962, p. 400) reported that *P. granulosus* is restricted to the lower foot of the range of *Parabolinoides* in central Texas; in Oklahoma it has the same range as *P. contractus.*

One specimen of *P. hebe* illustrated by Berg (1953, pl. 59, fig. 4) has the expanded anterior border and flattened preglabellar field characteristic of *P. granulosus.* The ornament is not apparent, but trilobites preserved in sandstone often do not show ornament unless the ornament is especially strong.

Occurrence.—Common in the *Paraboli-*

noides Subzone at HS 41, 42.5, 44; RR 142.3, 147.

Genus *Saratogia* Walcott, 1916
Saratogia modesta (Lochman and Hu)

Pl. 3, fig. 11

Idahoia (*Meeria*) *modesta* Lochman and Hu, 1959, p. 420, pl. 59, figs. 33-45.
Saratogia modesta (Lochman and Hu) Bell and Ellinwood, 1962, p. 394-395, pl. 54, figs. 6-8.

Remarks.—The frontal area that ranges from one-third to two-fifths of the length of the glabella plus occipital ring, the upturned border, the semicircular palpebral lobes, and the well-impressed occipital furrow place this species in *Saratogia* rather than in *Idahoia.* Bell and Ellinwood (1962, p. 395) have summarized the criteria that distinguish *S. modesta* from *Saratogia americana* (Lochman and Hu), and Grant (1965, p. 122) has listed the differences between *S. modesta* and *Saratogia fracida* Grant.

Occurrence.—Scarce in the *Drumaspis* Subzone at HS 148; JoR 7, 10, 16.

Saratogia fria Lochman and Hu

Pl. 3, fig. 12

Saratogia fria Lochman and Hu, 1959, p. 422, pl. 59, figs. 1-11; Bell and Ellinwood, 1962, p. 394, pl. 53, figs. 13-21; Grant, 1965, p. 122-123, pl. 13, fig. 21.
Idahoia wisconsensis Lochman and Hu, 1959 (part), pl. 59, figs. 19-20, 22-24.

Remarks.—This species is characterized by a frontal area that is usually one-third as long as the glabella plus occipital ring, a downsloping preglabellar field that is strongly longitudinally ridged (especially noticeable on internal molds), a pitted anterior border furrow, an upturned anterior border with faint terrace lines, prominent elevated palpebral lobes situated close to the glabella, and strongly divergent anterior facial sutures.

As reported by Bell and Ellinwood (1962, p. 393, in discussion of *Idahoia wisconsensis*), many of Lochman and Hu's (1959, pl. 59, figs. 12-32) illustrations of *I. wisconsensis* look like their illustrations of *S. fria.* Grant (1965, p. 119 in the synonymy of *I. wisconsensis*) reached a similar conclusion.

Occurrence.—Scarce in the *Drumaspis* Subzone at JoR 26. Abundant in the upper part of the *Saratogia* Zone at JoR 180, 198, 200, 203, 217, 274, 283, 285, 290, 294, 300.

Genus *Stigmacephaloides* Ellinwood *in* Bell and Ellinwood, 1962
Stigmacephaloides curvabilis Ellinwood

Pl. 3, figs. 16, 17

Stigmacephaloides curvabilis Ellinwood, *in* Bell and Ellinwood, 1962, p. 401, pl. 56, figs. 2-5.

Remarks.—The smooth cranidium that slopes down sharply anteriorly, the narrow (exsag.) posterior areas, and the prominent palpebral areas characterize this species. Anterior downsloping of the cranidium is greatest in small specimens. Most specimens from the Arbuckle Mountains have a small node in the center of the occipital ring.

Three fragmentary cranidia near the top of the range of *S. curvabilis* have a strongly convex glabella and a coarsely pitted ornament. This may represent a new species, but the material is too fragmentary to merit naming a species at this time. The best specimen of this group is illustrated (pl. 3, fig. 17).

Occurrence.—Common in the upper part of the *Saratogia* Zone at HS 251, 257, 258, 268; JoR 142, 169, 180, 183, 217, 271, 274, 281, 283, 294.

Genus *Taenicephalus* Ulrich and Resser *in* Walcott, 1924

Taenicephalus Ulrich and Resser *in* Walcott, 1924, p. 59; 1925, p. 116.
Bemaspis Frederickson, 1949, p. 357; Lochman *in* Harrington and others, 1959, p. 306.

Remarks.—Berg (1953, p. 560) summarized the criteria used to distinguish *Taenicephalus* from *Conaspis. Taenicephalus* is characterized by incomplete palpebral furrows, frontal area one-fourth to one-third the length of the cranidium, and a slightly to moderately convex glabella.

Grant (1965, p. 136) put *Bemaspis* in synonymy with *Taenicephalus* because he felt that the large palpebral lobes that characterized *Bemaspis gouldi* (the type and only species in *Bemaspis*) were probably of specific, but not generic, value.

Taenicephalus gouldi (Frederickson)

Pl. 2, fig. 16

Bemaspis gouldi Frederickson, 1949, p. 357, pl. 71, figs. 11-14.
Taenicephalus gouldi (Frederickson) Bell and Ellinwood, 1962, p. 401-402, pl. 57, figs. 1-9; Grant, 1965, p. 137, pl. 12, figs. 1-2.

Remarks.—*Taenicephalus gouldi* is characterized by (1) a cranidium that is wider across the furrowless palpebral lobes than it is long, (2) an anteriorly rounded, moderately convex glabella, (3) lack of fossulae, and (4) a short preglabellar field of low convexity. The latter three criteria serve to distinguish it from *Taenicephalus shumardi*. Some specimens of *T. gouldi* have a small occipital node.

Occurrence.—Abundant in the *Taenicephalus* Subzone at HS 50; RR 150, 153.

Taenicephalus shumardi (Hall)
Pl. 2, fig. 17

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; BELL and ELLINWOOD, 1962, p. 402, pl. 57, figs. 10-21 (synonymy to date); GRANT, 1965, p. 137-138, pl. 12, figs. 21-22, 25-26 (synonymy to date).

Remarks.—Bell and Ellinwood (1962, p. 402) and Grant (1965, p. 137-138) summarized the three ratios used to characterize *Taenicephalus shumardi*. To quote Grant (p. 137):

> . . . the axial length of the cranidium is greater than the width across the palpebral lobes. The width of the base of the glabella just anterior to the occipital furrow is at least as great as the axial length of the glabella exclusive of the occipital ring and furrow. . . . The brim [preglabellar field] is at least as wide as the border and may be wider.

Taenicephalus wichitaensis, the only *Taenicephalus* previously reported from Oklahoma, has been placed in synonymy with *T. shumardi* by Bell and Ellinwood on the basis of these ratios. I agree with their decision.

The surface ornament of ridges and granules described by Bell and Ellinwood (p. 402) occurs on many Arbuckle Mountains specimens.

Several small cranidia from the Arbuckle Mountains that are assigned to and occur well within the range of *T. shumardi* are similar to one illustrated by Bell and Ellinwood (1962, pl. 56, fig. 20). They found occasional specimens high in the range of *Taenicephalus* that had some idahoiid characters and assigned them with some reservations to *Taenicephalus* sp. Specimens from Oklahoma do not have large crescentic palpebral lobes but do have the taenicephaliid ornament and a preglabellar field that is narrower (sag.) than the anterior border. These cranidia are small (1 to 2 mm in length), and comparison with slightly larger cranidia suggests that in *T. shumardi* the width (sag.) of the preglabellar field may increase more with size than does the width (sag.) of the anterior border.

Occurrence.—Abundant in the *Taenicephalus* Zone at HS 61, 67, 70, 75, 78, 81, 83, 84, 88, 93; RR 156, 162, 181, 183.

Genus *Wilbernia* Walcott, 1924
***Wilbernia halli* Resser**
Pl. 2, fig. 19

Conocephalites diadematus HALL, 1863 (part), pl. 7, figs. 37-38.
Wilbernia halli RESSER, 1937, p. 28; GRANT, 1965, p. 124, pl. 12, fig. 23 (synonymy to date).

Remarks.—*Wilbernia halli* is characterized by a preglabellar field-anterior border ratio between 1:1 and 1:2, a tapered glabella with strongly incised furrows, a convex preglabellar field, and a slightly convex to flat anterior border. Nine cranidia are assigned to this species.

Occurrence.—Scarce in the *Taenicephalus* Zone at HS 70, 75, 83.

***Wilbernia halli* Resser, var. A, Ellinwood**
Pl. 2, fig. 20

Wilbernia halli Resser, var. A, ELLINWOOD *in* Bell and Ellinwood, 1962, p. 395, pl. 54, figs. 16-18; GRANT, 1965, p. 124, pl. 12, fig. 8.

Remarks.—Two cranidia whose preglabellar fields are wider (sag.) than the anterior borders are assigned to this variant of *Wilbernia halli*. They occur low in the range of the species.

Occurrence.—Scarce in the *Taenicephalus* Zone at HS 70.

***Wilbernia expansa* Frederickson**
Pl. 2, fig. 21; pl. 3, fig. 1

Wilbernia expansa FREDERICKSON, 1949, p. 362-363, pl. 72, figs. 13-16; BELL and others, 1952, p. 187, pl. 32, figs. 3a-c; BELL and ELLINWOOD, 1962, p. 395, pl. 54, figs. 11, 12; GRANT, 1965, p. 123, pl. 14, fig. 5.
Wilbernia halli Resser, var. A, NELSON, 1951, p. 777, pl. 107, figs. 9, 16.

Remarks.—This species is characterized by a concave frontal area, a preglabellar field-anterior border ratio between 1:4 and 1:6, and a faint anterior border furrow that is almost tangent to the front of the glabella.

Twenty-one cranidia from the Arbuckle Mountains are assigned to this species.

Occurrence.—Scarce in the *Taenicephalus* Zone at HS 78, 83, 93; RR 183. Scarce in the *Idahoia lirae* Subzone at RR 188, 198, 204. Scarce in the *Drumaspis* Subzone at JoR 7, 26, 60. Scarce in the upper part of the *Saratogia* Zone at JoR 200.

Wilbernia diademata (Hall)

Pl. 3, fig. 2

Conocephalites diadematus HALL, 1863 (part), p. 167, pl. 7, fig. 36; pl. 8, fig. 21.
Wilbernia diademata (Hall) RESSER, 1937, p. 28; GRANT, 1965, p. 123, pl. 13, fig. 27 (synonymy to date).

Remarks.—Two cranidia from the western Arbuckle Mountains are assigned to this species on the basis of their convex (tr.), slightly tapered, faintly furrowed, anteriorly rounded glabellae. Their preglabellar field-anterior border ratio of 1:2½ is intermediate between that characteristic of *W. diademata* (1:2; *see* Bell and Ellinwood, 1962, p. 395; Grant, 1965, p. 123) and *Wilbernia pero* (1:3 to 1:7; *see* Grant, 1965, p. 124). The raised anterior border on my figured specimen is characteristic of *W. pero.* Thus the frontal area is more characteristic of *W. pero,* and the glabella is like that of *W. diademata,* strongly suggesting a relationship between these species. Longacre (1970, p. 32) reported a few specimens intermediate between these species.

Occurrence.—Scarce in the *Idahoia lirae* Subzone at JoR 2; RR 198.

Family PLETHOPELTIDAE Raymond, 1925

Genus *Leiocoryphe* Clark, 1924

Leiocoryphe occipitalis Rasetti

Pl. 4, fig. 13

Leiocoryphe occipitalis RASETTI, 1944, p. 245, pl. 38, fig. 4; BELL and ELLINWOOD, 1962, p. 403, pl. 59, fig. 4.
Leiocoryphe cf. *L. occipitalis* Rasetti, RASETTI, 1959, p. 386, pl. 53, fig. 31.

Remarks.—*Leiocoryphe occipitalis* has a small, convex, nearly featureless cranidium that lacks palpebral furrows but has an occipital furrow. The latter characteristic readily distinguishes it from other species in the genus. In the western Arbuckle Mountains, specimens low in the range of *L. occipitalis* have a moderately impressed occipital furrow, and this furrow becomes progressively fainter in stratigraphically higher collections. This trend culminates in two specimens in the highest two collections that have no occipital furrow but are like the other specimens of *L. occipitalis* in all other respects.

I have seen the holotype of *Stenopilus brevis* Raymond and agree with Rasetti (1944, p. 245-246) that this species belongs in *Leiocoryphe.* Cranidia of *Leiocoryphe brevis* (Raymond) lack palpebral lobes, have the strongly convex *anterior* margin characteristic of other species of *Leiocoryphe,* and have a rather flat posterior margin. Cranidia of species of *Stenopilus,* on the other hand, are characterized by the presence of palpebral lobes, a convex *posterior* margin, and a flat to slightly convex anterior margin—features not found on *L. brevis.* Perhaps the easiest way to distinguish *L. brevis* from other species of *Leiocoryphe* is by its strongly punctate cranidial surface (*see* Rasetti, 1944, pl. 38, fig. 3, for a good illustration of this feature). *L. brevis* lacks the occipital furrow characteristic of *L. occipitalis.*

Occurrence.—Scarce in the lower part of the *Rasettia magna* Subzone at JoR 348, 475, 487, 535.

Leiocoryphe platycephala Kobayashi

Pl. 4, figs. 9, 10, 12

Leiocoryphe platycephala KOBAYASHI, 1935a, p. 49, pl. 8, fig. 2.
Leiocoryphe transversa RASETTI, 1945b, p. 469, pl. 61, fig. 9; 1959, p. 385-386, pl. 53, figs. 25-30.

Remarks.—Rasetti (1945b, p. 469; 1959, p. 385-386) summarized the distinguishing features of this taxon but apparently missed Kobayashi's previous naming of this wide (tr.), short (sag.) species. Cranidia from the Arbuckle Mountains are slightly longer (sag.) than those figured by Kobayashi and Rasetti, but otherwise they are very similar. Associated pygidia (pl. 4, fig. 10) appear to be identical to those figured by Rasetti (1959, pl. 53, figs 28-30).

Occurrence.—Common in the *Saukiella serotina* Subzone at HS 1181, 1199, 1231; JoR 854, 876, 938, 957, 997, 1015.

Genus *Plethometopus* Ulrich *in* Bridge, 1931

Plethometopus granulosus Stitt, n. sp.

Pl. 6, figs. 10-14

Material available.—58 cranidia, 5 pygidia, well preserved, good size range.

Description.—Cranidium elongate, moderately convex, essentially smooth anterior to eyes. Glabella clearly defined by axial furrow posterior to eyes. Occipital furrow moderately to faintly impressed, straight in center, and slightly curved posteriorly at ends. Occipital ring triangular, forming a blunt spine that commonly is ornamented by fine longitudinal ridges. Fine granules cover the posterior margin of the occipital ring and sometimes the entire ring. These granules also occur along the entire posterior margin of the cranidium, covering the posterior borders, the areas immediately anterior to the posterior border furrows, and sometimes the extreme posterior part of the glabella adjacent to the occipital furrow. Granules not normally present on molds. Posterior one-half to one-third of posterior area only part of fixigenae clearly defined by axial furrow. Posterior areas broadly triangular in comparison with other species of *Plethometopus*. Border furrows are clearly impressed near axial furrow and fade out laterally. Palpebral areas situated on, to slightly anterior of midline of cranidium. Palpebral furrows very faint to absent, palpebral lobes small. Anterior course of facial sutures straight to slightly divergent in front of palpebral lobes.

Librigenae smooth (no lateral border furrow), downsloping, tapering posteriorly to a blunt genal spine. Fine terrace lines cover the tip of the genal spine.

Pygidium transversely elliptical. Axis consists of articulating half ring, two axial rings, and a terminal axial piece. Terminal axial piece has faint transverse furrows that rise from the axial furrow but do not connect across the top. Pleural region has five pleurae on each side of axial region, and pleural region slopes down to narrow border. Posterior pair of pleurae faint. Granules cover the axial rings and pleurae; area posterior of terminal axial piece is smooth.

Holotype.—OU 6510, plate 6, figure 10.

Paratypes.—OU 6511a, plate 6, figure 11; OU 6511b, plate 6, figure 12; OU 6512, plate 6, figure 13; OU 6513, plate 6, figure 14.

Etymology.—*Granulosus*, L., referring to the granules that occur along the posterior margin of the cranidium and on the pygidium.

Remarks.—This species is characterized by (1) granules covering the posterior margin of cranidium, (2) broadly triangular posterior areas, (3) palpebral areas situated on or anterior to midline of cranidium, and (4) anterior course of facial sutures straight to slightly divergent in front of eyes. This combination of characteristics distinguishes *P. granulosus* from other species in the genus.

Occurrence.—Abundant in the *Rasettia magna* Subzone at JoR 371, 385, 481, 497, 535, 539, 550, 561, 568, 592.

***Plethometopus convergens* (Raymond)**

Pl. 6, fig. 15

Plethopeltis convergens RAYMOND, 1924, p. 419, pl. 13, fig. 2.

Plethometopus convergens (Raymond) ULRICH *in* Bridge, 1931, p. 221; RASETTI, 1944, p. 251-252, pl. 39, fig. 27; 1959, p. 384, pl. 53, figs. 15-19.

Remarks.—This species is distinguished from *Plethometopus granulosus* by (1) absence of granules on posterior margin of cranidium, (2) much fainter axial furrow, (3) eyes situated on or posterior to midline of cranidium, and (4) narrow posterior areas. Longacre (1970, p. 19) found that this species ranges from the *Saukiella pyrene* Subzone to the middle of the *Saukiella serotina* Subzone in central Texas, but its occurrence in the Arbuckle Mountains is only in the *Rasettia magna* Subzone.

Occurrence.—Scarce in the *Rasettia magna* Subzone at JoR 610.

***Plethometopus armatus* (Billings)**

Pl. 6, figs. 17, 18

Bathyurus armatus BILLINGS, 1860, p. 319, fig. 23; *in* Logan and others, 1863, p. 238, fig. 273; 1865, p. 411, fig. 392.

Plethopeltis armatus (Billings) RAYMOND, 1913, p. 65, pl. 17, fig. 18.

Plethometopus armatus (Billings) ULRICH *in* Bridge, 1931, p. 221; RASETTI, 1944, p. 251, pl. 39, fig. 25; RASETTI, 1959, p. 383, pl. 52, fig. 14; pl. 53, figs. 1-8.

Plethometopus convexus (Whitfield) BELL and ELLINWOOD, 1962 (part), p. 403, pl. 59, fig. 6 (not fig. 5 = *Plethometopus* sp. undet.).

Remarks.—This species is represented by one cranidium and a number of pygidia. The cranidium differs from those of *Plethometopus obtusus* in that the facial sutures converge anterior to the eyes and the occipital spine is much longer and sharper. *P. armatus* has larger posterior areas, a larger occipital ring, and a longer occipital spine than does

Plethometopus convergens. Longacre (1970, p. 18-19) discussed the reasons for assigning to *P. armatus* one of the specimens called *Plethometopus convexus* (Whitfield) by Bell and Ellinwood.

Occurrence.—Scarce in the upper part of the *Saukiella serotina* Subzone at HS 1231, 1240, 1274; JoR 983, 1002.

Plethometopus obtusus Rasetti

Pl. 6, fig. 16

Plethometopus obtusus Rasetti 1945b, p. 472, pl. 62, figs. 1, 2; 1959, p. 383-384, pl. 53, figs. 11-14.
Unassigned pygidium no. 7, Rasetti, 1945b, p. 477, pl. 62, figs. 29, 30.
Plethometopus modestus Ulrich, Winston and Nicholls, 1967, p. 87-88, pl. 10, fig. 11.

Remarks.—This species is distinguished from *Plethometopus granulosus* by the absence of granules and by narrower posterior areas and from *Plethometopus modestus* by facial sutures that diverge anterior to the eyes and by broader posterior areas. Specimens called *P. modestus* by Winston and Nicholls have the characteristics of *P. obtusus* and are hereby reassigned.

The occurrence of *P. obtusus* in the Arbuckle Mountains is similar to its distribution in central Texas (Longacre, 1970, p. 19) in the upper part of the *Saukiella serotina* Subzone and the *Corbinia apopsis* Subzone.

Occurrence.—Scarce in the upper part of the *Saukiella serotina* Subzone at HS 1322, 1326; JoR 957, 1043. Scarce in the *Corbinia apopsis* Subzone at HS 1340; JoR 1050.

Genus *Plethopeltis* Raymond, 1913
Plethopeltis arbucklensis Stitt, n. sp.

Pl. 8, figs. 10-15

Available material.—265 cranidia, 79 pygidia, good size range, mostly well preserved.

Description.—Cranidium slightly elongate, moderately convex. Glabella length one-half to two-thirds of cranidial length, slightly longer than wide, flatly convex, tapered, rounded anteriorly. Glabellar furrows normally absent. A few specimens (pl. 8, fig. 12) have two pairs of glabellar furrows; posterior pair appear as posteriorly-directed slots near the axis and not connected to the axial furrow. Anterior pair of furrows appear as pits near the axial furrow and opposite the palpebral lobes. Axial furrow moderately to faintly impressed. Occipital furrow broad, moderately impressed, bowed slightly forward at axis, curved forward but not reaching axial furrow at lateral extremities. Occipital ring broadly triangular, widest at axis, with median node; posterior margin of occipital ring covered by terrace lines.

Frontal area variable. Length ranges from slightly less than one-third to slightly less than one-half of glabellar length and from one-fourth to one-fifth of cranidial length. On most specimens, frontal area moderately convex and continues downslope of glabella. On some specimens, faint anterior border furrow that divides the frontal area into a subequal preglabellar field and anterior border is present. On a few specimens, frontal area nearly flat immediately anterior to the glabella, then steeply and convexly downsloping, becoming concave and less steeply downsloping near the cranidial margin; on these specimens, anterior border furrow absent. Fixigenae moderately convex, gently downsloping laterally. Width immediately posterior to palpebral lobes one-third to one-fifth of basal glabellar width. Palpebral lobes medium sized, centered at or slightly anterior to glabellar midlength. Palpebral furrows usually absent, rarely very faintly impressed. Posterior areas broadly triangular, directed slightly backward. Posterior border furrow moderately impressed near axial furrow, becoming fainter near margin of cranidium. Anterior course of facial sutures slightly divergent.

Librigenae crescentic, convex, gently to moderately downsloping laterally. Eyes prominent. No lateral border differentiated, but lateral margin covered by terrace lines. Genal spine elongate, sharp, covered on margins by terrace lines.

Pygidium transversely elliptical. Axis elevated, extending almost to posterior margin of pygidium. Axis consists of articulating half ring, one well-defined axial ring, and a long terminal axial piece on which are faint indications of two or three axial rings. Three pairs of pleurae present; raised posterior part of each separated from lower anterior part by pleural furrows. Pleural field gently downsloping near axis, then strongly downsloping to borderless pygidial margin. Lateral anterior margin of pygidium covered by terrace lines.

Entire external surface of cranidium and pygidium usually covered by ornament of closely spaced fine granules, except areas covered by terrace lines. Internal mold smooth.

Holotype.—OU 6522, plate 8, figure 12.

Paratypes.—OU 6523a, plate 8, figure 10; OU 6523b, plate 8, figure 14; OU 6524, plate 8, figure 11; OU 6525, plate 8, figure 13; OU 6526, plate 8, figure 15.

Etymology.—*Arbucklensis,* named for the occurrence of this species in the Arbuckle Mountains.

Remarks.—Comparison of my material with the generic descriptions of *Plethopeltis* (Ulrich *in* Bridge, 1931, p. 219) and *Paraplethopeltis* (Bridge and Cloud, 1947, p. 555, and especially their discussion on p. 556) places this species in *Plethopeltis. P. arbucklensis* has the slightly shorter frontal area, wider posterior areas, triangular occipital ring, and more anteriorly located palpebral lobes characteristic of this genus.

Cranidia of *P. arbucklensis* are characterized by the variable frontal area and granular ornament; pygidia are distinguished by a long terminal axial piece, ribbed appearance of the pleural field, and granular ornament.

This new species most closely resembles *Plethopeltis saratogensis* (Walcott) and *Plethopeltis walcotti* Raymond. *P. arbucklensis* differs most obviously in the pygidium, which has a narrower, longer axis, fewer axial rings, a much longer terminal axial piece, and different pleural-field topography. The cranidium of *P. arbucklensis* differs from those of *P. saratogensis* and *P. walcotti* in having a more tapered, more anteriorly rounded glabella, a less convex frontal area (usually), and an external surface that is entirely covered with small granules. *P. arbucklensis* differs from *Plethopeltis granulosus* Resser in having a much fainter axial furrow and in lacking well-impressed glabellar furrows.

Occurrence.—Abundant at the base of the *Missisquoia* Subzone at HS 1348, 1353, 1357, 1360; JoR 1058, 1059, 1062, 1063, 1065, 1067, 1069, 1070, 1080.

Genus *Stenopilus* Clark, 1924
Stenopilus pronus Raymond
Pl. 6, figs. 1-3

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; Bell and Ellinwood, 1962, p. 403, pl. 59, figs. 7-9; Clark and Shaw, 1968, p. 1021-1022, pl. 126, figs. 1-8.

Stenopilus aduncus Resser, 1942, p. 60, pl. 10, figs. 14-17.

Stenopilus elongatus Rasetti, 1944, p. 257, pl. 39, figs. 20, 21; Rasetti, 1945a, p. 122-124, pl. 1, figs. 10-16.

Remarks.—This is the stratigraphically lower and more elongate of the two species of *Stenopilus* found in the Arbuckle Mountains. The ratio of width (measured across the palpebral lobes) to length (measured sagittally, with the cranidium held so that the palpebral lobes and the base of the occipital region of the cranidium are level) is less than 0.80, usually between 0.70 and 0.75. This is the key to separating cranidia of *S. pronus* from those of *Stenopilus latus,* whose ratio of width to length is greater than 0.80. As reported by Winston and Nicholls (1967, p. 88), no difference seems to exist between pygidia assigned to *S. pronus* and those assigned to *S. latus.*

I have seen the holotype and other specimens that Rasetti used in naming *Stenopilus elongatus,* and in my opinion, his specimens are actually small *S. pronus.* In my collections of *S. pronus* I have a complete gradation in size from 5 to 17 mm in length and a slight increase in convexity of the posterior part of the cranidium in the smaller specimens (pl. 6, fig. 1) Rasetti's specimens of *S. elongatus* are small (5.5 to 8 mm in length), have width to length ratios of less than 0.8, and have the same amount of posterior convexity as my smaller specimens; consequently, I have placed *S. elongatus* in synonymy with *S. pronus.* This conclusion agrees with that expressed in a similar discussion by Clark and Shaw (1968, p. 1021-1022).

Stenopilus aduncus Resser appears to be identical to *S. pronus* and is placed in synonymy with it.

I have also seen the holotypes of *Stenopilus intermedius* Clark and *Stenopilus dubius* Rasetti, as well as Rasetti's specimens of *S. intermedius,* and these two species may be conspecific. The more anterior position of the eyes and the rounder (less pointed) anterior margin of the cranidium serve to differentiate *S. intermedius* and *S. dubius* from *S. pronus,* and a width to length ratio of less than 0.80 differentiates both of them from *S. latus.*

The highest occurrence of *S. pronus* is 72 feet below the lowest occurrence of *S. latus* in the Joins Ranch section.

Occurrence.—Abundant in the *Rasettia* *magna* Subzone at JoR 348, 481, 487, 535, 561, 568, 592.

Stenopilus latus Ulrich
Pl. 6, figs. 4-7

Stenopilus latus Ulrich *in* Bridge, 1931, p. 222, pl. 19, figs. 27, 28, 32, 33; Winston and Nicholls, 1967, p. 88, pl. 9, fig. 28; pl. 10, fig. 14.

Stenopilus bacca Resser, 1942, p. 59-60, pl. 10, figs. 8-13.

Leiocoryphe halei Winston and Nicholls, 1967, p. 87, pl. 10, figs. 10, 13.

Remarks.—This is the stratigraphically higher and more equidimensional of the two species of *Stenopilus* found in the Arbuckle Mountains. The ratio of width (measured across the palpebral lobes) to length (measured sagittally, with the cranidium held so that the palpebral lobes and the base of the occipital region of the cranidium are level) is more than 0.80, usually between 0.90 and 1.00. The external surfaces of *Stenopilus latus* cranidia are covered by fine pits (pl. 6, fig. 5) that are not preserved on internal molds.

Small specimens of *S. latus* are troublesome to identify (*see* Ulrich *in* Bridge, 1931, p. 222; Winston and Nicholls, 1967, p. 87). Determining the presence or absence of eyes is critical in distinguishing *Stenopilus* from *Leiocoryphe;* this is difficult, particularly with small specimens. The palpebral furrows can be seen clearly in specimens of *S. latus* that are 6-7 mm long or longer (pl. 6, fig. 7). As the specimens decrease in size below 6 mm, it becomes increasingly difficult to determine if what one sees is a palpebral furrow (pl. 6, figs. 5, 6) or merely a wiggle (pl. 6, fig. 4) in the facial suture. Winston and Nicholls decided that these small cranidia were in fact eyeless and assigned them to a new species, *Leiocoryphe halei.* However, in all other respects these small cranidia are identical to larger cranidia of *S. latus,* and the small cranidia have essentially the same stratigraphic range as the larger cranidia. For these reasons I believe that the small cranidia are juvenile *S. latus* and that the eyes are present but so small (less than ½ mm) that they are difficult to see. Thus I have placed *L. halei* in synonymy with *S. latus.*

Stenopilus bacca Resser appears to be identical to *S. latus* and is placed in synonymy with it.

Occurrence.—Abundant in the *Saukiella junia* Subzone at HS 1068, 1087, 1092, 1118, 1120, 1123, 1127, 1163, 1165, 1171; JoR 664, 684, 701, 717, 732, 739, 745, 749, 753, 755, 759, 768, 770, 773, 780, 785, 802, 820, 827. Abundant in the *Saukiella serotina* Subzone at HS 1175, 1179, 1194, 1199, 1208, 1221, 1224, 1230, 1231, 1240, 1254, 1265, 1270, 1274, 1278, 1280, 1284, 1290, 1307, 1324, 1326; JoR 830, 833, 835, 837, 840, 852, 854, 876, 896, 902, 906, 911, 922, 938, 943, 950, 957, 969, 973, 978, 983, 985, 991, 997, 1002, 1003, 1010, 1015, 1022, 1031, 1040. Scarce at the base of the *Corbinia apopsis* Subzone at JoR 1046.

Family Pterocephaliidae Kobayashi, 1935
(as emended by Palmer, 1962)

Subfamily Pterocephaliinae Kobayashi, 1935

Genus *Camaraspis* Ulrich and Resser *in* Ulrich, 1924
Camaraspis convexa (Whitfield)
Pl. 2, fig. 3

Arionellus (*Agraulos*) *convexus* Whitfield, 1878, p. 57.

Camaraspis convexa (Whitfield) Frederickson, 1948b, p. 798-799, pl. 123, figs. 12-13 (synonymy to date); Bell and others, 1952, p. 181-182, pl. 29, figs. 2a-f (synonymy to date); Lochman and Hu, 1960, p. 813-814, pl. 96, figs. 8-17; Grant, 1965, p. 139, pl. 10, figs. 3, 6.

Camaraspis plana Frederickson, 1948b, p. 799, pl. 123, figs. 14-15; DeLand and Shaw, 1956, p. 549, pl. 65, fig. 1; pl. 66, fig. 13.

Remarks.—This species is characterized by its low to moderate cranidial convexity and its faint cranidial furrows. Smaller specimens (less than 4 mm in length) of this species commonly have more distinct cranidial furrows than do larger specimens (those longer than 7 mm); a study of specimens in the intermediate size range (4 to 7 mm in length) illustrates the transition.

Scattered through the stratigraphic range of *C. convexa* are a few small specimens that have a granular ornament covering the cranidium (exclusive of cranidial furrows). This ornament has not been observed on larger specimens. In fact, on two large cranidia, tiny pits cover the same areas, both on external surfaces and on internal molds. Grant (1965, p. 140) reported a similar occurrence. The significance of these ornamental variations is unknown.

Pygidia associated with cranidia of *C. convexa* are like those illustrated by Wilson (1951, pl. 90, figs. 5, 6) and Grant (1965, pl. 10, fig. 6). Most cranidia have a small medial node on the occipital ring.

The status of *Camaraspis parabola* Frederickson (1948b, p. 799-800, pl. 123, figs. 16-19) is uncertain. No markedly convex specimens lacking an occipital furrow were found. In other respects, *C. parabola* is not different from *C. convexa.*

Occurrence.—Abundant in the *Elvinia* Zone at HS 32.5, 37; RR 126, 127, 128, 131, 133, 134, 137, 138, 139, 140.

Camaraspis wichitaensis Stitt, new name

Camaraspoides berkeyi (Resser) FREDERICKSON, 1949, p. 349-350, pl. 68, figs. 1-6, 8, 9 (not fig 7); WILSON, 1951, p. 631, pl. 90, fig. 9; NELSON, 1951, p. 774-775, pl. 107, figs. 6, 14.
Camaraspis berkeyi (Resser) GRANT, 1965, p. 139-140, pl. 10, fig. 1.

Remarks.—This name is proposed for the paleontologic concept called *Camaraspoides berkeyi* (Resser) by Frederickson (1949, p. 349-350), Wilson (1951, p. 631), and Nelson (1951, p. 774-775), and *Camaraspis berkeyi* (Resser) by Grant (1965, p. 139-140). These names are no longer available because the holotype of *Modocia berkeyi* Resser (Frederickson, 1949, pl. 68, fig. 7), which is the type of species of *Camaraspoides* Frederickson, has been assigned to *Dellea suada* (*see* discussion of *D. suada*). No redescription is given here because the original description by Frederickson is complete, and Wilson and Grant have already made additional comments that clarify the concept of this species. Grant's suggestion (1965, p. 139) that large specimens of *C. wichitaensis* may be ecologic variants of *C. convexa* should be considered by anyone working with this genus.

I designate as the holotype of *C. wichitaensis* a specimen illustrated by Frederickson (1949, pl. 68, figs. 2, 3) (O.G.M. 105-16F-155).

Occurrence.—No specimens of this species were found in the Arbuckle Mountains.

Genus _Pterocephalia_ Roemer, 1849
Pterocephalia sanctisabae Roemer
Pl. 2, figs. 1, 2

Pterocephalia sanctisabae ROEMER, 1849, p. 421; 1852, p. 92, pl. 11, figs. 1a-d; BRIDGE, *in* Bridge and Girty, 1937, p. 246, pl. 67, figs. 1a-d; pl. 68, figs. 7-43; FREDERICKSON, 1949, p. 355, pl. 69, figs. 1-4; PALMER, 1960, p. 88-89, pl. 9, figs. 7, 8, 13 (synonymy to date); 1965b, p. 72-73, pl. 17, figs. 1-3; GRANT, 1965, p. 140-141, pl. 8, figs. 25, 28-29 (synonymy to date).

Remarks.—This species is characterized by its tapered glabella with moderately impressed glabellar furrows, its prominent eye ridges, and its broad, long, flat to slightly concave frontal area. Pygidia have at least 5 axial rings and 4 or 5 pairs of pleurae.

Occurrence.—Common in the *Elvinia* Zone at HS 32.5, 37; RR 117, 120, 126, 128, 133, 134, 138, 139, 140.

Family PTYCHASPIDIDAE Raymond, 1924
(as emended by Longacre, 1970)

Subfamily DRUMASPIDINAE Longacre, 1970

Genus _Dartonaspis_ Miller, 1936
Dartonaspis wichitaensis (Resser)
Pl. 3, fig. 13

Chariocephalus wichitaensis RESSER, 1942, p. 10-11, pl. 2, figs. 1-8.
Dartonaspis wichitaensis (Resser) BELL and ELLINWOOD, 1962, p. 397, pl. 55, fig. 6.
Chariocephalus affinis RESSER, 1942, p. 8, pl. 1, figs. 14-20.
Chariocephalus agravius RESSER, 1942, p. 8-9, pl. 1, figs. 21-28.
Chariocephalus angustatus RESSER, 1942, p. 9, pl. 1, figs. 35-40.
Chariocephalus bellus RESSER, 1942, p. 6, pl. 1, figs. 4-6.
Chariocephalus bulla RESSER, 1942, p. 7, pl. 1, figs. 7-11.
Chariocephalus gracilens RESSER, 1942, p. 9-10, pl. 1, figs. 29-31.
Chariocephalus montis RESSER, 1942, p. 10, pl. 1, figs. 32-34.
Chariocephalus tenerus RESSER, 1942, p. 5-6, pl. 1, figs. 1-3.
Chariocephalus teres RESSER, 1942, p. 7-8, pl. 1, figs. 12-13.
Chariocephalus ulrichi RESSER, 1942, p. 11, pl. 2, figs. 9-14.

Remarks.—*Dartonaspis wichitaensis* is characterized by its quadrate, slightly anteriorly expanded glabella, wide (tr.) fixigenae, short (exsag.) posterior areas, and pitted cranidium (exclusive of cranidial furrows). It differs from *Dartonaspis knighti* in that its frontal area is visible in dorsal view rather than being obscured by the very convex glabella characteristic of *D. knighti* (*see* Miller, 1936, pl. 8, figs. 34, 35; Berg, 1953, pl. 61, figs. 5, 6). *D. wichitaensis* differs from *Chariocephalus whitfieldi* in its wider fixigenae, longer palpebral lobes, and anteriorly expanded glabella.

Resser (1942, p. 4-11, pl. 1, figs. 1-40; pl. 2, figs. 1-14) named 11 "species" of *Chari-*

ocephalus from 3 localities in the Arbuckle Mountains and 2 localities in the Wichita Mountains. The differences between these "species" are present only in the descriptions and disappear when the illustrations of the "species" are compared. I have decided that these 11 nominal species constitute only 1 paleontologic species and have placed 10 of them in synonymy with *D. wichitaensis,* which was well described and illustrated by Resser.

D. wichitaensis occurs stratigraphically above *Drumaspis idahoensis,* which may be its ancestor.

Occurrence.—Scarce in the upper part of the *Saratogia* Zone at JoR 174, 180.

Genus *Drumaspis* Resser, 1942

Drumaspis RESSER, 1942, p. 28; BELL and ELLINWOOD, 1962, p. 390; GRANT, 1962, p. 983-984; GRANT, 1965, p. 114.

Type species.—*Drumaspis walcotti* Resser, 1942, p. 28-29, pl. 4, figs. 37-41.

Remarks.—Collections of *Drumaspis* from central Texas (Bell and Ellinwood, 1962, p. 390-391), Minnesota (Grant, 1962, p. 983-985), Montana and Wyoming (Grant, 1965, p. 114-115), and Oklahoma have all yielded the same paleontologic conclusion: two distinct species succeed each other stratigraphically, with a narrow zone of overlap where the lower species grades into the upper.

The stratigraphically lower species is characterized by a pair of posterior glabellar furrows that do *not* connect across the axis of the glabella and by fixed cheeks that are *less* than one-third (usually about one-fourth) as wide as the glabella (fixed cheeks measured immediately posterior to the palpebral lobes, glabella measured at glabellar midpoint). The lower species commonly has a more tapered glabella than the upper species, although this is not always true (*see* Grant, 1962, p. 984-985, for a reversal of this trend). The lower species in Texas and Oklahoma has a granular and ridged ornament on the cranidium, but specimens from the Minnesota and Montana-Wyoming areas are smooth.

The stratigraphically higher species is characterized by a pair of posterior glabellar furrows that *connect* across the axis of the glabella and by fixed cheeks that are one-third to one-half as wide as the glabella. The higher species commonly has a more quadrate, blunt glabella than the lower species and is smooth (except for faint ridges and granules on the occipital ring in specimens from Texas and Oklahoma). Specimens from the zone of gradation have a faint connection between the posterior pair of glabellar furrows and fixed cheeks that are close to one-third as wide as the glabella; these specimens may have to be assigned somewhat arbitrarily.

Resser (1942, p. 28-35, pl. 4, figs. 32-41; pl. 5, figs. 1-35) created the genus *Drumaspis* and assigned to it 14 species: 3 from 1 locality, 2 from a second, and 9 from 9 other localities. Throughout his paper (not only in the genus *Drumaspis*), similar specimens from different localities were assigned to different species. Later work has resulted in much synonymizing of Resser's species. Lochman (1953b, p. 895) assigned *Drumaspis utahensis* Resser to *Dartonaspis;* Palmer (1968, p. 85) placed it in synonymy with *Drumaspis idahoensis* Resser.

I was able to assign all but one of Resser's 14 nominal species of *Drumaspis* to one of the two species described above. The characteristics of *D. briscoensis, D. maxwelli, D. wichitaensis, D. clara, D. texana, D. osella,* and *D. nitida* match the characteristics of the lower species; five are ridged and granulated and all have tapered glabellae. The features of *D. idahoensis, D. alberta, D. deckeri, D. utahensis, D. goodsirensis,* and *D. sabinensis* match the characteristics of the higher species; 4 are smooth and 3 have rather blunt glabellae.

Drumaspis walcotti, the type species, is placed in neither of these groups. The holotype (Resser, 1942, pl. 4 figs. 37-39) clearly has nonconnecting posterior glabellar furrows, but the fixed cheeks are more than one-third the glabellar width. The other illustrated specimen (Resser, pl. 4, figs. 40-41), presumably the paratype, has connecting posterior glabellar furrows, but the fixed cheeks are less than one-third the glabellar width. Grant (1965, p. 114) believes that the holotype and paratype are not conspecific, and I tend to agree. Lochman and Hu (1959, p. 416-417) identified *D. walcotti* in collections from the same formation in Idaho that provided Resser's original material. Their collections are from a thin coquina, and their illustrations of *D. walcotti* show some specimens (Lochman and Hu, 1959, pl. 60, figs. 1, 4, 7, 12) with nonconnecting glabellar furrows and some (pl. 60, figs. 2, 3, 11, 13) with connecting furrows. Grant (1965, p. 114) surmised that both Resser and Lochman and Hu collected from the zone of gradation or overlap of the two species. Until someone collects more extensively in this area the status of *D. walcotti* will remain unclear.

In Texas (Bell and Ellinwood, 1962), Minnesota (Grant, 1962), and Montana-Wyoming (Grant, 1965), the stratigraphically lower taxon has recently been assigned to *D. texana*, *D. sabulosa* Grant, and *D. briscoensis*, respectively, and the upper species has been assigned to *D. deckeri*, *D. tanycodia* Grant, and *D. idahoensis*, respectively. Palmer (1968, p. 85), working in Alaska, assigned specimens with connecting glabellar furrows to *D. idahoensis* and synonymized *D. deckeri* with it. Perhaps these nominal species are all biologically valid, but stratigraphically they do segregate into two groups, each of which has certain features in common, as outlined earlier. If we continue to use different names in the several areas where this segregation is observed, some of the confusion that Resser originated will remain. Because the lower species in each of these widely separated areas have certain features in common, I prefer to regard them, for now, as belonging to a single species. I assign them to *D. texana*, which is well illustrated and described by Resser and by Bell and Ellinwood. The same logic prevails for the higher species, which I assign to *D. idahoensis*, following the recent discussion of this species by Palmer (1968, p. 85).

I do not regard this subject as closed by any means. Someone should study the collections of *Drumaspis* from the six areas recently studied and make additional collections from Resser's other localities. Grant (1962, 1965) has emphasized glabellar convexity, width of fixed cheeks, and variations in the frontal area as means of distinguishing species in Texas, Minnesota, and Montana-Wyoming. Specimens from Oklahoma are very similar to those from central Texas.

The pygidia assigned to *Drumaspis* by Lochman and Hu (1959, pl. 60, figs. 8, 9) and Bell and Ellinwood (1962, pl. 52, figs. 13-15) are strikingly different from pygidia assigned to *Drumaspis* by Grant (1965, pl. 14, figs. 9, 12). The one pygidium found in the Arbuckle Mountains is similar to those illustrated by Bell and Ellinwood. Anyone who tackles the *Drumaspis* problem on a regional basis should also investigate this aspect of *Drumaspis* variation.

Drumaspis texana **Resser**
Pl. 3, fig. 14

Drumaspis texana RESSER, 1942, p. 32-33, pl. 5, figs. 27-30; BELL and ELLINWOOD, 1962, p. 391, pl. 52, figs. 7-9, 13, 14.
Drumaspis briscoensis RESSER, 1942, p. 30, pl. 5, figs. 4-8; GRANT, 1965, p. 115, pl. 14, figs. 7-9.
Drumaspis clara RESSER, 1942, p. 33-34, pl. 5, figs. 23-26.
Drumaspis maxwelli RESSER, 1942, p. 31, pl. 5, figs. 12, 13.
Drumaspis nitida RESSER, 1942, p. 34, pl. 5, figs. 34, 35.
Drumaspis osella RESSER, 1942, p. 32, pl. 5, figs. 17-20.
Drumaspis wichitaensis RESSER, 1942, p. 33, pl. 5, figs. 21, 22.
Drumaspis sabulosa GRANT, 1962, p. 984-985, pl. 139, fig. 6.

Remarks.—This species is characterized by a posterior pair of glabellar furrows that do not connect across the glabella, fixigenae less than one-third as wide as the glabella, granulated and ridged ornament on cranidium (exclusive of cranidial furrows), and slightly tapered glabella. In the highest part of its range *D. texana* grades into *Drumaspis idahoensis*, and the ranges of the two overlap in the Joins Ranch and U.S. Highway 77 sections.

Occurrence.—Common in the lower part of the *Drumaspis* Subzone at HS 124, 130, 138, 144, 145, 148; JoR 7, 10, 16, 26, 60.

Drumaspis idahoensis **Resser**
Pl. 3, fig. 15

Drumaspis idahoensis RESSER, 1942, p. 29, pl. 4, figs. 32-36; GRANT, 1965, p. 115, pl. 14, figs. 11-12; PALMER, 1968, p. 85, pl. 13, figs. 1-5.
Drumaspis alberta RESSER, 1942, p. 29-30, pl. 5, figs. 1-3.
Drumaspis deckeri RESSER, 1942, p. 31-32, pl. 5, figs. 14-16; BELL and ELLINWOOD, 1962, p. 391, pl. 52, figs. 10-12, 15.
Drumaspis goodsirensis RESSER, 1942, p. 30, pl. 5, fig. 9.
Drumaspis sabinensis RESSER, 1942, p. 31, pl. 5, figs. 10, 11.
Drumaspis utahensis RESSER, 1942, p. 34, pl. 5, figs. 31-33.
Drumaspis tanycodia GRANT, 1962, p. 985, pl. 139, fig. 7.

Remarks—This species is characterized by its posterior pair of glabellar furrows that connect across the top of the glabella, fixigenae that are one-third or more as wide as the glabella, and a smooth, blunt glabella. It occurs stratigraphically higher than *Drumaspis texana*, except for a zone of gradation or overlap.

Occurrence.—Scarce in the middle and upper part of the *Drumaspis* Subzone at HS 148, 216; JoR 26, 71, 109.

Subfamily EUREKIINAE Hupé, 1953

Genus *Bayfieldia* Clark, 1924

Bayfieldia binodosa (Hall)

Pl. 5, figs. 6, 7

Conocephalites? binodosus HALL, 1863, p. 160, pl. 7, fig. 47.
Ptychoparia binodosa (Hall) CLARK, 1924, p. 32,
Eurekia binodosa (Hall) WALCOTT, 1925, p. 89; GRANT, 1965, p. 116, pl. 15, figs. 15, 18.
Bayfieldia binodosa (Hall) WINSTON and NICHOLLS, 1967, p. 83, pl. 9, figs. 1, 2.
Bayfieldia finkelnburgi CLARK, 1924, p. 32, pl. 4, fig. 7.
Eurekia finkelnburgi (Clark) RESSER, 1935, p. 28.
Corbinia implumis WINSTON and NICHOLLS, 1967, p. 86, pl. 9, fig. 3.

Remarks.—This species has recently been redescribed and illustrated by Winston and Nicholls, who along with Longacre (1970, p. 36-37) summarized the diagnostic characteristics of this variable species. Longacre decided that *Corbinia implumis* Winston and Nicholls is a subjective synonym of *Bayfieldia binodosa*.

Occurrence.—Scarce in the *Rasettia magna* Subzone at JoR 582, 632. Common in the *Saukiella junia* Subzone at HS 1038, 1058, 1060, 1120, 1127; JoR 653, 657, 684, 701, 707, 711, 732, 759.

Bayfieldia simata Winston and Nicholls

Pl. 5, figs. 9, 10

Bayfieldia simata WINSTON and NICHOLLS, 1967, p. 84, pl. 9, figs. 20, 23-26.

Remarks—This species has been well described and illustrated by Winston and Nicholls. *B. simata* is distinguished from *Bayfieldia binodosa* by its much flatter glabella and longer, flatter frontal area. It can be distinguished from *Monocheilus truncatus* and *Magnacephalus smilus* by its faint anterior border furrow, its occipital furrow that bifurcates laterally, its more tapered glabella, and its longer frontal area.

Occurrence.—Common in the upper part of the *Saukiella junia* Subzone at HS 1127, 1135, 1148; JoR 732, 753, 759, 768, 773, 802. Common in the *Saukiella serotina* Subzone at HS 1175, 1181, 1197, 1224, 1258; JoR 896, 983, 997, 1040.

Bayfieldia simata Winston and Nicholls var. A, Winston and Nicholls

Pl. 5, fig. 8

Bayfieldia simata Winston and Nicholls, var. A, WINSTON and NICHOLLS, 1967, p. 84, pl. 9, figs. 24, 26.

Remarks.—This variant occurs low in the range of *Bayfieldia simata*. The cranidium is not different, but the pygidium has a higher axis than usual for *B. simata* and has two small nodes on the terminal axial piece.

Occurrence.—Scarce in the upper part of the *Saukiella junia* Subzone at HS 1127; JoR 732, 753.

Genus *Corbinia* Walcott, 1924

Corbinia apopsis Winston and Nicholls

Pl. 5, figs. 11, 12

Bayfieldia sp. RASETTI, 1959, p. 388-389, pl. 55, figs. 20-23.
Corbinia apopsis WINSTON and NICHOLLS, 1967, p. 86, pl. 11, figs. 13, 14, 17, 22.

Remarks.—This species has been well described and illustrated by Winston and Nicholls. Pygidia from the Arbuckle Mountains (pl. 5, fig. 12) have a weblike ornament of terrace lines along the margin and on the marginal spines.

Occurrence.—Common in the *Corbinia apopsis* Subzone at HS 1334, 1340; JoR 1046, 1050, 1054.

Genus *Eurekia* Walcott, 1924

Eurekia granulosa Walcott

Pl. 5, fig. 13

Eurekia granulosa WALCOTT, 1924, p. 56-57, pl. 12, fig. 1; WALCOTT, 1925, p. 90, pl. 16, figs. 13-17; RESSER, 1935, p. 28 (list).
Eurekia sedgwicki (Billings) WINSTON and NICHOLLS, 1967, p. 85, pl. 10, figs. 12, 16.

Remarks.—This genus has been redescribed by Winston and Nicholls (1967, p. 84-85). This species is characterized by its convex granulose cranidium, anteriorly rounded glabella, deep posteriorly curved glabellar furrows, and an anteriorly concave border furrow. It occurs stratigraphically lower than *Eurekia eos*, although some specimens high in the range of *Eurekia granulosa* tend toward the blunter glabella characteristic of *E. eos*.

Rasetti (1944, p. 258) and Longacre (1970, p. 38-39) have commented on the uncertain status of *Menocephalus sedgwicki* Billings. Specimens assigned to *Eurekia sedgwicki* (Billings) by Winston and Nicholls (1967, p. 85) were reassigned to *Eurekia granulosa* by Longacre (1970, p. 38).

Occurrence.—Common in the lower part of the *Rasettia magna* Subzone at JoR 487, 505, 535. Scarce in the base of the *Saukiella junia* Subzone at JoR 653.

Eurekia eos (Hall)

Pl. 5, figs. 14, 15

Conocephalites eos HALL, 1863, p. 151, pl. 7, figs. 24, 25; pl. 8, figs. 8, 9.
Eurekia eos (Hall) WALCOTT, 1924, p. 89 (list); RESSER, 1935, p. 28 (list); WINSTON and NICHOLLS, 1967, p. 85, pl. 10, figs. 15, 17.

Remarks.—This species is distinguished from *Eurekia granulosa* by its blunt anteriorly truncate glabella and its nearly transverse anterior border furrow. In addition to the coarse granular ornament that covers the cranidium (except in the cranidial furrows), exfoliated cranidia are covered by fine pits that occur between the granules. These tiny pits occur even in the glabellar furrows, although not in any of the other cranidial furrows.

The pygidium has 3 axial rings, 2 nodes on the terminal axial piece, and blunt, foot-shaped spines along the margin.

Occurrence.—Common in the upper part of the *Saukiella junia* Subzone at HS 1148, 1163, 1171; JoR 780, 802, 820. Abundant in the *Saukiella serotina* Subzone at HS 1188, 1197, 1199, 1206, 1208, 1213, 1221, 1224, 1230, 1231, 1235, 1240, 1265, 1270, 1290; JoR 833, 852, 854, 870, 876, 880, 896, 906, 913, 950, 957, 973, 978, 983, 985, 997, 1003, 1006, 1010, 1015, 1022.

Subfamily PTYCHASPIDINAE Longacre, 1970

Genus *Conaspis* Hall, 1863

Conaspis HALL, 1863, p. 152; BERG, 1953, p. 560.

Remarks.—Berg (1953, p. 560) summarized the criteria used to distinguish *Conaspis* from *Taenicephalus*. *Conaspis* is characterized by straight, complete palpebral furrows, frontal area always less than one-fourth of the length of the cranidium, glabella moderately to highly convex, and anterior border never narrower than preglabellar area.

Although Frederickson (1949, p. 344) did not find any specimens assignable to *Conaspis* in the Honey Creek Limestone, I found 10 cranidia that I have assigned to 2 species of *Conaspis*.

Conaspis testudinata Ellinwood

Pl. 2, fig. 15

Conaspis testudinatus ELLINWOOD, *in* Bell and Ellinwood, 1962, p. 404-405, pl. 58, figs. 10-13.

Remarks.—Three cranidia from two collections are assigned to this species, which has been well described and illustrated by Bell and Ellinwood. The most striking feature of this species is the coarsely pustulose ornament of the cranidium.

Occurrence.—Scarce in the *Taenicephalus* Zone at HS 61, 67.

Conaspis cf. *C. tumida* Kurtz

Pl. 3, fig. 10

Conocephalites perseus HALL, 1863 (part), p. 153, pl. 7, figs. 18, 19, 23.
Conaspis perseus (Hall) SHIMER and SHROCK, 1944, pl. 263, fig. 27; NELSON, 1951, p. 775, pl. 107, fig. 11.
Conaspis tumidus KURTZ *in* Bell and others, 1952, p. 185, pl. 31, fig. 5; BERG, 1953, p. 562, pl. 60, fig. 8.

Remarks.—This species is characterized by its strongly convex glabella, short, downsloping frontal area, and narrow posterior areas. Specimens from the western Arbuckle Mountains differ from those in the Upper Mississippi Valley (Bell and others, 1952, pl. 31, fig. 5; Berg, 1953, pl. 60, fig. 8; Nelson, 1951, pl. 107, fig. 11) in having a shallower preglabellar furrow and a curved, not pointed, anterior border.

Seven cranidia from the *Idahoia lirae* Subzone are assigned to this species. It occurs near the top of the *Conaspis* Zone in the Upper Mississippi Valley (*see* Berg, 1953, p. 556, table 1).

Occurrence.—Scarce in the *Idahoia lirae* Subzone at HS 104; JoR 4; RR 193, 199.

Genus *Euptychaspis* Ulrich *in* Bridge, 1931

Euptychaspis typicalis Ulrich

Pl. 6, fig. 19

Euptychaspis typicalis ULRICH *in* Bridge, 1931, p. 218, pl. 19, figs. 5-7; DAKE and BRIDGE, 1932, p.

740, pl. 12, fig. 3; Rasetti, 1959, p. 393, pl. 52, figs. 11-13; Winston and Nicholls, 1967, p. 78-79, pl. 9, fig. 17.

Remarks.—This species is characterized by its parallel-sided glabella, only slightly expanded frontal lobe of the glabella, and wide fixigenae. As reported by Winston and Nicholls (1967, p. 78), *Euptychaspis typicalis* appears to be the basic stock from which *Euptychaspis jugalis* and *Euptychaspis kirki* evolved. Low in the range of *Euptychaspis, E. typicalis* is sometimes difficult to distinguish from the other two species, but with progressive evolution toward their final forms, distinguishing the three species becomes easier.

Fine pits cover the cranidium (except the cranidial furrows) on internal molds of *E. typicalis*. Some specimens have a small notch on the front of the glabella; a few possess a small triangular anterior border.

Occurrence.—Common in the *Saukiella junia* Subzone at HS 1058, 1087, 1120, 1123, 1171; JoR 653, 749, 753, 755, 802. Scarce in the lower part of the *Saukiella serotina* Subzone at HS 1199, 1224; JoR 830, 870.

Euptychaspis jugalis Winston and Nicholls

Pl. 6, fig. 20

Euptychaspis jugalis Winston and Nicholls, 1967, p. 79, pl. 9, fig. 13.

Remarks—This species has been well described by Winston and Nicholls. It is characterized by the low, expanded frontal lobe of the glabella, fixigenae that are narrow and pulled in toward the glabella anterior to the eyes (expanding posterior to the eyes), and the low, smooth profile of the glabella and frontal area. The flattened middle and posterior glabellar lobes mentioned by Winston and Nicholls are best developed in stratigraphically higher specimens. Specimens low in the range of *Euptychaspis jugalis* have a slightly higher glabella and wider fixigenae and are difficult to distinguish from *Euptychaspis typicalis*.

Fine pits cover the entire cranidium (exclusive of cranidial furrows) on both the external surface and internal molds. Some specimens have a small notch on the front of the glabella.

Occurrence.—Scarce in the upper part of the *Saukiella junia* Subzone at HS 1148, 1175. Common in the *Saukiella serotina* Subzone at HS 1179, 1197, 1199, 1206, 1217; JoR 830, 852, 854, 870, 997, 1022.

Euptychaspis kirki Kobayashi

Pl. 6, fig. 21

Euptychaspis kirki Kobayashi, 1935a, p. 56, pl. 10, figs. 4, 5; Winston and Nicholls, 1967, p. 79, pl. 9, fig. 18.

Euptychaspis sp. Stauffer, 1940, p. 55, pl. 6, figs. 9, 10.

Remarks.—A greatly expanded frontal lobe of the glabella that in some specimens overhangs the reduced frontal area (especially stratigraphically higher specimens) is the outstanding characteristic of this species. The fixigenae are raised and intermediate in width between those of *Euptychaspis typicalis* and *Euptychaspis jugalis*. Fine to coarse pits cover the cranidium (except the cranidial furrows), in some cases creating a ropy appearance on the frontal area and anterior fixigenae. Most specimens have a conspicuous notch on the front of the glabella; the notch is much better developed than on specimens of *E. typicalis* or *E. jugalis*.

Occurrence.—Abundant in the *Saukiella serotina* Subzone at HS 1181, 1197, 1206, 1213, 1217, 1221, 1231, 1235, 1238, 1240, 1250, 1254, 1270, 1280, 1284, 1290; JoR 870, 876, 880, 896, 902, 906, 913, 938, 943, 950, 957, 969, 978, 983, 985, 991, 1002, 1003, 1006, 1010, 1022, 1040, 1043.

Genus *Keithia* Raymond, 1924

Keithia sp. undet.

Pl. 7, fig. 14

Remarks.—One specimen is assigned to this genus on the basis of its convex glabella, especially the tumid anterior end, and the posterior glabellar furrows that do not connect across the axis. It most closely resembles *Keithia similus* Rasetti (1944, p. 242, pl. 37, figs. 20, 21) from which it differs in having a parallel-sided glabella and a coarse-granular ornament.

Occurrence.—Scarce in the *Rasettia magna* Subzone at JoR 539.

Genus *Keithiella* Rasetti, 1944

Keithiella cf. *K. patula* Winston and Nicholls

Pl. 7, fig. 13

Keithiella patula WINSTON and NICHOLLS, 1967, p. 79-80, pl. 10, figs. 4, 7.

Remarks.—One specimen is assigned to this genus on the basis of its parallel-sided glabella (less convex than in species of *Keithia*), elevated palpebral areas, slightly divergent anterior facial sutures, lack of a preglabellar field, and a very faint connection between the posterior pair of glabellar furrows. It resembles *K. patula* most closely, differing principally in the elevated palpebral areas of its fixigenae. Otherwise it is very similar and has the same stratigraphic occurrence.

Occurrence.—Scarce in the middle part of the *Saukiella serotina* Subzone at HS 1221.

Genus *Ptychaspis* Hall, 1863
***Ptychaspis* sp. undet.**
Pl. 3, fig. 3

Remarks.—One pygidium is assigned to this genus on the basis of its broad (tr.), short (sag.), elliptical shape; its convex (tr.) axis with two axial rings and a terminal piece; and its prominent pleurae with well-defined pleural and interpleural furrows. The external surface is covered with fine to medium granules that are present, but less prominent, on the internal mold.

This specimen is most similar to and has the same stratigraphic occurrence as *Ptychaspis granulosa* (Owen) (*see* Bell and others, 1952, p. 193, pl. 35, figs. 1c, 1d). It differs from *P. granulosa* in possessing fewer axial rings and having the terminal piece situated farther from the pygidial margin, characteristics that also distinguish it from pygidia of *Ptychaspis bullasa* Lochman and Hu (1959, p. 422, pl. 58, figs. 27-31, 33, 34). *Ptychaspis* sp. undet. also lacks the raised border characteristic of *P. bullasa.*

Occurrence.—Scarce in the *Drumaspis* Subzone at HS 138.

Subfamily SAUKIINAE Ulrich and Resser, 1933
Genus *Calvinella* Walcott, 1914
***Calvinella tenuisculpta* Walcott**
Pl. 6, figs. 8, 9

Calvinella tenuisculpta WALCOTT, 1914, p. 391, pl. 64, figs. 7, 7a; WINSTON and NICHOLLS, 1967, p. 80, pl. 11, fig. 4.

Remarks.—After much debate I concluded that this is the only species of *Calvinella* in the Arbuckle Mountains. The fixigenae of *C. tenuisculpta* are wider immediately anterior and posterior to the palpebral lobes than are the fixigenae of *Calvinella spiniger* (Hall), but otherwise these two species are rather similar. The width (tr.) of each palpebral area of the fixigenae ranges from one-half to two-thirds the width of the glabella (glabellar width measured where palpebral area widest). The measurements of this variation spread along a continuum with no obvious breaks. Stratigraphically higher specimens (pl. 6, fig. 9) tend to have wider fixigenae, but this variation is not consistent enough to merit designation as a different species. Winston and Nicholls (1967, p. 80) reported a similar situation, but they interpreted it differently. However, as they (p. 80, pl. 11, figs. 5, 9) pointed out, the specimens they assigned to *C. ozarkensis* have wider fixigenae than do the specimens assigned to *C. ozarkensis* by Walcott (1914, pl. 70, figs. 1-6) or Ulrich (*in* Bridge, 1931, pl. 19, figs. 8, 9, 11).

Longacre (1970, p. 46-47) reported difficulty in recognizing consistent differences between *C. tenuisculpta* and *Calvinella procera* Winston and Nicholls.

Occurrence.—Common in the *Saukiella serotina* Subzone at HS 1175, 1206, 1217, 1221, 1224, 1230, 1284, 1288, 1328; JoR 837, 876, 896, 911, 914, 922, 950, 957, 1043.

Genus *Prosaukia* Ulrich and Resser, 1933
***Prosaukia* sp. undet.**
Pl. 7, fig. 21

Remarks.—One specimen is assigned to this genus, but preservation is too fragmentary for specific determination. The specimen has a tumid, tuberculated glabella, upsloping palpebral areas, and a downsloping frontal area divided by the anterior border furrow into a narrow (sag.) preglabellar field and a slightly wider anterior border. The occipital ring is broken off. The posterior glabellar furrows are well impressed and connected across the axis, and the anterior glabellar furrows are well impressed and posteriorly directed.

Occurrence.—Scarce in the upper part of the *Saukiella serotina* Subzone at JoR 1010.

Genus *Saukia* Walcott, 1914
***Saukia tumida* Ulrich and Resser**
Pl. 4, fig. 15

Saukia tumida ULRICH and RESSER, 1933, p. 192, pl. 30, figs. 11, 12; WINSTON and NICHOLLS, 1967, p. 81, pl. 9, figs. 7, 9, 11.

Remarks.—This species is characterized by its coarsely pustulose and deeply furrowed glabella, steeply sloping frontal area, and high palpebral lobes. It is represented in collections from the Arbuckle Mountains by 14 specimens.

Occurrence.—Scarce in the lower part of the *Saukiella junia* Subzone at HS 1032, 1053, 1078, 1082, 1087; JoR 653.

Genus *Saukiella* Ulrich and Resser, 1933
Saukiella pyrene (Walcott)
Pl. 4, fig. 16

Saukia pyrene WALCOTT, 1914, p. 382, pl. 67, figs. 18-20.
Saukiella pyrene, (WALCOTT) ULRICH and RESSER, 1933, p. 204, pl. 34; pl. 35, figs. 1-8; RAASCH, 1951, p. 145; NELSON, 1951, p. 783, pl. 110, figs. 4, 7; LONGACRE, 1970, p. 51-53, pl. 5, figs. 4-8 (synonymy to date).

Remarks.—The genus *Saukiella* is represented by only seven specimens in collections from the Arbuckle Mountains, and only one of these is assigned to *Saukiella pyrene*. Longacre (1970, p. 51-53) studied the variation in this species in the much larger central Texas collections and synonymized Ulrich and Resser's splitting of Walcott's original material.

S. pyrene is distinguished from *Saukiella serotina* Longacre by its anteriorly expanded glabella, one pair of distinctly impressed glabellar furrows anterior to the transglabellar furrow, and the narrower palpebral area of the fixigenae. *S. pyrene* occurs stratigraphically lower than *S. serotina* in the western Arbuckle Mountains.

Occurrence.—Scarce in the *Rasettia magna* Subzone at JoR 582.

Saukiella serotina Longacre
Pl. 4, fig. 17

Saukiella norwalkensis Ulrich and Resser, *in* WINSTON and NICHOLLS, 1967, p. 82, pl. 11, figs. 6-8, 12.
Saukiella serotina LONGACRE, 1970, p. 53, pl. 6, figs. 1-3.

Remarks.—Longacre, working with large collections of *Saukiella* from central Texas, decided that *Saukiella norwalkensis* Ulrich and Resser was a junior subjective synonym of *Saukiella pyrene*. This left the specimens of *Saukiella* that Winston and Nicholls (1967, p. 82, pl. 11, figs. 6-8, 12) had called *S. norwalkensis* without a name, and she assigned those and other specimens to a new species, *Saukiella serotina*. *S. serotina* is distinguished from *S. pyrene* by its straight-sided to slightly tapering glabella, only one distinctly impressed glabellar furrow, and much wider palpebral area. *S. serotina* occurs stratigraphically higher than *S. pyrene.*

Occurrence.—Scarce in the *Saukiella serotina* Subzone at HS 1199, 1317; JoR 837, 906, 1010.

Family REMOPLEURIDIDAE Hawle and Corda 1847

Genus *Apatokephaloides* Raymond, 1924
Apatokephaloides clivosus Raymond
Pl. 5, fig. 21

Apatokephaloides clivosus RAYMOND, 1924, p. 425, pl. 13, fig. 13 (not fig. 17, referred to *Bayfieldia ulrichi* by Rasetti, 1945b, p. 465); RASETTI, 1963, p. 1010, pl. 130, figs. 19, 20; WINSTON and NICHOLLS, 1967, p. 86-87, pl. 11, fig. 11.

Remarks.—This species has recently been redescribed by Winston and Nicholls, and two cranidia from the Arbuckle Mountains have been assigned to it. One of them (pl. 5, fig. 21) has a node on the occipital ring similar to the one illustrated by Rasetti (1963, pl. 130, fig. 19), but the preglabellar field is not shortened as in his specimen.

Occurrence.—Scarce in the *Corbinia apopsis* Subzone at HS 1334; JoR 1046.

Family ?SHUMARDIIDAE Lake, 1907

Genus *Idiomesus* Raymond, 1924
Idiomesus levisensis (Rasetti)
Pl. 5, figs. 1-5

Stigmametopus levisensis RASETTI, 1944, p. 257, pl. 37, figs. 8, 9.
Idiomesus levisensis (Rasetti) RASETTI, 1946, p. 539.
Idiomesus intermedius RASETTI, 1959, p. 393, pl. 51, figs. 25, 26; WINSTON and NICHOLLS, 1967, p. 73, pl. 10, fig. 21.
Idioniesus sp. HAMBLIN, 1958. pl. 5, fig. 14 (genus misspelled; figure of cranidium, not pygidium).

Remarks.—As reported by Winston and Nicholls (1967), the number of lateral glabellar pits is the characteristic used to distinguish the three described species of *Idiomesus.*

All three species have a posterior transglabellar furrow. *I. levisensis* has, in addition, two pairs of lateral glabellar pits, *I. intermedius* has one pair of lateral glabellar pits, and *I. tantillus* has no lateral glabellar pits. Collections of *Idiomesus* from the Arbuckle Mountains have a posterior transglabellar furrow and show a continuous gradation from one faint pair (pl. 5, figs 1, 2) to two strongly impressed pairs (pl. 5, fig. 5) of lateral glabellar pits. Most specimens (pl. 5, figs. 3, 4) have a posterior pair of strongly impressed pits and an anterior pair of faintly to moderately impressed pits. Specimens with the several combinations of pits occur together in the same beds and show no stratigraphic segregation or trend, and I suggest that *I. levisensis* and *I. intermedius* are not separate species but end members of the same species. For this reason I have placed *I. intermedius* in synonymy as a subjective synonym of *I. levisensis.*

Certain other features of *I. levisensis* cranidia are worth noting. The glabella, frontal area, and fixigenae are ornamented by numerous fine pits (pl. 5, fig. 5), and faint terrace lines are on the frontal area and anterior edge of the fixigenae (pl. 5, fig. 2). The preglabellar furrow ranges from absent to strongly impressed, but this variation is related neither to the variation in the number of lateral glabellar pits nor to stratigraphic position. The few specimens that have two strongly impressed lateral glabellar pits commonly have a pustulelike swelling immediately anterior of the pits (pl. 5, fig. 5). Two specimens lack the usual posterior transglabellar furrow but are like other specimens of *Idiomesus* in all other aspects.

Longacre (1970, p. 54-56), in working with collections from central Texas, has found that cranidia with two pairs of strongly impressed pits also have a broad axial furrow posterior to the eyes and low posterior fixigenae that slope down and merge with the broad axial furrow. She examined this holotype of *I. levisensis* and found that it shows this posterior flattening of the axial furrow and fixigenae also, so she assigned the cranidia with these features to this species. In central Texas, *I. levisensis* is restricted to the *Saukiella pyrene* and *Saukiella junia* Subzones and occurs below *I. intermedius*. The latter, as defined by Longacre, usually has one well-impressed pair of pits, a second faintly to moderately impressed pair of pits, a slotlike axial furrow, and elevated fixigenae. Examination of the Arbuckle Mountains collections shows that, as the number of well-impressed pairs of pits increases, the axial furrow broadens and the posterior fixigenae become lower (compare pl. 5, fig. 2, and pl. 5, fig. 5). However, this association of features does not show any stratigraphic trend such as is found in Texas. I interpret it to be another aspect of variation within this species, but it does not change my interpretation that only one species of *Idiomesus* is present in the Arbuckle Mountains.

Occurrence.—Common in the *Saukiella junia* Subzone at HS 1053, 1087, 1089, 1110, 1120, 1123, 1144, 1148, 1163, 1171; JoR 749, 753, 759, 768. Abundant in the *Saukiella serotina* Subzone at HS 1181, 1206, 1221, 1230, 1235, 1240, 1258, 1270, 1310, 1317, 1322; JoR 880, 886, 896, 902, 906, 957, 969, 973, 978, 985, 1010, 1031, 1040, 1043. Scarce at the base of the *Corbinia apopsis* Subzone at JoR 1046.

Family Solenopleuridae Angelin, 1854

Subfamily Hystricurinae Hupé, 1953

Genus *Hystricurus* Raymond, 1913

Hystricurus millardensis Hintze

Pl. 8, figs. 17, 18

Hystricurus millardensis Hintze, 1952, p. 168, pl. 6, figs. 17-21; Winston and Nicholls, 1967, p. 76, pl. 12, figs. 14, 18.

Remarks.—Specimens from the Arbuckle Mountains are assigned to this species of *Hystricurus* because of their evenly tapered, anteriorly truncated glabellae and the presence of fossulae. Ornament on the external surface consists of rounded, mixed coarse and fine granules spread evenly over the cranidium (exclusive of cranidial furrows); on internal molds the granules are medium sized, less dense, and look like small spines.

Numerous specimens of *H. millardensis* and *Symphysurina brevispicata* occur together in a thin coquina at the base of the McKenzie Hill Limestone in the Joins Ranch section. Unfortunately, most of these specimens have been crushed, presumably during compaction of the enclosing limestone matrix.

Occurrence.—Locally abundant at the base of the *Symphysurina* Zone at HS 1785; JoR 1468 (coquina).

Family Uncertain

Genus *Apoplanias* Lochman, 1964

Apoplanias rejectus Lochman

Pl. 8, fig. 16

Apoplanias rejectus Lochman, 1964a, p. 57-58, pl. 14, figs. 23-31; pl. 15, figs. 15-19.

Remarks.—Five cranidia are assigned to this species; they match Lochman's original description very well.

A. rejectus lacks the inflated preglabellar area and elevated palpebral lobes of *Highgatella cordilleri* (Lochman), a similar trilobite reported from the *Missisquoia* Zone in central Texas by Winston and Nicholls (1967, p. 73).

Occurrence.—Scarce in the lower part of the *Missisquoia* Zone at JoR 1080, 1126, 1162, 1171.

Genus *Cliffia* Wilson, 1951

Cliffia lataegenae (Wilson)

Pl. 1, figs. 13, 14

Acrocephalites lataegenae WILSON, 1949, p. 31-32, pl. 10, fig. 14.

Cliffia lataegenae (Wilson) WILSON, 1951, p. 633, pl. 90, figs. 18-24; BELL and others, 1952, p. 182, pl. 29, fig. 6; DELAND and SHAW, 1956, p. 551, pl. 65, figs. 11-12 (species name misspelled); LOCHMAN and HU, 1960, p. 814, pl. 95, figs. 1-7.

Remarks.—These small trilobites are characterized by their sunken, tapering, truncate glabella with two well-impressed pairs of furrows, very convex preglabellar field, elevated palpebral areas, and fine-granular ornament. A few specimens also have coarse pustules on the preglabellar field. Pygidia found in the Arbuckle Mountains are like those figured by Wilson (1951).

Although the *Treatise* placed *Cliffia* in the Family Solenopleuridae, Subfamily Acrocephalitinae, I doubt that this North American cratonic genus was descended from or ancestral to the other genera in this subfamily, all of which are Asiatic. I prefer to place *Cliffia* in Family Uncertain for the present.

Occurrence.—Scarce in the *Elvinia* Zone at HS 32.5; RR 126, 131, 133, 134, 137, 138, 139, 140.

Genus *Comanchia* Frederickson, 1950

Comanchia amplooculata (Frederickson)

Pl. 2, fig. 7

Ptychopleurites amplooculata FREDERICKSON, 1948b, p. 803, pl. 123, figs. 9-11.

Comanchia amplooculata (Frederickson) WILSON and FREDERICKSON, 1950, p. 900, pl. 1, figs. 6, 7; BELL and ELLINWOOD, 1962, p. 391, pl. 52, figs. 16-18.

Remarks.—This species is locally abundant in the *Irvingella major* coquina and also occurs in the *Eoorthis* coquina. Grant (1965, p. 117) summarized the criteria that distinguish *C. amplooculata* from his new species *Comanchia lippa*.

Occurrence.—Locally abundant at the top of the *Elvinia* Zone at HS 38; RR 142. Scarce at the base of the *Parabolinoides* Subzone at HS 40.

Genus *Dellea* Wilson, 1949

Dellea suada (Walcott)

Pl. 1, fig. 5

Ptychoparia suada WALCOTT, 1891, p. 274, pl. 21, fig. 9.

Dellea suada (Walcott) WILSON, 1951, p. 636-638, pl. 91, figs. 4-10, 18, 20-23, 25-26 (synonymy to date); GRANT, 1965, p. 130, pl. 8, figs. 10, 14 (synonymy to date).

Dellea juvenalis FREDERICKSON, 1949, p. 351, pl. 69, figs. 8-15; GRANT, 1965, p. 129, pl. 8, fig. 13.

Dellea wilbernsensis WILSON, 1949, p. 35, pl. 11, figs. 1, 2, 4-7, 12.

Agraulus convexus Whitfield, BERKEY, 1898 (part), p. 288, pl. 20, figs. 9-10 (not fig. 11 or pl. 21, figs. 3, 7).

Agraulus convexus Whitfield, var. A, BERKEY, 1898, p. 288, pl. 20, figs. 1, 2; pl. 21, fig. 5.

Modocia berkeyi RESSER, 1935, p. 42.

Camaraspoides berkeyi (Resser) FREDERICKSON, 1949, p. 349-350, pl. 68, fig. 7 (holotype) only (not figs. 1-6, 8, 9).

Remarks.—This species is characterized by a moderately convex, moderately elevated glabella, a downsloping preglabellar field and anterior fixigenae, and a slightly to moderately upturned anterior border. It has been well described by Wilson (1949, p. 35, identified then as *D. wilbernsensis*, with additions in 1951, p. 636-638).

I believe that only one species of *Dellea* is present in the Arbuckle Mountains. This species corresponds well to the concept of *Dellea juvenalis* Frederickson (1949, p. 351, pl. 69, figs. 8-15), but I do not see that *D. juvenalis* as currently defined (*see* Grant, 1965, p. 129, pl. 8, fig. 13, as well as Frederickson) differs significantly from *D. suada*. *D. juvenalis* is supposed to have more steeply downsloping anterior fixigenae and a more upturned anterior border. However, comparison of the Arbuckle Mountains material with (1) the figured holotype of *D. suada* (Wilson, 1951, pl. 91, fig. 25), (2) material from central Texas identified as *D. suada*, and (3) other published illustrations and descriptions of *D. suada* (*see* Lochman and Hu, 1960, p. 813, pl. 96, figs. 22-27; Grant, 1965, pl. 8, figs. 10, 14) convinces me that the Oklahoma specimens are conspecific with *D. suada*. Consequently, I have placed *D. juvenalis* Frederickson in synonymy with *D. suada*.

Wilson (1949, p. 35) proposed *Dellea*

wilbernsensis as the type species of *Dellea*, then decided later (Wilson, 1951, p. 636) that *D. wilbernsensis* was conspecific with *Ptychoparia suada* Walcott. He proposed that *D. suada* (Walcott) be the type species and placed *D. wilbernsensis* in synonymy with it. Palmer (1965b, p. 83-84) suggested that *D. wilbernsensis* may indeed be a valid species because the holotype has a granular ornament, whereas the holotype of *D. suada* is smooth. Palmer (1960, p. 57-58) found that careful examination of surface ornament enabled him to separate otherwise similar trilobites into stratigraphically separated groups that he interpreted as representing different species. In my collections of *D. suada*, some cranidia have a granular ornament and others are smooth. When this variation was investigated, I found that specimens that were lowest and highest in my collections were smooth; in the middle of the range, both smooth and granular specimens were present in the same collections. In other words, examination of surface ornament did not allow me to separate my specimens into stratigraphically separated groups that might represent different species. I conclude, therefore, that in *D. suada* the surface ornament is not of specific value and that Wilson was correct in placing *D. wilbernsensis* in synonymy with *D. suada*. Study of the stratigraphic distribution of ornament on *Dellea* in central Texas led to a similar conclusion (W. C. Bell, pers. comm.).

Resser (1935, p. 42) created a new species, *Modocia berkeyi*, that was based upon material described and illustrated by Berkey (1898, p. 288-289, pl. 20, 21). Resser designated as the holotype Columbia University no. 22283, although he did not figure any specimens. Frederickson (1949, p. 349-350, pl. 68) created a new genus, *Camaraspoides*, and designated as the genotype *Camaraspoides berkeyi* (Resser) (the only species assigned to this new genus); he illustrated a specimen labeled Columbia University no. 22283 as the holotype of *C. berkeyi* (Resser). The negatives from which Frederickson made his prints of this holotype were provided by W. C. Bell (Frederickson, 1949, p. 349). At Bell's suggestion I re-examined his paired stereo photographs of the holotype (Columbia Univ. no. 22283) and have come to the conclusion that this specimen should without doubt be assigned to *Dellea suada*. In making this assignment I am making *Modocia berkeyi* a subjective synonym of *D. suada* (*see International Code of Zoological Nomenclature*, Article 61b). Furthermore, I am placing in synonymy the type species of *Camaraspoides* and thus destroying *Camaraspoides* as an eligible name to cover the concept described by Frederickson (*see* discussion of *Camaraspis wichitaensis*).

Occurrence.—Common in the *Elvinia* Zone at HS 32.5; RR 126, 127, 128, 131, 133, 134, 137, 138, 139, 140.

Dellea? punctata **Palmer**

Pl. 1, fig. 6

Dellea? punctata PALMER, 1965b, p. 84, pl. 3, fig. 8.

Remarks.—This species is characterized by its large, bluntly rounded glabella with distinct fossulae and by its pitted external surface. Arbuckle Mountains specimens of this species have a preglabellar field-anterior border ratio that ranges from 3:2 to 1:1, whereas Palmer (1965b, p. 84) reported this ratio as nearly 2:1. Small puckers or pits are in the anterior border furrow on some specimens. These are the only additions I would make to Palmer's description.

Palmer has also discussed the generic assignment of this species to *Dellea* rather than to *Deadwoodia*, and I agree with his conclusion.

In the Great Basin this species occurs at the very top of the *Elvinia* Zone, which is also its occurrence in the Arbuckle Mountains.

Occurrence.—Scarce at the top of the *Elvinia* Zone at RR 142.

Genus *Ellipsocephaloides* Kobayashi, 1935

Ellipsocephaloides silvestris **Resser**

Pl. 3, figs. 18, 19

Ellipsocephaloides silvestris RESSER, 1942, p. 64, pl. 11, figs. 1-3; pl. 12, fig. 7; BELL and ELLINWOOD, 1962, p. 406, pl. 59, figs. 10-12; GRANT, 1965, p. 143, pl. 14, fig. 31.

Ellipsocephaloides nitela RESSER, 1942, p. 66, pl. 11, fig. 13; pl. 12, figs. 1-3.

Ellipsocephaloides gracilis FENIAK *in* Bell and others, 1952, p. 188, pl. 34, fig. 3; BERG, 1953, p. 557 (list); GRANT, 1962, p. 994-995.

Chariocephalus whitfieldi Hall, DECKER, 1945, p. 39, pl. 9, fig. 15.

Remarks.—This is another genus to which Resser (1942, p. 62-67) assigned many new and similar-looking species whose biostratigraphic positions relative to one another are unknown. Two of these nominal species are based on material from the Arbuckle Mountains. *Ellipsocephaloides nitela* Resser was defined on material collected at or near my U.S. Highway 77 measured section (Resser's locality 12m). *Ellipsocephaloides silvestris* Resser was defined on material collected in the same general area as my Joins Ranch measured section (Resser's locality 91b). Specimens from these measured sections that I assign to *Ellipsocephaloides* constitute, in my opinion, only one paleontologic species. I assign them to *E. silvestris,* which has page priority, and agree with Bell and Ellinwood's (1962, p. 406) synonymizing of *E. nitela* with *E. silvestris.*

Ellipsocephaloides silvestris is characterized by its smooth glabella that sometimes has two or three pairs of faint furrows, its prominent palpebral lobes and palpebral furrows, and its faint anterior border furrow and narrow anterior border that is raised along the axial line. On some specimens the border furrow is absent. The pygidium (pl. 3, fig. 19) is characterized by a fan-shaped pleural region with a spinose margin.

Bell and Ellinwood (1962, p. 406) stated that the principal difference between *Ellipsocephaloides silvestris* and *Ellipsocephaloides gracilis* Feniak is that the former has a more equidimensional glabella. I found that the width of the glabella ranges from 0.7 to slightly more than 0.9 of the length of the glabella on 36 specimens from the Arbuckle Mountains. The same measurements on the photograph of *E. gracilis* (Bell and others, 1952, pl. 34, fig. 3) yield a proportion that falls within this range. Because these two species are alike in other aspects and occupy a similar biostratigraphic position, I consider them conspecific and place *E. gracilis* in synonymy (an action predicted by Bell and others, 1952, p. 188).

All of Resser's "species" fall within the range of glabellar proportions given above. In addition, I measured the fixigenae immediately posterior to the palpebral furrows on 25 specimens in my collections, and the fixigenae are from 0.3 to 0.5 as wide as the glabellae. Again, all of Resser's "species" on which this measurement is possible fall within this range. However, on some of his species with extremely wide fixigenae this measurement was not possible. Some (*E. argutus, E. briscoensis,* and *E. carus*) resemble *Ellipsocephaloides curtus* (Whitfield). Other species (*E. sawbackensis, E. montis,* and *E. declivis*) appear to be similar to each other and differ from *E. silvestris* in their well-impressed glabellar furrows, more posteriorly located palpebral lobes, and lack of an anterior border furrow.

Occurrence.—Common to locally abundant in the *Drumaspis* Subzone at HS 209, 211; JoR 60 (coquina), 71, 108. Common to locally abundant in the upper part of the *Saratogia* Zone at HS 232, 241, 243, 245, 251 (coquina), 257.

Genus *Magnacephalus* Stitt, n. gen.

Available material.—21 cranidia, 6 pygidia, mostly incomplete but well preserved.

Description.—Cranidium (minus posterior areas) elongate, moderately to strongly convex longitudinally, flatly convex transversely. Glabella large, occupying four-fifths of the cranidium sagittally and three-fourths of the cranidium transversely. Glabella low, flatly convex transversely, moderately to strongly convex longitudinally, not rising notably above the fixigenae. Glabellar furrows absent. Axial furrow moderately impressed, apparent as a thin etched line around the glabella. Occipital furrow moderately impressed, curving gently forward laterally, appearance like axial furrow. Occipital ring occupies slightly less than one-fifth of the cranidial length, expanded slightly at lateral extremities. Small medial occipital node present on some specimens. Frontal area downsloping, narrow, occupying one-twelfth to one-seventeenth of the cranidial length. Preglabellar field not differentiated. Anterior border furrow merges with axial furrow at anterolateral corners of glabella and dies out before reaching anterior facial sutures. Fixigenae narrow, moderately convex (sag.). Palpebral lobes narrow, elongate, centered just posterior to glabellar midline; length slightly more than one-third glabellar length. Palpebral furrows faintly impressed to absent. Posterior areas narrow (sag.). Posterior border furrow moderately impressed, appearance like axial, occipital, and anterior border furrows. Anterior course of facial sutures slightly convergent.

Small specimens (5 mm or less in length) have an ornament of large, low pustules on the glabella and occipital ring. Larger specimens appear to be smooth or finely pitted on the entire cranidium, both on external surfaces and internal molds.

Librigenae unknown.

Pygidium transversely elliptical, flatly convex. Axis broad, low, consisting of articulating half ring, one axial ring, and a broad terminal axial piece that occupies slightly more than one-half the length of the axis. Axial furrow and all other pygidial furrows moderately impressed, with same thin, etched appearance as furrows on cranidium. Pleural fields triangular and flatly convex near axis and anterior end of pygidium, downsloping steeply to vertically near margin of pygidium. Five pairs of marginal spines that become smaller toward the axis. Marginal spines and immediately adjacent, steeply downsloping part of pleural fields covered by coarse granules. Terminal axial piece actually overhangs the pair of marginal spines nearest the axis. Border not differentiated. One pair of anterior interpleural furrows present on pleural fields.

Type species.—*Magnacephalus smilus*, n. sp.

Remarks. — *Magnacephalus* differs from both *Monocheilus* (Resser, 1937, p. 19; Nelson, 1951, p. 778) and *Stigmacephalus* (Resser, 1937, p. 25; Nelson, 1951, p. 779) in its proportionally larger glabella, much shorter frontal area, and different character of the palpebral lobes. *Monocheilus* has long (exsag.) palpebral lobes with distinct palpebral furrows. *Stigmacephalus* has shorter palpebral lobes situated at or anterior to the glabellar midlength, with or without faint palpebral furrows. *Magnacephalus* has furrowless palpebral lobes about the same length as those of *Stigmacephalus* but situated just *posterior* of the glabellar midlength.

The spinose pygidium assigned to this genus is quite different from the nonspinose pygidia assigned to either *Stigmacephalus* or *Monocheilus* and may in fact be the most unique feature of *Magnacephalus.*

Etymology.—*Magna*, L., large; *kephale*, Gr., head; referring to the large glabella characteristic of this genus.

Magnacephalus smilus Stitt, n. sp.

Pl. 5, figs. 16-18

Remarks.—Because *Magnacephalus smilus* is the only species assigned to *Magnacephalus,* the generic description also serves as the species description.

Holotype.—OU 6516, plate 5, figure 17.

Paratypes.—OU 6517, plate 5, figure 16; OU 6518, plate 5, figure 18.

Etymology.—*Smila,* L., carving knife, chisel, graving tool; referring to the etched or engraved appearance of the thin cranidial and pygidial furrows.

Occurrence.—Common in the middle part of the *Saukiella junia* Subzone at HS 1089, 1123, 1127; JoR 701, 711, 732, 745, 749, 755.

Genus *Monocheilus* Resser, 1937
Monocheilus truncatus Ellinwood

Pl. 5, fig. 19

Monocheilus truncatus Ellinwood *in* Bell and Ellinwood, 1962, p. 389-390, pl. 52, figs. 1-3.

Remarks.—This species was described and illustrated by Bell and Ellinwood. Specimens from the Arbuckle Mountains have fainter occipital and palpebral furrows and an ornament of fine to medium granules scattered over the entire cranidium, exclusive of the various cranidial furrows. These are the only additions I can make to the original description.

Monocheilus cordillerensis Lochman (1964a, p. 54, pl. 13, figs. 15-19) was described from crushed specimens. Its tapered glabella and longer frontal area distinguish it from *M. truncatus.* The only uncrushed specimen (pl. 13, fig. 18) may be a *Bayfieldia simata.*

Occurrence.—Scarce in the lower part of the *Rasettia magna* Subzone at JoR 371, 385, 395, 475, 535.

Genus *Morosa* Palmer, 1960
Morosa? bothra Stitt, n. sp.

Pl. 1, figs. 17-19

Available material.—40 cranidia, 2 pygidia, mostly well preserved.

Description.—Cranidium small (usually less than 4 mm long), quadrate, moderately convex. Glabella elongate, convex, high, slightly tapered, bluntly rounded anteriorly. Two pairs of faintly impressed glabellar furrows present; posterior pair stronger, curved posteriorly. Axial furrow well impressed, continuous with occipital furrow but does not intersect posterior border furrows. Preglabellar furrow only moderately impressed. Deep, narrow anterolateral fossulae present. Occipital furrow narrow, nearly straight, well impressed. Occipital ring widest (sag.) at center, tapered laterally, usually with a small medial node. Frontal area downsloping, one-fourth to one-seventh of cranidial length, one-fourth to one-third of glabellar length. Preglabellar field convex, downsloping. Anterior border convex, downsloping, always slightly narrower than preglabellar field. Border slightly tapered laterally but extending to anterolateral corners of cranidium. Anterior border furrow well impressed, curving gently to the posterior in plan view. Fixigenae convex (exsag.), slightly upsloping away from axial furrow, width between one-third and one-fourth basal glabellar width. Palpebral lobes elongate, centered at or slightly anterior to glabellar midlength. Palpebral furrows slightly curved, faint to moderately impressed. Weak eye ridges present. Posterior areas narrow (exsag.), length (tr.) slightly less than basal glabellar width (sag.). Posterior border furrows well impressed, do not intersect axial furrow. Anterior course of facial sutures only slightly divergent anterior to palpebral lobes, curving axially before reaching anterior lateral corners of cranidium. Entire external surface of cranidium (exclusive of cranidial furrows) covered by fine granules. Granules sometimes aligned longitudinally on anterior fixigenae. Border commonly covered by terrace lines.

Librigenae unknown.

Pygidium transversely elliptical. Axis consists of an articulating half ring, two axial rings, and a terminal axial piece. One well-impressed pair of anterior pleural furrows, one or two other pairs faintly impressed. Pleural fields nearly horizontal next to axis, then sharply downsloping to shallow border furrow and narrow, slightly elevated border. Axis and pleurae covered by fine granules.

Holotype.—OU 6506, plate 1, figure 18.

Paratypes.—OU 6507, plate 1, figure 17.

Etymology.—*Bothros*, Gr., pit, hole, hollow or trench; refers to the prominent fossulae on cranidia of this species.

Remarks.—This species is tentatively assigned to *Morosa* because it fits many of the generic criteria given by Palmer (1960, p. 98-99; 1965b, p. 86-88), with several notable differences. *M.*? *bothra* has a proportionally shorter frontal area, a less laterally tapered anterior border, an anterior border furrow that is more curved in plan view, an anterior margin that in front view is almost as strongly bowed upward as the anterior border furrow, and an ornament of fine granules (all other described species of *Morosa* are pitted). These features and the prominent fossulae serve to distinguish *M.*? *bothra* from Palmer's described species of *Morosa*. *M.*? *bothra* can be distinguished from *M. simplexa* by its more convex glabella, deeper fossulae, and wider preglabellar field than anterior border.

The only associated pygidia from the Arbuckle Mountains are incomplete. *M.*? *bothra* also occurs in central Texas at the same stratigraphic position (W. C. Bell, pers. comm.), and a pygidium (pl. 1, fig. 19) from The University of Texas collections of *M.*? *bothra* was used to complete the description.

Palmer (1965b, genus and species undet. no. 6, p. 93, pl. 18, fig. 24) illustrated a trilobite that is similar to *M.*? *bothra*. His figured specimen differs in having a more tapered glabella, a shallower anterior border, and a smooth external surface.

Occurrence.—Common near the top of the *Elvinia* Zone at HS 32.5, 37; RR 134, 137, 138, 139, 140.

Morosa simplexa **Stitt, n. sp.**

Pl. 1, figs. 20, 21

Available material.—5 well-preserved cranidia.

Description.—Cranidium small (usually less than 4 mm), quadrate, moderately convex. Glabella elongate, moderately convex, tapered, bluntly rounded anteriorly. Two pairs of faintly impressed, posteriorly directed glabellar furrows; posterior pair usually the only one visible. Axial furrow well impressed, preglabellar furrow faintly to moderately impressed. Small fossulae at anterior lateral corners of glabella. Second pair of small pits present where faint eye ridges intersect axial furrow. Occipital furrow well impressed laterally, shallow and bowed slightly forward at axis; intersects axial furrow. Occipital ring widest at axis, small medial node present. Frontal area slightly convex, downsloping, slightly more than one-third of glabellar length. Preglabellar field slightly narrower than anterior border. Anterior border tapered laterally but extending to anterolateral corners of cranidium. Anterior border furrow nearly straight, moderately impressed laterally, sometimes shallower at axis. In front view anterior margin of cranidium nearly horizontal, whereas anterior border furrow bowed upward. Fixigenae moderately convex (exsag.), nearly horizontal (tr.) at palpebral areas; width one-fourth to one-fifth of basal glabellar width. Palpebral lobes distinct, centered about opposite glabellar midlength. Palpebral furrows moderately to faintly impressed. Faint, short eye ridges present. Posterior areas narrow (exsag.), width (tr.) slightly less than basal glabellar width. Posterior border furrows well impressed, do not intersect axial furrow. Anterior course of facial sutures moderately divergent.

Cranidium (exclusive of cranidial furrows) apparently covered by tiny pits that give external surface a slightly roughened appearance.

Librigenae and pygidium unknown.

Holotype.—OU 6508, plate 1, figure 21.

Paratypes.—OU 6507, plate 1, figure 20.

Etymology.—*Simplex,* L., simple; referring to the unspectacular appearance of these small trilobites.

Remarks.—This species falls within the generic concept of *Morosa* as defined by Palmer (1960, p. 98-99; 1965b, p. 86-88) and occurs higher stratigraphically than any of the previously described species. It is less obviously punctate and does not have as tapered an anterior border as Palmer's species of *Morosa.* In addition, it has a less convex glabella than either *M. brevispina* or *M. longispina* and narrower fixigenae and a more tapered glabella than *M. extensa. M. simplexa* can be distinguished from *Morosa*? *bothra* by its less convex glabella, its narrower preglabellar field than anterior border, and its less distinct fossulae.

M. simplexa also occurs near the top of the *Elvinia* Zone in central Texas (W. C. Bell, pers. comm.).

Occurrence.—Scarce near the top of the *Elvinia* Zone at HS 37; RR 139.

Genus *Spinacephalus* Stitt, n. gen.

Material available.—4 cranidia, none of which is complete.

Description.—Cranidium elongate, convex. Glabella elongate, convex, slightly tapering, bluntly rounded anteriorly. Four pairs of glabellar furrows; anterior pair faint to absent, others short, moderately to well impressed. Occipital furrow absent, occipital ring not differentiated. Large spine situated on axis of glabella between third and fourth pairs of glabellar furrows, rises vertically from glabellar surface, and gradually curves posteriorly. Axial furrow well impressed along anterior three-fourths of glabella, moderately to faintly impressed opposite glabellar spine. Preglabellar furrow only faintly impressed along central three-fifths of glabella. Prominent fossulae present. Frontal area one-fifth to one-sixth of glabellar length. Preglabellar field downsloping, subequal in width (sag.) to anterior border. Anterior border furrow faintly impressed, straight to curving slightly forward laterally. Anterior border upsloping, widest along axis, tapering laterally. Fixigenae narrow (tr.), convex (exsag.), elevated at palpebral areas. Palpebral furrows well impressed, palpebral lobes prominent, flat, situated close to glabella. Palpebral lobes continue anteriorly until tangent with axial furrow, dividing fixigenae into anterior and posterior parts. Posterior areas incomplete, appear to be sharply downsloping and narrow (exsag.). Anterior course of facial sutures moderately divergent.

Cranidium smooth except for longitudinal ridges and grooves on preglabellar field and possibly granules on posterior areas.

Librigenae and pygidium unknown.

Type species.—*Spinacephalus frontis,* n. sp.

Remarks.—Palmer (1962, p. 7) referred to the axial glabellar spine of *Deiracephalus* as "a unique feature among Cambrian trilobites; . . . " *Spinacephalus* differs from *Deiracephalus* in the character of the frontal area and the palpebral areas. Without the glabellar spine, *Spinacephalus* is somewhat similar to species of *Richardsonella.*

Etymology.—*Spina,* L., thorn or spine; *kephale,* Gr., head; referring to the prominent spine on the glabella.

Spinacephalus frontis Stitt, n. sp.
Pl. 4, figs. 18-20

Remarks.—Because *Spinacephalus frontis* is the only species assigned to *Spinacephalus,* the generic description also serves as the species description.

Holotype.—OU 6514, plate 4, figures 18-20.

Paratypes.—OU 6515a, OU 6515b, OU 6515c (not figured).

Etymology.—*Frontis,* L., brow or forehead; referring to the distinctive frontal area.

Occurrence.—Scarce in the *Rasettia magna* Subzone at JoR 487.

Measured Sections

The measured sections are listed alphabetically, and the location of each one is included in the introductory comments about the section. Positions of the measured sections are shown on the index map of the western Arbuckle Mountains (fig. 1), and individual geologic maps of the area immediately surrounding each section are included with the introductory comments for the section. All sections were measured with a 5-foot Jacob's staff and Brunton compass and were checked by Brunton-and-tape traverses. Each section was painted every 5 feet with a stripe of yellow paint, and the stripes were numbered every 25 feet above the base of the section.

Descriptions follow Folk's (1959, 1962) limestone classification and are based on binocular examination of fresh, wet, etched surfaces. Insoluble residues were used to determine the presence and approximate quantities of quartz and feldspar silt and sand, glauconite, dolomite, and ankerite or siderite. Colors are estimated from the fresh, wet surfaces.

Weathering descriptions are taken from field notes. Thin beds are up to 6 inches thick, medium beds are 6 inches to 1 foot thick, and thick beds are greater than 1 foot thick. "Massive" is occasionally used to indicate very thick or seemingly unbedded units.

Direction for offsets presumes traverse up the section.

Beds from which trilobites were collected and the identified species in each collection are listed after the lithologic description of the beds. Species are listed alphabetically in each collection, and the number of cranidia and pygidia assigned to each species are given in that order in parentheses after the species name. A notation of "RR-118 *Elvinia roemeri* (3-2)" means that at 118 feet above the base of the Royer Ranch measured section 3 cranidia and 2 pygidia were collected that are assigned to *Elvinia roemeri.*

U.S. Highway 77 Section (HS)

This painted section is 7.8 miles south of Davis, Oklahoma, and roughly 1 mile west of U.S. Highway 77. It is on land that is part of the large Chapman Ranch, and permission should be secured at ranch headquarters before visiting the section. A road log is given below to make location of the section easier, and a geologic map of the area immediately surrounding the section is shown in figure 3.

Mileage

0.0	Intersection of U.S. 77 and State 7 in Davis, Oklahoma. Turn south on U.S. 77.
1.5	Weigh station on left.
3.0	Jollyville.
3.4	Washita River.
4.0	Intersection of State 77D and 77B. Continue on U.S. 77.
4.7	Honey Creek.
5.2	Entrance to Turner Falls Park on right.
6.1	Turner Falls lookout on right.
7.8	Turn right off U.S. 77 through aluminum gate north of Ardmore Geological Society sign. To obtain permission to go through gate, proceed 1.4 miles south on U.S. 77, turning left on narrow paved road that leads to Chapman Ranch headquarters. The foreman is Mr. Ellis, and his house is the first one on the left. Retrace route to geologic sign, go through aluminum gate, and proceed on the dirt road.
8.0	Road divides; take left fork.
8.3	Road divides; take left fork.
8.6	Cross dry creek bed.
8.9	Cross dry creek bed.
9.1	Dirt tank at right side of road.
9.15	Cross dry creek bed.
9.45	Park near fence on left side of road opposite feed troughs. To reach base of section, walk northwest about three-fourths of a mile to end of road, cross fence, cross Honey Creek at dam, and walk downstream about 50 yards to a northwest-trending valley with Honey Creek Limestone cropping out on southwest side and Reagan Sandstone cropping out on northeast side. Proceed northwest up valley about 75-100 yards to base of section.

Formations cropping out in the line of section have the following thicknesses:

McKenzie Hill Limestone (only lower part of formation measured)	65 feet
Butterly Dolomite	286 feet
Signal Mountain Limestone	414 feet
Royer Dolomite	752 feet
Fort Sill Limestone	154 feet
Honey Creek Limestone	101 feet

Reagan Sandstone 18 feet
(only upper part of formation measured)

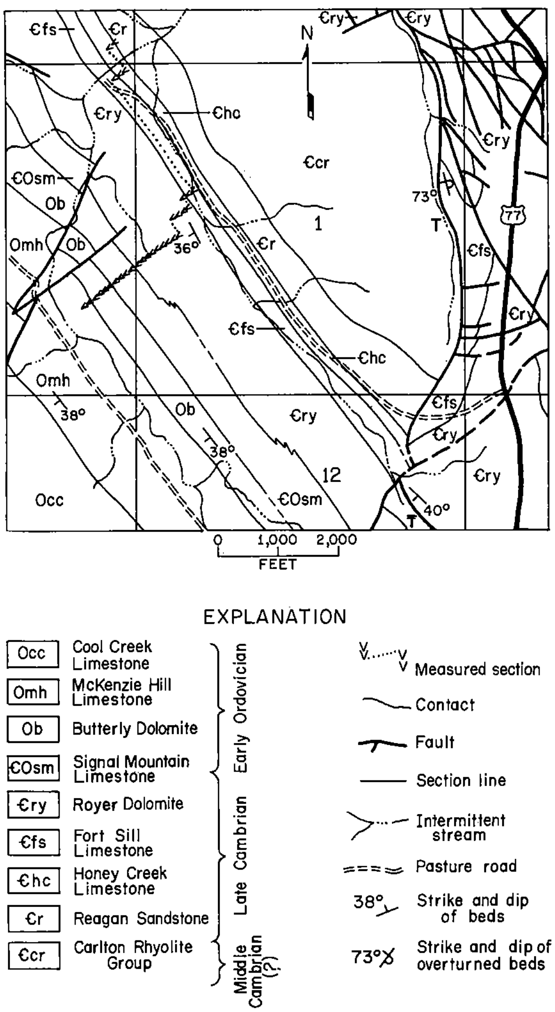

Figure 3. Geologic map of area immediately surrounding U.S. Highway 77 measured section. Geology mapped by W. E. Ham.

Refer to plate 9 (in pocket) for a diagram of trilobite occurrences and ranges for this section.

Township and range coordinates for this section are SE¼, SE¼, sec. 35, T. 1 S., R. 1 E.; NE¼, NE¼, and NE¼, SE¼, sec. 2, T. 2 S., R. 1 E.; and SW¼, NW¼, and NW¼, SW¼, sec. 1, T. 2 S., R. 1 E.

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
McKenzie Hill Limestone: 65 feet measured		
16. Limestone—mostly sandy, fine to medium intrasparite and pelsparite. Scarce biomicrite containing sparse trilobites. Dolomite at 1,749 feet and from 1,755 to 1,768 feet. Scattered dolomitic patches in limestone. Authigenic quartz at 1,785 to 1,786 feet. Light to dark brownish gray, thin to thick beds; weathers medium to light gray, with brownish-orange dolomitic patches.	65	1,725–1,790

Section offset 40 feet to northwest at 1,755 feet.

Symphysurina Zone
HS-1785 *Hystricurus millardensis* (4-1)

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
Butterly Dolomite: 286 feet thick		
15. Dolomite—medium- to coarsely crystalline dolomite. Limestone at 1,710 to 1,715 feet. Dark to medium grayish brown, thick to thin beds; weathers light to medium brown. Coarse to fine quartz sand from 1,715 to 1,725 feet.	55	1,670–1,725
14. Dolomite — mostly coarse; some medium-crystalline dolomite. White to light gray or pink, medium to thick beds; weathers medium to dark gray. Pitted or honeycombed weathering common.	113	1,557–1,670

Section offset 20 feet to southeast at 1,670 feet.

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
13. Dolomite—mostly medium- to coarsely crystalline dolomite. Scattered finely to medium-crystalline dolomite. Scarce medium to very coarse quartz sand at top of unit. Medium to dark grayish brown, thick to medium beds; weathers various shades of brown. Pitted or honeycombed weathered surfaces common, especially on highly jointed beds.	118	1,439–1,557
Signal Mountain Limestone: 414 feet thick		
12. Limestone—mostly sparse trilobite biomicrite and intrasparite. Pelsparite, intramicrite, oösparite and oömicrite less common. Various lithologies occur together in the same bed and in separate beds. Scattered dolomite, silicified brachiopods, and silt- to fine-sand-sized quartz; glauconite scarce. Medium brownish gray, mostly thin to medium beds below 1,407 feet, medium to very thick beds from 1,407 to 1,439 feet. Beds weather light to medium gray with brownish-orange dolomitic patches. Scattered silicified *Apheoorthis* above 1,405 feet.	212	1,227–1,439

Missisquoia Zone
HS-1425 *Missisquoia typicalis* (2-2)

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE

1422 *Missisquoia typicalis* (2-0)
1420 *Missisquoia typicalis* (0-1)
1409 *Missisquoia typicalis* (0-1)
1360 *Plethopeltis arbucklensis* (1-0)
1357 *Plethopeltis arbucklensis* (6-2)
1353 *Homagnostus reductus* (1-0)
Plethopeltis arbucklensis (11-1)
1348 *Plethopeltis arbucklensis* (16-4)

Saukia Zone

Corbinia apopsis Subzone

HS-1340 *Corbinia apopsis* (1-0)
Plethometopus obtusus (2-0)
Triarthropsis marginata (1-0)
1334 *Apatokephaloides clivosus* (1-0)
Corbinia apopsis (0-1)
Leiobienvillia leonensis (1-0)

Saukiella serotina Subzone

HS-1328 *Calvinella tenuisculpta* (1-0)
1326 *Acheilops masonensis* (1-0)
Plethometopus obtusus (1-0)
Stenopilus latus (1-0)
1324 *Stenopilus latus* (2-0)
1322 *Idiomesus levisensis* (1-0)
Plethometopus obtusus (1-0)
1317 *Idiomesus levisensis* (1-0)
Saukiella serotina (1-0)
1310 *Idiomesus levisensis* (1-0)
Stenopilus latus (1-0)
1307 *Stenopilus latus* (1-0)
1290 *Euptychaspis kirki* (5-0)
Eurekia eos (1-0)
Stenopilus latus (2-0)
1288 *Calvinella tenuisculpta* (1-0)
1284 *Bowmania americana* (1-0)
Calvinella tenuisculpta (0-1)
Euptychaspis kirki (1-0)
Stenopilus latus (4-0)
1280 *Euptychaspis kirki* (1-0)
Stenopilus latus (3-0)
1278 *Briscoia llanoensis* (1-0)
Stenopilus latus (2-0)
1274 *Plethometopus armatus* (2-0)
Stenopilus latus (2-0)
1270 *Euptychaspis kirki* (4-0)
Eurekia eos (1-0)
Idiomesus levisensis (1-0)
Stenopilus latus (2-0)
1265 *Eurekia eos* (1-0)
Stenopilus latus (1-0)
1258 *Bayfieldia simata* (0-1)
Bowmania americana (1-0)
Briscoia llanoensis (1-1)
Idiomesus levisensis (1-0)
1254 *Euptychaspis kirki* (2-0)
Stenopilus latus (2-1)
1250 *Euptychaspis kirki* (2-0)
1240 *Euptychaspis kirki* (1-0)
Eurekia eos (1-0)
Idiomesus levisensis (5-0)
Plethometopus armatus (0-1)
Stenopilus latus (7-0)
1238 *Euptychaspis kirki* (1-0)
1237 *Rasettia wichitaensis* (0-1)
1235 *Euptychaspis kirki* (1-0)
Eurekia eos (1-0)
Idiomesus levisensis (1-0)
1231 *Euptychaspis kirki* (1-0)
Eurekia eos (2-0)
Leiocoryphe platycephala (0-1)
Plethometopus armatus (0-1)
Stenopilus latus (5-0)
1230 *Calvinella tenuisculpta* (2-1)
Eurekia eos (1-0)
Idiomesus levisensis (1-0)
Rasettia wichitaensis (0-1)
Stenopilus latus (1-0)

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
11. Limestone—mostly fine to medium trilobite intrasparite. Occasional beds of oösparite, pelsparite, and sparse trilobite biomicrite. Dolomite crystals and fine to medium quartz sand common; scattered glauconite and silicified brachiopods. Brown - weathering dolomite in medium beds at 1,041 to 1,047 feet. Medium brownish gray, thin to medium beds; weathers various shades of gray. Brownish-orange dolomitic patches common on weathered surfaces.	202	1,025–1,227

Saukiella serotina Subzone

HS-1224 *Bayfieldia simata* (0-1)
Bynumina vescula (1-0)
Calvinella tenuisculpta (0-1)
Euptychaspis typicalis (2-0)
Eurekia eos (0-1)
Stenopilus latus (3-0)
1221 *Calvinella tenuisculpta* (5-1)
Euptychaspis kirki (2-0)
Eurekia eos (2-0)
Idiomesus levisensis (3-0)
Keithiella cf. *K. patula* (1-0)
Rasettia wichitaensis (1-2)
Stenopilus latus (1-0)
1217 *Bynumina vescula* (2-0)
Calvinella tenuisculpta (2-0)
Euptychaspis jugalis (1-0)
Euptychaspis kirki (2-0)
1213 *Bynumina vescula* (1-0)
Euptychaspis kirki (2-0)
Eurekia eos (2-0)
1208 *Eurekia eos* (2-0)
Stenopilus latus (1-0)
1206 *Bynumina vescula* (2-0)
Calvinella tenuisculpta (6-1)
Euptychaspis jugalis (2-0)
Euptychaspis kirki (1-0)
Eurekia eos (1-2)
Idiomesus levisensis (3-0)
1199 *Bowmania pennsylvanica* (2-0)
Briscoia cf. *B. hartti* (1-0)
Euptychaspis jugalis (4-0)
Euptychaspis typicalis (1-0)
Eurekia eos (6-1)
Leiocoryphe platycephala (2-1)
Saukiella serotina (1-0)
Stenopilus latus (14-1)
1197 *Bayfieldia simata* (1-1)
Bynumina vescula (1-0)

	DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
	Euptychaspis jugalis (9-0)		
	Euptychaspis kirki (1-0)		
	Eurekia eos (8-0)		
1194	*Stenopilus latus* (5-0)		
1188	*Bynumina vescula* (1-0)		
	Eurekia eos (5-0)		
	Heterocaryon tuberculatum (1-0)		
1181	*Bayfieldia simata* (2-1)		
	Bynumina vescula (1-0)		
	Euptychaspis kirki (1-0)		
	Idiomesus levisensis (1-0)		
	Leiocoryphe platycephala (1-0)		
	Rasettia wichitaensis (1-5)		
1179	*Euptychaspis jugalis* (3-0)		
	Stenopilus latus (1-0)		
1175	*Bayfieldia simata* (0-1)		
	Calvinella tenuisculpta (2-0)		
	Stenopilus latus (5-2)		

Saukiella junia Subzone

HS-1171	*Euptychaspis typicalis* (2-0)		
	Eurekia eos (2-0)		
	Idiomesus levisensis (1-0)		
	Rasettia wichitaensis (0-1)		
	Stenopilus latus (5-0)		
	Triarthropsis marginata (1-0)		
1165	*Euptychaspis jugalis* (1-0)		
	Stenopilus latus (1-0)		
1163	*Eurekia eos* (1-0)		
	Idiomesus levisensis (2-0)		
	Stenopilus latus (0-1)		
1148	*Bayfieldia simata* (1-0)		
	Euptychaspis jugalis (1-0)		
	Eurekia eos (0-2)		
	Idiomesus levisensis (1-0)		
	Triarthropsis marginata (1-0)		
1144	*Idiomesus levisensis* (2-0)		
1135	*Bayfieldia simata* (1-1)		
1127	*Bayfieldia binodosa* (1-0)		
	Bayfieldia simata var. A (0-1)		
	Magnacephalus smilus (3-0)		
	Stenopilus latus (1-0)		
1123	*Euptychaspis typicalis* (6-0)		
	Idiomesus levisensis (1-0)		
	Magnacephalus smilus (1-0)		
	Stenopilus latus (7-1)		
1120	*Acheilops masonensis* (1-0)		
	Bayfieldia binodosa (1-1)		
	Bynumina vescula (2-0)		
	Euptychaspis typicalis (6-0)		
	Idiomesus levisensis (1-0)		
	Stenopilus latus (14-2)		
	Theodenisia sp. undet. (1-0)		
1118	*Stenopilus latus* (2-0)		
1115	*Bynumina vescula* (1-0)		
1110	*Bynumina vescula* (1-0)		
	Idiomesus levisensis (2-0)		
	Triarthropsis limbata (1-0)		
1092	*Stenopilus latus* (4-0)		
1089	*Idiomesus levisensis* (1-0)		
	Magnacephalus smilus (1-0)		
1087	*Euptychaspis typicalis* (1-0)		
	Idiomesus levisensis (3-0)		
	Rasettia wichitaensis (3-0)		
	Saukia tumida (4-0)		
	Stenopilus latus (3-0)		
1082	*Saukia tumida* (2-0)		
1078	*Saukia tumida* (1-0)		
1068	*Stenopilus latus* (2-0)		
1060	*Bayfieldia binodosa* (1-1)		
	Bynumiella oklahomensis (1-0)		
1058	*Bayfieldia binodosa* (2-1)		
	Euptychaspis typicalis (5-0)		
1053	*Idiomesus levisensis* (1-0)		
	Saukia tumida (2-0)		
1038	*Bayfieldia binodosa* (1-1)		
1032	*Saukia tumida* (3-0)		
	Triarthropsis limbata (1-0)		

Royer Dolomite: 752 feet thick

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
10. Dolomite—mostly medium- to finely crystalline dolomite. Some coarsely crystalline dolomite, especially near top of unit. Dark grayish brown to reddish brown at base becoming light brown near top, medium to thick beds; weathers medium to dark grayish brown to brown. Honeycombed or pitted surfaces in some highly jointed beds.	133	892–1,025
9. Dolomite—medium- to coarsely crystalline dolomite. Light brownish gray to almost white, medium to thick, occasionally massive beds; weathers medium gray to dark grayish brown. Craggy, honeycombed weathered surfaces common.	79	813– 892
8. Covered.	9	804– 813
7. Limestone—coarse to fine intrasparite. Coarsely crystalline dolomite at 707 feet. Light brownish gray, medium to thick beds; weathers medium to dark gray to grayish brown.	111	693– 804

Section offset about 70 feet to southeast at 695 feet.

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
6. Dolomite—mostly very coarsely to coarsely crystalline dolomite. White to very light gray or light reddish brown, mostly medium to thick beds; weathers medium to dark gray to grayish brown. Honeycombed or pitted weathered surfaces common.	95	598– 693
5. Dolomite—coarsely to medium-crystalline dolomite. Medium to light grayish brown or reddish brown, medium to thick or massive beds; weathers medium to dark brown or grayish brown. Beds well jointed; faces of joints commonly honeycombed or pitted by weathering.	325	273– 598

Section offset about 150 feet to southeast at 590 feet.

Fort Sill Limestone: 154 feet thick

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
4. Limestone — sandy to silty	154	119– 273

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
sparse trilobite biomicrite. Scattered lenses and occasional beds of fine intrasparite and pelsparite, especially from 222 to 243 feet. Very fine-sand- to silt-sized quartz common. Scattered glauconite, phosphatic brachiopods, sponge spicules (above 211 feet), and dolomite (especially above 200 feet). Light gray to light brownish gray, thin to thick beds; weathers various shades of gray and grayish brown. Beds from 215 to 240 feet have very shaly, weathered character.		

Section offset about 2,000 feet southeast on top of thick bed at 150 feet to outcrops in stream bed.

Saratogia Zone

HS-268 *Stigmacephaloides curvabilis* (2-0)
258 *Stigmacephaloides curvabilis* (1-0)
257 *Ellipsocephaloides silvestris* (1-0)
Stigmacephaloides curvabilis (1-0)
251 *Ellipsocephaloides silvestris* (32-0)
Stigmacephaloides curvabilis (1-0)
245 *Ellipsocephaloides silvestris* (1-0)
243 *Ellipsocephaloides silvestris* (2-0)
241 *Ellipsocephaloides slivestris* (1-0)
232 *Ellipsocephaloides silvestris* (1-0)

Drumaspis Subzone

HS-216 *Drumaspis idahoensis* (1-0)
211 *Ellipsocephaloides silvestris* (1-0)
209 *Ellipsocephaloides silvestris* (1-0)
148 *Drumaspis idahoensis* (2-0)
Drumaspis texana (3-0)
Saratogia modesta (1-0)
145 *Drumaspis texana* (1-0)
144 *Drumaspis texana* (1-0)
138 *Drumaspis texana* (1-0)
Pseudagnostus communis (1-0)
Ptychaspis sp. undet. (0-1)
130 *Drumaspis texana* (2-0)
Pseudagnostus communis (3-1)

Idahoia lirae Subzone

HS-124 *Drumaspis texana* (3-0)
Idahoia lirae (9-2)
Pseudagnostus communis (7-1)
121 *Idahoia lirae* (1-0)

Honey Creek Limestone: 101 feet thick

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
3. Limestone—glauconitic trilobite pelmatozoan biosparite and biomicrite. Phosphatic brachiopods, ferroan dolomite common. Silt- to coarse-sand-sized quartz common; average grain size decreases upward. Light gray to light brownish gray, thin to thick beds; weathers various shades of gray and brown.	101	18– 119

Section offset about 400 feet southeast across Honey Creek at 40 feet.

Idahoia lirae Subzone

HS-114 *Idahoia lirae* (6-0)
112 *Idahoia lirae* (2-0)
Idahoia lirae var. A (5-0)
110 *Idahoia lirae* (2-0)
Pseudagnostus communis (1-0)
107 *Idahoia lirae* (1-0)
104 *Conaspis* cf. *C. tumida* (1-0)
Idahoia lirae (1-0)
102 *Idahoia lirae* (2-0)
100 *Idahoia lirae* (11-0)
98 *Idahoia lirae* (1-0)

Taenicephalus Zone

HS- 93 *Pseudagnostus communis* (1-2)
Taenicephalus shumardi (2-0)
Wilbernia expansa (1-0)
88 *Pseudagnostus communis* (2-3)
Taenicephalus shumardi (3-1)
84 *Pseudagnostus communis* (1-3)
Taenicephalus shumardi (21-0)
83 *Pseudagnostus communis* (3-0)
Taenicephalus shumardi (43-0)
Wilbernia expansa (5-0)
Wilbernia halli (5-0)
81 *Pseudagnostus communis* (1-1)
Taenicephalus shumardi (12-3)
78 *Croixana bipunctata* (2-0)
Pseudagnostus communis (0-1)
Taenicephalus shumardi (27-3)
Wilbernia expansa (2-0)
75 *Orygmaspis llanoensis* (1-0)
Taenicephalus shumardi (17-0)
Wilbernia halli (3-0)
70 *Orygmaspis llanoensis* (14-0)
Taenicephalus shumardi (66-4)
Wilbernia halli var. A (2-0)
67 *Conaspis testudinata* (2-0)
Taenicephalus shumardi (17-0)
61 *Conaspis testudinata* (3-0)
Orygmaspis llanoensis (1-0)
Taenicephalus shumardi (25-1)
50 *Orygmaspis llanoensis* (4-3)
Taenicephalus gouldi (37-1)

Parabolinoides Subzone

HS- 48 *Parabolinoides contractus* (14-0)
44 *Parabolinoides contractus* (58-1)
Parabolinoides granulosus (1-0)
Pseudagnostus communis (0-1)
42.5 *Parabolinoides contractus* (1-0)
Parabolinoides granulosus (7-0)
41 *Parabolinoides contractus* (3-0)
Parabolinoides granulosus (1-0)
40 *Comanchia amplooculata* (2-0)
Irvingella major (8-0)
Parabolinoides contractus (12-0)
Sulcocephalus candidus (6-0)

Elvinia Zone

HS- 38 *Comanchia amplooculata* (2-0)
Irvingella major (179-3)
Sulcocephalus candidus (26-0)
37 *Camaraspis convexa* (12-0)
Dokimocephalus intermedius (5-0)
Morosa? *bothra* (1-0)
Morosa simplexa (1-0)
Pterocephalia sanctisabae (2-6)

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
32.5 *Camaraspis convexa* (8-0) *Cliffia lataegenae* (1-0) *Dellea suada* (1-0) *Dokimocephalus intermedius* (1-0) *Elvinia roemeri* (1-1) *Morosa? bothra* (2-0) *Pterocephalia sanctisabae* (4-2)		
Reagan Sandstone: 18 feet estimated		
2. Covered – probably Reagan Sandstone.	16	2– 18
1. Sandstone—coarse glauconitic quartz sandstone. Beds loosely cemented by quartz; limonitic rims around quartz grains may also act as a cement. Light brownish gray, medium to thick beds; weathers various shades of brown.	2	0– 2

JOINS RANCH SECTION (JoR)

This painted section is approximately 11.5 miles west-southwest of Davis, Oklahoma, on land once owned by Sherman Joins and now owned by Mrs. Banks, one of his daughters. Permission to visit the section may be obtained from Virgil Johnson, the foreman for this large ranch. He lives north of Woodford, Oklahoma, and can be located by using the following road log.

Mileage

- 0.0 Intersection of U.S. Highway 77 and State Highway 53. Proceed west on State 53.
- 8.0 Woodford. Turn right (north) onto black-topped road.
- 9.0 Road becomes gravel-topped. Continue ahead.
- 10.6 White house on left, surrounded by large trees. Turn left through gate just beyond house. If gate is locked, inquire at white house for key. Proceed on gravel road through three gates in addition to the one at the white house.
- 15.0 Virgil Johnson's house.

To reach the Joins Ranch section use the following road log. A geologic map of the area immediately surrounding the section is shown in figure 4.

Mileage

- 0.0 Intersection of U.S. Highway 77 and State Highway 7 in Davis, Oklahoma. Turn west on State 7.
- 3.5 Turn left (south) off of State 7 onto gravel road (at Murray County-Garvin County line).
- 3.8 Gravel road turns right.
- 4.3 Gravel road turns left.
- 6.3 Aluminum gate. Continue on gravel road and cross Colbert Creek just beyond gate.
- 8.3 Road divides; turn left past feed shed.
- 8.4 Aluminum gate.
- 9.8 Aluminum gate.
- 10.7 Aluminum gate; windmill and dirt tank just beyond gate.
- 12.0 Aluminum gate. Second house on right is residence of foreman of Zellers Ranch. Get permission to drive through to Banks Ranch and then continue past house on pasture road.
- 12.5 New house on right; continue past house, driving west.
- 12.6 Road divides; left for Joins Ranch section and right for Royer Ranch section. Drive carefully from here on, as roads get worse. Remainder of road log applies to Joins Ranch section only.
- 12.7 Wooden gate. After gate, road bears right through rock field, then bears left toward tin shed.
- 13.1 Road divides just past tin shed. Take left fork toward distant windmill.
- 13.4 Windmill on left.
- 13.5 Pasture road goes next to fence, then bears to right down slope and continues up next hill along drainage ditch.
- 14.3 Wire gate—proceed through gate onto Banks Ranch. Turn northwest across field on very faint road.
- 14.7 Pass by low hill of iron ore on north side near fence.
- 14.9 Turn north along fence. After passing through low bushes, bear west.
- 15.6 Park car. Road gets extremely rough ahead. To reach the section, proceed west about 2,000 feet along the crest of the hill until intersecting the paint stripes. Section begins at the base of the Fort Sill Limestone.

Formations cropping out in the line of section have the following thicknesses:

McKenzie Hill Limestone (only lower part of formation measured)	7 feet
Butterly Dolomite	151 feet
Signal Mountain Limestone	732 feet
Fort Sill Limestone	580 feet

Refer to plate 10 (in pocket) for a diagram of trilobite occurrences and ranges for this section.

Township and range coordinates for this section are W½, SE¼, sec. 21, T. 1 S., R. 1 W.; NW¼, NE¼, and SE¼, NW¼, sec. 28, T 1 S., R. 1 W.

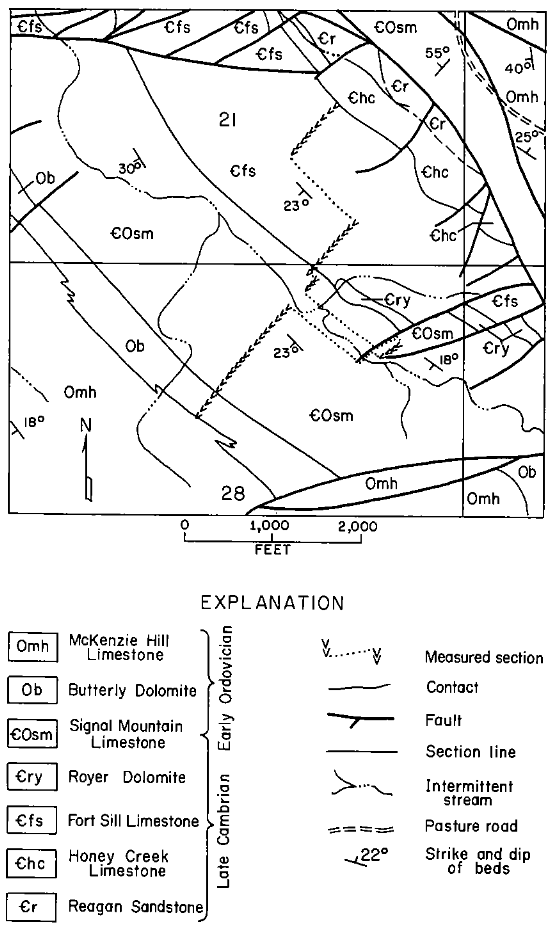

Figure 4. Geologic map of area immediately surrounding Joins Ranch measured section. Geology mapped by W. E. Ham.

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
McKenzie Hill Limestone: 7 feet measured		
22. Limestone – sandy dolomitic intrasparite grading up into sparse trilobite biomicrite. Medium to dark brownish-gray, thin to medium beds; weathers medium to light gray. Abundant trilobites and brachiopods in a thin coquina at 1,468 feet.	7	1,463–1,470

Symphysurina Zone

JoR-1468 *Hystricurus millardensis* (44-4)
Symphysurina brevispicata (50-5)

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
Butterly Dolomite: 151 feet thick		
21. Dolomite – finely to coarsely crystalline sandy dolomite. Light to dark brown, thin to very thick or massive beds; weathers to a grayish brown to dark reddish brown; honeycombed, craggy appearance. Coarsely crystalline dolomite predominates in thicker beds; finely to medium-crystalline dolomite, locally vaguely and irregularly laminated, predominates in thinner beds.	151	1,312–1,463
Signal Mountain Limestone: 735 feet thick		
20. Limestone – mostly sparse to very sparse trilobite biomicrite and intramicrite. Scattered lenses and occasional beds of pelsparite and fine to coarse intrasparite. Very fine to fine quartz sand present in small quantities throughout this unit. Scattered pyrite, glauconite, and dolomitic patches and lenses, the latter especially along joints above 1,085 feet. Medium brownish gray to gray, thin to thick beds; weathers light to medium gray, with brownish-orange dolomitic patches. Scattered silicified *Apheoorthis* present on weathered surfaces above 1,114 feet.	342	970–1,312

Missisquoia Zone

JoR-1257 *Missisquoia typicalis* (6-3)
1205 *Missisquoia typicalis* (3-0)
1199 *Missisquoia typicalis* (6-4)
1197 *Missisquoia typicalis* (1-5)
1190 *Missisquoia typicalis* (15-11)
1187 *Missisquoia typicalis* (9-16)
1174 *Missisquoia typicalis* (0-1)
1171 *Apoplanias rejectus* (1-0)
Missisquoia typicalis (4-2)
1162 *Apoplanias rejectus* (1-0)
Missisquoia typicalis (3-0)
1153 *Missisquoia typicalis* (21-7)
1142 *Missisquoia typicalis* (11-6)
1137 *Symphysurina brevispicata* (2-0)
1129 *Missisquoia typicalis* (1-0)
1126 *Apoplanias rejectus* (2-0)
1125 *Missisquoia typicalis* (77-62)
1114 *Missisquoia typicalis* (3-1)
1080 *Apoplanias rejectus* (1-0)
Plethopeltis arbucklensis (1-0)
1070 *Plethopeltis arbucklensis* (1-0)
1069 *Plethopeltis arbucklensis* (3-0)
1067 *Plethopeltis arbucklensis* (15-2)
1065 *Missisquoia depressa* (7-7)
Plethopeltis arbucklensis (92-21)
1063 *Homagnostus reductus* (1-0)
Missisquoia depressa (2-5)
Plethopeltis arbucklensis (50-27)
1062 *Plethopeltis arbucklensis* (8-1)
1059 *Missisquoia depressa* (0-1)
Plethopeltis arbucklensis (5-3)
1058 *Missisquoia depressa* (10-8)
Plethopeltis arbucklensis (56-18)

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE

Saukia Zone

Corbinia apopsis Subzone

JoR-1054 *Corbinia apopsis* (12-8)
1050 *Corbinia apopsis* (1-0)
Plethometopus obtusus (1-0)
1046 *Apatokephaloides clivosus* (1-0)
Bowmania pennsylvanica (3-0)
Corbinia apopsis (1-0)
Idiomesus levisensis (2-0)
Stenopilus latus (3-0)

Saukiella serotina Subzone

JoR-1043 *Acheilops masonensis* (1-0)
Bowmania pennsylvanica (1-0)
Calvinella tenuisculpta (5-0)
Euptychaspis kirki (3-0)
Idiomesus levisensis (1-0)
Plethometopus obtusus (1-1)
1040 *Bayfieldia simata* (0-1)
Euptychaspis kirki (1-0)
Idiomesus levisensis (2-0)
Stenopilus latus (1-0)
1031 *Idiomesus levisensis* (1-0)
Stenopilus latus (4-1)
1022 *Bowmania americana* (1-0)
Euptychaspis jugalis (2-0)
Euptychaspis kirki (6-0)
Eurekia eos (18-0)
Rasettia wichitaensis (1-2)
Stenopilus latus (1-0)
1015 *Eurekia eos* (0-1)
Leiocoryphe platycephala (1-0)
Stenopilus latus (7-0)
1010 *Euptychaspis jugalis* (1-0)
Euptychaspis kirki (8-0)
Eurekia eos (2-0)
Heterocaryon tuberculatum (1-0)
Idiomesus levisensis (4-0)
Prosaukia sp. undet. (1-0)
Saukiella serotina (1-0)
Stenopilus latus (1-0)
1006 *Euptychaspis kirki* (4-0)
Eurekia eos (1-0)
1003 *Bowmania americana* (1-0)
Bowmania pennsylvanica (2-0)
Euptychaspis kirki (2-0)
Eurekia eos (0-1)
Stenopilus latus (11-1)
1002 *Acheilops masonensis* (2-0)
Bowmania pennsylvanica (1-0)
Euptychaspis kirki (3-0)
Heterocaryon tuberculatum (4-0)
Plethometopus armatus (0-1)
Stenopilus latus (14-1)
997 *Bayfieldia simata* (1-0)
Briscoia llanoensis (2-0)
Dikelocephalus sp. 2 (1-0)
Euptychaspis jugalis (1-0)
Eurekia eos (3-1)
Heterocaryon tuberculatum (1-0)
Leiocoryphe platycephala (1-0)
Stenopilus latus (5-1)
991 *Euptychaspis kirki* (4-0)
Stenopilus latus (2-0)
985 *Euptychaspis kirki* (2-0)
Eurekia eos (3-0)
Idiomesus levisensis (2-0)
Stenopilus latus (1-0)
983 *Bayfieldia simata* (9-6)
Euptychaspis kirki (3-0)
Eurekia eos (9-0)
Plethometopus armatus (0-1)
Rasettia wichitaensis (0-1)
Stenopilus latus (26-2)
Theodenisia marcoui (2-0)
978 *Euptychaspis kirki* (2-0)
Eurekia eos (1-0)
Idiomesus levisensis (1-0)
Stenopilus latus (4-0)
973 *Briscoia llanoensis* (2-0)
Eurekia eos (1-0)
Idiomesus levisensis (2-0)
Rasettia wichitaensis (0-1)
Stenopilus latus (7-0)

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
19. Limestone—mixed calcarenites and calcilutites. Interbedded and interlayered intrasparite, intramicrite, oömicrite, oösparite, and sparse trilobite biomicrite. Individual lithologies can occur together in various combinations in the same bed or in different beds. Scattered brownish-orange dolomite, glauconite, and fine to very fine quartz sand. Medium brownish gray, thin to thick beds; weathers light to medium gray, with scattered brownish-orange dolomitic patches. Alternating exposed beds and covered intervals.	111	859– 970

Saukiella serotina Subzone

JoR-969 *Euptychaspis kirki* (1-0)
Idiomesus levisensis (2-0)
Stenopilus latus (2-0)
957 *Calvinella tenuisculpta* (1-0)
Euptychaspis kirki (5-0)
Eurekia eos (1-0)
Idiomesus levisensis (2-0)
Leiocoryphe platycephala (1-0)
Plethometopus obtusus (1-0)
Stenopilus latus (8-1)
Theodenisia marcoui (2-0)
950 *Calvinella tenuisculpta* (1-0)
Euptychaspis kirki (1-0)
Eurekia eos (1-0)
Stenopilus latus (4-0)
943 *Euptychaspis kirki* (1-0)
Stenopilus latus (2-0)
938 *Euptychaspis kirki* (1-0)
Leiocoryphe platycephala (2-0)
Stenopilus latus (11-0)
922 *Calvinella tenuisculpta* (0-1)
Stenopilus latus (1-0)
914 *Calvinella tenuisculpta* (1-0)
913 *Euptychaspis kirki* (1-0)
Eurekia eos (1-0)
911 *Calvinella tenuisculpta* (1-0)
Stenopilus latus (2-0)
906 *Bowmania americana* (2-0)
Euptychaspis kirki (3-0)
Eurekia eos (13-2)

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE

Idiomesus levisensis (3-0)
Rasettia wichitaensis (1-1)
Saukiella serotina (1-1)
Stenopilus latus (1-0)
902 *Euptychaspis kirki* (1-0)
Idiomesus levisensis (1-0)
Stenopilus latus (1-0)
896 *Bayfieldia simata* (2-0)
Calvinella tenuisculpta (5-2)
Euptychaspis kirki (3-0)
Eurekia eos (6-0)
Idiomesus levisensis (4-0)
Rasettia wichitaensis (2-0)
Stenopilus latus (1-0)
886 *Idiomesus levisensis* (1-0)
880 *Bynumina vescula* (1-0)
Euptychaspis kirki (1-0)
Eurekia eos (3-1)
Idiomesus levisensis (2-0)
876 *Bowmania pennsylvanica* (1-0)
Calvinella tenuisculpta (2-0)
Euptychaspis kirki (2-0)
Eurekia eos (6-0)
Leiocoryphe platycephala (10-1)
Stenopilus latus (9-1)
870 *Bynumina vescula* (1-0)
Euptychaspis jugalis (11-0)
Euptychaspis kirki (2-0)
Euptychaspis typicalis (3-0)
Eurekia eos (20-1)

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
18. Limestone—interbedded intrasparite, intramicrite, and sparse trilobite biomicrite. Scattered oöliths, glauconite, hematite, brownish-orange dolomite, and very fine quartz sand. Medium brownish gray, medium to thin beds; weathers light to medium gray, with brownish-orange dolomitic patches. Alternating exposed beds and covered intervals.	61	798– 859

Saukiella serotina Subzone

JoR-854 *Bowmania pennsylvanica* (3-0)
Euptychaspis jugalis (1-0)
Eurekia eos (6-3)
Heterocaryon tuberculatum (2-0)
Leiocoryphe platycephala (9-3)
Stenopilus latus (7-1)
852 *Euptychaspis jugalis* (1-0)
Eurekia eos (1-0)
Stenopilus latus (1-0)
840 *Stenopilus latus* (4-0)
837 *Calvinella tenuisculpta* (2-0)
Saukiella serotina (1-0)
Stenopilus latus (8-1)
835 *Rasettia wichitaensis* (0-2)
Stenopilus latus (1-0)
833 *Eurekia eos* (3-0)
Stenopilus latus (2-0)
830 *Bowmania americana* (4-0)
Bowmania pennsylvanica (1-0)
Bynumiella oklahomensis (1-0)
Euptychaspis jugalis (1-0)
Euptychaspis typicalis (1-0)
Stenopilus latus (21-1)

Saukiella junia Subzone

JoR-827 *Stenopilus latus* (5-1)
820 *Eurekia eos* (1-1)
Stenopilus latus (3-0)
802 *Bayfieldia simata* (1-0)
Euptychaspis typicalis (2-0)
Eurekia eos (2-0)
Stenopilus latus (3-1)

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
17. Limestone—sparse trilobite intramicrite. Intrasparite at 703 feet, oösparite and oömicrite at 707 feet and 773 to 780 feet. Silicified brachiopods common; scattered dolomite and glauconite. Fine to very fine quartz sand at 707 feet. Medium to light brownish gray, thin beds; weathers medium gray, with scattered brownish-orange dolomitic patches.	97	701– 798

Section offset 1,600 feet northwest (across fault) at 780 feet and rejoins line of section used from 300 to 684 feet.

Saukiella junia Subzone

JoR-785 *Stenopilus latus* (2-0)
780 *Bowmania pennsylvanica* (1-0)
Eurekia eos (2-0)
Stenopilus latus (3-0)
773 *Bayfieldia simata* (1-0)
Stenopilus latus (2-1)
770 *Stenopilus latus* (7-1)
768 *Bayfieldia simata* (1-0)
Idiomesus levisensis (1-0)
Stenopilus latus (6-2)
759 *Bayfieldia binodosa* (1-0)
Bayfieldia simata (1-0)
Idiomesus levisensis (1-0)
Stenopilus latus (0-2)
755 *Euptychaspis typicalis* (1-0)
Magnacephalus smilus (3-2)
Rasettia wichitaensis (0-1)
Stenopilus latus (0-1)
753 *Bayfieldia simata* var. A (5-2)
Euptychaspis typicalis (3-0)
Idiomesus levisensis (3-0)
Rasettia wichitaensis (3-0)
Stenopilus latus (1-0)
749 *Euptychaspis typicalis* (2-0)
Idiomesus levisensis (3-0)
Magnacephalus smilus (1-0)
Stenopilus latus (21-2)
745 *Magnacephalus smilus* (5-0)
Stenopilus latus (4-0)
739 *Stenopilus latus* (10-0)
732 *Bayfieldia binodosa* (0-5)
Bayfieldia simata var. A (2-0)
Magnacephalus smilus (0-1)
Stenopilus latus (43-5)
717 *Stenopilus latus* (1-0)
711 *Bayfieldia binodosa* (1-2)
Magnacephalus smilus (1-0)
709 *Rasettia wichitaensis* (1-0)
707 *Bayfieldia binodosa* (2-1)
Stenopilus latus (10-0)

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
16. Limestone – interbedded	18	683– 701

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
oösparite and oömicrite. Oöliths predominantly coarse sand size, some dolomitized. Sponge spicules common, scattered glauconite. Medium brownish gray, medium to thin beds; weathers light to medium gray.		

Section offset 1,600 feet southeast (across fault) to second low hill on bed of silicified *Cymbithyris hami* Cooper at 684 feet.

Saukiella junia Subzone

JoR-701 *Bayfieldia binodosa* (1-3)
Bynumina vescula (3-0)
Magnacephalus smilus (6-3)
Stenopilus latus (2-0)
684 *Bayfieldia binodosa* (2-0)
Stenopilus latus (2-0)

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
15. Limestone—sparse to packed trilobite biomicrite and intramicrite. Intraclasts mostly medium to coarse. Oösparite with scarce sponge spicules at 664 feet. Scattered glauconite and brownish-orange dolomite. Medium to light brownish gray, thin to medium beds; weathers light to medium gray with abundant brownish-orange dolomitic patches and occasional chert. Alternating exposed beds and covered intervals. Silicified brachiopods at 656 feet.	36	647– 683

Saukiella junia Subzone

JoR-664 *Stenopilus latus* (1-0)
657 *Bayfieldia binodosa* (1-0)
653 *Bayfieldia binodosa* (1-4)
Euptychaspis typicalis (2-0)
Eurekia granulosa (8-0)
Saukia tumida (2-0)

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
14. Limestone—interbedded trilobite biomicrite and biosparite, intrasparite, intramicrite, and pelsparite. Different lithologies occur together in the same beds as well as in separate beds. Pelsparite gently crossbedded at 624 feet. Scattered very fine to coarse quartz sand at base of unit. Scattered brownish-orange dolomite crystals and dolomitic lenses. Scarce glauconite and sponge spicules. Medium to light brownish gray, mostly thin to medium beds; weathers light to medium gray, with brownish-orange dolomitic patches.	70	577– 647

Section offset 100 feet southeast to crest of hill at 590 feet.

Rasettia magna Subzone

JoR-632 *Bayfieldia binodosa* (1-0)
610 *Plethometopus convergens* (6-0)
592 *Plethometopus granulosus* (14-1)
Rasettia magna (1-2)
Stenopilus pronus (18-0)
Theodenisia microps (1-0)
582 *Bayfieldia binodosa* (1-0)
Saukiella pyrene (1-0)

Fort Sill Limestone: 577 feet thick

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
13. Limestone—algal biomicrite. Sparry algal(?) blebs, irregularly laminated and swirled clasts, micrite intraclasts, pellets, and scattered glauconite occur mixed together. Horizontally laminated pelsparite and fine intrasparite at 565 feet. Trilobites common. From 560 to 578 feet abundant *Cryptozoon*-type algal heads present, 2 inches to 2½ feet in diameter. Medium brownish gray, thick to medium beds; weathers medium to light gray.	30	547– 577

Rasettia magna Subzone

JoR-568 *Plethometopus granulosus* (4-0)
Rasettia magna (1-0)
Stenopilus pronus (4-1)
561 *Plethometopus granulosus* (2-0)
Rasettia magna (1-0)
Stenopilus pronus (2-0)
550 *Plethometopus granulosus* (10-1)
Rasettia magna (1-1)

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
12. Limestone—interbedded trilobite algal biomicrite and horizontally laminated pelsparite and fine intrasparite. Light to medium brownish gray, medium to thin, occasionally thick beds; weathers medium to light gray.	12	535– 547

Rasettia magna Subzone

JoR-539 *Keithia* sp. undet. (1-0)
Plethometopus granulosus (0-1)
Rasettia magna (2-2)

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
11. Limestone—algal biomicrite. Sparry algal(?) strips and blebs, irregular, vaguely laminated or swirled masses, and oncolites. Scattered trilobite fragments. Horizontally laminated pelsparites at 495 feet and 507 to 512 feet. Scattered sponge spicules and dolomitic lenses. Medium to light brownish gray, thick to thin beds; weathers medium to light gray with brownish-orange dolomitic stringers.	60	475– 535

Rasettia magna Subzone

JoR-535 *Bowmania americana* (1-0)
Eurekia granulosa (3-0)
Leiocoryphe occipitalis (1-0)
Monocheilus truncatus (4-0)
Plethometopus granulosus (22-2)
Rasettia magna (13-12)
Stenopilus pronus (6-0)
510 *Rasettia magna* (1-1)
505 *Eurekia granulosa* (14-0)
497 *Plethometopus granulosus* (1-0)
Rasettia magna (0-1)

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE

487 *Eurekia granulosa* (2-0)
Leiocoryphe occipitalis (4-0)
Rasettia magna (6-5)
Spinacephalus frontis (4-0)
Stenopilus pronus (5-0)
481 *Plethometopus granulosus* (3-0)
Rasettia magna (0-1)
Stenopilus pronus (7-1)

10. Limestone — intramicrite. Light-grayish-brown intraclasts set in medium-grayish-brown micrite; intraclast content decreases upward. Dolomite scarce. Light to medium grayish brown, thin to medium beds; weathers medium to light gray with scattered brownish-orange dolomitic patches. Interval poorly exposed.	26	449– 475

Rasettia magna Subzone

JoR-475 *Leiocoryphe occipitalis* (1-0)
Monocheilus truncatus (2-0)
Theodenisia microps (1-0)

9. Limestone—algal biomicrite. Abundant oncolites and sparry algal(?) strips. Scattered sponge spicules, pyrite, and dolomite. Abundant oncolites at 438 feet. Medium grayish brown, thin to thick beds; weathers medium gray.	40	409– 449
8. Limestone—very sparse trilobite biomicrite. Scarce lenses of poorly washed intrasparite. Irregular dolomitic patches and sponge spicules common. Scattered pyrite. Light brownish gray, mostly thin to medium beds; weathers medium to light gray with scattered brownish-orange dolomitic patches and occasional brown chert stringers.	54	355– 409

Rasettia magna Subzone

JoR-395 *Monocheilus truncatus* (1-0)
388 *Illaenurus quadratus* (3-0)
385 *Illaenurus quadratus* (2-0)
Monocheilus truncatus (1-0)
Plethometopus granulosus (1-0)
371 *Monocheilus truncatus* (1-0)
Plethometopus granulosus (1-0)

7. Limestone—micrite with sparry strips and blebs that may be recrystallized algae. Brown dolomitic patches and lenses common. Medium grayish brown, thin to medium beds; weathers medium to dark gray, with scattered brown dolomitic patches and scarce chert. Silicified brachiopods at 335 and 338 feet.	34	321– 355

Rasettia magna Subzone

JoR-348 *Leiocoryphe occipitalis* (3-0)
Stenopilus pronus (2-0)
Theodenisia microps (2-0)

6. Limestone—sparse trilobite biomicrite. Scarce lenses of fine to coarse intrasparite or pelsparite. Sponge spicules present but seldom abundant. Lenses of brown dolomite common; scattered phosphatic brachiopods, scarce glauconite. Light brownish gray, thin to thick beds; weathers light to medium gray with brown dolomitic patches. Chert scarce.	97	224– 321

Section offset 1,200 feet to southeast on top of cherty, slabby bed at 300 feet.

Saratogia Zone

JoR-307 *Rasettia capax* (0-1)
300 *Rasettia capax* (2-1)
Saratogia fria (2-0)
294 *Rasettia capax* (0-1)
Saratogia fria (1-0)
Stigmacephaloides curvabilis (4-0)
290 *Saratogia fria* (7-0)
285 *Rasettia capax* (3-0)
Saratogia fria (2-0)
283 *Briscoia*? sp. undet. (0-1)
Dikelocephalus sp. 1 (3-1)
Pseudagnostus communis (1-0)
Rasettia capax (0-1)
Saratogia fria (7-0)
Stigmacephaloides curvabilis (1-0)
281 *Stigmacephaloides curvabilis* (3-0)
274 *Rasettia capax* (0-1)
Saratogia fria (2-0)
Stigmacephaloides curvabilis (3-0)
271 *Stigmacephaloides curvabilis* (1-0)
254 *Rasettia capax* (1-0)
225 *Pseudagnostus communis* (1-0)

5. Limestone—poorly washed pelsparite and intrasparite. Very fine to fine pellets and intraclasts cemented by sparry calcite interlayered with sparse trilobite biomicrite. Brown dolomite preferentially replacing the pelsparite and intrasparite. Sponge spicules common to abundant, scattered phosphatic brachiopods. Light brownish gray, thin to medium beds; weathers light to medium gray with brown dolomitic patches. Sponge spicules and twig-shaped chert common on weathered surfaces; silicified brachiopods at 222 feet. Similar to unit 1.	41	183– 224

Saratogia Zone

JoR-217 *Pseudagnostus communis* (1-4)
Rasettia capax (0-3)
Saratogia fria (35-0)
Stigmacephaloides curvabilis (3-0)
203 *Saratogia fria* (1-0)
200 *Saratogia fria* (3-0)
Wilbernia expansa (1-0)
198 *Saratogia fria* (3-0)

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
4. Limestone—sparse trilobite biomicrite. Scattered lenses of intrasparite and pelsparite. Scattered algal(?) balls, hematite, dolomite rhombs, glauconite, and phosphatic brachiopods. Sponge spicules abundant, 158-183 feet. Light to medium brownish gray to light reddish purple, thin to medium beds; weathers light to medium gray. Abundant sponge spicules and twig-shaped chert on weathered surfaces, 158-183 feet.	55	128– 183

Saratogia Zone

JoR-183 *Stigmacephaloides curvabilis* (1-0)
180 *Dartonaspis wichitaensis* (1-0)
Pseudagnostus communis (13-4)
Saratogia fria (1-0)
Stigmacephaloides curvabilis (1-0)
174 *Dartonaspis wichitaensis* (10-0)
169 *Stigmacephaloides curvabilis* (1-0)
142 *Stigmacephaloides curvabilis* (1-0)

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
3. Limestone—sparse to packed trilobite biomicrite. Layers, irregular patches, and lenses of intrasparite and other debris abundant. Small algal(?) heads at 75 feet. Patches of brown dolomite common; scattered very fine quartz sand. Light to medium brownish gray, thin to thick beds; weathers light to medium gray, with brown dolomitic patches.	68	60– 128

Drumaspis Subzone

JoR-109 *Drumaspis idahoensis* (3-0)
108 *Ellipsocephaloides silvestris* (1-0)
Pseudagnostus communis (0-1)
71 *Drumaspis idahoensis* (1-0)
Ellipsocephaloides silvestris (1-0)

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
2. Limestone—poorly washed pelsparite and intrasparite. Fine to medium intraclasts, pellets, and fossil(?) debris cemented by sparry calcite interlayered with sparse trilobite biomicrite. Scattered patches and layers of dolomite, scarce glauconite. Light brownish gray to light brown, thin beds; weathers light gray with brown dolomitic patches. Sponge spicules scattered on weathered surfaces. Interval mostly covered.	29	31– 60

Drumaspis Subzone

JoR- 60 *Drumaspis texana* (1-0)
Ellipsocephaloides silvestris (95-7)
Pseudagnostus communis (1-1)
Wilbernia expansa (1-0)

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
1. Limestone—sparse to packed trilobite biomicrite. Scattered linguloid brachiopods, algal(?) debris, glauconite, hematite along seams, very fine to fine quartz sand, brown dolomitic rhombs. Light brownish gray to light purplish gray, thin to medium beds; weathers light to medium gray.	31	0– 31

Drumaspis Subzone

JoR- 26 *Drumaspis idahoensis* (3-0)
Drumaspis texana (4-0)
Pseudagnostus communis (3-1)
Saratogia fria (4-0)
Wilbernia expansa (6-0)
16 *Drumaspis texana* (13-0)
Pseudagnostus communis (1-2)
Saratogia modesta (1-0)
10 *Drumaspis texana* (3-0)
Pseudagnostus communis (0-7)
Saratogia modesta (8-2)
7 *Drumaspis texana* (2-0)
Idahoia lirae (1-0)
Pseudagnostus communis (1-0)
Saratogia modesta (1-0)
Wilbernia expansa (1-0)

Idahoia lirae Subzone

JoR- 4 *Conaspis* cf. *C. tumida* (1-0)
Idahoia lirae (2-0)
2 *Idahoia lirae* (7-0)
Pseudagnostus communis (0-1)
Wilbernia diademata (1-0)
0 *Idahoia lirae* (2-1)

Honey Creek Limestone: not measured or described

ROYER RANCH SECTION (RR)

This painted section is approximately 9 miles west-southwest of Davis, Oklahoma. It is on land that was originally part of the Royer Ranch, later part of the Sherman Joins Ranch, and is now owned by Mrs. Zellers, one of Sherman Joins' daughters. Mr. Grover, the foreman, lives on the ranch, and his permission should be secured before visiting the section.

To reach the section, use the road log given for the Joins Ranch section for the first 12 miles, then use the road log given below. A geologic map of the area immediately surrounding the section is shown in figure 5.

Mileage

12.0 Aluminum gate. Second house on right is residence of Mr. Grover, foreman of Zellers Ranch. Get his permission to visit the section, then continue past house on pasture road.

12.5 New house on right; driving west, continue past house.

12.6 Road divides; bear right for Royer Ranch section. Road curves north.

13.3 Wire gate.

14.2 Old Royer Ranch headquarters. Park car here. To reach the section, walk west (approximately 2,300 feet) past old windmill, across dry creek, through several fields, across a second creek, and up a north-facing scarp. Follow the Reagan-Honey Creek contact until intersecting the paint stripes. The section begins in the Reagan Sandstone.

Formations cropping out in the line of section have the following thicknesses:

Fort Sill Limestone	6 feet
(only lower part of formation measured)	
Honey Creek Limestone	102 feet
Reagan Sandstone	112 feet
(only top part of formation measured)	

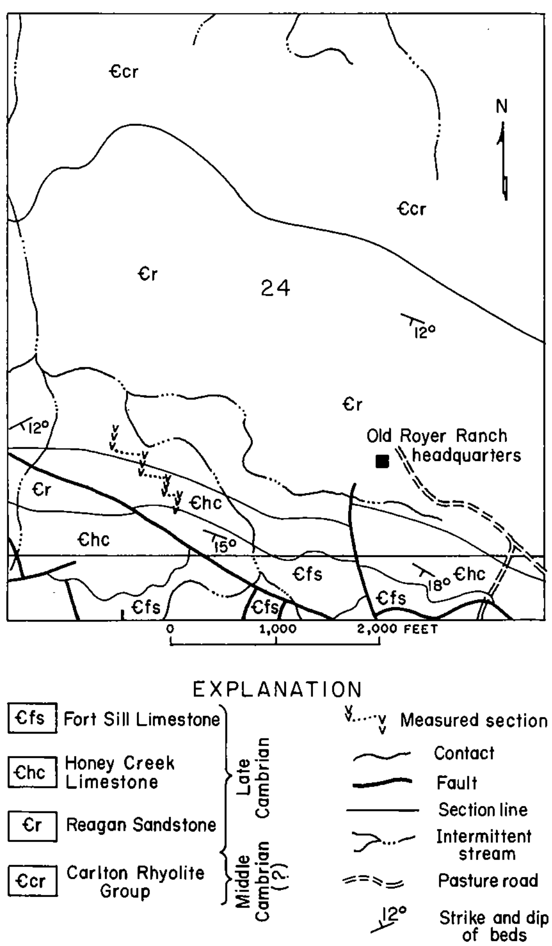

Figure 5. Geologic map of area immediately surrounding Royer Ranch measured section. Geology mapped by W. E. Ham.

Refer to plate 11 (in pocket) for a diagram of trilobite occurrences and ranges for this section.

Township and range coordinates for this section are S½, SW¼, sec. 24, T. 1 S., R. 1 W.

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
Fort Sill Limestone: 6 feet measured		
4. Limestone—sparse trilobite biomicrite and fine intrasparite. Light brownish gray, thin to medium beds; weathers medium gray.	6	214– 220

Saratogia Zone

Idahoia lirae Subzone

RR-217 *Idahoia lirae* (1-0)

Honey Creek Limestone: 102 feet thick		
3. Limestone—glauconitic trilobite pelmatozoan biosparite and biomicrite. Poorly washed biosparite common. Trilobites, pelmatozoan fragments, and phosphatic brachiopods abundant; scattered calcitic brachiopods. Glauconite abundant in lower part of unit, decreasing upward. Scattered ferroan dolomite in lower part of unit. Fine-sand- to silt-size quartz common; fine sand predominates in the lower part of the unit, silt predominates near the top. Fresh color ranges from light greenish gray below 185 feet to reddish gray above 185 feet. Thin to medium beds, weathers various shades of gray.	102	112– 214

Section offset 150 feet to east at 140 feet; offset 50 feet to east at 160 feet.

Saratogia Zone

Idahoia lirae Subzone

RR-210	*Idahoia lirae* (1-0)
	Pseudagnostus communis (1-0)
208	*Idahoia lirae* (2-0)
	Pseudagnostus communis (0-1)
207	*Idahoia lirae* (2-0)
205	*Idahoia lirae* (1-0)
	Pseudagnostus communis (3-0)
204	*Idahoia lirae* (15-3)
	Pseudagnostus communis (5-2)
	Wilbernia expansa (1-0)
202	*Idahoia lirae* (4-0)
	Pseudagnostus communis (1-1)
199	*Conaspis* cf. *C. tumida* (3-0)
	Idahoia lirae (5-0)
	Pseudagnostus communis (0-1)
198	*Idahoia lirae* (10-0)
	Pseudagnostus communis (0-1)
	Wilbernia diadamata (1-0)
	Wilbernia expansa (1-0)
195	*Idahoia lirae* (7-0)
	Pseudagnostus communis (1-1)
193	*Conaspis* cf. *C. tumida* (1-0)
	Idahoia lirae (11-0)

DESCRIPTION | THICKNESS IN FEET | FEET ABOVE BASE

Pseudagnostus communis (0-2)
188 *Idahoia lirae* (11-1)
Pseudagnostus communis (0-1)
Wilbernia expansa (1-0)
187 *Idahoia lirae* (3-0)

Taenicephalus Zone

RR-183 *Orygmaspis llanoensis* (1-0)
Pseudagnostus communis (0-2)
Taenicephalus shumardi (1-0)
Wilbernia expansa (1-0)
181 *Orygmaspis llanoensis* (1-0)
Pseudagnostus communis (1-0)
Taenicephalus shumardi (4-0)
162 *Orygmaspis llanoensis* (3-0)
Taenicephalus shumardi (7-1)
156 *Orygmaspis llanoensis* (1-0)
Taenicephalus shumardi (1-0)
153 *Orygmaspis llanoensis* (15-0)
Taenicephalus gouldi (19-1)
150 *Orygmaspis llanoensis* (13-0)
Taenicephalus gouldi (21-7)

Parabolinoides Subzone

RR-147 *Parabolinoides contractus* (76-2)
Parabolinoides granulosus (12-0)
Pseudagnostus communis (0-1)
145 *Parabolinoides contractus* (25-7)
142.5 *Parabolinoides contractus* (6-0)
Parabolinoides granulosus (1-0)

Elvinia Zone

RR-142 *Comanchia amplooculata* (49-10)
Dellea? punctata (3-0)
Homagnostus tumidosus (0-2)
Irvingella major (97-2)
Pseudagnostus communis (2-0)
Sulcocephalus candidus (1-0)
140 *Camaraspis convexa* (4-0)
Cliffia lataegenae (0-1)
Dellea suada (1-1)
Dokimocephalus intermedius (2-0)
Elvinia roemeri (5-0)
Morosa? bothra (12-1)
Pterocephalia sanctisabae (4-1)
139 *Camaraspis convexa* (4-1)
Cliffia lataegenae (1-0)
Dellea suada (3-0)
Dokimocephalus curtus (2-0)
Dokimocephalus intermedius (3-0)
Elvinia roemeri (0-1)
Morosa? bothra (3-0)
Morosa simplexa (1-0)
Pterocephalia sanctisabae (3-2)
138 *Camaraspis convexa* (4-0)
Cliffia lataegenae (1-0)
Dellea suada (3-0)
Dokimocephalus intermedius (4-0)
Elvinia roemeri (2-4)
Morosa? bothra (17-0)
Pterocephalia sanctisabae (2-2)
137 *Camaraspis convexa* (22-1)
Cliffia lataegenae (5-1)
Dellea suada (5-1)
Dokimocephalus curtus (1-0)
Dokimocephalus intermedius (8-0)

DESCRIPTION | THICKNESS IN FEET | FEET ABOVE BASE

Elvinia roemeri (5-1)
Morosa? bothra (6-0)
134 *Camaraspis convexa* (15-0)
Cliffia lataegenae (0-1)
Dellea suada (2-0)
Dokimocephalus intermedius (4-0)
Elvinia roemeri (2-2)
Irvingella major (2-0)
Morosa? bothra (3-0)
Pterocephalia sanctisabae (2-0)
133 *Burnetiella ectypa* (4-0)
Camaraspis convexa (32-2)
Cliffia lataegenae (1-1)
Deckera completa (1-0)
Dellea suada (10-2)
Dokimocephalus intermedius (4-1)
Elvinia roemeri (7-2)
Pterocephalia sanctisabae (3-1)
131 *Burnetiella ectypa* (1-0)
Camaraspis convexa (43-2)
Cliffia lataegenae (0-3)
Dellea suada (5-4)
Dokimocephalus intermedius (5-0)
Elvinia roemeri (8-2)
128 *Camaraspis convexa* (4-0)
Dellea suada (1-0)
Elvinia roemeri (1-0)
Pterocephalia sanctisabae (0-1)
127 *Camaraspis convexa* (8-0)
Dellea suada (4-1)
Dokimocephalus intermedius (1-0)
Elvinia roemeri (1-1)
Plataspella anatina (1-0)
Pseudagnostus communis (1-0)
Xenocheilos minutum (2-0)
126 *Apachia trigonis* (2-0)
Burnetiella ectypa (1-0)
Camaraspis convexa (5-0)
Cliffia lataegenae (1-2)
Deckera completa (1-0)
Dellea suada (1-0)
Dokimocephalus intermedius (1-0)
Elvinia roemeri (10-1)
Irvingella major (15-1)
Kindbladia wichitaensis (11-0)
Plataspella anatina (11-0)
Pseudagnostus communis (1-3)
Pterocephalia sanctisabae (2-2)
Xenocheilos minutum (1-0)
120 *Elvinia roemeri* (2-0)
Irvingella major (3-0)
Kindbladia wichitaensis (1-0)
Pseudagnostus communis (4-1)
Pterocephalia sanctisabae (0-1)
117 *Elvinia roemeri* (1-0)
Plataspella anatina (3-0)
Pseudagnostus communis (1-0)
Pterocephalia sanctisabae (1-0)
113 *Elvinia roemeri* (1-0)
Kindbladia wichitaensis (4-0)
Plataspella anatina (1-0)

Reagan Sandstone: 112 feet measured

Description	Thickness in feet	Feet above base
2. Sandstone—mostly medium- to coarse-grained quartz sandstone. Glauconite common, feldspar less	37	75–

DESCRIPTION	THICKNESS IN FEET	FEET ABOVE BASE
common than in unit 1. Beds loosely cemented by quartz and possibly limonite. Occasional hematite. Light brown to light brownish orange or brownish red, medium to thick beds; weathers various shades of brown.		
1. Sandstone—mostly fine- to medium-grained quartz sandstone. Sand-size feldspar grains and glauconite common to abundant. Beds loosely cemented by quartz; limonitic rims common around quartz grains: may also act as a cement. Scattered hematite and squashed phosphatic brachiopods. Occasional horizontal laminations. Scarce trilobites in a few very fine-grained beds. Light brown to light brownish orange, thin to medium beds; weathers various shades of brown.	75	0– 75

Section offset 280 feet east on resistant bed at 55 feet.

Elvinia Zone

RR- 70 (float)
Elvinia roemeri (1-0)
67 *Sulcocephalus cereus* (10-0)
Sulcocephalus latus (8-0)

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PLATES

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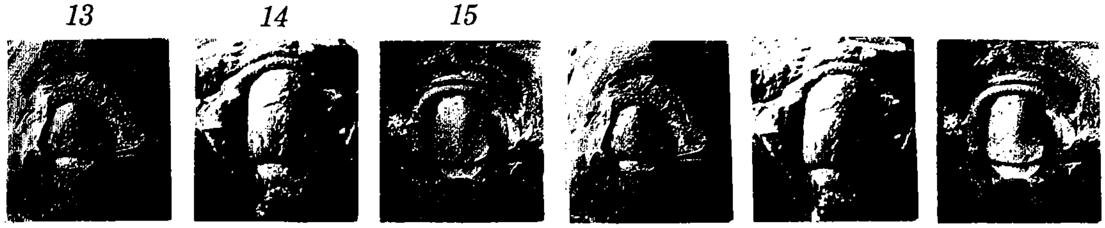

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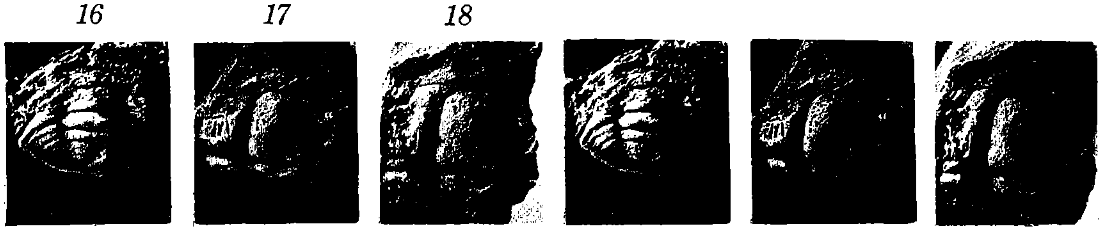

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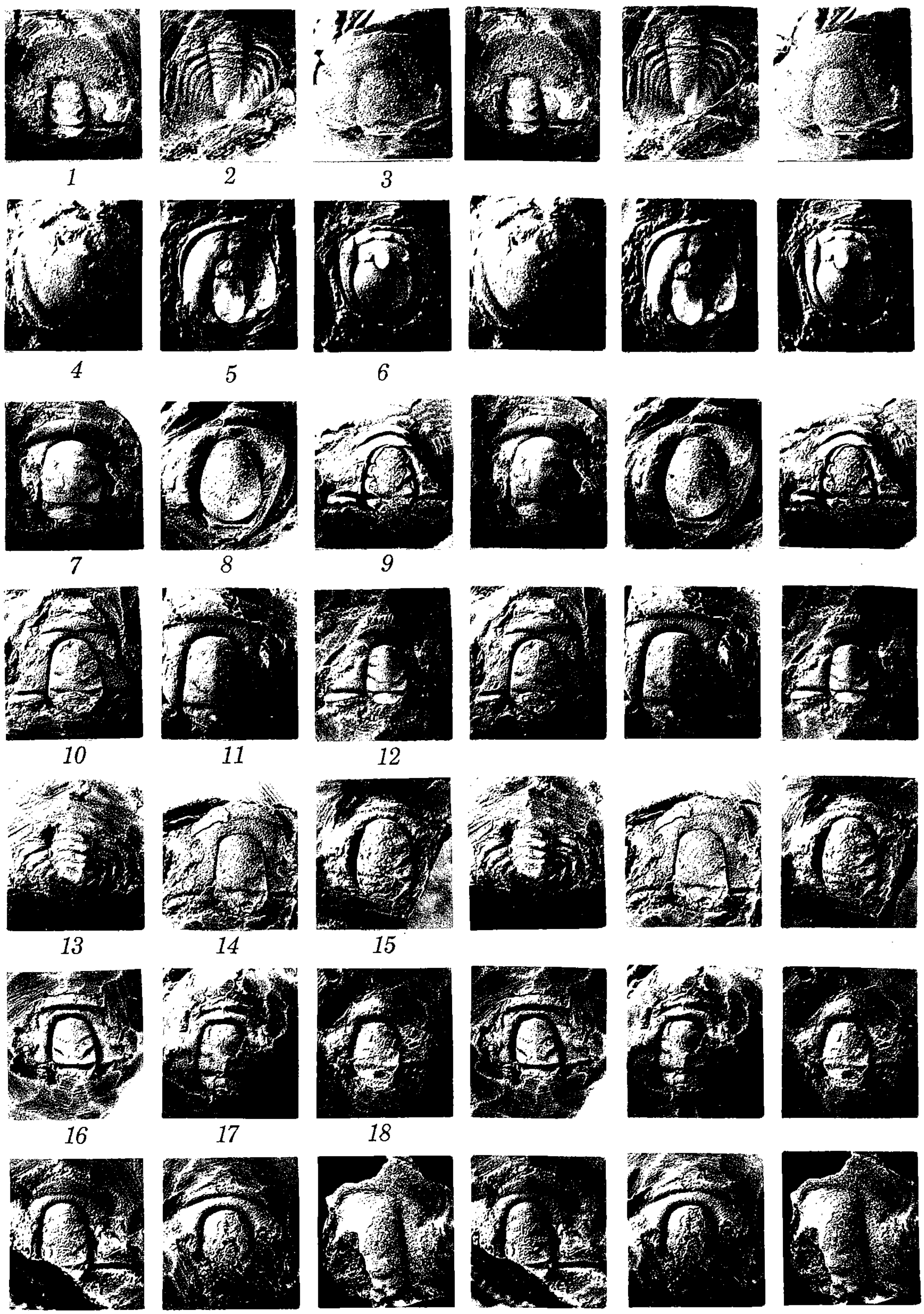

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Plate 2

TRILOBITES OF THE *Elvinia* AND *Taenicephalus* ZONES

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Trilobites of the *Saratogia* Zone

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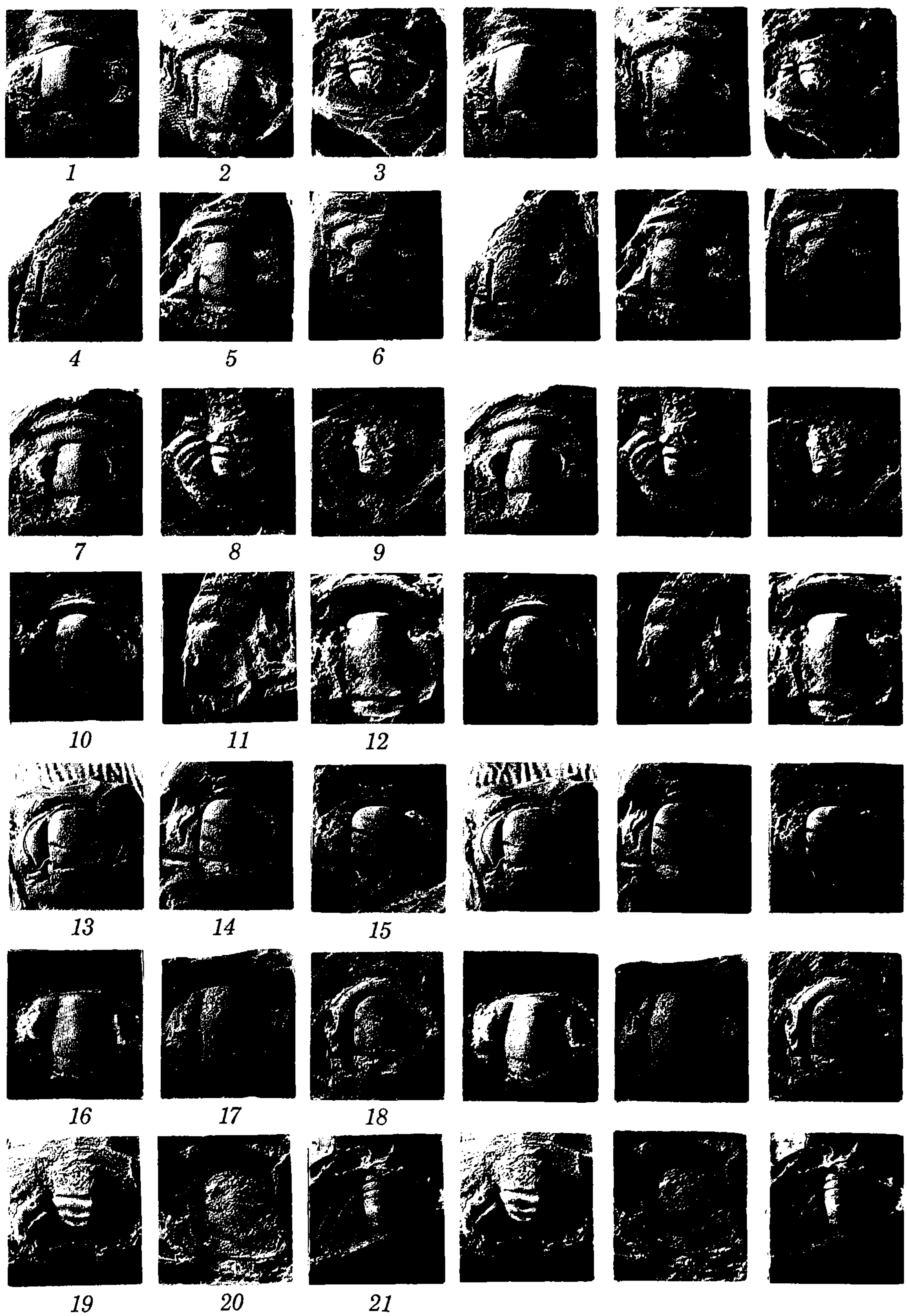
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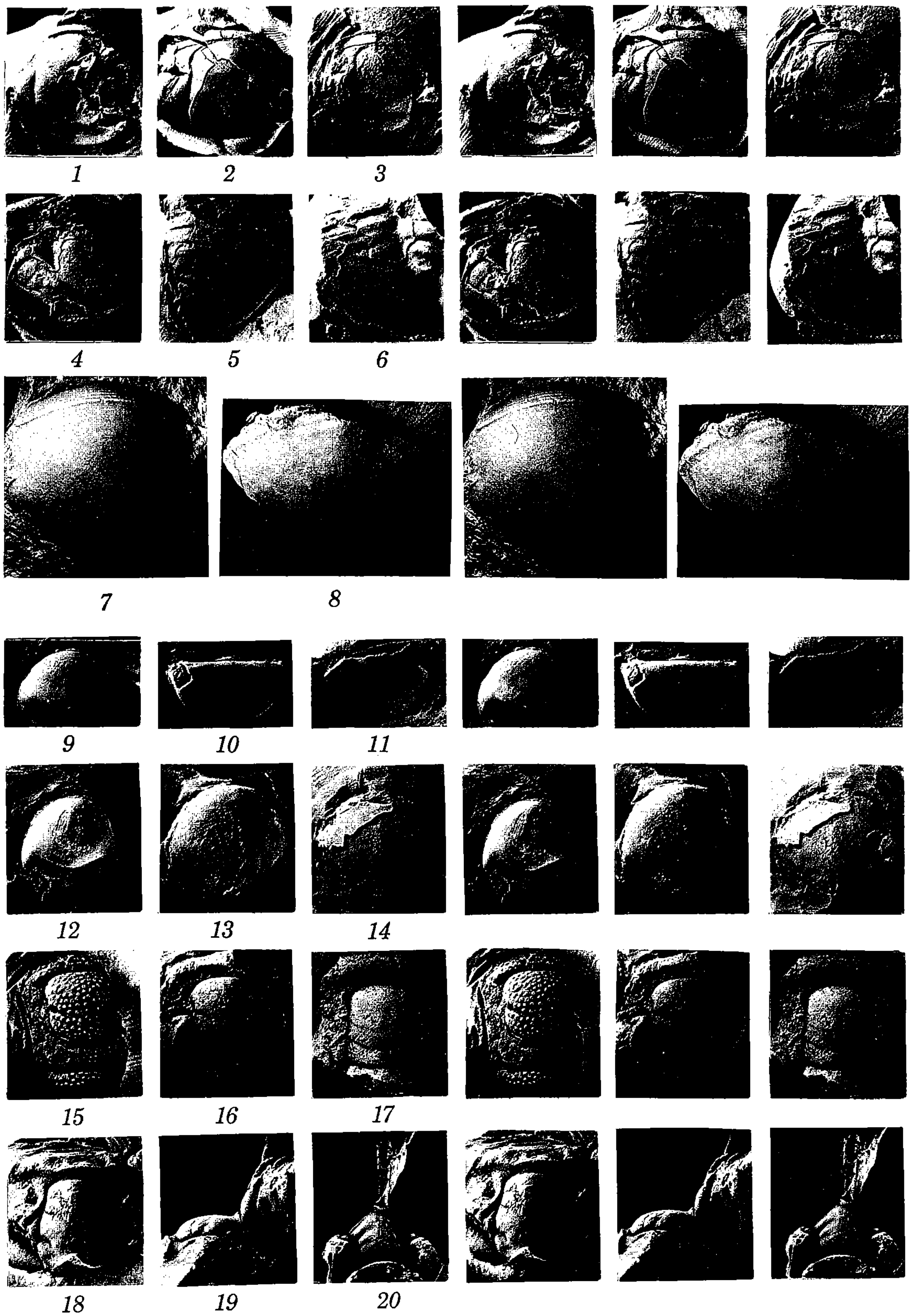
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Plate 4

TRILOBITES OF THE *Saratogia* AND *Saukia* ZONES

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9,10,12	*Leiocoryphe platycephala* Kobayashi. *9,* internal mold of medium cranidium, ×4 (UT 14010), from JoR-854; *10,* unexfoliated medium pygidium, ×5 (UT 14011), from JoR-854; *12,* unexfoliated medium cranidium, ×3 (UT 14012), from JoR-876.	33
13	*Leiocoryphe occipitalis* Rasetti. Unexfoliated medium cranidium, ×6 (UT 14013), from JoR-348.	33
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18-20	*Spinacephalus frontis* Stitt, n. gen., n. sp. *18,* unexfoliated large cranidium with spine broken, ×2½ (OU 6514, holotype), from JoR-487; *19,* side view of complete holotype cranidium, ×2; *20,* front view of complete holotype cranidium, ×2.	52

Plate 5

TRILOBITES OF THE *Saukia* ZONE

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1-5 *Idiomesus levisensis* (Rasetti). These five specimens illustrate variation in the glabellar pits and the axial furrow characteristic of this species. *1,* unexfoliated small cranidium, showing one faint pair of glabellar pits and a narrow axial furrow, ×7 (UT 14018), from JoR-1010; *2,* unexfoliated small cranidium, showing one faint pair of glabellar pits and a narrow axial furrow, ×7 (UT 14019), from HS-1206; *3,* internal mold of medium cranidium, showing a strongly impressed posterior pair and a moderately impressed anterior pair of glabellar pits and a broad axial furrow, ×5 (UT 14020), from JoR-896; *4,* internal mold of medium cranidium, showing a strongly impressed posterior pair and a faintly impressed anterior pair of glabellar pits and a broad axial furrow, ×6 (UT 14021), from HS-1144; *5,* internal mold of medium cranidium, showing two strongly impressed pairs of glabellar pits and a broad axial furrow, ×5 (UT 14022), from HS-1087. 45

6, 7 *Bayfieldia binodosa* (Hall). *6,* partly exfoliated large cranidium, showing granular ornament and character of frontal area, ×1½ (UT 14023), from JoR-759; *7,* internal mold of large pygidium, showing pointed marginal spines, ×1¾ (UT 14024), from JoR-653. 41

8 *Bayfieldia simata* Winston and Nicholls, var. A, Winston and Nicholls. Internal mold of medium pygidium, showing two nodes on terminal piece and pointed marginal spines, ×1 (UT 14025), from HS-1127. 41

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11, 12 *Corbinia apopsis* Winston and Nicholls. *11,* partly exfoliated medium cranidium, ×2½ (UT 14028), from JoR-1054; *12,* partly exfoliated large pygidium, showing ornament, ×1½ (UT 14029), from JoR-1054. 41

13 *Eurekia granulosa* Walcott. Partly exfoliated medium cranidium, ×1½ (UT 14030), from JoR-505. 41

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19 *Monocheilus truncatus* Ellinwood. Unexfoliated medium cranidium, ×3 (UT 14033), from JoR-535. 50

20 *Dikelocephalus* sp. 2. Unexfoliated small cranidium, ×6 (UT 14034), from JoR-997. 17

21 *Apatokephaloides clivosus* Raymond. Unexfoliated small cranidium, ×8 (UT 14035), from HS-1334. 45


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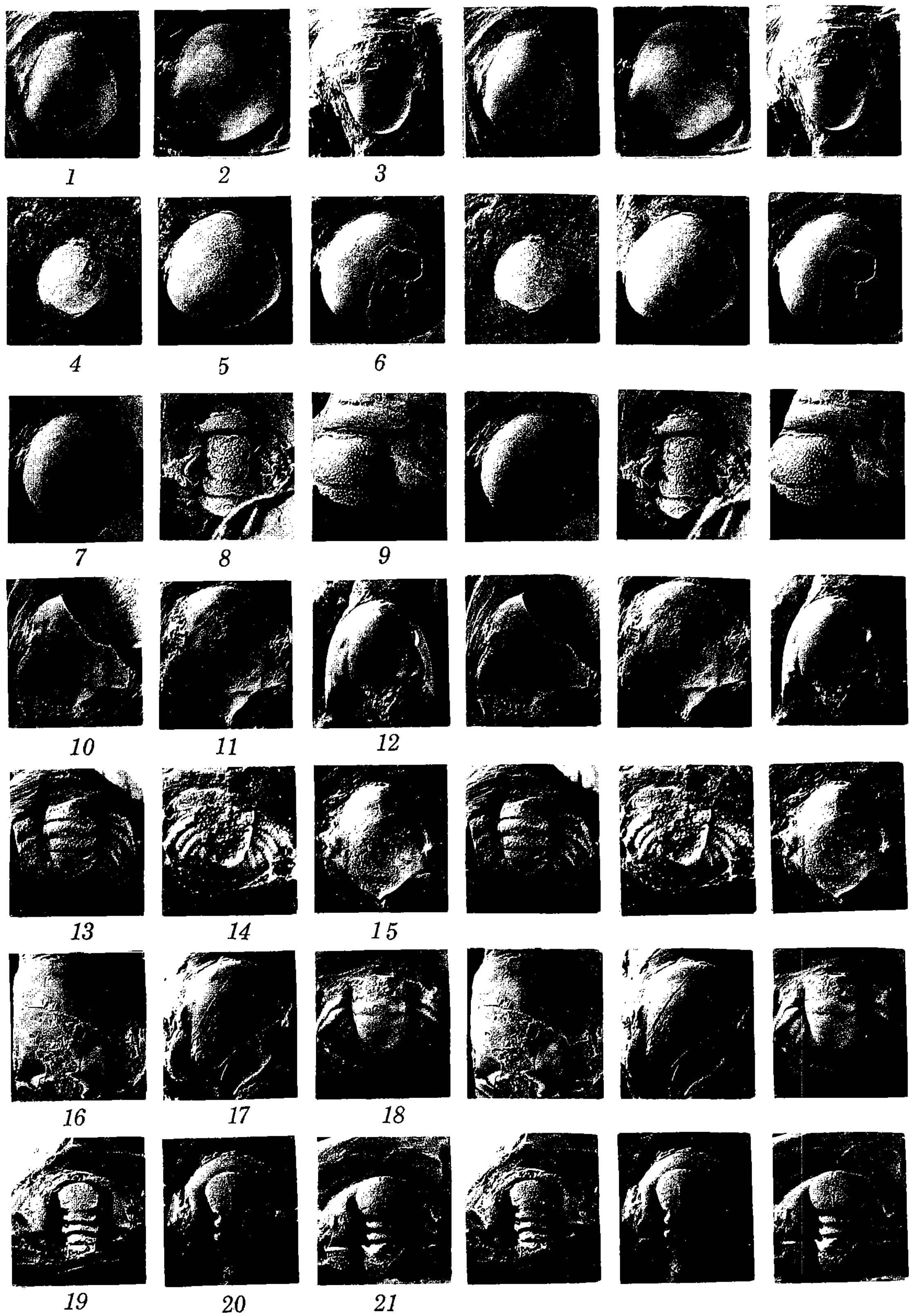
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Plate 6

Trilobites of the *Saukia* Zone

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1-3	*Stenopilus pronus* Raymond. *1,* unexfoliated small cranidium, ×3, (UT 14036), from JoR-592; *2,* unexfoliated medium cranidium, ×2 (UT 14037), from JoR-592; *3,* unexfoliated medium pygidium, ×3 (UT 14038), from JoR-481.	36
4-7	*Stenopilus latus* Ulrich. *4,* unexfoliated small cranidium, palpebral furrows not visible, ×10 (UT 14039), from HS-1120; *5,* unexfoliated small cranidium, showing barely visible palpebral furrows and ornament of fine pits, ×7 (UT 14040), from HS-1120; *6,* unexfoliated medium cranidium, palpebral furrows clearly visible, ×4 (UT 14041), from HS-1120; *7,* unexfoliated medium cranidium, palpebral furrows clearly visible, ×2½ (UT 14042), from HS-1120.	37
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17, 18	*Plethometopus armatus* (Billings). *17,* unexfoliated medium cranidium, showing long occipital spine, ×2½ (UT 14047), from HS-1274; *18,* unexfoliated medium pygidium, ×4 (UT 14048), from HS-1240.	34
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Plate 7

Trilobites of the *Saukia* Zone

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1	*Theodenisia microps* (Rasetti). Unexfoliated large cranidium, ×5 (UT 14052), from JoR-592.	16
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3	*Triarthropsis limbata* Rasetti. Unexfoliated small cranidium, ×10 (UT 14054), from HS-1110.	16
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6	*Theodenisia* sp. undet. Unexfoliated medium cranidium, ×6 (UT 14057), from HS-1120.	16
7-9	*Bowmania americana* (Walcott). *7,* unexfoliated small cranidium, ×5 (UT 14058), from JoR-1022; *8,* unexfoliated medium cranidium, ×3 (UT 14059), from JoR-830; *9,* unexfoliated medium cranidium, ×3 (UT 14060), from JoR-906.	22
10	*Bowmania pennsylvanica* Rasetti. Unexfoliated medium cranidium, ×3 (UT 14061), from JoR-854.	21
11	*Heterocaryon tuberculatum* Rasetti. Internal mold of medium cranidium, showing tumid glabella, ×3 (UT 14062), from JoR-1002.	22
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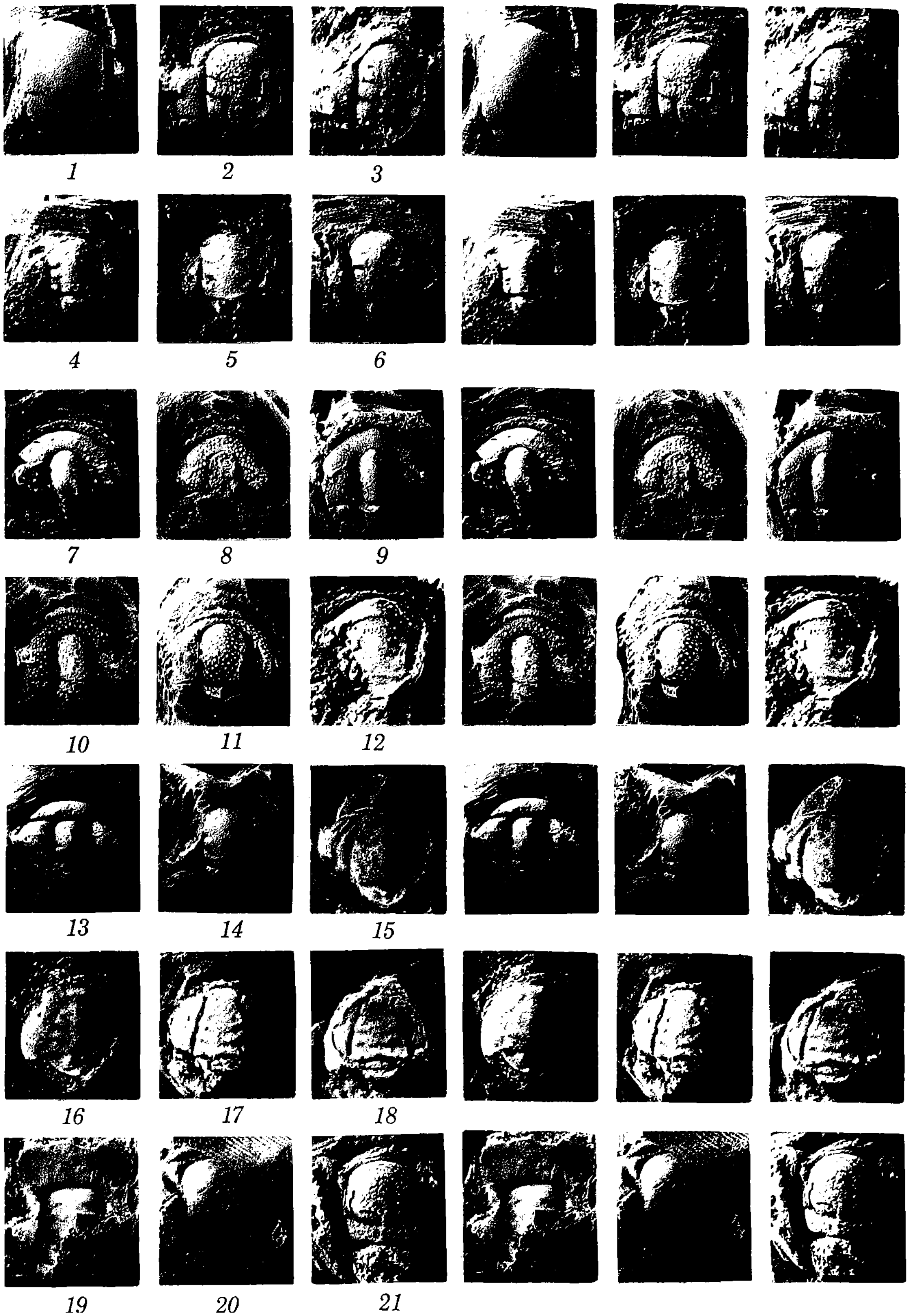
20	*Briscoia* cf. *B. hartti* (Walcott). Internal mold of large cranidium, ×1½ (UT 14068), from HS-1199.	17
21	*Prosaukia* sp. undet. Unexfoliated small cranidium, ×7 (UT 14069), from JoR-1010.	44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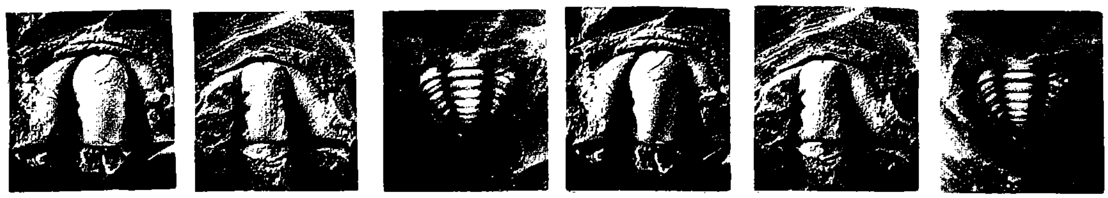

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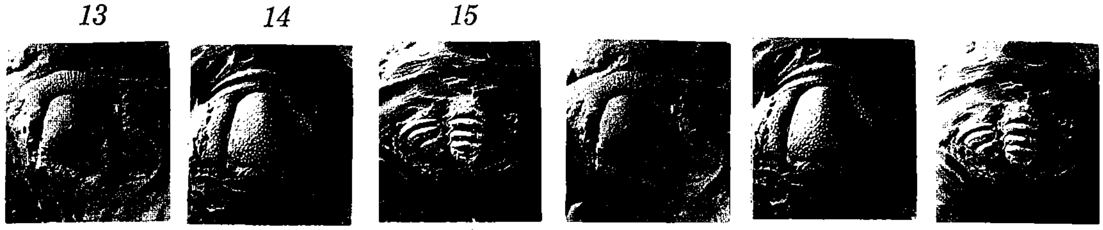

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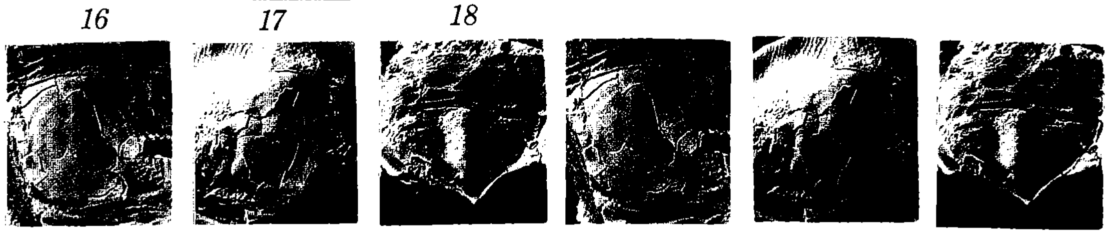

19 20 21

Plate 8

TRILOBITES OF THE *Missisquoia* AND *Symphysurina* ZONES

Figure		*Page*
1-4	*Missisquoia typicalis* Shaw. *1,* unexfoliated medium cranidium, ×6 (UT 14070), from JoR-1187; *2,* unexfoliated medium cranidium, ×5 (UT 14071), from JoR-1142; *3,* unexfoliated small pygidium, ×8 (UT 14072), from JoR-1125; *4,* mostly exfoliated large pygidium, ×3 (UT 14073), from JoR-1197.	26
5-8	*Missisquoia depressa* Stitt, n. sp. *5,* unexfoliated medium cranidium, ×6 (OU 6527, holotype), from JoR-1065; *6,* unexfoliated medium cranidium, ×5 (OU 6528a, paratype), from JoR-1058; *7,* unexfoliated small pygidium, ×5 (OU 6528b, paratype), from JoR-1058; *8,* unexfoliated medium pygidium, ×7 (OU 6528c, paratype), from JoR-1058.	25
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16	*Apoplanias rejectus* Lochman. Unexfoliated medium cranidium, ×2½ (UT 14075), from JoR-1080.	46
17, 18	*Hystricurus millardensis* Hintze. *17,* internal mold of medium cranidium, ×1¾ (UT 14076), from HS-1785; *18,* mostly exfoliated medium pygidium, ×2 (UT 14077), from JoR-1468.	46
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(**Boldface** number indicates main reference; brackets indicate plate explanations)