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Trilobites of the Upper Cambrian Ptychaspid Biomere, Wilberns Formation, Central Texas

By
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TRILOBITES OF THE UPPER CAMBRIAN PTYCHASPID BIOMERE WILBERNS FORMATION, CENTRAL TEXAS

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TRILOBITES OF THE UPPER CAMBRIAN PTYCHASPID BIOMERE WILBERNS FORMATION, CENTRAL TEXAS

SUSAN ANN LONGACRE

ABSTRACT—Trilobites collected during the past 20 years from the Morgan Creek, Point Peak, and San Saba Members of the Wilberns Formation comprise 89 species assigned to 45 genera belonging to zones of the upper Franconian and Trempealeauan Stages of the Upper Cambrian Croixan Series. New zonal names are proposed in the interest of a regionally applicable nomenclature. Although none of the zonal nomenclature is identical to that of the 1944 Cambrian Correlation Chart of Howell *et al.*, the four zones recognized in central Texas are equivalent to the eight highest zones on the Chart. Stratigraphically lowest is the Franconian *Taenicephalus* Zone, with a locally recognized *Parabolinoides* Subzone at its base; this zone is equivalent to the *Conaspis* Zone of the Correlation Chart. The Franconian *Idahoia* Zone, with a locally recognized *Idahoia lirae* Subzone at its base, is equivalent to the *Ptychaspis* Subzone of the *Ptychaspis-Prosaukia* Zone of the Correlation Chart. The sparsely fossiliferous *Ellipsocephaloides* Zone corresponds to the *Prosaukia* Subzone of the *Ptychaspis-Prosaukia* Zone on the Chart. Almost two-thirds of the trilobite species described occur in the Trempealeauan *Saukia* Zone, which corresponds to the five highest zones of the Correlation Chart; local subzones, in ascending order, are the *Saukiella pyrene* Subzone, the *Saukiella junia* Subzone, the *Saukiella serotina* Subzone, and the *Corbinia apopsis* Subzone.

The succession of ptychoparioid trilobite faunas within these zones characterizes the Ptychaspid Biomere. The base of the biomere is at the base of the *Taenicephalus* Zone; the top coincides with the lowest occurrence of an Ordovician trilobite fauna. Trilobite families that characterize the Ptychaspid Biomere are the Ptychaspididae and the Parabolinoididae.

Systematic descriptions include two new subfamilies, Drumaspidinae and Ptychaspidinae, and eight new species, *Conaspis leptoholcis, Idiomesus infimus, Euptychaspis frontalis, Keithiella scapane, Saukiella serotina, Prosaukia remora, Calvinella prethoparia,* and *Westonaspis? texana.*

INTRODUCTION

BETWEEN the base of the Upper Cambrian *Eoorthis* bed and the lowest Ordovician trilobites in central Texas is a complex of interrelated trilobite species and genera that constitute the here named Ptychaspid Biomere. The systematic descriptions and study of relationships among species in this new biomere are the subjects of this paper.

This study has as its foundation the investigations and collections of many people. The lithostratigraphy of the Wilberns Formation was described by Bridge, Barnes, & Cloud (1947) and by Cloud & Barnes (1948). Fossil collecting from the Wilberns was begun by Barnes and others before 1947, and, during the summer of 1947, W. C. Bell collected from sections measured and painted by Barnes. While working as a field assistant to Barnes (1949–1950), Howard Ellinwood collected material from the *Eoorthis* bed to the top of the Wilberns Formation in numerous measured sections. These collections were the basis for his Ph.D. thesis (1953), and most of the material used in this study is from his collections. Thesis studies by Alexander (1956), Jansen (1957), Winston (1957), and Wise (1964), and an unfinished study by Harry Nicholls, all supervised by W. C. Bell, added greatly to the Texas collections. As part of a larger project by Barnes and Bell on the Cambrian of central Texas, Bell & Ellinwood (1962) described and illustrated trilobite species then known to occur from the *Eoorthis* bed to the lower part of the San Saba Limestone. Based on material from the calcitic San Saba on the western side of the Llano Uplift, Winston & Nicholls (1967) described and illustrated Cambrian and Ordovician trilobites from the remainder of the Wilberns Formation. I am deeply indebted to all of these gentlemen for having made the extensive collections on which this study is based.

Although most of the trilobites were adequately prepared before this study began, many still required cleaning before the identifications could be made. This additional preparation, the borrowing of type specimens, and 4 years of relatively uninterrupted work on the faunas have led to certain opinions that differ from those of Bell, Ellinwood, Winston, and Nicholls. This paper is based on my Ph.D. dissertation at The University of Texas at Austin, supervised by W. C. Bell.

Reference is made to trilobites collected in the Arbuckle Mountains of Oklahoma by James H.

Stitt, and to his conclusions. Although most species are common to both Oklahoma and central Texas, only one new species, *Saukiella serotina,* occurs in both areas. Because its proposal is based on specimens from central Texas and because its name is borne by a subzone we both recognize, we have agreed that this paper appear in print before his, which is currently in press at the Oklahoma Geological Survey. Where taxonomic problems common to both areas were resolved by Stitt, I have given him the credit and the accompanying burden of defense.

Acknowledgments

I am deeply indebted to W. Charles Bell for his counsel, guidance, and support, without which this project could not have been completed. I am grateful to A. R. Palmer, R. A. Robison, Christina Lochman-Balk, Patrick K. Sutherland, Ernest L. Lundelius, Jr., and Keith Young for their reviews of the manuscript and for their constructive suggestions. James H. Stitt worked simultaneously on comparable faunas from Oklahoma, and I thank him for his discussions on problems of mutual interest. For the loan of type specimens, thanks are extended to Porter Kier and Jesse Merida of the U.S. National Museum, René Bureau of Laval University in Quebec, Canada, Copeland MacClintock of the Peabody Museum of Natural History, and Bernhard Kummel of Harvard's Museum of Comparative Zoology. I thank Michael Taylor for sending information about some Trempealeauan trilobites from the Great Basin. I am grateful to the Department of Geological Sciences, the Bureau of Economic Geology, and the Geology Foundation at The University of Texas at Austin for financial and moral support during my graduate studies and the National Science Foundation for a graduate fellowship. I am most grateful to George Coates of San Antonio and the Owen-Coates Fund of the Geology Foundation of The University of Texas at Austin for making this publication financially possible.

The Ptychaspid Biomere

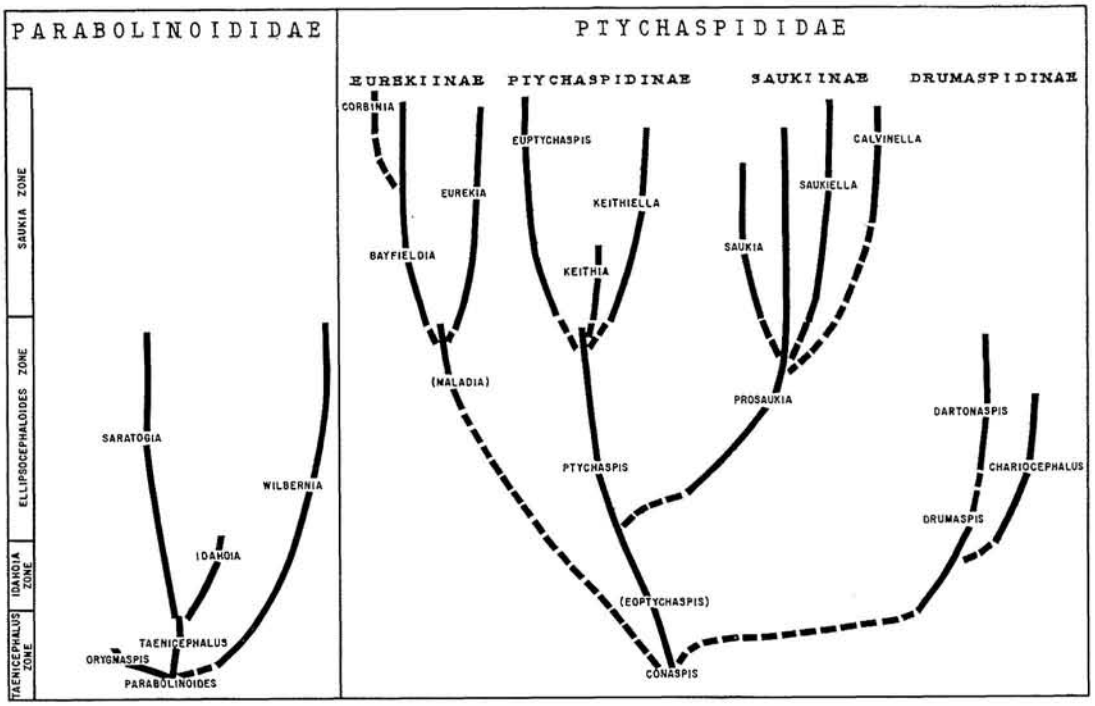
The biomere is a new type of biostratigraphic unit recently recognized and named by Palmer (1965a). Although the environmental and biologic conditions responsible for the biomere are open to debate, the unit does exist. Palmer recognized the first one in the Upper Cambrian nonagnostid trilobites from the Great Basin (1965a, 1965b), and he urged that similar units be sought in other areas.

Palmer (1965a, p. 149) defined the biomere as "a regional biostratigraphic unit bounded by abrupt non-evolutionary changes in the dominant elements of a single phylum." Within its boundaries is a complex of interrelated species and genera; dominant families of the complex either are unknown in or are insignificant elements of older or younger faunal complexes. Although the biomere is of stage magnitude, it should not be used as or substituted for the stage because the boundaries are, or may be, time-transgressive (Palmer, 1962, p. 9; 1965a, p. 150; 1965b, p. 4).

Palmer (1965a, p. 150; 1965b) described the characteristics and faunal content of the type biomere, the Pterocephaliid Biomere, named after one of the two families that are dominant in the interval between the base of the *Aphelaspis* Zone and the top of the *Elvinia* Zone.

Immediately above the Pterocephaliid Biomere is a complex of interrelated ptychoparioid trilobites that constitute another biomere. The abrupt faunal change across the *Elvinia-Taenicephalus* (or *Conaspis*) zonal boundary has long been recognized (Frederickson, 1949; Wilson, 1951; Nelson, 1951; Bell, Feniak, & Kurtz, 1952; Bell, Berg, & Nelson, 1956; Lochman, 1964a; Grant, 1965). A comparable change in the trilobite fauna occurs between the top of the Cambrian *Saukia* Zone and the lowest Ordovician trilobite fauna (Frederickson, 1941; Palmer, *in* Bass & Northrop, 1953; Lochman, 1964a, 1964b; Winston & Nicholls, 1967; Stitt, in press). Between the base of the *Taenicephalus* Zone and the top of the *Saukia* Zone is a complex of trilobite genera and species dominated by two families, the Ptychaspididae and the Parabolinoididae. These two families are not represented in older or younger faunas. The characteristics and faunal content of these families are fully discussed in the systematic descriptions and are illustrated in text-figure 1. The lower boundary of this biomere is at the *Eoorthis* coquina, a boundary that probably is time-transgressive (Bell, 1950, p. 493). The upper boundary may or may not be isochronous.

The most appropriate name for this distinct complex of trilobites is the Ptychaspid Biomere. The Ptychaspididae is the only family represented throughout the biomere, and the ptychaspid genus *Conaspis* is the possible progenitor of the three Ptychaspididae subfamilies that dominate the *Saukia* Zone: Eurekiinae, Ptychaspidinae, and Saukiinae.



TEXT-FIG. *1*—Inferred phylogenetic relationships in the families Parabolinoididae and Ptychaspididae. Genera not represented in central Texas are enclosed in parentheses.

The ranges of all species of the Ptychaspid Biomere are illustrated on composite range charts (text-figs. 2, 3). Evident on the charts are greater species diversity and longer ranges of species in the upper part of the biomere relative to those in the lower part of the biomere. Relative abundance of each species is indicated by the width of the bar: narrow bar for rare occurrence, wide bar for common to abundant occurrences, and variable width for significant changes in relative abundance. The thickness of the zones on the charts is composite; in 19 measured sections the *Taenicephalus* Zone averaged about 45 feet thick, and the *Idahoia* Zone, about 18 feet. Although the base of the *Ellipsocephaloides* Zone is present in nine sections, only in the James River, Morgan Creek, Camp San Saba, and Threadgill Creek sections (text-fig. 6) is the entire zone present. Therefore the thickness of the *Ellipsocephaloides* Zone is a composite from those four sections: 90 feet, fossiliferous; 80 feet, unfossiliferous. Thickness of the *Saukia* Zone is based on the Threadgill Creek and James River sections, where total thickness averages 175 feet.

The complex of species in the Ptychaspid Biomere is divided into four assemblage zones and several locally recognized subzones.

LITHOLOGY OF THE WILBERNS FORMATION

The following discussion of the Wilberns Formation is designed to give a general view of the lithology and an understanding of the geometric relationship between the lithic and faunal boundaries (text-fig. 4). The Wilberns Formation contains four members: Welge Sandstone, Morgan Creek Limestone, Point Peak Siltstone, and San Saba Limestone.

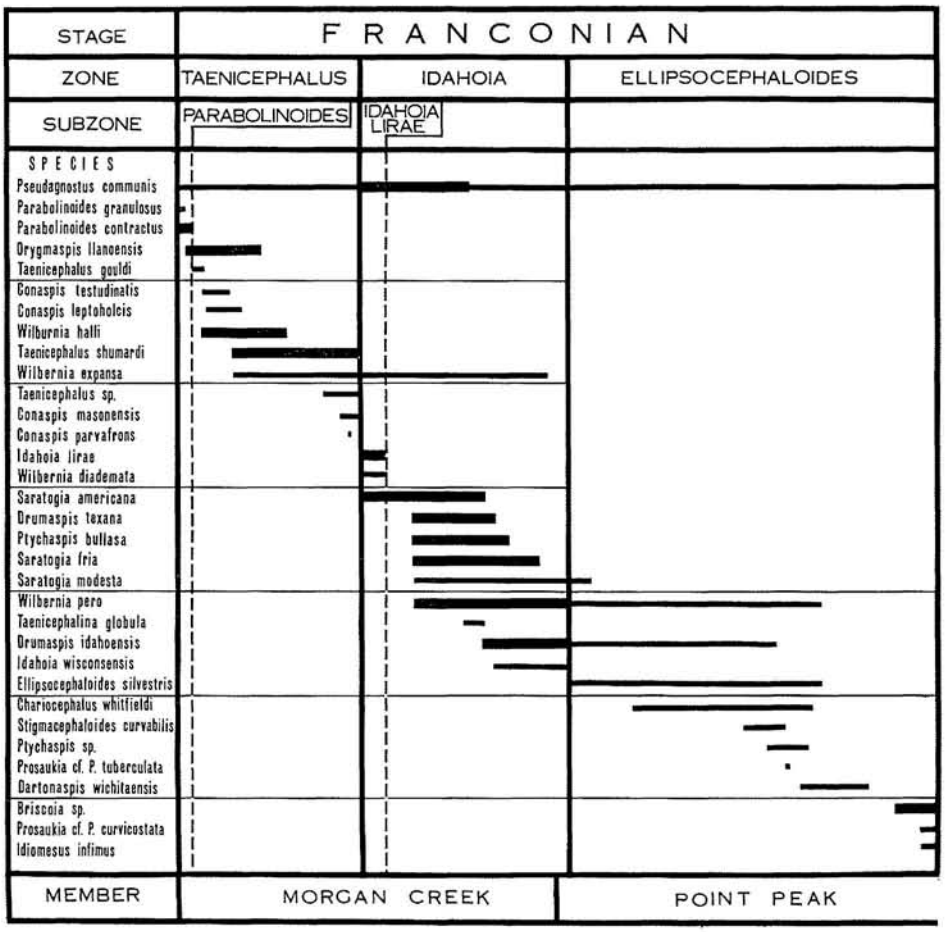
The Welge Member is a tan, well sorted, medium- to fine-grained, usually nonglauconitic sandstone that unconformably overlies the Lion Mountain Member of the Riley Formation. The disconformity between the Riley and Wilberns is correlative with the Dresbach-Franconia disconformity in the Upper Mississippi Valley. The Welge contains trilobites of the *Elvinia* Zone (Pterocephaliid Biomere). Through a very short interval, the Welge grades up into the Morgan Creek Limestone.

The Morgan Creek Member, with an average thickness of 120 feet, is a gray to greenish, fine- to coarse-grained biosparite with some micrite and biomicrite. It is locally oölitic, and extensive algal accumulations are common in the upper

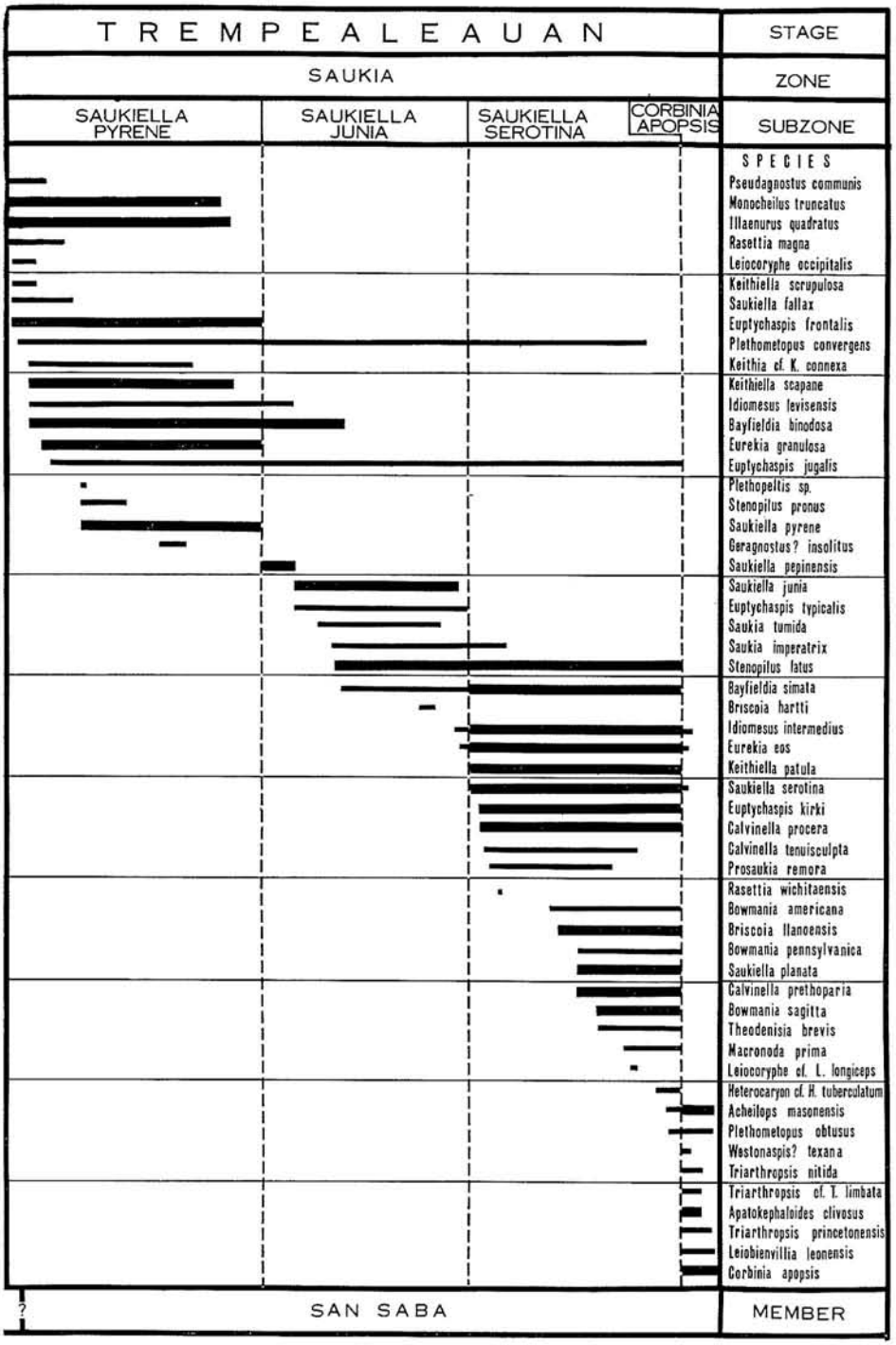
part of the member. The lower one-third of the Morgan Creek contains abundant *Elvinia* Zone trilobites. Approximately 50 feet above the base of the Morgan Creek is the base of the *Taenicephalus* Zone (Ptychaspid Biomere), in association with the *Eoorthis* coquina. The *Taenicephalus* Zone is contained entirely within the Morgan Creek. Approximately 95 feet above the base of the Morgan Creek is the base of the *Idahoia* Zone. Although this zone is best represented in the Morgan Creek, a few *Idahoia* Zone species occur in the overlying member.

The boundary between the Morgan Creek and the Point Peak Members is gradational, and placement of the boundary in the field is somewhat arbitrary. The Point Peak is composed of interbedded micaceous, calcareous siltstone, silty limestone, intraformational conglomerate, and stromatolitic limestone. At best the Point Peak can be described as poorly fossiliferous. The boundary between the *Idahoia* and *Ellipsocephaloides* Zones occurs near the base of the member. At only one locality does the base of the *Saukia* Zone occur in the Point Peak; at all other localities, this boundary is in the San Saba Member. The boundary between the Point Peak and the San Saba ranges from gradational to distinct.

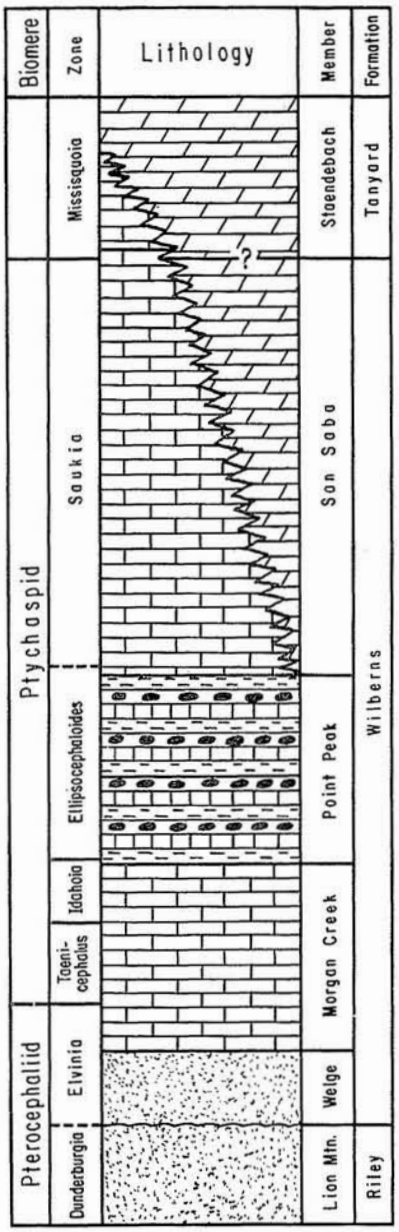
The San Saba Member ranges in thickness from 160 to almost 300 feet, and it is divisible into two major facies. The calcitic limestone facies is abundantly fossiliferous, locally sandy, fine- to coarse-grained glauconitic biosparite and biomicrite. On the western edge of the Llano Uplift, medium-grained, well-rounded quartz sand commonly is interbedded with lime-



TEXT-FIG. 2—Composite ranges of species in the Franconian part of the Ptychaspid Biomere, Wilberns Formation. Only the lower, fossiliferous half of the *Ellipsocephaloides* Zone is illustrated. Narrow bar indicates rare occurrence, wide bar indicates common to abundant occurrence.



TEXT-FIG. *3*—Composite ranges of species in the Trempealeauan part of the Ptychaspid Biomere, Wilberns Formation. Narrow bar indicates rare occurrence, wide bar indicates common to abundant occurrence.



TEXT-FIG. 4.—Columnar section illustrating general relationship between lithostratigraphic and biostratigraphic units.

stone at about the Cambrian-Ordovician boundary. The dolomitic facies is predominantly medium- to coarse-grained, gray, dolomitized limestone. About the only source of fossils in this facies is residual chert. Generally the calcitic facies is overlain by the dolomitic facies, with some exceptions, and both facies are not always present in any one section. The general trend in thickness of the facies is that the dolomite thickens eastward and the calcitic facies thickens westward. Few *Saukia* Zone trilobites have been collected from the dolomitic facies, and those taxa that do occur in the dolomite look quite different from species in the calcitic facies. *Saukia* Zone taxa are abundant in the sparites of the calcitic facies of the San Saba.

The Wilberns Formation is conformably overlain by the Staendebach Member of the Tanyard Formation, Ellenburger Group. Calcitic and dolomitic facies of the Staendebach are superjacent to calcitic and dolomitic facies of the San Saba, respectively.

TRILOBITE ZONATION

INTRODUCTION

The trilobite zonation used in this paper is directly applicable in central Texas, most of it is applicable in Oklahoma, and I suggest that its use could be even more extensive. Although none of the zonal nomenclature is identical to that of the Cambrian Correlation Chart (Howell *et al.*, 1944), the four zones recognized in central Texas are equivalent to the eight highest zones of the Croixan Series of the Chart. In addition, the four Texas zones are either equivalent to or identical with zones locally recognized in the Montana-Wyoming area and in the Upper Mississippi Valley.

Ulrich & Resser (1930, 1933) initiated a large scale description of trilobites from the Upper Mississippi Valley. Twenhofel, Raasch, & Thwaites (1935) generally described the faunas and stratigraphy of the Upper Cambrian in the Upper Mississippi Valley. Their local faunal succession and then unpublished work by Raasch form the basis of the Croixan zonal units of the Cambrian Correlation Chart. Implicit in this Chart is the wide-spread applicability of the zonal nomenclature. Some years later, Raasch (1951) proposed that the *Saukia* Zone replace the five highest zones of the Correlation Chart. Subsequently, specific details of faunas and lithostratigraphy of the Upper Mississippi Valley were published by Nelson (1951, 1956), Bell, Feniak, & Kurtz (1952), Berg (1953, 1954), Bell, Berg, & Nelson (1956), and Grant (1962).

Prior to 1960 very little detailed published information was available for comparing the latest Cambrian nearshore trilobites of the Upper Mississippi Valley with faunas from other areas of the marginal cratonic sea. Grant (1965) published the detailed systematic paleontology of Franconian and Trempealeauan faunas collected from measured sections in northwestern Wyoming and southwestern Montana. Bell & Ellin-

wood (1962) and Winston & Nicholls (1967) did the same for comparable collections from sections in central Texas. The use by these authors of locally applicable zonal nomenclature suggests possible dissatisfaction with the nomenclature of the Cambrian Correlation Chart outside of the Upper Mississippi Valley.

It is important to understand that during the Late Cambrian the Upper Mississippi Valley was an area of nearshore detrital accumulation. Conversely, carbonate accumulation dominated in all other marginal cratonic areas. That the composition of a benthic fauna would be at least in part affected by the kind of substrate is to be expected. Although the Franconian and Trempealeauan faunas of the Upper Mississippi Valley are comparable to those from the carbonate areas, there are distinct differences. Not only are different taxa present, but the dominant elements of the faunas are different. If, apparently, most of the Upper Cambrian marginal cratonic rocks of North America are carbonates, then the needs for establishing a regional biostratigraphy would best be served if zonal nomenclature were derived from faunas in the carbonate areas.

In all fairness to the other side of the argument, I recognize that the zones are based on trilobite assemblages, and I realize that the name-giving taxon need not be present for its name to be applied to the assemblage. However, if the name-giving taxon is geographically or environmentally restricted, its choice as the source for a zonal name was a poor one. Workers in other areas will recognize and name local zones rather than use a name that has little or no local significance.

I believe that enough is now known about Upper Cambrian trilobite faunas in the marginal cratonic areas of North America that an attempt to establish a zonal nomenclature that is both locally and regionally acceptable is possible. To this end, I submit the zonal nomenclature used in this paper.

Shaw (1954), Shaw & Deland (1955), and Grant (1965) used the *Taenicephalus* Zone as a local equivalent of the Franconian *Conaspis* Zone of the Correlation Chart. *Taenicephalus* is abundant through most of the *Conaspis* Zone, or its equivalents, in central Texas, Oklahoma (Frederickson, 1949), the Upper Mississippi Valley (Nelson, 1951; Bell, Feniak, & Kurtz, 1952; Berg, 1953), and the Montana-Wyoming area (Shaw & Deland, 1955; Grant, 1965). Specimens assignable to species of *Conaspis* are scarce outside of the Upper Mississippi Valley. I propose that the name *Taenicephalus* be substituted for *Conaspis* on a revised correlation chart. In addition, I agree with Grant (1965, p. 85) that researchers be consistent and use only trilobite names in their zonal nomenclature. Therefore, the *Eoorthis* Subzone, based upon a genus of brachiopod, should be abandoned.

The name *Ptychaspis-Prosaukia* is inconsistent with the pattern of other zonal names in that it combines two generic names into one label. The hyphenated zonal name leads directly to its own subzonation, the *Ptychaspis* Subzone and the *Prosaukia* Subzone. Because I think subzonal nomenclature should reflect local subdivisions and bear locally applicable names, I suggest that the *Ptychaspis-Prosaukia* label be abandoned.

Evidently Twenhofel, Raasch, & Thwaites (1935, p. 1702, 1704) first used the hyphenated name, *Ptychaspis-Prosaukia* fauna, and until recently this lead has been followed. Although the entire fauna is characterized by species of *Ptychaspis,* the upper part also contains species of *Prosaukia,* a genus that is represented in stratigraphically higher faunas. The interval through which *Ptychaspis* and *Prosaukia* overlap is known as the *Prosaukia* division of the *Ptychaspis-Prosaukia* fauna (Twenhofel, Raasch, & Thwaites, 1935, p. 1704), the *Prosaukia* Subzone of the *Ptychaspis-Prosaukia* Zone (Howell *et al.,* 1944), and the *Prosaukia* Zone (Moore, 1955, p. 564). Such a subdivision restricts *Ptychaspis miniscaensis,* the type species, to the *Prosaukia* Zone or Subzone, an esthetically untidy situation.

Outside the Upper Mississippi Valley, specimens assignable to species of *Ptychaspis* are not common, and specimens assignable to species of *Prosaukia* are exceedingly scarce. In Minnesota and Wisconsin most of the Franconian species (and specimens) of *Prosaukia* have come from either cross-bedded or thin-bedded Mazomanie sandstone (Berg, 1954, p. 867); a few additional species (and specimens) have come from the Reno greensands (Berg, 1954, p. 869). Thus, not only are these genera restricted geographically, but most species of *Prosaukia* are environmentally segregated in the one area where the genus is well represented.

Not only should the name *Ptychaspis-Prosaukia* be abandoned, but I think the interval can and should be treated as two zones. In carbonate areas it can be divided into a lower, fossiliferous zone dominated by species of *Idahoia, Saratogia, Drumaspis,* and *Wilbernia* and an upper, poorly fossiliferous zone containing species of *Dartonaspis, Briscoia, Ptychaspis, Prosaukia, Ellipsocephaloides,* and, in Oklahoma, *Saratogia.* Grant (1965) called the lower of the two the *Idahoia* Zone and recognized three local sub-

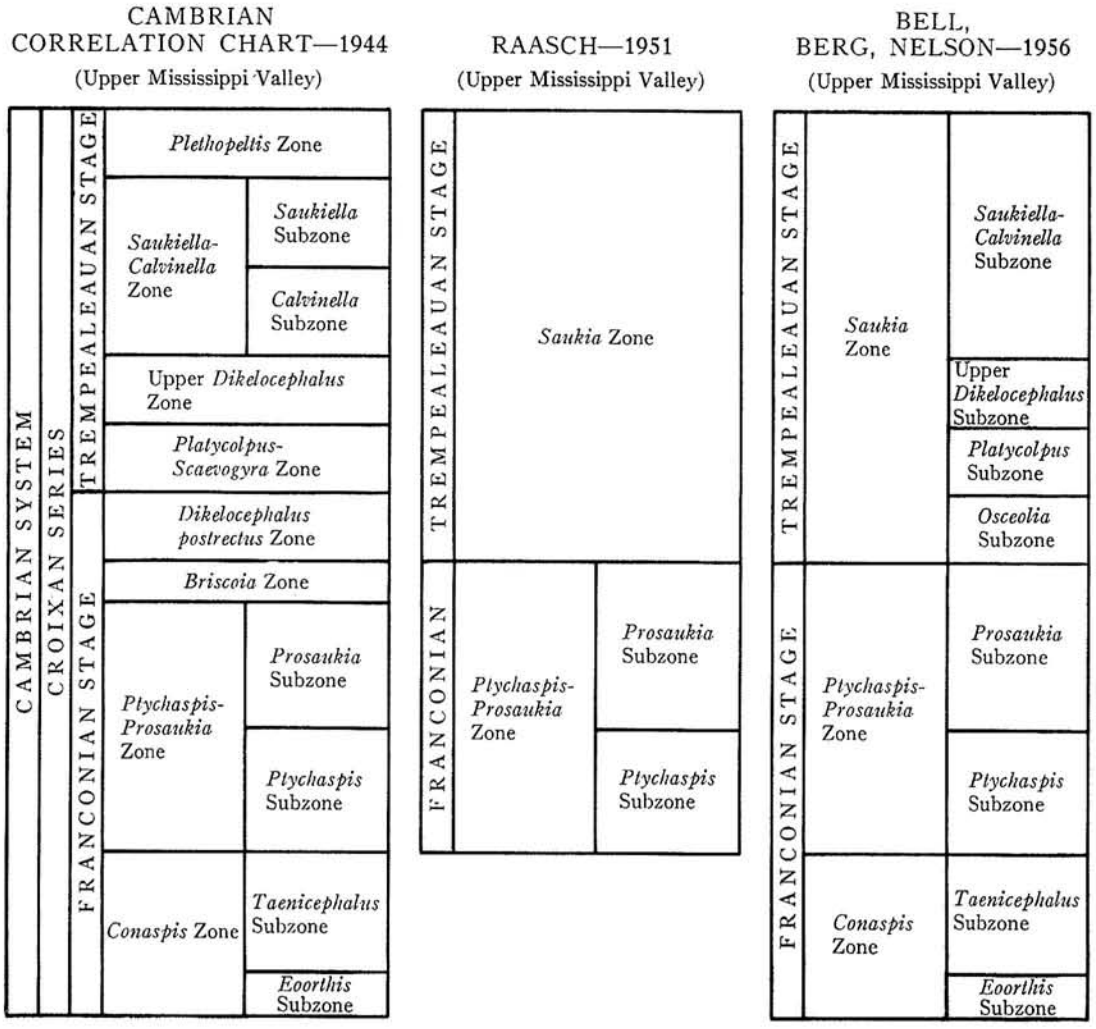
zones based on species of *Idahoia;* above this he recognized a poorly fossiliferous *Prosaukia* Zone. Stitt (in press) leaves the two parts in one zone, the *Saratogia* Zone, the lower part divided into *Idahoia lirae* (basal) and *Drumaspis* Subzones; the upper part of the *Saratogia* Zone is not subzoned. I propose that the lower fossiliferous interval be named the *Idahoia* Zone, a name that can be applied regionally, and that the upper, sparsely fossiliferous interval be named the *Ellipsocephaloides* Zone, after a genus that is represented in all areas.

I agree with Raasch (1951), Bell, Berg, & Nelson (1956), and Grant (1965) that the *Briscoia* Zone of the Correlation Chart should be abandoned. Furthermore, I follow Raasch (1951), Bell, Berg, & Nelson (1956), and Winston & Nicholls (1967) in recognizing only the *Saukia* Zone as Trempealeauan and in abandoning the five highest zones of the Cambrian Correlation Chart.

Text-figure 5 compares the zonation of the Cambrian Correlation Chart with that of Raasch (1951), Bell, Berg, & Nelson (1956), Grant (1965), Winston & Nicholls (1967), and this paper.

Franconian Stage

The Franconian Stage is represented in the Wilberns Formation by the *Elvinia, Taenicephalus, Idahoia,* and *Ellipsocephaloides* Zones. Although a discussion of the *Elvinia* Zone

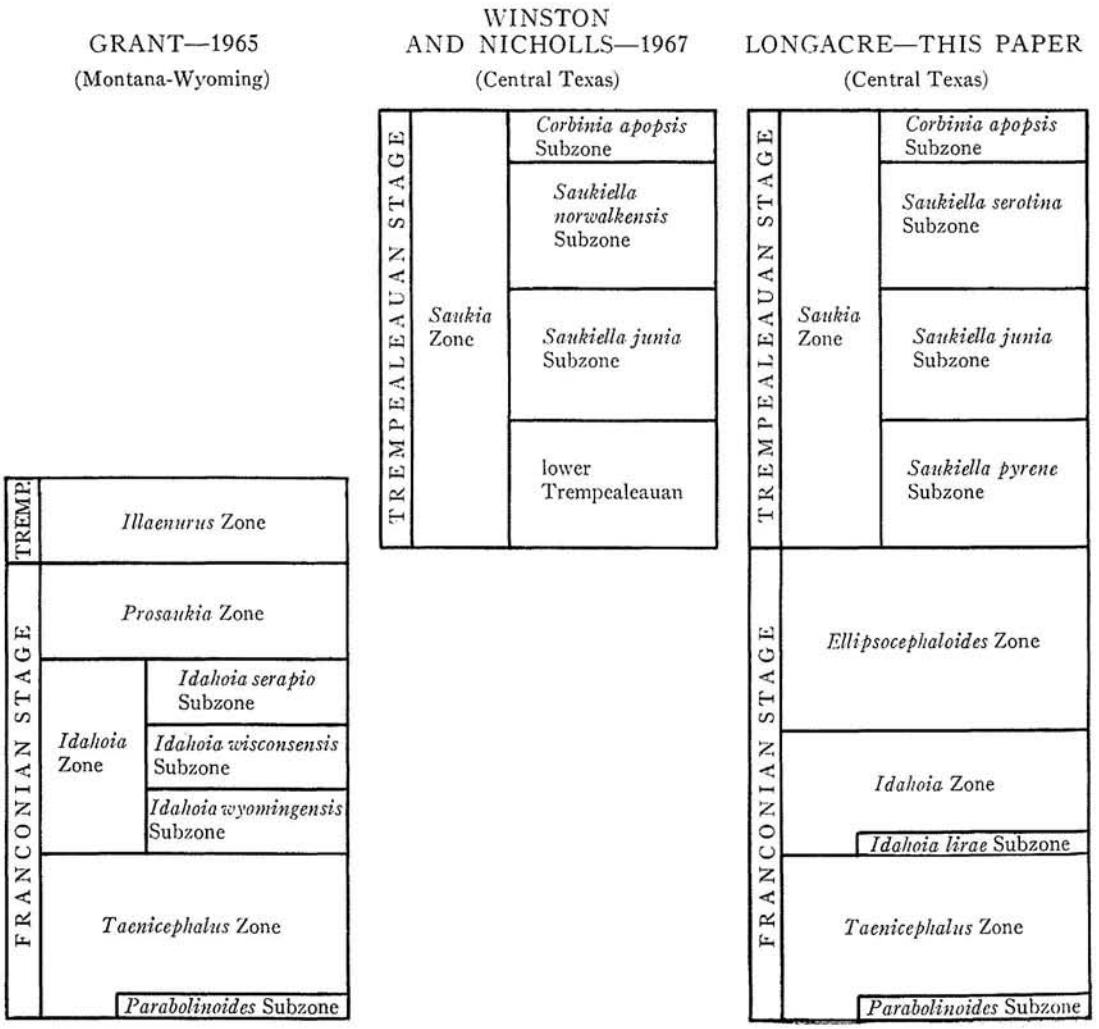


Text-fig. 5—Correlation Chart.

fauna is outside the scope of this paper, several species that originate in the *Elvinia* Zone occur also in the very base of the *Parabolinoides* Subzone of the *Taenicephalus* Zone; these include *Irvingella major, Sulcocephalus candidus, Comanchia amplooculata,* and *Dellea? punctata.*

Taenicephalus ZONE

The *Taenicephalus* Zone is present in 20 measured sections in central Texas and occurs entirely within the Morgan Creek Member of the Wilberns Formation. The base of the zone is usually marked by a coquina of brachiopods dominated by the genera *Eoorthis* and *Billingsella;* the lowest occurrence of species of *Parabolinoides* is normally in this brachiopod coquina. The base of the *Taenicephalus* Zone is at section localities B-312, CO-124, CR-697, E-848, EC-1, GM-546, GR-118, JR-121, LL-671.8, MC-660, PK-885, SK-200, SS-46, ST-478, SU-56, TA-0.6, TC-934–934.5, TR-291, and WC-889. Trilobites of the *Taenicephalus* Zone include *Conaspis leptoholcis,* n. sp., *C. masonensis, C. parvafrons, Orygmaspis llanoensis, Parabolinoides contractus, P. granulosus, Taenicephalus gouldi, T. shumardi, T.* sp., and *Wilbernia halli. Wilbernia expansa* and *Pseudagnostus communis* occur in this zone but are not confined to it. The top of the zone is at the base of the *Idahoia* Zone. In most sections, the zone is abundantly fossiliferous in its lower 15 feet and less fossiliferous toward the top.



Parabolinoides Subzone.—Grant (1965, p. 84) defined a *Parabolinoides* Subzone at the base of the *Taenicephalus* Zone in Montana and Wyoming. A comparable limiting of species of *Parabolinoides* to the basal 1 to 3 feet of the *Taenicephalus* Zone occurs in 19 measured sections in central Texas; at Eckert's Crossing, the measured section base is in a creek bed and is stratigraphically above the *Parabolinoides* Subzone. The base of the *Parabolinoides* Subzone is the base of the *Taenicephalus* Zone; the top of the subzone is defined by the highest occurrence of *Parabolinoides*. In the measured sections, the top of the subzone is at B-312.5, CO-126, CR-697, E-849.5, GM-547, GR-119, JR-122, LL-673, MC-663, PK-886, SK-201, SS-47.5, ST-478, SU-58, TA-2, TC-935.5–936, TR-292.5, and WC-889. Trilobites confined to the *Parabolinoides* Subzone include *P. contractus* and *P. granulosus;* other species not confined to the subzone include *Orygmaspis llanoensis* and *Taenicephalus gouldi.* Brachiopods abundant in the subzone include *Eoorthis remnicha, E. indianola* and *Billingsella coloradoensis.*

The range of species in the *Parabolinoides* Subzone of central Texas is similar to that in the *Parabolinoides* Subzone of Oklahoma (Stitt, in press). However, in Texas, *Orygmaspis llanoensis* occurs through as much as half of the subzone and *Taenicephalus gouldi* occurs at the top of the subzone, whereas, in Oklahoma, *Orygmaspis* and *Taenicephalus* occur above the range of *Parabolinoides.* In Montana and Wyoming (Grant, 1965, p. 84), the lowest occurrence of most species of the *Taenicephalus* Zone is in the *Parabolinoides* Subzone, whereas in Texas most species originate above the top of the subzone. A *Parabolinoides* Subzone can be recognized in the Upper Mississippi Valley (Berg, 1953, p. 556), where *Parabolinoides* is abundant in and confined to the lower part of the *Conaspis* Zone. *Parabolinoides* is a subzonal name that is both locally and regionally applicable.

Idahoia ZONE

The *Idahoia* Zone is present in the Morgan Creek and Point Peak Members of the Wilberns Formation. Although some specimens were collected from siltstone in the lower part of the Point Peak, most of the fossil material is from the Morgan Creek. The lowest occurrence of *Idahoia lirae, Wilbernia diademata,* and *Saratogia americana* marks the base of the zone. In measured sections the base of the *Idahoia* Zone is at B-346.5, CO-162, CR-743-747, E-894, EC-20.5, GM-590, GR-165, JR-169, LL-714, MC-706, PK-922, SK-232, SS-92.5, ST-528, SU-166, TA-56, TC-983, TR-342, and WC-925. The top of the *Idahoia* Zone is at the base of the *Ellipsocephaloides* Zone. Trilobites confined to the *Idahoia* Zone are *Drumaspis texana, Idahoia lirae, I. wisconsensis, Ptychaspis bullasa, Saratogia americana, S. fria, Taenicephalina globula,* and *Wilbernia diademata. Drumaspis idahoensis* is common in the upper half of the zone. Three cranidia, intermediate between *D. idahoensis* and *Dartonaspis* but assigned to *D. idahoensis,* were collected in the middle of the *Ellipsocephaloides* Zone. Other species not confined to the *Idahoia* Zone are *Pseudagnostus communis, Saratogia modesta, Wilbernia expansa,* and *W. pero.*

The *Idahoia* Zone of central Texas is equivalent to the *Idahoia lirae* and *Drumaspis* Subzones of the *Saratogia* Zone in Oklahoma (Stitt, in press), to the *Idahoia* Zone in Montana and Wyoming (Grant, 1965, p. 85–87, pl. 4), and to the *Ptychaspis* Subzone of the Upper Mississippi Valley (Nelson, 1951, p. 769, table 1; Bell, Feniak, & Kurtz, 1952, p. 177, table 1; Grant, 1962, p. 974, table 2).

Idahoia lirae Subzone.—*Idahoia lirae* is abundant in and confined to a maximum interval of 6 feet at the base of the *Idahoia* Zone, and, although scarce, *Wilbernia diademata* is also restricted to this interval. *Saratogia americana* and *Pseudagnostus communis* can occur in the interval, but they are not confined to it. No other trilobites occur in this interval. The *Idahoia lirae* Subzone is defined from the base of the zone to the top of the range of *I. lirae.* The top of the *I. lirae* Subzone is at CO-162, CR-743-747, E-894, EC-21.5, GM-594, GR-171, JR-177, LL-719, MC-707, PK-922, SK-233, SS-94.5, ST-528, TA-56, TC-987, TR-344.5, and WC-925.

The fauna of the *Idahoia lirae* Subzone of central Texas is almost identical to that of the *I. lirae* Subzone at the base of the *Saratogia* Zone in Oklahoma (Stitt, in press), the only differences being that *Saratogia americana* occurs in the subzone only in Texas and *Conaspis tumidas* occurs in the subzone only in Oklahoma. The *Idahoia lirae* Subzone is equivalent to at least the lower part of the *I. wyomingensis* Subzone of Montana and Wyoming (Grant, 1965, p. 86) and is comparable to the *Stigmacephalus oweni* faunule of the St. Croix Valley in Minnesota and Wisconsin (Nelson, 1951, p. 769, table 1) and, thereby, to the *Psalaspis* zonule of southeastern Minnesota (Bell, Feniak, & Kurtz, 1952, p. 177, table 1; Grant, 1962, p. 973–978, table 2).

Ellipsocephaloides ZONE

The *Ellipsocephaloides* Zone is represented in the Point Peak Member of the Wilberns Formation in nine measured sections. The base of the zone is normally marked by the lowest occur-

rence of *E. silvestris* or, in the absence of *E. silvestris,* by the lowest occurrence of *Charriocephalus whitfieldi.* The base of the zone is at EC-55, GR-204, JR-210, LL-750, MC-750, SS-138.5, TA-163, TC-1085, and WC-1060. The top of the zone is at the base of the *Saukia* Zone.

The *Ellipsocephaloides* Zone is poorly fossiliferous, and collections are small and widely spaced in the sections. The Point Peak is predominantly siltstone, with interspersed intraformational conglomerate and stromatolitic-limestone units. Trilobites are not well preserved in the siltstone. Most of the *Ellipsocephaloides* fauna is from the limestone beds. Species limited to the zone include *Briscoia* sp., *Charriocephalus whitfieldi, Dartonaspis wichitaensis, Ellipsocephaloides silvestris, Idiomesus infimus,* n. sp., *Prosaukia* cf. *P. curvicostata, P.* cf. *P. tuberculata, Ptychaspis* sp., and *Stigmacephaloides curvabilis.* Four species common in the *Idahoia* Zone also occur in the *Ellipsocephaloides* Zone: *Saratogia modesta* is scarce at the base of the zone; three cranidia assigned to *Drumaspis idahoensis* were collected above the middle of the fossiliferous part of the zone; *Wilbernia pero* occurs through the lower two-thirds of the zone; and *Pseudagnostus communis* occurs at the base.

Specimens that are stratigraphically scattered and mostly broken or poorly preserved constitute the fauna of the *Ellipsocephaloides* Zone. In spite of my definition and naming of the zone and Grant's recognition of the equivalent *Prosaukia* Zone, the problems inherent in this part of the section are not resolved, the type area notwithstanding. In the Montana and Wyoming area, Oklahoma, and central Texas, this interval is sparsely fossiliferous, and specimens assignable to *Prosaukia* are very scarce. Grant (1965, p. 142) identified one pygidium as *Prosaukia* sp. Bell & Ellinwood (1962, p. 406) identified three cranidia as *P.* cf. *P. curvicostata* and, by my count, three cranidia as *P.* cf. *P. tuberculata.* Stitt (in press) found no specimens assignable to *Prosaukia* in this part of the section. I think *Prosaukia* is not a regionally applicable or acceptable name for this zone and prefer to use the name *Ellipsocephaloides;* not only is it more meaningful in Texas, but species of *Ellipsocephaloides* occur in equivalent faunas in Montana and Wyoming (Grant, 1965, p. 87) and in the Upper Mississippi Valley (Bell, Feniak, & Kurtz, 1952, p. 177, table 1; Berg, 1953, p. 557; Grant, 1962, p. 974, table 2).

Trempealeauan Stage

The Trempealeauan Stage is represented by the *Saukia* Zone. The number of species in the zone is almost twice that of the underlying three zones combined. In the *Saukia* Zone, 55 species are present, as opposed to 33 species in the three Franconian zones above the *Elvinia* Zone.

Saukia zone

The *Saukia* Zone is present in eight measured sections on the western side and one section on the eastern side of the Llano Uplift. The base of the zone in the James River section is 45 feet below the top of the Point Peak Member, and in all other sections the zone is confined to the San Saba Member of the Wilberns Formation. On the eastern side of the uplift, the San Saba is a poorly fossiliferous, dolomitized limestone. From only one section on the eastern side, Morgan Creek, have identifiable *Saukia* Zone taxa been collected; above these few collections from the lower part of the San Saba, the limestone is dolomitized. On the western side of the uplift the San Saba is a fossiliferous calcitic limestone, and the entire *Saukia* Zone is well represented. The zone is dominated by species of *Saukiella, Calvinella, Bayfieldia, Euptychaspis, Corbinia,* and *Eurekia.*

The *Saukia* Zone of central Texas is equivalent to the *Saukia* Zone of the Upper Mississippi Valley (Raasch, 1951, p. 148–149, chart 1) and to all except the lowest part of the *Saukia* Zone of Oklahoma (Stitt, in press).

Four subzones are recognized in the *Saukia* Zone and in ascending order are: the *Saukiella pyrene* Subzone, the *Saukiella junia* Subzone, the *Saukiella serotina* Subzone, and the *Corbinia apopsis* Subzone. Winston & Nicholls (1967) studied part of the *Saukia* Zone and defined three subzones: the *Saukiella junia* Subzone, the *Saukiella norwalkensis* Subzone, and the *Corbinia apopsis* Subzone. I have used their subzonation with only one change, a new name for the *Saukiella norwalkensis* Subzone because of what I regard as a misidentification by them. The lower Trempealeauan of Bell & Ellinwood (1962) and Winston & Nicholls (1967) is herein named the *Saukiella pyrene* Subzone.

Saukiella pyrene Subzone.—This is the lowest subzone of the *Saukia* Zone, and its base is normally marked by the lowest occurrence of *Monocheilus truncatus* and *Illaenurus quadratus.* In measured sections the base is at BC-23, JR-347, MC-915±, SPH-85.5, SS-302.5, and TC-1233. The top of the subzone is at the base of the *Saukiella junia* Subzone. Species confined to the *Saukiella pyrene* Subzone are *Euptychaspis frontalis,* n. sp., *Eurekia granulosa, Geragnostus? insolitus, Illaenurus quadratus, Keithia* cf. *K. connexa, Keithiella scrupulosa, K. scapane,* n. sp., *Leiocoryphe occipitalis, Monocheilus truncatus, Plethopeltis* sp., *Rasettia magna, Saukiella fallax, S. pyrene,* and *Stenopilus*

pronus. The highest occurrence of *Pseudagnostus communis* is in the lowest part of this subzone. *Euptychaspis jugalis* and *Plethometopus convergens* range through the *Saukiella pyrene, S. junia,* and *S. serotina* Subzones. *Bayfieldia binodosa* and *Idiomesus levisensis* occur in the *Saukiella pyrene* and *S. junia* Subzones.

The *Saukiella pyrene* Subzone is equivalent to the *Illaenurus* Zone of Montana and Wyoming (Grant, 1965) and to at least the upper half of the *Rasettia magna* Subzone of the *Saukia* Zone in Oklahoma (Stitt, in press).

Saukiella junia Subzone.—The *Saukiella junia* Subzone was first defined by Winston & Nicholls (1967, p. 69). The base of the subzone is at the lowest occurrence of *Saukiella pepinensis,* and species confined to the subzone are *Briscoia hartti, Euptychaspis typicalis, Saukia tumida, Saukiella junia,* and *S. pepinensis. Bayfieldia simata, Eurekia eos, Idiomesus intermedius, Saukia imperatrix,* and *Stenopilus latus* range through the *Saukiella junia* and *S. serotina* Subzones. The base of the *S. junia* Subzone is at BC-70, CC-27, JR-453, SH-12.6, SS-356, and TC-1291. The top of the subzone is at the base of the *S. serotina* Subzone.

The *Saukiella junia* Subzone of central Texas is equivalent to the *S. junia* Subzone of Oklahoma (Stitt, in press).

Saukiella serotina Subzone.—Winston & Nicholls (1967, p. 69) defined a *Saukiella norwalkensis* Subzone above the *S. junia* Subzone; but, because I have placed *S. norwalkensis* in synonymy with *S. pyrene* and propose a new species, *S. serotina,* for the specimens identified as *S. norwalkensis* by Winston and Nicholls, I have renamed their *S. norwalkensis* Subzone the *S. serotina* Subzone.

The base of the subzone is normally marked by the lowest occurrence of *Saukiella serotina, Euptychaspis kirki,* and *Calvinella procera*. Species confined to the *S. serotina* Subzone are *Bowmania americana, B. pennsylvanica, B. sagitta, Briscoia llanoensis, Calvinella prethoparia,* n. sp., *C. procera, C. tenuisculpta, Euptychaspis kirki, Heterocaryon tuberculatum, Leiocoryphe* cf. *L. longiceps, Macronoda* cf. *M. prima, Prosaukia remora,* n. sp., *Rasettia wichitaensis, Saukiella planata,* and *Theodenisia brevis*. Although *Saukiella serotina* is abundant throughout the subzone, it can occur in the base of the *Corbinia apopsis* Subzone. Other species occurring in but not confined to the *Saukiella serotina* Subzone are *Acheilops masonensis, Bayfieldia simata, Euptychaspis jugalis, Eurekia eos, Idiomesus intermedius, Keithiella patula, Plethometopus convergens, P. obtusus, Saukia imperatrix,* and *Stenopilus latus*. The base of the subzone is at CC-58, JR-484, LC-32, LCS-32, SH-52, SS-375, and TC-1357. The top of the subzone is at the base of the *Corbinia apopsis* Subzone.

The *Saukiella serotina* Subzone of central Texas is equivalent to the *S. serotina* Subzone of Oklahoma (Stitt, in press).

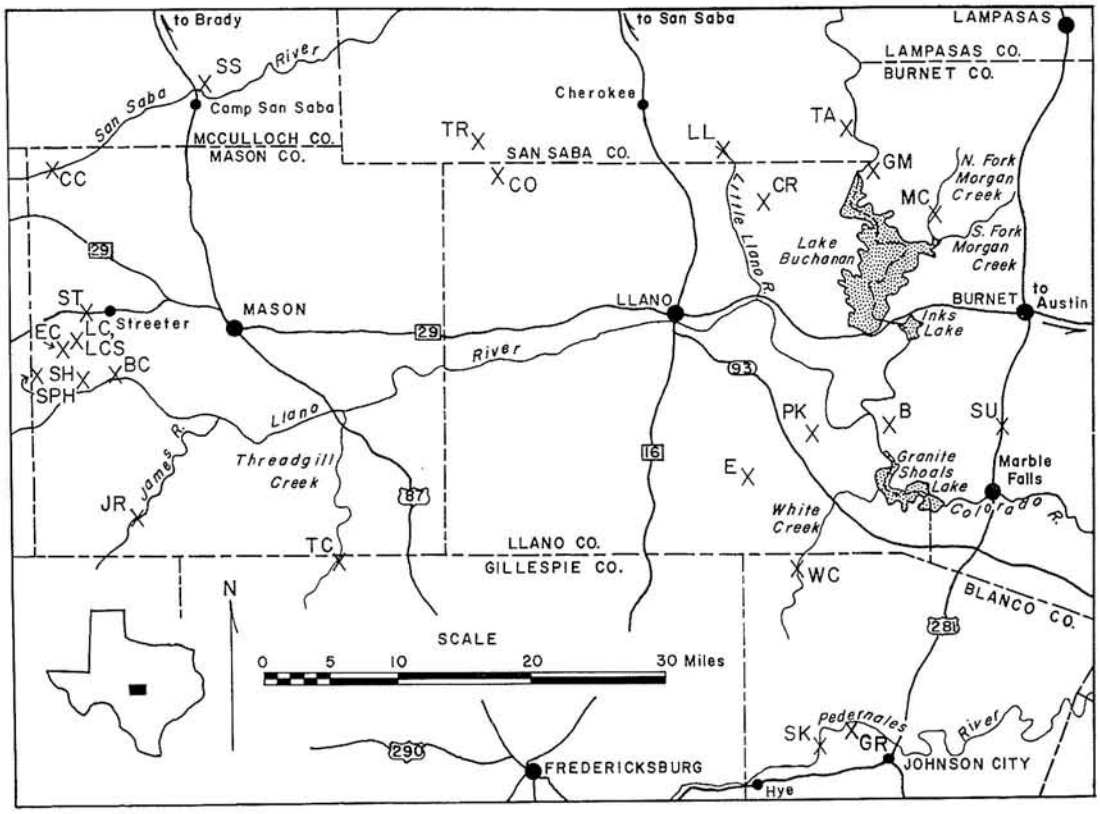
Corbinia apopsis Subzone.—The *Corbinia apopsis* Subzone is the highest subzone of the *Saukia* Zone, and its base is marked by the lowest occurrence of *Corbinia apopsis*. Species confined to the subzone include *Apatokephaloides clivosus, Corbinia apopsis, Leiobienvillia leonensis, Triarthropsis* cf. *T. limbata, T. nitida, T. princetonensis,* and *Westonaspis? texana,* n. sp. Although *Acheilops masonensis* and *Plethometopus obtusus* are common in this subzone, they first occur in the top of the *Saukiella serotina* Subzone. Other species not confined to the *Corbinia apopsis* Subzone are *Eurekia eos, Idiomesus intermedius,* and *Saukiella serotina*. The base of the subzone is at CC-67, JR-538, LC-48, LCS-53, SH-72, SS-411, and TC-1402. The top of the subzone is at the base of the Ordovician *Missisquoia* Zone, at CC-90, JR-597, LCS-108.5, SS-417, and TC-1415.

The *Corbinia apopsis* Subzone of central Texas is equivalent to the *Corbinia apopsis* Subzone of Oklahoma (Stitt, in press).

Systematic Paleontology

Families of trilobites are arranged alphabetically under each order, subfamilies are alphabetized within the families, genera are alphabetized under each family or subfamily, and species are alphabetized under each genus. Unless stated otherwise in the descriptions, designations from the *Treatise on Invertebrate Paleontology* have been used for familial assignments of genera (Harrington *et al.,* 1959), for morphologic terminology for trilobites (Harrington, 1959; Harrington, Moore, & Stubblefield, 1959), and for directional orientation terms (Harrington, 1959). Ornament terms are from those of the *Treatise* and others in common usage. Where applicable, orientation and location of measurements are indicated in the species descriptions.

Not all species described and commented upon are illustrated. This paper is to be used in concert with those of Bell & Ellinwood (1962) and Winston & Nicholls (1967). If the photographic record of a species was sufficient or if additional photographs would not enhance that record, the species was not alloted space on the plates. The figured specimens are deposited with the Bureau of Economic Geology (BEG) and The Univer-



TEXT-FIG. 6—Index map showing location of measured sections.

sity of Texas at Austin; the support collections are stored at The University of Texas at Austin. Plates contain three columns of stereophotographs, and the fossils were magnified or reduced to make pictures slightly less than 1 inch square.

At the end of each species description is a list of occurrences in measured sections. Each collection is alphanumeric: the initials refer to the specific measured section, the number refers to the footage of the collection above the base of that section. The bases of the sections are at various lithostratigraphic and biostratigraphic horizons. For the nine sections not discussed in Bell & Ellinwood (1962, p. 386–388), the location, section base, and footages of lithic boundaries are given below. Measured section locations are plotted in text-figure 6. The sections are listed below in alphabetic order according to their initials.

B *Backbone Ridge.*

BC *Bluff Creek*—Near mouth of Bluff Creek, close to the Llano River, Bear Springs area, southwestern Mason County. Base of section is in Point Peak Member of Wilberns Formation. Top of Point Peak Member is at BC-2; top of San Saba Member is at BC-262.

CC *Calf Creek*—On the Blockhouse Ranch, northwestern Mason County, along lower reach of Calf Creek and downstream along San Saba River. Base of section in lower San Saba Member; top of San Saba at CC-152.

CO *Cold Creek.*

CR *Carter Ranch.*

E *East Canyon.*

EC *Eckert's Crossing,* Leon Creek area.

GM *Gray Mountain,* Goodrich Ranch area.

GR *Gipson Ranch*—Base of section about 2,500 feet west-southwest of mouth of Hickory Creek, about 4 miles northwest of Johnson City, Blanco County. Base of section in Cap Mountain Member of Riley Formation. Top of Cap Mountain Member at GR-1; top of Lion Mountain Member of Riley Formation at GR-42; top of Morgan Creek Member at GR-197; top of Point Peak Member at GR-222.

JR (Upper) *James River.*

LC *Leon Creek* (Ellinwood)—On Leon Creek 2 miles north of junction with Llano River

Mason County, along prominent bend in Leon Creek where course changes from north-south to east-west. Base of section is in San Saba Member; top of San Saba at LC-154.

LCS *Leon Creek Section* (Winston)—Base of section is in bed of Leon Creek in prominent bend of creek about 1.4 miles southeast of point where U.S. Highway 183 crosses Leon Creek. Base of section is in San Saba Member; top of section at LCS-154.

LL *Little Llano.*

MC *Morgan Creek.*

PK *Packsaddle Mountain.*

SH *Spring Hollow,* Leon Creek area—Base of section is in bed of Spring Hollow, 40 feet west of a fence that crosses Leon Creek and 1,650 feet south of the L. B. Eckert Ranch headquarters, western Mason County. Base of section is in San Saba Member; top of section at SH-85.

SK *Klett-Walker.*

SPH *Sheep Pen Hollow,* Leon Creek area—Base of section is in bed of Sheep Pen Hollow, 3,450 feet northeast of the Wes Eckert Ranch headquarters, western Mason County. Base of section is in Point Peak Member; top of Point Peak at SPH-45; top of section at SPH-166.

SS *Camp San Saba.*

ST *Streeter.*

SU *Sudduth.*

TA *Tanyard.*

TC *Threadgill Creek.*

TR *Taylor Ranch*—About 5 miles northeast of Pontotoc, San Saba County. Top of section about 3,000 feet north-northwest of intersection of Cherokee-Pontotoc road and road to Taylor Ranch headquarters and about 1,000 feet east of road to Taylor Ranch headquarters. Base of section is in Cap Mountain Member of Riley Formation; top of Cap Mountain Limestone at TR-165; top of Lion Mountain Sandstone at TR-215; top of Welge Sandstone at TR-240; top of Morgan Creek Member at TR-366; top of Point Peak Member at TR-443.

WC *White Creek.*

The following publications or theses contain graphic or verbal descriptions of the above measured sections. Plate 1 in Bridge, Barnes, & Cloud (1947) graphically illustrates the sections at Backbone Ridge, Bluff Creek, Calf Creek, Camp San Saba, Carter Ranch, East Canyon, Little Llano, Morgan Creek, Packsaddle Mountain, Scott-Klett (Klett-Walker), Tanyard, Threadgill Creek, and White Creek; plate 2 contains a profile section from Morgan Creek. Cloud & Barnes (1948) described sections from Backbone Mountain (p. 303–307), Bluff Creek (p. 179–185), Klett-Walker (Scott-Klett, p. 343), and Tanyard (p. 244–251); plate 14 contains graphic sections from Backbone Mountain, Bluff Creek, Camp San Saba, East Canyon, Klett-Walker (Scott-Klett), Tanyard, and Threadgill Creek. Barnes & Bell (1954) described sections from Streeter (p. 41–45), Camp San Saba (p. 45–62), and Calf Creek (p. 62–67). Ellinwood (1953) described the location and faunal content of the following measured sections: Leon Creek (p. 189), Calf Creek (p. 190), Streeter (p. 190–192), Upper James River (p. 192–198), Camp San Saba (p. 198–203), Threadgill Creek (p. 204–209), Leon Creek (p. 211–215), Carter Ranch (p. 215–216), Tanyard (p. 217–219), Sudduth (p. 222–223), Backbone Ridge (p. 224–225), and White Creek (p. 226–229). Winston (1957) described sections from Eckert's Crossing (p. 122–125), Leon Creek (p. 128–133), Sheep Pen Hollow (p. 145–148), and Spring Hollow (151–155). Jansen (1957) described the section from Gray Mountain (p. 145–150). Sections described by Wise (1964) include Gipson Ranch (p. 199–206).

The occurrence data for the *Saukia* Zone taxa are not identical to those of Winston & Nicholls (1967); additional data and changes in taxonomy and nomenclature contribute to the differences.

Phylum ARTHROPODA Siebold & Stannius, 1845
Class TRILOBITA Walch, 1771
Order AGNOSTIDA Kobayashi, 1935
Family AGNOSTIDAE McCoy, 1849

Genus GERAGNOSTUS Howell, 1935

***Geragnostus? insolitus* Grant**

Pl. 3, figs. 19–21.

Geragnostus? insolitus GRANT, 1965, p. 107, pl. 15, figs. 9, 10, 12.

Remarks.—Numerous cephala and pygidia from one locality are assigned to this species. *Geragnostus? insolitus* is characterized by its inflated, bilobed, deeply furrowed glabella, a complete preglabellar median furrow, and a narrow, distinctly furrowed, and nonexpanding pygidial axial lobe that does not approach the border furrow (sag.). Surface of cephalic exoskeleton is not smooth and may have fine granules; pygidial exoskeleton is granulate. Internal molds are smooth and have more distinct furrows. Most of the specimens are poorly preserved internal molds.

These specimens appear to be conspecific with those in Grant's illustrations. The generic assignment is tentative because the specimens differ from *Geragnostus* in possessing a complete preglabellar median furrow.

G.? insolitus occurs in the *Saukiella pyrene*

Subzone in central Texas, and in the Montana-Wyoming area it also occurs low in the Trempealeauan.

Occurrence.—Locally common in the *Saukiella pyrene* Subzone at BC-34, 37-37.5, 41, 41.5-44, 42.

Family PSEUDAGNOSTIDAE Whitehouse, 1936

Genus PSEUDAGNOSTUS Jaekel, 1909

***Pseudagnostus communis* (Hall & Whitfield)**

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

Pseudagnostus communis (Hall & Whitfield) PALMER, 1955a, p. 720, pl. 76, figs. 1–3; BELL & ELLINWOOD, 1962, p. 389, pl. 51, figs. 7–21 (synonymy to date).

Remarks.—*Pseudagnostus communis* has been described and illustrated by previous workers. Bell & Ellinwood's (1962) figured specimens illustrate the variation in depth and completeness of furrows on the Texas specimens.

P. communis has been reported from the *Aphelaspis, Elvinia, Taenicephalus, Idahoia,* and *Ellipsocephaloides* Zones in central Texas. Two collections from the lowest part of the *Saukia* Zone have two cephala and two pygidia that are assigned to this species. The furrows are very shallow and in most respects look like *P. laevis* Palmer (1955b, p. 97, pl. 19, figs. 8, 9, 11, 12), even to the slightly depressed axial part of the pygidial border. These four specimens are included in *P. communis* because the convex pygidia are nearly equidimensional, whereas, *P. laevis* pygidia are distinctly elongate and flatly convex. Given more material and tighter biostratigraphic control, the two may be shown to be chronospecific.

Occurrence.—Scarce at the base but becoming more common toward the top of the *Taenicephalus* Zone at E-866, 875; EC-9, 14; GM-572, 575, 579; GR-133, 159; MC-661.5, 685; SS-77, 83; ST-511; TA-34; TR-324, 333, 335.5; WC-889, 913.5, 917. Common to locally abundant in the lower half, becoming scarce in the upper half of the *Idahoia* Zone at B-377.5; CO-193; CR-743-747; E-875, 876, 877, 894, 897, 916, 917, 923, 930, 932, 935; GM-594, 604, 606, 615; GR-167, 168, 169, 173, 183, 185, 195; JR-177, 188, 196, 204; LL-725, 728, 738, 741; MC-706, 707, 712, 714, 718, 721; SS-109, 111.5, 116; ST-574, 575, 578; SU-116; TC-994, 1009, 1015-1025, 1017, 1025; TR-342; WC-950, 968, 977, 988. Scarce in the *Ellipsocephaloides* Zone at GR-204, 210; LL-750. Scarce in the *Saukiella pyrene* Subzone of the *Saukia* Zone at SPH-93, 95.

Order PTYCHOPARIIDA Swinnerton, 1915

Family CATILLICEPHALIDAE Raymond, 1938

Genus ACHEILOPS Ulrich, 1931

Acheilops Ulrich in BRIDGE, 1931, p. 218; RASETTI, 1954b, p. 611; in HARRINGTON *et al.,* 1959, p. 0517; WINSTON & NICHOLLS, 1967, p. 77.

Type species.—*Acheilops dilatus* Ulrich, in Bridge, 1931, p. 219, pl. 19, figs. 20–22.

Remarks.—Although Rasetti (in Harrington *et al.,* 1959) did not make a definite familial assignment for *Acheilops,* Winston & Nicholls (1967) discussed the current concept of this genus and presented a sound argument for its assignment to the Catillicephalidae.

***Acheilops masonensis* Winston & Nicholls**

Pl. 6, fig. 19.

Acheilops masonensis WINSTON & NICHOLLS, 1967, p. 77, pl. 11, figs. 13–15.

Remarks.—Although this is the third most abundant species in the *Corbinia apopsis* Subzone, it is not very common in relation to *C. apopsis* and *Apatokephaloides clivosus. Acheilops masonensis* is characterized by an anteriorly expanded and truncated glabella, lack of a frontal area and anterior fixigenae, short palpebral lobes, and stout posterior limbs. The figured specimen shows the base of an occipital spine and a granular external surface ornament. Additional range data are provided below.

Occurrence.—Scarce in the *Saukiella serotina* Subzone at CC-61. Scarce to common in the *Corbinia apopsis* Subzone at CC-67, 69.5; JR-538, 539, 540; LC-48; LCS-53, 53.5, 55.5; SH-72; SS-411; TC-1402, 1405, 1409.

Genus THEODENISIA Clark, 1948

Theodenisia CLARK, 1948, p. 643; RASETTI, 1954b, p. 607; 1963, p. 1012; in HARRINGTON *et al.,* 1959, p. 0285.

Type species.—*Denisia eminens* Clark, 1924, p. 23, pl. 3, fig. 10.

Remarks.—Rasetti (1954b, p. 607; in Harrington *et al.,* 1959) gives an excellent diagnosis, description, and discussion of this genus and the species included in it.

***Theodenisia brevis* (Rasetti)**

Acheilus brevis RASETTI, 1944, p. 236, pl. 36, figs. 36, 37.

Theodenisia brevis (Rasetti) RASETTI, 1954b, p. 609; WINSTON & NICHOLLS, 1967, p. 77, pl. 11, fig. 19.

Remarks.—This species is characterized by its equidimensional, anteriorly expanded glabella with recurved glabellar furrows. Anterior fixigenae are reduced, and frontal area is obsolete. Nine fragmentary cranidia are assigned to this species.

Occurrence.—Scarce in the *Saukiella serotina* Subzone at LCS-45; SH-54. Scarce in the *Corbinia apopsis* Subzone at LCS-54.

Genus Triarthropsis Ulrich, 1931

Triarthropsis Ulrich in Bridge, 1931, p. 214; Rasetti, 1954b, p. 606; in Harrington *et al.*, 1959, p. 0285.

Type species.—*Triarthropsis nitida* Ulrich in Bridge, 1931, p. 214, pl. 19, figs. 3, 4.

Remarks.—Rasetti's (1954b, p. 606) description of the genus is an adequate diagnosis of *Triarthropsis.*

Triarthropsis cf. *T. limbata* Rasetti

Pl. 6, fig. 20.

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

Remarks.—Five fragmentary cranidia seem to be conspecific with Rasetti's types from the Conococheague Formation in Maryland. The stout, pointed glabella with four sets of shallow furrows, the long frontal area, the divergent anterior facial sutures, and the long posterior limbs set this taxon apart from other species of *Triarthropsis.* Because the anterior border is not clearly visible on any of the Texas specimens, the specific assignment is tentative.

Occurrence.—Scarce in the *Corbinia apopsis* Subzone at CC-67; JR-539, 540.

Triarthropsis nitida Ulrich

Pl. 6, fig. 21.

Triarthropsis nitida Ulrich in Bridge, 1931, p. 241, pl. 9, figs. 3, 4; Rasetti, 1954b, p. 607, text-fig. 2d; 1959, p. 382, pl. 55, figs. 6–13; Winston & Nicholls, 1967, p. 78, pl. 11, figs. 27, 28.

Remarks.—*Triarthropsis nitida* is well described and illustrated. Texas cranidia differ from those illustrated by Rasetti (1959) in that the glabella is not so long and on many specimens the anterior facial sutures diverge in front of the palpebral lobes, resulting in relatively wide anterior fixigenae. *T. nitida* is distinguished from the associated *Triarthropsis* cf. *T. limbata* in having only three glabellar furrows, a rounded instead of a pointed glabella, and relatively shorter, posteriorly curved limbs.

Occurrence.—Scarce in the *Corbinia apopsis* Subzone at CC-67; JR-540; LCS-53, 53.3, 55.5; SH-72.

Triarthropsis princetonensis Kobayashi

Triarthropsis princetonensis Kobayashi, 1935a, p. 56, pl. 8, fig. 1; Winston & Nicholls, 1967, p. 78, pl. 11, fig. 26.
Theodenisia princetonensis (Kobayashi) Rasetti, 1954b, p. 609.

Remarks.—Only four cranidia are assigned to this species. The nearly rectangular glabella, recurved glabellar furrows, broad fixigenae, and short but definite frontal area distinguish this species from other species of *Triarthropsis* or from species of the closely allied genus *Theodenisia.* Although these cranidia have slightly broader posterior fixigenae than does the holotype from Montana, I think they are conspecific.

Occurrence.—Sparse in the *Corbinia apopsis* Subzone at CC-67; LCS-55.5; SH-72.

Family Dikelocephalidae Miller, 1889

Genus Briscoia Walcott, 1924

Briscoia Walcott, 1924a, p. 37; 1925, p. 74; Ulrich & Resser, 1930, p. 59; Kobayashi, 1935a, p. 50; Lochman in Harrington *et al.*, 1959, p. 0254; Palmer, 1968, p. 58.

Type species.—*Briscoia sinclairensis* Walcott, 1924a, p. 37, text-fig. 9.

Remarks.—Not only *Briscoia* but the entire family needs to be reevaluated, preferably with material from measured sections. A major problem encountered in the Dikelocephalidae involves fragmented material from evidently large specimens. Although the specimens from central Texas are not sufficient for a generic diagnosis or revision, one of the problems with *Briscoia* is evident in the Texas collections: the pygidia of *Briscoia* sp. (*Ellipsocephaloides* Zone) have subequally divided pleurae, whereas the pleurae on pygidia of *B. llanoensis* are markedly unequally divided. Both of these pygidial forms are represented in other described species of *Briscoia.*

Briscoia hartti (Walcott)

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

Remarks.—The one specimen figured by Winston and Nicholls and two lesser fragments make up the total sample in the Texas collections. I offer no changes in the systematics or range data of Winston and Nicholls.

Occurrence.—Scarce in the *Saukiella junia* Subzone at SS-372.5; TC-1341-1346.

Briscoia llanoensis Winston & Nicholls

Briscoia llanoensis Winston & Nicholls, 1967, p. 73, pl. 10, figs. 1–3, 5.

Remarks.—The only addition to Winston and Nicholls' description is that the frontal areas on the smaller specimens are proportionally longer than on the larger ones. Additional range data are provided below.

Occurrence.—Abundant in the *Saukiella serotina* Subzone at CC-58.2, 61, 63±; JR-521.5, 529, 532; LCS-40, 44, 45, 45.4, 45.8, 52; SH-58.5-60, 61.5, 61.5-62, 65.5; SS-409; TC-1379-1385, 1388, 1391.5, 1392, 1394, 1395, 1400.

Briscoia sp.

Briscoia sp. BELL & ELLINWOOD, 1962, p. 390, pl. 52, figs. 5, 6.

Remarks.—All that is known about this species is discussed and illustrated in Bell & Ellinwood (1962).

Occurrence.—Locally abundant in the *Ellipsocephaloides* Zone at JR-275, 283, 284, 284.5; MC-864; SS-188.

Family ILLAENURIDAE Vogdes, 1890

Genus ILLAENURUS Hall, 1863

Illaenurus HALL, 1863, p. 176; Lochman in HARRINGTON *et al.*, 1959, p. 0271; GRANT, 1965, p. 124.

Type species.—*Illaenurus quadratus* Hall, 1863, p. 176, pl. 7, figs. 52–57.

Diagnosis.—Cranidium moderately convex, rectangular, may be wider (across eyes) than long, or vice versa. Glabella only partly defined by axial furrow. Occipital and posterior border furrows faint to absent. Eyes behind, on, or in front of cranidial midlength. Anterior border narrow, almost flat, downsloping. Anterior facial sutures slightly convergent to divergent. Pygidium tapered-elliptical, without axial and pleural furrows.

Illaenurus quadratus Hall

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

Remarks.—This species is characterized by its elongate cranidium, eyes that are posterior to the cranidial midline, and anterior facial sutures that are parallel to slightly divergent. One small specimen (SPH-87) is quadrate, its eyes centered on the cranidial midline; it could belong to *Illaenurus truncatus* Feniak, but I believe it is an early juvenile of *I. quadratus* that reflects its ancestry, as Grant (1965) suggests.

Bell & Ellinwood (1962, pl. 55, fig. 2) figured a cranidium that has markedly divergent anterior facial sutures; one other specimen from the same collection is comparable to it, but the rest of the specimens have parallel or slightly divergent facial sutures. I have included these two specimens in *I. quadratus* and not in *I. montanensis* Kobayashi, which has divergent facial sutures, because I am not convinced about the validity of the latter species. Direction of the anterior facial sutures is rather a poor feature for separation of species, especially as it can be affected by compaction or curling of the molt. In collections of more than three or four specimens there is a continuous gradation from strictly parallel to more or less divergent anterior facial sutures, without any relation to size of the specimen. If the divergence of facial sutures among specimens of *I. quadratus* figured by Hall (1863), Nelson (1951), and Bell & Ellinwood (1962) is compared with that of *I. montanensis* figured by Kobayashi (1935a) and Grant (1965), the complete overlap in degree of divergence between the two species is readily apparent. Although I have seen neither Kobayashi's nor Grant's original material, I suggest two possible alternatives: (1) lump them into one species with a variable degree of anterior facial suture divergence, or (2) based on more intensive study of existing and new material, arrive at something more definitive for specific identification than facial-suture divergence.

Occurrence.—Locally common in the *Saukiella pyrene* Subzone at BC-23; JR-347, 369.5, 357, 374.5; SPH-87, 91, 93, 94, 95, 96.5, 100, 114.5.

Family LECANOPYGIDAE Lochman, 1953

Genus RASETTIA Lochman, 1953

Platycolpus RAYMOND, 1913, p. 63; RASETTI, 1944, p. 250.

Rasettia LOCHMAN, 1953, p. 886; Lochman in HARRINGTON *et al.*, 1959, p. 0380.

Type species.—*Bathyurus capax* Billings, 1860, p. 318, fig. 20.

Remarks.—The diagnosis given by Lochman (in Harrington *et al.*, 1959) summarizes the characteristics of this genus.

Rasettia magna Ellinwood

Pl. 3, fig. 1.

Rasettia magna Ellinwood, in BELL & ELLINWOOD, 1962 (part), p. 397, pl. 55, fig. 9 (not fig. 10=*R. capax* (Billings)).

Remarks.—Stitt (in press) has excellent collections of *Rasettia capax* (Billings), *R. magna* Ellinwood, and *R. wichitaensis* (Resser) from Oklahoma, where the three have nonoverlapping ranges. He found that the cranidia and pygidia assigned by Ellinwood to *R. magna* are not associated with one another in Oklahoma; pygidia assigned by Ellinwood (Bell & Ellinwood, 1962, pl. 55, fig. 10) to *R. magna* are associated with cranidia Stitt assigned to *R. capax,* and the Oklahoma cranidia of *R. magna* are associated with different pygidia. The Texas material comes from a spot locality and could have been from one horizon or from an interval. It is not possible to determine whether *R. capax* and *R. magna* have overlapping ranges in Texas. My assignments are based on Stitt's associations.

Three relatively small pygidia are assigned to this species, and they are characterized by the smooth curvature of the anterior edge of the pleural field, an articulating half ring, two axial

rings, and a terminal axial piece with two low nodes. Two faint pleurae are present, and a third is suggested.

Occurrence.—Scarce in the basal *Saukiella pyrene* Subzone at MC-1065-1075; TC-1233, 1258.

Rasettia wichitaensis (Resser)

Pl. 4, fig. 18.

Platycolpus wichitaensis Resser, 1942b, p. 41, pl. 6, figs. 26–29.
Platycolpus oklahomensis Resser, 1942b (part), p. 40, pl. 6, figs. 20, 21 (not figs. 22–25).

Remarks.—Stitt (in press) concludes from his Oklahoma material and from examination of Resser's types that some of the specimens Resser assigned to *Platycolpus oklahomensis* (not the holotype) actually belong in *P. wichitaensis*. Comparison of one poorly preserved pygidium from Texas with Stitt's excellent collections has confirmed the assignment of the pygidium to *Rasettia wichitaensis*.

This pygidium is elliptical and characterized by an articulating half ring, one axial ring, and a terminal axial piece; the moderately convex pleural field is crossed by only one furrow, the shallow anterior pleural furrow.

Occurrence.—Scarce in the *Saukiella serotina* Subzone at SH-52.

Family Olenidae Burmeister, 1843

Genus Leiobienvilla Rasetti, 1954

Leiobienvillia Rasetti, 1954a, p. 583; Henningsmoen, 1957, p. 159; Poulsen in Harrington *et al.*, 1959, p. 0267.

Type species.—*Leiobienvillia laevigata* Rasetti, 1954a, p. 583, pl. 61, figs. 3–6, text-fig. 3.

Remarks.—Henningsmoen (1957) gave an excellent diagnosis and discussion of *Leiobienvillia*, the only olenid represented in the Ptychaspid Biomere in central Texas.

Leiobienvillia leonensis Winston & Nicholls

Leiobienvillia leonensis Winston & Nicholls, 1967, p. 75, pl. 11, figs. 16, 20, 21.

Remarks.—I have included this species in order to give additional range data. This is the only olenid present in the Ptychaspid Biomere, and its occurrence at the very top of the biomere may be significant.

Occurrence.—Scarce in the *Corbinia apopsis* Subzone at CC-67; JR-539, 540, 542, 543; LC-48; LCS-53, 55.5; SH-72; SS-411; TC-1402.

Family Plethopeltidae Raymond, 1925

Genus Leiocoryphe Clark, 1924

Leiocoryphe Clark, 1924, p. 21; Lochman in Harrington *et al.*, 1959, p. 0409.

Type species.—*Leiocoryphe gemma* Clark, 1924, p. 21, pl. 3, fig. 8.

Remarks.—The diagnosis given by Lochman (in Harrington *et al.*, 1959) summarizes the characteristics of this genus.

Leiocoryphe cf. *L. longiceps* Rasetti

Pl. 6, fig. 13.

Leiocoryphe longiceps Rasetti, 1963, p. 1010, pl. 130, figs. 21–26.

Remarks.—Four poorly preserved cranidia are tentatively assigned to this species. The semielliptical outline, sinuous posterior margin, lack of palpebral lobes, and longer and narrower proportions set this species apart from all others of *Leiocoryphe*. However, the fragmentary Texas specimens are flatter and have longer, slightly elevated occipital segments that suggest blunt spines. These specimens may belong to *L. longiceps*, but the material is too poor to be definitely assigned.

Occurrence.—Scarce in the *Saukiella serotina* Subzone at CC-61.

Leiocoryphe occipitalis Rasetti

Leiocoryphe occipitalis Rasetti, 1944, p. 245, pl. 38, fig. 4; Bell & Ellinwood, 1962, p. 403, pl. 59, fig. 4.

Remarks.—Six cranidia are assigned to this species. *Leiocoryphe occipitalis* is characterized by its lack of palpebral lobes, by a complete occipital furrow, and by its small size.

Occurrence.—Scarce in the *Saukiella pyrene* Subzone at MC-915 ±; SS-302.5, 307.5.

Genus Plethometopus Ulrich, 1931

Plethometopus Ulrich in Bridge, 1931, p. 221; Rasetti, 1944, p. 251; Lochman in Harrington *et al.*, 1959, p. 0410.

Type species.—*Bathyurus armatus* Billings, 1860, p. 319, fig. 23.

Remarks.—The diagnosis given by Lochman (in Harrington *et al.*, 1959) summarizes the characteristics of this genus.

Plethometopus armatus (Billings)

Bathyurus armatus Billings, 1860, p. 319, fig. 23; 1863, p. 238, fig. 273; 1865, p. 411, fig. 392.
Plethopeltis armata (Billings) Raymond, 1913, p. 65, pl. 7, fig. 18; 1924, p. 416.
Plethometopus armatus (Billings) Ulrich in Bridge, 1931, p. 221; Rasetti, 1944, p. 251, pl. 39, fig. 25; 1959, p. 383, pl. 53, figs. 1–8, and pl. 52, fig. 14.
Plethometopus convexus (Whitfield) Bell & Ellinwood, 1962 (part), p. 403, pl. 59, fig. 6 (not fig. 5=*Plethometopus* sp.).

Remarks.—The specimen with an occipital spine (Bell & Ellinwood, 1962, pl. 59, fig. 6) that Bell assigned to *Plethometopus convexus* is misnumbered in the explanation of the plate. It

is from the spot locality 86T-5-13A and not from the *Saukiella pyrene* Subzone at MC-1065. The associated fauna in the dolomitic San Saba at the spot locality is totally unfamiliar, and, therefore, I cannot relate this specimen to any subzone of the *Saukia* Zone.

This specimen is assigned to *Plethometopus armatus,* the type species, because of its slender occipital spine and its faint axial and preglabellar furrows (see Ulrich in Bridge, 1931, p. 221).

Because of lack of biostratigraphic control, Bell assigned this specimen to *P. convexus,* the first described Midcontinent species. However, I think this name should be avoided. Ulrich (in Bridge, 1931, p. 221) reports that Whitfield had 10 specimens upon which he based *Illaenurus convexus.* Although nine of those cranidia belong to *Stenopilus,* the figured holotype is *Plethometopus.* The occipital ring on the holotype is missing, but it was restored in the original illustration by using the associated *Stenopilus* material. Although Ulrich restored a blunt occipital spine in two of his figures (pl. 19, figs. 30, 31), he also stated that none of his specimens preserve this feature. Because we don't know what *Plethometopus convexus* looks like, I suggest that it be considered an indeterminate species and that the name be restricted to the holotype until more data from Wisconsin become available.

Occurrence.—Common at spot locality 86T-5-13A.

Plethometopus convergens (Raymond)

Pl. 3, figs. 11, 12.

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

Plethometopus convergens (Raymond) Ulrich in Bridge, 1931, p. 221; Rasetti, 1944, p. 251, pl. 39, fig. 27; 1959, p. 384, pl. 53, figs. 15–19.

Remarks.—This species is characterized by convergent anterior facial sutures, palpebral lobes that are on or behind the cranidial midlength, triangular posterior limbs, very shallow furrows, and a broadly triangular occipital segment with a suggestion of a terminal node. The larger the specimen, the more it looks like Rasetti's illustrations of specimens of comparable size. The pygidia agree quite well with Rasetti's illustration except that the axial node is absent.

Plethometopus convergens occurs stratigraphically below *P. obtusus* and is distinguished from it by the rearward position of the palpebral lobes, by convergence of the facial sutures, and by shallower furrows.

Occurrence.—Scarce in the *Saukiella pyrene* Subzone at BC-36, 41; SS-302.5. Scarce in the *Saukiella junia* Subzone at BC-70. Scarce to common in the *Saukiella serotina* Subzone at CC-61; JR-529, 532; LCS-32.4, 35.7, 39, 40, 45; SH-52.6, 54.

Plethometopus obtusus Rasetti

Pl. 6, figs. 14, 15.

Plethometopus obtusus Rasetti, 1945b, p. 472, pl. 62, figs. 1, 2; 1959, p. 383, pl. 53, figs. 11–14.

Plethometopus modestus Ulrich, Winston & Nicholls, 1967, p. 87, pl. 10, fig. 11.

Remarks.—*Plethometopus obtusus* is distinguished from the stratigraphically lower *P. convergens* by the central or forward position of the palpebral lobes, by divergent anterior facial sutures, and by deeper furrows. *P. obtusus* is distinguished from *P. modestus* by divergent anterior facial sutures, by more anteriorly located palpebral lobes, and by broader triangular posterior limbs. A bluntly pointed occipital ring and lack of distinct axial and preglabellar furrows distinguishes *P. obtusus* from *P. armatus.*

Winston & Nicholls (1967) assigned all specimens of *Plethometopus* to *P. modestus.* I recognize two stratigraphically separated species of *Plethometopus* in the *Saukia* Zone, neither of which is *P. modestus.* Winston and Nicholls' figured specimen (pl. 10, fig. 11) belongs to the higher species, *P. obtusus.*

Occurrence.—Very scarce at the top of the *Saukiella serotina* Subzone at TC-1400. Scarce to locally common in the *Corbinia apopsis* Subzone at JR-539, 540; LC-48; LCS-53.3, 55.5; SS-411.

Genus Plethopeltis Raymond, 1913

Pl. 4, figs. 1–6.

Plethopeltis Raymond, 1913, p. 64; 1924, p. 412; Field, 1915, p. 37; Ulrich in Bridge, 1931, p. 219.

Type species.—*Agraulos saratogensis* Walcott, 1890, p. 276, pl. 21, fig. 14.

Diagnosis.—Cranidium moderately convex. Glabella subrectangular to slightly tapering, completely outlined by axial and preglabellar furrows; glabellar furrows may or may not be present. Frontal area not divided. Occipital ring may extend back into blunt spine. Palpebral lobes small, slightly elevated. Librigenae transversely convex, unfurrowed, with blunt genal spines. Pygidium wider than long; axis bluntly rounded; pleurae either strongly ribbed or with furrows of variable strength; no border furrow.

Remarks.—*Plethopeltis* is distinguished from all other genera of the Plethopeltidae by its distinct and complete axial and preglabellar furrows and by its lack of an anterior border furrow.

The taxonomic and nomenclatorial history of the material from Hoyt's Quarry, 4 miles west of Saratoga Springs, New York, needs to be compiled. Walcott (1886) began the sequence with a

faunal list that included *Ptychoparia* (*Agraulos*) *saratogensis*, a nomen nudum. Four years later he described *Agraulos saratogensis* Walcott (1890, p. 276, pl. 21, fig. 14) and allied this species to *Bathyurus armatus* Billings (1860, p. 319, fig. 23). Only the holotype is mentioned by number (U.S.N.M. 23863); the drawing on plate 21, figure 14, is presumably of the holotype.

In 1912, Walcott again published on *Agraulos saratogensis*, describing a granular ornament and illustrating five specimens with poorly retouched photographs (pl. 43, figs. 11–15). Figures 11 and 11a (U.S.N.M. 58558) illustrate an internal mold of a cranidium (pl. 4, fig. 1); the glabellar furrows were added in retouching. Written on the back of this specimen is "Type of *Agraulos saratogensis*." The holotype number, 23863, does not appear on this or any other specimen in the type collection or support material. Resser (1942a, p. 41) stated that the two numbers referred to the same specimen. In the U.S. National Museum catalogue beside the number 58558 is a notation, in what appears to be Resser's handwriting, that the original type number was 23863 (Jesse Merida, U.S.N.M., letter of January 11, 1968). Thus, 58558 does equal 23863. Comparison of the specimen 58558 with Walcott's drawing of 23863 also indicates that 58558 is indeed the holotype.

Figure 12 (Walcott, 1912) illustrates a free cheek (U.S.N.M. 58559). It is an internal mold, and Bertillon ornament is vaguely apparent along the outer margin.

Figures 13 and 13a (U.S.N.M. 58560) are of a partly exfoliated pygidium (pl. 4, fig. 4). Small granules crest the axial rings and pleural ribs, and low anastomosing lines cover the margin of the pleural field.

An unexfoliated cranidium (U.S.N.M. 58561) is illustrated in Walcott's figures 14 and 14a (pl. 4, fig. 3). A fine granular ornament covers this cranidium, and delicate Bertillon ornament crosses the frontal area, the fixigenae, and the occipital ring. The recurved glabellar furrows are distinct but not so deep as Walcott's photograph indicates. This is the specimen that became holotype of *Plethopeltis granulosa* Resser (1942a, p. 41).

A hypostoma is illustrated in figures 15, 15a. This specimen was not found in the type collection or in the support material.

Two distinct groups are among the 50 specimens in Walcott's support collection. The first is characterized by a smooth internal mold and an exoskeleton that is smooth except for small granules that can occur on the occipital ring, posterior parts of the glabella and fixigenae, and on the posterior border; the transverse or anteriorly bowed occipital furrow is impressed only across the axial region; the axial furrow is faint on the exoskeleton, moderately well impressed on internal molds; and the glabellar furrows are faint to absent. When he restudied Walcott's collection, Resser (1942a) restricted *P. saratogensis* to this first group and established *P. granulosa* for the second. *P. granulosa* is characterized by granules and Bertillon ornament on the exoskeleton, internal molds that can preserve part or all of this ornament, glabellar furrows that are faint to well impressed (as on the holotype, U.S.N.M. 58561) on both exoskeleton and mold, an axial furrow that is always distinct, and a transverse or anteriorly bowed occipital furrow that extends almost to the axial furrow and has its lateral ends directed forward.

Raymond established the genus *Plethopeltis* in 1913, made *Agraulos saratogensis* Walcott the type species, and included *Bathyurus armatus* Billings (1860) in his new genus.

Field (1915) studied material collected by Raymond from Hoyt's Quarry and compared it with that illustrated by Walcott. He concluded that *Plethopeltis* was a valid genus quite distinct from *Agraulos*. He also declared that the two forms of *P. saratogensis* (one with a faint glabellar furrow and no ornament and the other with deeper furrows and granular ornament) came from the same collecting horizons and belong in the same species.

In 1924, Raymond reevaluated the type species, using the published literature and his own collections from Hoyt's Quarry. Presumably, from his statements, he did not see any of Walcott's specimens. Raymond noted that Walcott had figured three forms under the name *P. saratogensis:* one with no glabellar furrows (1890, pl. 21, fig. 14), one with faint glabellar and deep dorsal furrows (1912, pl. 43, figs. 11, 11a), and one with deep glabellar and dorsal furrows (1912, pl. 43, figs. 14, 14a). Raymond stated that, of the 37 cranidia he collected, 22 were of the unfurrowed form, 15 had the faint glabellar and deeper dorsal furrows, and none had the deep glabellar furrows. Because the species originally described by Walcott had faint glabellar furrows, Raymond restricted *P. saratogensis* to the form with faint glabellar furrows and established *P. walcotti* for the form with no glabellar furrows (pl. 4, fig. 2).

In Raymond's collections, the trays labeled *P. walcotti* contain 46 cranidia that are well enough preserved to show presence or absence of glabellar furrows; 10 of these (only one unexfoliated) have smooth glabellas, 33 have

faint glabellar furrows, and 3 granular cranidia have faint glabellar furrows. Of the unornamented specimens in the trays labeled *P. saratogensis* (Walcott), 1 cranidium has a smooth glabella, 10 have faint furrows, 1 has deep, recurved glabellar furrows; 5 granular cranidia have faint furrows, and 1 granular cranidium has deep and recurved glabellar furrows. Comparison of holotypes shows the only difference to be that *P. saratogensis* has very vague depressions where glabellar furrows would be, whereas *P. walcotti* is smooth.

After looking at all of Walcott's and Raymond's material, I agree with Resser that there are two distinct species in Hoyt's quarry material, *P. saratogensis* and *P. granulosa,* and I consider *P. walcotti* to be a synonym of *P. saratogensis. P. saratogensis* is characterized by a smooth to faintly furrowed glabella, distinct axial and preglabellar furrows, an incomplete occipital furrow, limited granulation, and an elliptical pygidium with pleural furrows ranging from faint to well impressed. Raymond's drawing of the holotype of *P. walcotti* shows a faint anterior border furrow that is not on the specimen. The holotype cranida and associated pygidia assigned to these three nominal species are illustrated in unretouched photographs (pl. 4, figs. 1–6).

Ulrich (in Bridge, 1931, p. 219) proposed that *Plethopeltis* be restricted to forms closely allied to *P. saratogensis.* He established the genus *Plethometopus* with *Bathyurus armatus* Billings as the type species and included in the new genus the following five of Raymond's species of *Plethopeltis: P. arenicola, P. laevis, P. angusta, P. lata,* and *P. convergens.* Removal of these five species and *Bathyurus armatus* restricts *Plethopeltis* to only those forms with a distinct circumglabellar furrow.

Species definitely assigned to *Plethopeltis* include *P. saratogensis* (Walcott), 1890; *P. buehleri* Ulrich, 1931; *P. platymarginatus* Ulrich, 1931; and *P. granulosa* Resser, 1942a. *P. walcotti* Raymond, 1924, is here synonymized with *P. saratogensis.* Raymond (1924) assigned specimens identified as *Agraulos saratogensis* Walcott by Weller (1903) to a new species, *Plethopeltis welleri.* Walcott (1912) thought that Weller's assignment was correct. Although I have not seen this material, I agree with Walcott. Another species that Raymond assigned to *Plethopeltis, Agraulos hemisphericus* Berkey (1898), was placed in synonymy with *Camaraspis convexa* (Whitfield) by Frederickson (1948, p. 798), and this assignment has not been disputed (Wilson, 1951, p. 630; Nelson, 1951, p. 774; Lochman & Hu, 1960, p. 813).

Plethopeltis sp.

Pl. 4, figs. 7, 8.

Remarks.—Four specimens from one locality belong to *Plethopeltis;* the specific assignment is uncertain because of poor preservation and a dearth of specimens.

The specimens are closely allied to *P. saratogensis* (Walcott) on the basis of low convexity, shallow axial and almost nonexistent glabellar furrows, a gently tapered glabella, and a recurved occipital furrow. On the other hand, the completeness of the occipital furrow and well-defined occipital segment and the sharply recurved, almost crimped appearance of the posterior border furrow and border indicate a close affinity to *P. buehleri* Ulrich. One of the specimens has the granular ornament and deeper, recurved glabellar furrows of *P. granulosa* Resser. The specimens are from the dolomitic facies of the San Saba Member of the Wilberns Formation; none have been recovered from the calcitic facies.

Occurrence.—Scarce in the *Saukiella pyrene* Subzone at MC-1065.

Genus Stenopilus Clark, 1924

Stenopilus Clark (June), 1924, p. 22; Raymond (July), 1924, p. 418; Rasetti, 1959, p. 385; Lochman in Harrington *et al.,* 1959, p. 0412.

Type species.—Stenopilus intermedius Clark, 1924, p. 22, pl. 3, fig. 9.

Remarks.—Although the diagnosis given by Lochman (in Harrington *et al.,* 1959) is sufficient, the illustrations of the cranidia (fig. 313, 6a, 6b) can be misleading. Rasetti (1945a, 1959), Ulrich (in Bridge, 1931), and Bell & Ellinwood (1962) adequately illustrated the common form of the genus.

Stenopilus latus Ulrich

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

Leicoryphe halei Winston & Nicholls, 1967, p. 87, pl. 10, figs. 10, 13.

Remarks.—Stenopilus latus is common in the Texas collections, and specimens larger than 4 or 5 mm correspond well with Ulrich's figures and descriptions. At this length the palpebral lobes are long and narrow, and the notches or pits along the posterior margin become less distinct. *Leiocoryphe halei* Winston & Nicholls ranges in size from minute up to about 4 mm. In the larger specimens there is a trace of long, slender palpebral lobes and a hint of the notches in the posterior margin. The ranges of the two are nearly coincident.

Stitt (in press), basing his conclusion on extensive collections from Oklahoma, thinks that

Leiocoryphe halei represents juvenile *Stenopilus latus,* and the smaller collections from Texas corroborate his conclusions. *Leiocoryphe halei* is synonymized with *Stenopilus latus.*

Occurrence.—Locally common in the *Saukiella junia* Subzone at BC-109-110; JR-460, 481; SH-12.6; SS-356, 360.5, 370; TC-1320-1325, 1330-1335, 1341-1346. Locally common in the *Saukiella serotina* Subzone at CC-58.2, 61; JR-521.5, 529; LCS-33, 33.5, 34-36, 40, 44, 45, 45.4, 52; TC-1379-1385, 1392, 1400.

Stenopilus pronus Raymond

Stenopilus pronus Raymond, 1924, p. 420, pl. 13, figs. 6, 7; Rasetti, 1944, p. 257, pl. 39, fig. 19; 1959, p. 385, pl. 53, figs. 20–24; Bell & Ellinwood, 1962, p. 403, pl. 59, figs. 7–9.
Stenopilus elongatus Rasetti, 1944, p. 257, pl. 39, figs. 20, 21; 1945a, p. 122, pl. 1, figs. 10–16.

Remarks.—Two small collections are assigned to this species and both are from the very base of the *Saukia* Zone. The specimens are markedly elongate (length-width ratio greater than 1.25) and thus are easily separated from the stratigraphically higher and more equidimensional *Stenopilus latus. S. elongatus* Rasetti looks like a small *S. pronus,* and examination of the types of *S. elongatus* revealed no significant difference other than size. Thus, I have placed *S. elongatus* in synonymy with *S. pronus.*

Occurrence.—Scarce in the base of the *Saukiella pyrene* Subzone at MC-1075; 41-3.1, 35 feet above the stromatolite bioherm at Camp San Saba bridge, McCulloch County.

Family Parabolinoididae Lochman, 1956

Diagnosis.—Subisopygous ptychoparioid trilobites. Glabella normally tapering, rounded to truncate anteriorly, with two or three pairs of usually distinct glabellar furrows; eye ridges strong to obsolete, eyes normally large and located near glabellar midlength, rarely small and more anteriorly located; frontal area one-third to two-thirds cranidial length, usually with distinct anterior border furrow; width (tr.) of posterior areas approximates basal glabellar width, length (exsag.) variable. Pygidium transversely elliptical, with well defined axis, two to four axial rings, terminal piece, no postaxial ridge; pleural furrows distinct; border furrow poorly defined or obsolete; margin smooth or spined. External surfaces commonly ornamented with granules or vermiform ridges, or both.

Remarks.—Assembled in this family are genera assigned to the families Parabolinoididae and Idahoiidae in the *Treatise* (Harrington *et al.,* 1959). I have grouped these genera into one family because of their morphologic similarities and because I think they are probably genetically related. Palmer (1965b, p. 32–33) discussed the differences between the strictly morphological families of the *Treatise* and the more interpretive, evolution-oriented families he recognized in the Pterocephaliid Biomere. The families Palmer recognized represent complexes of genera that morphologically, spatially, and temporally have a high probability of being genetically related. I have tried to follow the concept he outlined in erecting families in the Ptychaspid Biomere.

Three lineages are evident in the Parabolinoididae (text-fig. 1): *Parabolinoides* to *Orygmaspis, Parabolinoides* to *Taenicephalus* to *Idahoia* and *Saratogia,* and *Parabolinoides* to *Wilbernia. Orygmaspis* differs from *Parabolinoides* in having larger, more posteriorly located palpebral areas and in having a generally less convex, smoother cranidium; *Orygmaspis llanoensis* var. A is the tie between *Parabolinoides contractus* and *O. llanoensis* (s.s.). The earliest species of *Wilbernia, W. halli* and *W. halli* var. A, differ from *Parabolinoides contractus* in having larger, more posterior palpebral areas that are closer to the glabella and in having modifications on the frontal area; later species of *Wilbernia* continue the modifications of the frontal area, and the glabella becomes proportionally larger and more rectangular. A few specimens of *Parabolinoides granulosus* have larger than normal palpebral areas, a vermiform ridge ornament instead of granules, and deeper furrows—features suggesting that *P. granulosus* is ancestral to *Taenicephalus gouldi.* Continuation of the trend toward a shorter, more blunt glabella and a deeper axial furrow, combined with modifications of the frontal area, relates *T. gouldi* to *T. shumardi.* Although there are some specimens high in the range of *T. shumardi* that indicate affinities with *Kendallina* and *Maustonia,* none of these specimens could be assigned to either genus. *Idahoia* and *Saratogia* are related to *Taenicephalus* through *T.* sp., which shares characters of all three genera.

Genus Idahoia Walcott, 1924

Idahoia Walcott, 1924b, p. 58; Lochman in Harrington *et al.,* 1959, p. 0252; Lochman & Hu, 1959, p. 420; Bell & Ellinwood, 1962, p. 391; Grant, 1962, p. 986; 1965, p. 117.
Meeria Frederickson, 1949, p. 358; Lochman in Harrington *et al.,* 1959, p. 0252; Lochman & Hu (as a subgenus of *Idahoia*), 1959, p. 419.

Type species.—*Idahoia serapio* Walcott, 1924b, p. 58, pl. 14, fig. 1.

Diagnosis.—Frontal area downsloping, generally longer than one-half the glabella (plus occipital ring). Glabellar furrows faint to absent.

Occipital furrow shallow, medially obscured. Anterior facial sutures widely divergent. Exoskeleton and internal molds ornamented.

Remarks.—Grant (1965, p. 121) suggested eight criteria that can be used to differentiate between *Idahoia* and *Saratogia*. The 320 Texas specimens assigned to species of *Idahoia* conform rather well with the criteria. The only significant discrepancy is that 64 specimens have relatively shorter frontal areas; of these, 25 are assigned to *Idahoia lirae* var. A, and many of the remaining are small (less than 3 mm) *I. lirae* (s.s.). The evaluation of the Texas idahoiids according to Grant's criteria is summarized in table 1.

Grant (1962, p. 986; 1965, p. 121) emphasized that the critical feature for separating *Idahoia* from *Saratogia* is the length of the frontal area (sag.) relative to the length of the rest of the cranidium. The species of *Idahoia* recognized by Grant have frontal areas that are markedly longer than one-half the length of the glabella (plus occipital ring); his species of *Saratogia* have frontal areas with lengths ranging from less than one-fifth to just less than one-half the length of the glabella (plus occipital ring).

TABLE 1—Summary of measurements and observations of all specimens assigned to species of *Idahoia* and *Saratogia*, according to Grant's (1965) eight criteria. For each criterion, the first alternative is characteristic of *Idahoia*, the second of *Saratogia*.

Grant's criteria \ Species		*Idahoia lirae*	*Idahoia lirae* var. A	*Idahoia wisconsensis*	*Saratogia americana*	*Saratogia modesta*	*Saratogia fria*
Total number of specimens		183	92	30	100	70	130
Total number measured		122	74	8	52	62	126
Frontal area length relative to glabellar length	$>\frac{1}{2}$	83	49	8			4
	$<\frac{1}{2}$	39	25		62	62	88
Glabellar furrows	Faint to absent	116	74	26	13	60	91
	Normally visible	6			48	3	18
Occipital furrow depth	Shallow, not visible across axis	106	70	23	4	11	49
	Well impressed, visible across axis	23	4	1	57	47	46
Anterior fixigenae	Wide	110	72	26	5		73
	Narrow	7	2		56	58	44
Anterior facial sutures	Widely divergent	100	70	26	5		78
	Narrowly divergent	17	4		56	58	39
External and internal surface ornament	Smooth external	2	10			21	
	Ornamented external	30	5	13	22	4	43
	Smooth internal	5	35	1	3	41	
	Ornamented internal	85	21	14	42	10	80
Frontal area topography	Preglabellar field downsloping, border normally downsloping	122	74	18		4	
	Preglabellar field downsloping, border upturned			8	62	58	126
Palpebral lobes	Long, narrow	100	50	5	3		5
	Large, flat, semicircular	5	8		55	53	100

Thus he was not confronted with the problem of an idahoiid with a frontal area usually slightly longer than one-half the glabella.

Such an idahoiid occurs at the base of the *Idahoia* Zone in Texas and Oklahoma. Frederickson established the monotypic genus *Meeria* for this taxon. I do not believe *Meeria* to be significantly different from *Idahoia,* and thus I follow Bell & Ellinwood (1962) in synonymizing *Meeria* with *Idahoia.*

Idahoia lirae (Frederickson)

Meeria lirae FREDERICKSON, 1949, p. 358, pl. 72, figs. 3–6; GRANT, 1965, p. 121 (in discussion of *Saratogia*).

Idahoia lirae (Frederickson) BELL & ELLINWOOD, 1962, p. 392, pl. 53, figs. 1–12.

Description.—*Idahoia lirae* is characterized by a downsloping frontal area that generally is slightly longer (sag.) than one-half the glabella (plus occipital ring), by faint to absent glabellar furrows, by an occipital furrow that is shallow laterally and partially to completely obscured across the axis, by widely divergent anterior facial sutures, and by surface ornament. In small specimens (less than 3–4 mm), length of the frontal area can be less than one-half the length of the glabella (plus occipital ring). The occipital ring can be spinose, nodose, or smooth. The stouter the occipital spine, the shallower is the medial segment of the occipital furrow and the longer (sag.) is the occipital ring; thus a stout spine can influence the axial length of the cranidium. Glabellar, occipital, and palpebral furrows are more distinct on the internal mold than on the exoskeleton; this appears to be true for all idahoiids in central Texas. The anterior border furrow ranges from narrow and distinct in smaller specimens to broad and shallow in larger ones. The specimens on which this furrow is indistinct to absent are grouped under *I. lirae* var. A. The convex preglabellar field slopes gently downward. The slightly convex anterior border is horizontal to downsloping.

Exoskeleton ornament consists of elongate ridges on at least the base of the occipital spine, and these ridges splay out onto the occipital ring; ridges and granules can cover the posterior limbs, the occipital ring, and the posterior one-half of the glabella. Internal molds have longitudinal caecal venations on the preglabellar field, and they can have low ridges and granules on the occipital ring and posterior part of the glabella.

Remarks.—Based on material from the Arbuckle and Wichita Mountains in Oklahoma, Frederickson (1949) erected the genus *Meeria* and included in it only one species, *M. lirae* Frederickson. From Frederickson's description, *M. lirae* has the faint glabellar furrows, medially obscured occipital furrow, biconvex and downsloping frontal area, smooth outer surface, and moderately wide anterior fixigenae that are characteristic of Grant's concept of *Idahoia.* Frederickson recorded his specimens as having smooth or nodose occipital rings; none have spines. No data were given on relative length of the frontal area.

Lochman & Hu (1959) recognized *Meeria* as a subgenus of *Idahoia* and described a new species, *Idahoia (Meeria) modesta.*

Bell & Ellinwood (1962) assigned *Idahoia (Meeria) modesta* Lochman & Hu to *Saratogia,* and they synonymized *Meeria* with *Idahoia.* They said (p. 392) that generally the frontal areas of *I. lirae* are longer than one-half the glabella (plus occipital ring), whereas the frontal areas of *S. modesta* are less than one-half.

In collections from the Arbuckle Mountains in Oklahoma, Stitt (in press) has material conspecific with Frederickson's *Meeria lirae.* Most of these specimens have occipital rings that are broken off at the axial line, and thus their axial lengths cannot be accurately measured. The broken specimens have medially obscured occipital furrows. When a spine is broken off the occipital ring, part of the spine can remain, or, if the spine is robust, part of the occipital ring is broken off. On specimens with well developed occipital spines, the medial part of the occipital furrow will be shallower; the stouter the spine, the more obscure the furrow. With these two observations in mind, it is reasonable to conclude that some of Frederickson's and Stitt's specimens did at one time have occipital spines.

The Texas cranidia from the basal part of the *Idahoia* Zone are conspecific with Frederickson's and Stitt's taxon, and I think Bell & Ellinwood (1962) were correct in synonymizing *Meeria* with *Idahoia.* Placement of *M. lirae* in *Idahoia* does not contradict Grant's concept of *Idahoia*—rather, it emphasizes the close relationship between *Idahoia* and *Saratogia* and reiterates the point that the more we know about closely related taxa (species and genera), the less distinct are the lines of separation.

I. lirae is distinguished from the stratigraphically higher *I. wisconsensis* (Owen) by its relatively shorter frontal area, generally smaller size, and absence of granules in the anterior border furrow of the internal molds. *I. lirae* has a preglabellar field-anterior border ratio of about 2:1, whereas the type species, *I. serapio* Walcott, has a 1:1 ratio and a row of pustules in the anterior border furrow.

I. lirae occurs through a maximum interval of 6 feet at the base of the *Idahoia* Zone in almost

every measured section in central Texas. Together with *Saratogia americana* and *Wilbernia diademata,* it signals the base of the *Idahoia* Zone.

Occurrence.—Abundant in the *Idahoia lirae* Subzone at the base of the *Idahoia* Zone at CO-162; CR-743-747; E-894; EC-20.5, 21.5; GM-590, 591, 594; GR-165, 167, 168, 169, 171; JR-172, 173, 175.5, 177; LL-714, 719; MC-706, 707; PK-922; SK-232, 233; SS-92.5, 94.5; ST-528; TA-56; TC-983, 986, 987; TR-342, 344.5; WC-925.

Idahoia lirae (Frederickson), var. A, Bell

Meeria lirae FREDERICKSON, 1949, pl. 72, fig. 5.
Idahoia lirae (Frederickson), var. A, Bell in BELL & ELLINWOOD, 1962, p. 393, pl. 53, figs. 10–12.

Remarks.—This morphologic variant occurs through the range of *Idahoia lirae* (s.s.) and is distinguished from it by the obscurely furrowed or undifferentiated frontal area and by the relatively longer preglabellar field. Variation is continuous between *I. lirae* (s.s.) and this variety. Two-thirds of the measurable specimens had frontal areas longer than one-half the length of the glabella (plus occipital ring); one-third had frontal areas slightly less than one-half the length of the glabella (plus occipital ring). This variant can have the same ornament distribution and pattern as *I. lirae* (s.s.).

Occurrence.—Common in the *Idahoia lirae* Subzone at CR-743-747; E-894; GM-590, 591, 594; GR-165, 167, 168, 169, 171; JR-173; MC-706; SK-232, 233; SS-92.5; TC-983, 986, 987.

Idahoia wisconsensis (Owen)

Crepicephalus? wisconsensis OWEN, 1852, table 1, fig. 13.
Idahoia wisconsensis (Owen) BELL, FENIAK, & KURTZ, 1952 (part), p. 189, pl. 37, figs. 3b, c, e, f (figs. 3a, d = *I. serapio* Walcott) (synonymy to date); BELL & ELLINWOOD, 1962, p. 393, pl. 52, figs. 19–21 (synonymy to date); GRANT, 1962, p. 986, pl. 139, fig. 5a; 1965, p. 119, pl. 14, fig. 13.

Remarks.—*Idahoia wisconsensis* is characterized by a preglabellar field-anterior border ratio ranging from about 3:1 to about 3:2; on 7 of the 16 measurable specimens this ratio is 2:1. On the 8 specimens with the entire axial length preserved, the length of the frontal area was 0.6 that of the glabella (plus occipital ring).

Exoskeleton ornament consists of two intersecting sets of ridges on the preglabellar field, a transverse set of ridges on the anterior border, a row of granules in the anterior border furrow, and granules on the posterior edge of the occipital ring and back onto the occipital spine. Internal molds preserve only the ornament of the frontal area.

I. wisconsensis can range down as far as the transition zone between *Drumaspis texana* and *D. idahoensis;* it can range up as far as the first occurrence of *Ellipsocephaloides silvestris.*

Occurrence.—Locally common in the upper one-third of the *Idahoia* Zone at JR-204, 205.5, 210; SK-260, 264, 265, 266; TC-1022, 1029.

Genus ORYGMASPIS Resser, 1937

Orygmaspis RESSER, 1937, p. 21; FREDERICKSON, 1949, p. 359; Lochman in HARRINGTON *et al.,* 1959, p. 0272; GRANT, 1965, p. 132.

Type species.—*Ptychoparia llanoensis* Walcott, 1890, p. 272, pl. 21, figs. 3–5.

Diagnosis.—Palpebral lobes at least 0.3 of glabellar length; posterior edge of palpebral lobes behind glabellar midlength. Fixigenae broad; posterior area triangular, long (tr.). Frontal area usually longer than one-half glabellar length.

Remarks.—*Orygmaspis* is distinguished from *Parabolinoides, Maustonia, Kendallina,* and *Taenicephalus* by its relatively large, posteriorly located palpebral lobes, broad fixigenae, shorter (exsag.) posterior limbs, ornament, and relatively longer frontal area.

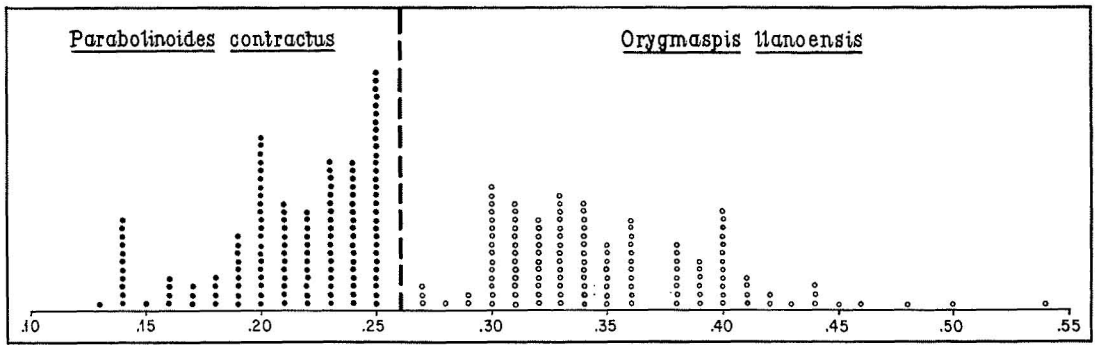
Only one species, *Orygmaspis llanoensis* (Walcott), is included in the genus. *O. firma* Frederickson, 1949, is synonymized with the type species, and *O. eryon* (Hall) Resser, 1937, was designated the type species of *Kendallina* (=*Kendallia*) by Raasch (1939).

Orygmaspis llanoensis (Walcott)

Pl. 1, figs. 7–16.

Ptychoparia llanoensis WALCOTT, 1890, p. 272, pl. 21, figs. 3–5; 1899, p. 458, pl. 64, fig. 4.
Conaspis llanoensis (Walcott) WALCOTT, 1914, p. 358 (footnote).
Orygmaspis llanoensis (Walcott) RESSER, 1937, p. 22; FREDERICKSON, 1949, p. 359, pl. 71, figs. 19–22; BELL & ELLINWOOD, 1962, p. 398, pl. 55, figs. 11–15; GRANT, 1965, p. 133, pl. 12, figs. 4, 7.
Orygmaspis firma FREDERICKSON, 1949, p. 359, pl. 71, figs. 15–18; BELL & ELLINWOOD, 1962, p. 398, pl. 55, fig. 16; pl. 56, fig. 1; GRANT, 1965, p. 132, pl. 12, figs. 3, 5, 6.

Description.—Cranidium usually longer than wide, flatly to moderately convex. Glabella tapered, the front broadly rounded or truncate; two or three pair of glabellar furrows that are more deeply impressed in the lower 3 feet of the range of the species; glabella usually keeled. Axial furrow distinct; preglabellar furrow can be shallower. Occipital furrow broad and shallow; occipital ring broad, tapers laterally, bears a median node. Frontal area highly variable; in the lower 3 feet of the range it is subequally divided into a flatly to moderately convex preglabellar field that is horizontal or downsloping and



TEXT-FIG. 7—Ratio of palpebral lobe length to glabellar length for *Parabolinoides contractus* (144 specimens) and *Orygmaspis llanoensis* (132 specimens). *P. contractus* has a ratio of less than 1:4, with the posterior edge of the palpebral lobes opposite the anterior one-half of the glabella. *O. llanoensis* has a ratio of greater than 1:4, with the posterior edge of the palpebral lobes opposite the posterior one-half of the glabella.

a flatly convex anterior border that is horizontal or downsloping; anterior border furrow distinct and transverse on most specimens from lower part of range. About 3 feet above the base of the range almost all frontal areas are smooth and lack an anterior border furrow; a few specimens with a smooth frontal area and all gradations toward the divided frontal area do occur together in the basal 3 feet of the range. Fixigenae broad, crossed by faint ocular ridges. Palpebral lobes relatively large, usually at least 0.3 the length of the glabella (text-fig. 7); posterior edges of the palpebral lobes opposite or behind glabellar midlength (text-fig. 7); these posterior edges of the palpebral lobes are usually opposite the lateral ends of the posterior pair of glabellar furrows, with the palpebral lobes straddling the interval between the posterior and middle pairs of glabellar furrows. Palpebral furrow usually absent. Posterior areas triangular, long (tr.); posterior border furrow very broad and shallow. Anterior facial sutures markedly divergent in front of the palpebral lobes; however, they can be only slightly divergent on specimens from the lower 3 feet of the range. Although the external surface is usually smooth, very low and longitudinally oriented ridges can be seen on the preglabellar field; a few specimens have a low, transverse ridge crossing the otherwise undifferentiated frontal area. Internal molds have longitudinally oriented, irregular ridges on the preglabellar field, a row of granules in the anterior border furrow, or a smooth but usually granulate ridge where this furrow should be; a few specimens have coarse granules scattered over the glabella, fixigenae, and frontal area, as indicated in Walcott's original figure (1890, pl. 21, fig. 3) and mentioned in Resser's generic diagnosis (1937, p. 21).

Pygidium transversely elliptical; axis raised, consists of an articulating half ring, three axial rings, and a terminal piece that can have two very low nodes or a low ridge across it. Furrows across pleural field shallow but distinct. Three or four pairs of marginal spines that can be slender, or short and stout, or mere stubs along the margin.

Remarks.—Orygmaspis llanoensis occurs throughout the lower half of the *Taenicephalus* Zone. Although it is entirely absent from the basal foot of the *Parabolinoides* Subzone, it is common to very abundant in the 6 feet above that point. There is a vast degree of morphologic variation throughout the lowest 3 feet of the range; above that the specimens conform well with *O. llanoensis* of all previous workers.

Both *O. llanoensis* and *O. firma* have been recognized in central Texas (Bell & Ellinwood, 1962). The two were distinguished on the basis of presence or absence of an anterior border furrow. Although there are specimens that can easily be assigned to *O. firma,* there are numerous specimens that close the gap between it and *O. llanoensis.* All the specimens that could be assigned to *O. firma* and the intermediates between it and *O. llanoensis* occur in the basal 3 feet of the range. I prefer to think of this group in terms of one variable species that, on extension through time, was morphologically restricted to the taxon called *O. llanoensis.* I have synonymized *O. firma* with *O. llanoensis.*

The spectrum of variation in this species extends even farther from *O. llanoensis* than *O. firma.* In the lower 3 feet of the range of *O. llanoensis* (s.s.) there are specimens that would not be assigned to that species were it not for the fact that they grade continuously into it. All these specimens have the large, posteriorly

placed eyes and slender limbs of *Orygmaspis,* and most of the frontal areas are longer than one-half the glabellar length. The variation is in the depth of all furrows, especially the anterior border furrow, and in the topography of the frontal area. There are several collections from the basal 2 feet of the range (E-849, 849.5; JR-122, 124; GR-120; TC-935.5, 935.5-936) in which the variation can best be seen. If the specimens from a collection are arranged in order of distinctness of furrows, the few specimens easily assignable to *O. llanoensis* are all at the less distinct end of the array, with specimens that could be called *O. firma* next in line. Beyond this, the furrows are quite distinct, the frontal area is subdivided, and there is variation in the topography of the frontal area. I am calling this distinctly furrowed group *O. llanoensis* var. A, a stratigraphically significant and morphologically differing group that is still included within *O. llanoensis.*

The pygidia associated with *O. llanoensis* are very similar to the one Frederickson figured (1949, pl. 71, fig. 22) except that the spines are shorter. These pygidia are also much like those associated with *Parabolinoides contractus.*

Occurrence.—Common to locally abundant in the *Parabolinoides* Subzone and in the lower one-half of the *Taenicephalus* Zone at B-315.5, 316; CO-129, 131; CR-711; E-849, 849.5, 850, 852, 855, 857; GM-547, 555, 559; GR-119, 120, 123, 124; JR-122, 124, 125, 126, 126.3, 127, 131, 132; LL-673, 676, 680.5, 682, 682.5; MC-661, 661.5, 662, 665, 667, 668, 671, 673; PK-886, 888, 895; SK-202, 204, 206; SS-48.25, 54, 55, 58, 60, 60.5, 62, 67, 68; ST-480, 481, 484; SU-60, 61; TA-10, 12; TC-935.5-936, 936-936.5, 939, 944.5; TR-292.5, 294, 296, 297.5, 300.5, 302.5; WC-891, 891.5, 894.5, 896, 898.

Orygmaspis llanoensis (Walcott), var. A, Longacre, n. var.

Pl. 1, figs. 7–10.

Description.—This variant is characterized by its distinct furrows, particularly the anterior border furrow, and a frontal area that has topographic relief and is subequally divided into a preglabellar field and anterior border. The variety can have all or part of the ornament characteristic of *Orygmaspis llanoensis.* Palpebral furrows can be distinct.

Remarks.—Although this variant is distinct from *O. llanoensis* of previous workers, it grades continuously into that morphologic group. Because it is difficult to draw a line between the two, I have purposely left the boundary vague. This variety occurs in the lower 3 feet of the species range. Although *O. llanoensis* can occur with its variety, the collections are dominated by the variety. The data indicate that in the lower part of its range *O. llanoensis* is a variable species. As time passed, a morphotype that originally was one end member in the morphologic distribution became dominant.

O. llanoensis var. A can occur with *Parabolinoides contractus* and looks very much like that species in the depth of furrows and character of the frontal area. However, the palpebral lobes are longer and more posteriorly located, and the posterior limbs are correspondingly shorter (exsag.). I think *O. llanoensis* var. A represents the evolutionary tie between *Parabolinoides* and *Orygmaspis.*

Occurrence.—Common in the interval 1 to 4 feet above the base of the *Taenicephalus* Zone at E-849, 849.5, 850; GR-119, 120; JR-122, 124; LL-673; MC-661, 661.5, 662; SK-202; SS-48.25; ST-480; TC-935.5-936, 936-936.5; TR-292.5, 294; WC-891, 891.5. Occurs with *O. llanoensis* at E-849; GR-120; JR-124; MC-661.5; TC-935.5-936.

Genus Parabolinoides Frederickson, 1949

Parabolinoides Frederickson, 1949, p. 360; Berg, 1953, p. 564; Lochman in Harrington *et al.*, 1959, p. 0272; Bell & Ellinwood, 1962, p. 398; Grant, 1965, p. 133.

Bernia Frederickson, 1949, p. 357.

Type species.—*Parabolinoides contractus* Frederickson, 1949, p. 361, pl. 71, figs. 4–10.

Diagnosis.—Palpebral lobes small. Posterior end of palpebral lobes opposite or forward of glabellar midlength. Posterior fixigenae long (exsag.) and broadly triangular.

Remarks.—*Parabolinoides* differs from all other genera in the family in its smaller and more anteriorly located palpebral lobes and in the correspondingly longer (exsag.) triangular posterior limbs. In addition, the frontal area is always divided into a preglabellar field and anterior border by a distinct anterior border furrow.

Three described species are included in *Parabolinoides: P. contractus* Frederickson, 1949, *P. palatus* Berg, 1953, and *P. granulosus* Ellinwood, 1962.

Parabolinoides contractus Frederickson, 1949

Pl. 1, figs. 2–6.

Parabolinoides contractus Frederickson, 1949, p. 361, pl. 71, figs. 4–10; Berg, 1953, p. 564, pl. 59, fig. 3; Bell & Ellinwood, 1962, p. 399, pl. 56, fig. 12; Grant, 1965, p. 134, pl. 10, figs. 20, 23–27.

Parabolinoides hebe Frederickson, 1949, p. 361, pl. 70, figs. 7, 8; pl. 71, figs. 1–3; Berg, 1953, p. 564, pl. 59, figs. 2, 4; Bell & Ellinwood, 1962, p. 400, pl. 56, figs. 6–11; Grant, 1965, p. 135, pl. 10, fig. 19.

Parabolinoides expansus Nelson, 1951, p. 776, pl. 107, figs. 1, 3; Lochman & Hu, 1960, p. 811, pl. 95, figs. 32–35; Grant, 1965, p. 135, pl. 10, figs. 18, 21, 22.

Maustonia cordillerensis LOCHMAN, 1950, p. 331, pl. 47, figs. 6–13.

Parabolinoides cordillerensis (Lochman) BERG, 1953, p. 563 (in discussion of *Maustonia*); GRANT, 1965, p. 134, pl. 11, figs. 1–5.

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

Description.—Cranidium usually wider than long, many specimens nearly quadrate. Glabella flatly to moderately convex, tapered, rounded to slightly truncated anteriorly, may be keeled; three pairs of glabellar furrows may be well impressed, the posterior pair may connect, particularly on small specimens. Axial and preglabellar furrows distinct. Occipital furrow broad, shallow, better impressed on molds than on exoskeleton. Occipital ring tapers laterally; occipital node usually present. Frontal area extremely variable: the preglabellar field and anterior border normally are subequal in length (sag.), but either one may be longer; the preglabellar field is moderately to flatly convex, horizontal or downsloping; the anterior border is flat to slightly convex and can be raised, can slope up or down, or can be horizontal; the variation in topography runs the gamut of possibilities. Although the distinct anterior border furrow is usually slightly curved or nearly transverse, it can have a suggestion of recurvature at the axial line. The length of the frontal area relative to the glabella ranges from 0.25 to greater than 0.60. Fixigenae relatively narrow, flatly convex, horizontal to downsloping laterally, narrowest opposite palpebral lobes, crossed by ocular ridges. Palpebral lobes small, length never greater than one-fourth glabellar length; posterior edge of eye opposite glabellar midlength or forward of this point, usually opposite anterior 0.4 of glabella; the posterior end of the eye is usually opposite the lateral end of the second pair of glabellar furrows. Palpebral furrow faint. Posterior areas broadly triangular; posterior border furrow broad, shallow. Anterior facial sutures range from nearly parallel to markedly divergent in front of the palpebral lobes. Surface of exoskeleton usually smooth. Internal molds can be ornamented, usually with just a longitudinally oriented pattern of caecal venations on the preglabellar field; low transverse pattern of ridges can be seen on some of the anterior borders. Eleven specimens from seven localities have a row of granules in the anterior border furrow in addition to the caecal venations.

Pygidium transversely elliptical. Raised, convex axis consists of an articulating half ring, two well-defined axial rings, a third axial ring that is partly or completely fused to a terminal axial piece that can bear two low nodes or a ridge. Pleural field crossed by shallow but distinct furrows. Two to five pairs of marginal spines, ranging from stubs to long, slender spines. Margin of exoskeleton covered by fine terrace lines; internal molds smooth.

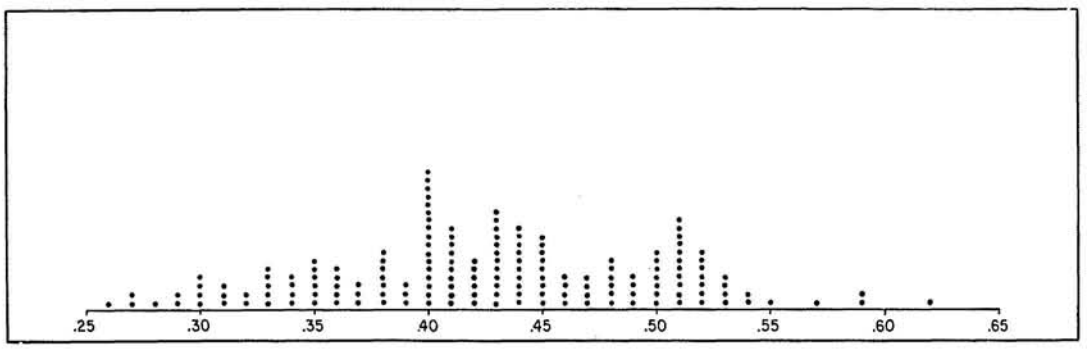
Remarks.—More than 150 specimens from the basal 2 feet of the *Taenicephalus* Zone in 19 measured sections yielded the information upon which this species is revised. The specimens were measured for glabellar length, length of the palpebral lobe, length of frontal area, and distance from the base of the glabella to a line connecting the posterior edges of the palpebral lobes.

The palpebral lobes are small and situated well forward on the cranidium. The ratios of palpebral lobe length and glabellar length ranged from 0.14 to 0.25; most of the ratios were between 0.20 and 0.25 (text-fig. 7). The eyes were never more than one-fourth glabellar length. The posterior edges of the palpebral lobes were always opposite the anterior one-half of the glabella; more than 50 percent of the specimens had the base of the eyes opposite the anterior two-fifths of the glabella. Another consistent relationship was that the posterior edges of the eyes were usually opposite or forward of the lateral ends of the second set of glabellar furrows; the palpebral lobes straddled the interval between the anterior and middle pair of glabellar furrows.

The length of the frontal area relative to glabellar length is quite variable. Values of the ratio ranged from 0.25 to 0.60, with major concentrations around 0.40 to 0.45 and 0.48 to 0.53 (text-fig. 8). Bell & Ellinwood (1962) set the cutoff between *Parabolinoides hebe* and *P. contractus* at 0.50; my data indicate that, although there appear to be two major clusters with respect to this ratio, there is a complete gradation between the two. There is no relation apparent between length of frontal area and anterior facial suture divergence. Thus, I have placed the two species in synonymy, the name of the type species prevailing.

There is a marked degree of variation in the topography of the frontal area; the preglabellar field is flatly to moderately convex, horizontal or downsloping; the anterior border is flatly to moderately convex, upsloping, horizontal and raised, or downsloping. Because this range in topography includes that of *P. expansus* Nelson, 1951, *P. expansus* is synonymized with *P. contractus.*

P. cordillerensis (Lochman) is characterized by the low topography of its frontal area, caecal venations on the preglabellar field, and, according to Grant (1965), granules in the anterior border furrow. The topography and caecal ve-



TEXT-FIG. 8—Ratio of frontal area length to glabellar length for 166 specimens of *Parabolinoides contractus*.

nations are features common to many specimens of *P. contractus;* the granules are present on a few, not always in association with the caecal venations. There is no reason sufficient for separating *P. cordillerensis* from *P. contractus.*

Four or five cranidia conform to *Bernia obtusa* Frederickson; I agree with Bell & Ellinwood (1962) and Grant (1965) that it is not a separate taxon and here include it in *P. contractus.*

In the upper 1 foot or less of the range of *P. contractus* and just above its range are cranidia very similar to, yet distinct from, *P. contractus.* Although the glabellae and frontal areas are quite like those of *P. contractus,* the palpebral lobes are larger and are farther back on the cranidium. These cranidia, described as *Orygmaspis llanoensis* (Walcott), var. A, Longacre, n. var., represent the intermediate form between *Parabolinoides* and *Orygmaspis.*

The pygidia of *P. contractus* and *O. llanoensis* are remarkably similar. In *P. contractus* the third axial ring is more or less fused to the terminal axial piece; three distinct axial rings can usually be seen on *O. llanoensis* pygidia. In all other respects the two are identical.

Occurrence.—Abundant in the basal *Parabolinoides* Subzone at B-312, 312.5; CO-124, 125, 126; CR-697; E-848.3, 848.7, 849, 849.5; GM-546, 547; GR-118, 119; JR-121, 122; LL-672.5, 673; MC-660, 661.5, 663; PK-885, 885.5, 886; SK-200-201, 201; SS-46, 46.5, 47, 47.5; ST-478; SU-56, 58; TA-0.6, 0.8, 1, 2; TC-934-934.5, 934.5-935, 935.25, 935.5-936; TR-291.2, 292.5; WC-889.

Parabolinoides granulosus Ellinwood

Parabolinoides granulosus Ellinwood in BELL & ELLINWOOD, 1962, p. 399, pl. 56, figs. 13–18.

Remarks.—*Parabolinoides granulosus* is characterized by its ornament, transversely convex preglabellar field that is flattened anterior to the glabella, and the convex anterior border with a recurved to backward-pointing posterior margin. In small specimens, at least the posterior pair of glabellar furrows may connect.

Occurrence.—Common to locally abundant in the basal 1 foot of the *Parabolinoides* Subzone at B-312, 312.5; CO-124; CR-697; E-848, 848.7; GM-546; GR-118; JR-121, 122; LL-672, 672.5; MC-660, 661, 662; PK-885; SS-46, 46.5, 47; SU-56; TC-934-934.5, 934.5-935.

Genus SARATOGIA Walcott, 1916

Saratogia WALCOTT, 1916, p. 195; LOCHMAN & HU, 1959, p. 420; BELL & ELLINWOOD, 1962, p. 393; GRANT, 1962, p. 988; 1965, p. 120.
Minkella LOCHMAN & HU, 1959, p. 414.

Type species.—*Conocephalites calciferous* Walcott, 1879, p. 129; 1912, pl. 43, figs. 7–10a.

Diagnosis.—Frontal area less than one-half the length of glabella (plus occipital ring). Glabellar furrows usually distinct. Occipital furrow well impressed, visible across axis. Anterior facial sutures narrowly to widely divergent. Preglabellar field downsloping, anterior border normally upturned. Exoskeleton and internal mold ornamented.

Remarks.—The two most consistent features among species of *Saratogia* are the frontal area length that is less than one-half that of the glabella (plus occipital ring) and the upturned anterior border. These two features readily distinguish *Saratogia* from *Idahoia.* All Texas specimens assigned to species of *Saratogia* were evaluated according to Grant's (1965, p. 121) eight criteria; the results are summarized in table 1, along with those for species of *Idahoia.*

Saratogia americana (Lochman & Hu)

Minkella americana LOCHMAN & HU, 1959, p. 414, pl. 58, figs. 1–20.
Saratogia americana (Lochman & Hu) BELL & ELLINWOOD, 1962, p. 393, pl. 54, figs. 1–5.

Remarks.—*Saratogia americana* is characterized by a frontal area that is normally about

two-fifths the length of the glabella (plus occipital ring), distinct glabellar and occipital furrows, narrowly divergent anterior facial sutures, surface ornament, and a convex, strongly downsloping preglabellar field and sharply upturned anterior border. Of the three Texas species of *Saratogia, S. americana* best conforms with Grant's criteria for the genus (table 1 in this study). As Bell & Ellinwood (1962, p. 393) mentioned, *S. americana* has a striking ornament and is relatively convex, and the length of the blunt, tapered glabella is equal to its basal width.

S. americana is abundant through the *Idahoia lirae* Subzone and occurs as high in the *Idahoia* Zone as the transition interval between *Drumaspis texana* and *D. idahoensis.*

Occurrence.—Abundant in the *Idahoia lirae* Subzone and scarce in the overlying beds of the *Idahoia* Zone at B-346.5, 347.5; CR-743-747; E-894, 897; EC-25, 26, 30, 32.5; GR-173, 180, 183; JR-169, 177, 189; LL-725, 728; MC-706, 707, 712, 718; SK-233, 245; ST-531, 536, 541, 572, 574.5, 575, 578; SU-116; TA-56; TC-986, 987, 994; WC-925, 950, 968.

Saratogia fria Lochman & Hu

Saratogia fria Lochman & Hu, 1959, p. 422, pl. 59, figs. 1–11; Bell & Ellinwood, 1962, p. 394, pl. 53, figs. 13–21; Grant, 1965, p. 122, pl. 13, fig. 21.

Remarks.—*Saratogia fria* is characterized by a frontal area that is slightly less than one-half the length of the glabella (plus occipital ring), by faint to absent glabellar furrows, by an occipital furrow that may or may not be visible across the axis (depending on the stoutness of the occipital spine), by widely divergent anterior facial sutures, and by its surface ornament. The preglabellar field is gently convex, slightly downsloping.

Texas specimens assigned to this species are very much like those from Montana assigned to *S. fria* by Grant (1965, p. 121). However, some specimens from both areas violate some of Grant's criteria for assignment to *Saratogia* (table 1 in this study): the glabellar furrows are faint to absent, the occipital furrow may or may not be well impressed, and the anterior facial sutures may be narrowly or widely divergent. In spite of these discrepancies and variations, *S. fria* is a compact and distinct species.

S. fria occurs with *S. modesta* but does not range so high as does the latter. A few specimens of *S. americana* occur in the lower one-half of the range of *S. fria.*

Occurrence.—Abundant in the middle of the *Idahoia* Zone at B-364.5, 377.5; CO-176, 184, 193; E-916, 932, 934, 935; EC-35, 36; GM-604; GR-180, 183; JR-188, 189, 195.5, 196, 200; LL-725, 728; MC-718, 721; SK-245, 248, 250.5, 260, 264; SS-101, 109, 111, 111.5; ST-536; SU-116; TC-1003, 1009, 1017; WC-950, 968, 977.

Saratogia modesta (Lochman & Hu)

Idahoia (Meeria) modesta Lochman & Hu, 1959, p. 420, pl. 59, figs. 33–45.
Saratogia modesta (Lochman & Hu) Bell & Ellinwood, 1962, p. 394, pl. 54, figs. 6–8.
Meeria modesta Lochman & Hu, Grant, 1965, p. 121 (in discussion of *Saratogia*).

Remarks.—*Saratogia modesta* is characterized by a frontal area about one-third the length of the glabella (plus occipital ring), a broadly rounded and normally unfurrowed glabella, a very wide, shallow, and uninterrupted occipital furrow, smoothly curved and narrowly divergent anterior facial sultures, a gently convex and down sloping preglabellar field, and a horizontal to gently upsloping anterior border. The occipital ring normally has a very low node. Palpebral furrows are not evident on exoskeletons, faint on internal molds.

The only ornament observed on the exoskeleton was a set of low, transverse, irregular ridges on the occipital ring. A few internal molds have longitudinal caecal venations on the preglabellar field and rarely have low granules in the anterior border furrow.

Grant (1965, p. 121) creates confusion by his unique reference, without discussion, to *Saratogia (Meeria) lirae* Frederickson and *S. (M.) modesta* Lochman & Hu. I can understand that confusion would arise from placing these two species in the same genus. According to Grant's criteria, that species could be neither *Idahoia* nor *Saratogia.* However, the confusion can be resolved by putting *Idahoia (Meeria) modesta* Lochman & Hu, with a frontal area less than one-half the length of the glabella (plus occipital ring), in the genus *Saratogia,* and by putting *Meeria lirae* Frederickson, with a frontal area longer than one-half the length of the glabella (plus occipital ring), in the genus *Idahoia.*

With the exception of the very faint to absent glabellar furrows, *S. modesta* conforms well with Grant's criteria for the genus (table 1 in this study).

S. modesta occurs with and above *S. fria.* Their lowest occurrences are approximately 12 feet above the base of the *Idahoia* Zone, and *S. modesta* extends up into the lower part of the range of *Ellipsocephaloides silvestris.*

Occurrence.—Common to locally abundant in the middle and upper *Idahoia* Zone at B-377.5; CO-176, 184, 202; E-917, 923, 932; GM-606, 615; GR-195; JR-188, 189, 200; LL-738, 741; MC-721; SK-248, 250.5, 264, 265; SS-109, 116, 119,

120; TC-1009, 1017, 1025; WC-968. Scarce at the base of the *Ellipsocephaloides* Zone at GR-204, 210; LL-750; WC-1069.

Genus STIGMACEPHALOIDES Ellinwood, 1962

Stigmacephaloides Ellinwood in BELL & ELLINWOOD, 1962, p. 401.

Type species.—*Stigmacephaloides curvabilis* Ellinwood in Bell & Ellinwood, 1962, p. 401, pl. 56, figs. 2–5.

Remarks.—The characteristics of this monotypic genus are well described in Bell & Ellinwood (1962, p. 401).

Stigmacephaloides curvabilis Ellinwood

Stigmacephaloides curvabilis Ellinwood in BELL & ELLINWOOD, 1962, p. 401, pl. 56, figs. 2–5; GRANT, 1965, p. 135, pl. 14, fig. 21.

Remarks.—This species is well described and illustrated in Bell & Ellinwood (1962). It is distinguished from species of *Stigmacephalus* by convexity of the anterior end of the cranidium, general smoothness of features, and shallow furrows.

Exoskeleton is without ornament. Internal molds may have longitudinal caecal venations across the anterior fixigenae and preglabellar field. One internal mold has a short row of low granules in its anterior border furrow adjacent to the axial line. A very low occipital node can be seen on internal molds.

Bell & Ellinwood (1962, p. 401) suggest that *Stigmacephalus* may be ancestral to *Stigmacephaloides*. A second possible ancestor could be *Saratogia*. Greater cranidial convexity and shallower furrows distinguish *Stigmacephaloides curvabilis* from stratigraphically lower *Saratogia modesta*.

Occurrence.—Scarce but locally common in the lower *Ellipsocephaloides* Zone at TC-1085-1090, 1093, 1095-1100, 1100, 1100-1105; WC-1069.

Genus TAENICEPHALUS Ulrich & Resser, 1924

Taenicephalus Ulrich & Resser in WALCOTT, 1924b, p. 59; 1925, p. 116; BERG, 1953, p. 565; Lochman in HARRINGTON *et al.*, 1959, p. 0274; GRANT, 1965, p. 136.

Type Species.—*Conocephalites shumardi* Hall, 1863, p. 154, pl. 7, figs. 1, 2; pl. 8, fig. 32.

Remarks.—The diagnosis given by Lochman (in Harrington *et al.*, 1959) and the description given by Berg (1953) is emended in one feature; the full length of the eyes extend opposite the anterior one-half of the glabella.

Taenicephalus gouldi (Frederickson)

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

Taenicephalus gouldi (Frederickson) BELL & ELLINWOOD, 1962, p. 401, pl. 57, figs. 1–9; GRANT, 1965, p. 137, pl. 12, figs. 1,2.

Remarks.—The cranidium of *Taenicephalus gouldi* is wider across the palpebral lobes than it is long, lacks fossulae, and usually lacks an occipital node. The exoskeleton may be covered with granules, and a coarse, longitudinally oriented, vermiform ridge pattern may cross the preglabellar field. The vermiform ridge pattern is usually preserved on internal molds, and the granular ornament may be preserved; some internal molds are smooth.

T. gouldi occurs in the lower *Taenicephalus* Zone, normally just above the *Parabolinoides* Subzone. In the 12 measured sections from which it has been recovered, *T. gouldi* commonly has a maximum range of 2 feet, but it may extend 2 feet more. *T. gouldi* is separated from *T. shumardi* by a minimum of 4 feet of section.

A few specimens of *Parabolinoides granulosus* look quite similar to *Taenicephalus gouldi* and seem to indicate an ancestor-descent relationship between the two species.

Occurrence.—Common in the lower *Taenicephalus* Zone at B-315.5, 316; CO-129; GM-551, 555(?); GR-120, 124(?); JR-125, 126, 126.3, 127; LL-676; PK-886; SK-202, 204; SS-50, 54; ST-484(?); TC-939; TR-296, 297.5.

Taenicephalus shumardi (Hall)

Conocephalites shumardi HALL, 1863, p. 154, pl. 7, figs. 1, 2; pl. 8, fig. 32.

Taenicephalus shumardi (Hall) WALCOTT, 1924b, p. 59, pl. 13, fig. 1; BELL & ELLINWOOD, 1962, p. 402, pl. 57, figs. 10–21 (synonymy to date); GRANT, 1965, p. 137, pl. 12, figs. 21, 22, 25, 26 (synonymy to date).

Remarks.—*Taenicephalus shumardi* is very common throughout most of the *Taenicephalus* Zone in central Texas. Cranidial length is greater than palpebral width, and the glabella is broader at the base than it is long. Grant (1965, p. 137) suggests as a third diagnostic character that the preglabellar field is at least as long as the anterior border. This character does not always occur on the Texas specimens. Of the nearly 500 specimens of *T. shumardi*, 75 have borders that are longer than their preglabellar fields (Bell & Ellinwood, 1962, pl. 57, fig. 18). In all other respects, these specimens are assignable only to *T. shumardi*. Although on some specimens the difference in relative length of the border may have resulted from compaction, there are numerous specimens on which the distinctly longer border is not a product of flattening of the border or curling of the preglabellar field.

In addition to the puckered anterior border furrow mentioned by Bell & Ellinwood (1962, p. 402), internal molds can show the vermiform ridge pattern or scattered pits on the preglabellar field.

T. shumardi ranges from a minimum of 8 feet above the *Eoothis* bed up to the top of the *Taenicephalus* Zone.

Occurrence.—Common to locally abundant in the *Taenicephalus* Zone at B-323, 328.5, 330; CO-136, 143; CR-711; E-857, 860, 861, 864, 866; EC-1, 3.5, 6, 7, 9, 14; GM-559, 568, 572, 573, 575; GR-126, 127, 131, 133, 137, 144, 148; JR-131, 132, 136, 156, 169; LL-682, 682.5, 686, 691, 693, 700; MC-671, 673, 678, 678.5, 682, 685; PK-895; SK-210, 213, 215; SS-58, 60, 60.5, 62, 67, 68, 69, 72, 83; ST-494, 511, 514, 520; SU-66; TA-10, 12, 14, 34, 40, 42; TC-944.5, 946, 948, 952, 975, 982; TR-302.5, 304.5, 309.5, 312, 314.5, 319, 324; WC-898, 901.5, 910, 913.5.

Taenicephalus sp. Bell & Ellinwood

Pl. 2, figs. 1, 2.

Taenicephalus sp. Bell & Ellinwood, 1962, p. 402, pl. 56, figs. 19–21.

Remarks.—I agree with Bell and Ellinwood that the systematic position of this taxon not be solidified until more data are available from the upper *Taenicephalus* Zone. The more than 75 very small cranidia assigned to *Taenicephalus* sp. all have large, elevated, well-defined palpebral lobes, a preglabellar field-anterior border ratio between 2:1 and 1:4, and taenicephalid ornament. Most specimens have an occipital node. Seven specimens have a very short preglabellar field and a thick, yet laterally tapering, anterior border that is medially expanded on both anterior and posterior edges, giving the border a diamond shape (pl. 2, fig. 2).

Fossulae, a short frontal area, and depth of furrows will distinguish this taxon from species of *Idahoia*. Elevated palpebral lobes and the highly convex but very slightly downsloping preglabellar field will distinguish *Taenicephalus* sp. from species of *Saratogia*. In the collection from JR-169, *Taenicephalus* sp. and *Saratogia americana* do occur together and are very difficult to separate. This mixture may represent the transition from *Taenicephalus* sp. to *S. americana*. Detailed collecting from this part of the section would be most helpful.

Taenicephalus sp. occurs through a maximum interval of 7 feet, with or just above the range of *T. shumardi*.

Occurrence.—Scarce to locally common at the top of the *Taenicephalus* Zone at CO-143; CR-730; E-875; EC-14; GM-572, 575; JR-169; MC-685, 689; SK-220; SS-76, 84, 90; TA-35; TC-975, 982; TR-333.5, 337; WC-912, 917.

Genus Wilbernia Walcott, 1924

Wilbernia Walcott, 1924b, p. 60; 1925, p. 123; Lochman in Harrington *et al.*, 1959, p. 0252.

Type species.—*Ptychoparia pero* Walcott, 1890, p. 274, pl. 21, fig. 6.

Remarks.—The characteristics of this genus are summarized by Lochman (in Harrington *et al.*, 1959). Because the palpebral lobes are posteriorly located and the fixigenae are not very wide, the eye ridges are angled back rather sharply.

Wilbernia diademata (Hall)

Conocephalites diadematus Hall, 1863 (part), p. 167, pl. 7, fig. 36; pl. 8, fig. 21.

Wilbernia diademata (Hall) Resser, 1937, p. 28; Nelson, 1951, p. 782, pl. 109, figs. 8, 11, 12; Bell & Ellinwood, 1962, p. 395, pl. 54, figs. 9, 10; Grant, 1965, p. 123, pl. 13, fig. 27.

Remarks.—*Wilbernia diademata* is distinguished by its gently convex anterior border that is about twice the length (sag.) of the preglabellar field, by its parallel-sided to gently tapered glabella that can be broadly rounded or truncated, and by its large size. There are a few specimens in the collections that seem to be intermediate between *W. diademata* and *W. pero*.

Exoskeleton smooth except for terrace lines on posterior one-half of occipital ring. Internal molds have a row of granules in the anterior border furrow. Occipital node may be present.

W. diademata is restricted to the lowest 6 feet of the *Idahoia* Zone, in association with *Idahoia lirae*.

Occurrence.—Common to locally abundant in the *Idahoia lirae* Subzone at B-346.5; CR-743-747; E-894, 897; EC-20.5, 21.5; GM-590; GR-168, 171; JR-172, 173, 178; MC-706, 707; PK-922; SK-232, 233; SS-94.5; ST-528; TC-983, 987.

Wilbernia expansa Frederickson

Wilbernia expansa Frederickson, 1949, p. 362, pl. 72, figs. 13–16; Bell, Feniak, & Kurtz, 1952, p. 187, pl. 32, figs. 3a-c; Bell & 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 its concave frontal area, particularly the anterior border, and by its very short (sag.) preglabellar field. Preglabellar field-anterior border ratio is between 1:4 and 1:7.

Surface of exoskeleton smooth. Internal molds can preserve longitudinal caecal venations on the anterior fixigenae and anterior border. Many molds preserve a row of granules in the anterior border furrow; these granules or low irregularities may be evident on the exoskeleton. A small occipital node can be present.

Wilbernia expansa occurs with the other three species of *Wilbernia: W. halli* in the *Taenicephalus* Zone and *W. diademata* and *W. pero* in the *Idahoia* Zone.

Occurrence.—Scarce to common in the *Taenicephalus* Zone at CO-143; EC-1, 9, 14.5; LL-686; MC-685; SS-83, 84; ST-511, 520; TA-40; TC-952; TR-314; WC-913.5, 917. Scarce but locally common in the *Idahoia* Zone at E-897, 920, 923, 932; EC-20.5, 21.5, 25, 26, 30; GM-591; GR-171, 188, 195; MC-706, 721; SK-233, 266; SS-92.5, 94.5, 116, 119, 120; ST-572, 578; TR-344.5.

Wilbernia halli Resser

Conocephalites diadematus HALL, 1863 (part), p. 167, pl. 7, figs. 37, 38.
Wilbernia halli RESSER, 1937, p. 28; NELSON, 1951, p. 777, pl. 107, figs. 17, 19; BELL, FENIAK, & KURTZ, 1952, p. 188, pl. 32, figs. 5a-b; BELL & ELLINWOOD, 1962, p. 395, pl. 54, figs. 13–18.

Remarks.—*Wilbernia halli* is characterized by a preglabellar field-anterior border ratio between 2:1 and 1:2, a tapering glabella, a convex preglabellar field, and a nearly flat anterior border. It is scarce to locally common in the lower one-half of the *Taenicephalus* Zone through a maximum interval of about 20 feet. *W. halli* var. A, Ellinwood, occupies the lower one-third of the species range.

Ornament on the exoskeleton consists of granules and a few low vermiform ridges over all areas behind the preglabellar field, a longitudinally directed system of ridges on the preglabellar field, and a smooth anterior border. Internal molds usually preserve the ridge pattern on the preglabellar field and a row of granules in the anterior border furrow, and the occipital ring can be pitted.

Occurrence.—Scarce to locally common in the lower one-half of the *Taenicephalus* Zone at B-317, 323; CO-131; CR-711; E-852, 855; GR-144; JR-131; LL-676, 680.5, 682; MC-665, 667, 668, 671, 673; PK-888; SK-204, 206, 210; SS-55, 60, 60.5, 62, 67, 68, 69; ST-481; SU-60, 61; TA-12; TC-944.5, 946, 948; TR-296, 300.5, 301.5, 302.5; WC-898.

Wilbernia halli Resser, var. A, Ellinwood

Wilbernia halli Resser, var. A, Ellinwood in BELL & ELLINWOOD, 1962, p. 395, pl. 54, figs. 16–18.
not *Wilbernia halli* Resser, var. A, NELSON, 1951, p. 777, pl. 107, figs. 9, 16 (= *W. expansa* Frederickson).

Remarks.—This variety is characterized by a preglabellar field-anterior border ratio from 2:1 (at the base of the range of the variety) up to but not including 1:1 (at the top of the range of the variety). *Wilbernia halli* var. A occurs stratigraphically below *W. halli.*

Occurrence.—Locally common in the lower part of the *Taenicephalus* Zone at B-317; CO-131; CR-711; E-852, 855; GR-144; JR-131; LL-676, 680.5, 682; MC-665, 667, 668; PK-888; SK-204, 206, 210; SS-55, 60; ST-481; SU-60, 61; TA-12; TR-296, 300.5, 301.5, 302.5.

Wilbernia pero (Walcott)

Conocephalites diadematus HALL, 1863 (part), pl. 8, fig. 18.
Ptychoparia pero WALCOTT, 1890, p. 274, pl. 21, fig. 6.
Wilbernia pero (Walcott) WALCOTT, 1924b, p. 60, pl. 13, fig. 4; BELL & ELLINWOOD, 1962, p. 396, pl. 54, figs. 19–21 (synonymy to date); GRANT, 1962, p. 989, pl. 139, figs. 8a-c; 1965, p. 124, pl. 14, fig. 6.

Remarks.—*Wilbernia pero* is characterized by a raised and convex anterior border that is more than twice the length (sag.) of the preglabellar field and by a parallel-sided, gently convex glabella. The convex anterior border distinguishes this species from *W. expansa.* The relatively longer and raised anterior border distinguishes *W. pero* from the stratigraphically lower *W. diademata.*

Ornament on the exoskeleton consists entirely of fine terrace lines that are transverse on the posterior one-half of the occipital ring; they are longitudinally directed across the posterior border, posterior, and palpebral areas of fixigenae, then curve around and become transverse on the anterior border. Ornament on the glabella unknown because of poor preservation. The only ornament on the internal mold is a row of granules in the anterior border furrow and vague impressions of the terrace lines on the anterior border. A very low occipital node is usually present.

Occurrence.—Common to locally abundant in the *Idahoia* Zone at B-364.5; CO-193; E-917; EC-25, 26, 29, 30, 35; GR-183; JR-188, 189, 195.5, 200; LL-725, 728; MC-721; SK-245, 260, 266; SS-109, 111.5; ST-574.5; SU-116; TC-1009, 1022; WC-977. Scarce in the *Ellipsocephaloides* Zone at JR-232, 233, 255; MC-764.

Family PTYCHASPIDIDAE Raymond, 1924

Diagnosis.—Isopygous ptychoparioid trilobites, with prominent, well-defined glabella that exhibits considerable variation in shape, convexity, and furrows; cranidial margins extremely variable when the family is considered as a whole, but relatively consistent within the subfamilies. Pygidium with prominent axis and numerous axial rings and pleurae, may or may not have marginal spines.

Remarks.—In addition to being the dominant family in the Ptychaspid Biomere, the Ptychaspididae is the only family represented throughout the biomere. Four subfamilies are recognized within the family: the Drumaspidinae,

Eurekiinae, Saukiinae, and Ptychaspidinae (text-fig. 1).

Similarities in glabellar shape, convexity, and furrowing, a reduced and pointed frontal area, and narrow fixigenae suggest that the Drumaspidinae are probably derived from *Conaspis* through *Drumaspis*. Similarities in glabellar shape and furrows accompanied by general flattening of the cranidium suggest that the Saukiinae are derived from *Ptychaspis* through *Prosaukia*. Cranidial similarities (exclusive of the frontal area) between *Maladia* and *Conaspis* lead me to think that *Maladia* is the intermediate form between *Conaspis* and the Eurekiinae.

Subfamily DRUMASPIDINAE Longacre, n. subfam.

Diagnosis.—Ptychaspididae with relatively large, nearly rectangular glabella; frontal area reduced, preglabellar field usually lacking; width of fixigenae up to one-half basal glabellar width. Pygidium with prominent axis, pleural region no wider than axis.

Remarks.—Three genera assigned to two closely related families in the *Treatise* are combined here into one subfamily, which probably is descended from *Conaspis*. Specimens in the Texas collections indicate that *Dartonaspis* was derived from *Drumaspis*. *Chariocephalus* could also have been derived from *Drumaspis*.

Palmer (1965b) revised the family Elvinidae and included in it genera of the Pterocephaliid Biomere. The revision left *Chariocephalus* and *Drumaspis* without a definite familial assignment. Bell & Ellinwood (1962) placed *Chariocephalus* in the Komaspididae, the family to which *Dartonaspis* is assigned in the *Treatise*. *Komaspis*, the Komaspididae, and the Komaspidacea are in dire need of massive revision (Palmer, pers. comm.). No name was available in the literature that would be suitable for the lineage that I think is represented by the three Franconian genera, *Drumaspis*, *Chariocephalus*, and *Dartonaspis*. Because *Drumaspis* is the earliest of the three to occur in the Ptychaspid Biomere and because I think it gave rise to the other two genera, the subfamily is appropriately named after *Drumaspis*.

Genus CHARIOCEPHALUS Hall, 1863

Chariocephalus HALL, 1863, p. 175; RESSER, 1942b, p. 4; Lochman in HARRINGTON *et al.*, 1959, p. 0297.

Type species.—*Chariocephalus whitfieldi* Hall, 1863, p. 175, pl. 6, figs. 49–51; pl. 10, fig. 20.

Remarks.—The diagnosis given by Lochman (in Harrington *et al.*, 1959) adequately describes the genus. If researchers agree that Resser (1942b, p. 4–13) included in *Chariocephalus* one or more species that belong to *Dartonaspis* (e.g., *C. wichitaensis* Resser, 1942b, p. 10, pl. 2, figs. 1–8), then his diagnosis for *Chariocephalus* should not be followed.

Chariocephalus is distinguished from the closely related *Dartonaspis* by its shorter (exsag.), narrower, and more anteriorly located palpebral areas of the fixigenae and by its slightly tapered glabella.

Chariocephalus whitfieldi Hall

Chariocephalus whitfieldi HALL, 1863, p. 175, pl. 6, figs. 49–51; pl. 10, fig. 20; BELL, FENIAK, & KURTZ, 1952, p. 188, pl. 37, figs. 4a-d; BELL & ELLINWOOD, 1962, p. 396, pl. 55, figs. 7, 8; GRANT, 1962, p. 983, pl. 139, fig. 4.

Remarks.—This species is characterized by an anteriorly tapered glabella with faint furrows, fossulae, and palpebral lobes that are up to one-half the length of the glabella and are opposite the anterior one-half of the glabella. Although biostratigraphic data are sparse, the range of *Chariocephalus whitfieldi* overlaps at least the lower part of the range of *Dartonaspis wichitaensis*.

Occurrence.—Scarce in the *Ellipsocephaloides* Zone at EC-67; JR-225, 245, 251; MC-844; TA-164; TC-1109.

Genus DARTONASPIS Miller, 1936

Dartonaspis MILLER, 1936, p. 29; Lochman in HARRINGTON *et al.*, 1959, p. 0295.

Type species.—*Dartonaspis knighti* Miller, 1936, p. 29, pl. 8, figs. 34, 35.

Remarks.—The diagnosis given by Lochman (in Harrington *et al.*, 1959) summarizes the characters of the genus, with the exception that the American species in the genus all have glabellae that expand anteriorly.

Dartonaspis wichitaensis (Resser)

Pl. 2, fig. 11.

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

Dartonaspis wichitaensis (Resser) BELL & ELLINWOOD, 1962, p. 397, pl. 55, fig. 6.

Remarks.—Eight fragmentary cranidia and two pygidia are assigned to this species. *Dartonaspis wichitaensis* is characterized by its anteriorly expanded glabella, the inflated palpebral areas of the fixigenae, short (exsag.) posteriorly directed limbs, and finely pitted exoskeleton and internal molds. These features distinguish *D. wichitaensis* from the stratigraphically associated *Chariocephalus whitfieldi*.

Occurrence.—Scarce in the *Ellipsocephaloides* Zone at JR-255, 265; MC-840, 844.

Genus DRUMASPIS Resser, 1942

Drumaspis RESSER, 1942b, p. 28; BELL & ELLINWOOD, 1962, p. 390; GRANT, 1962, p. 983; 1965, p. 114.

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

Diagnosis.—Glabella quadrate to slightly elongate, parallel-sided to slightly tapering, and gently rounded to strongly truncated anteriorly. Two to four pairs of glabellar furrows that may or may not connect. Frontal area short. Palpebral and posterior fixigenae wide, downsloping. Long palpebral lobes with distinct palpebral furrow.

Remarks.—Species of *Drumaspis* can be separated into two morphologic groups: one with disconnected glabellar furrows and a second in which one or two of the posterior pairs of glabellar furrows are continuous. Biostratigraphic data from Texas (Bell & Ellinwood, 1962), Minnesota (Grant, 1962), Montana and Wyoming (Grant, 1965), and Oklahoma (Stitt, in press) demonstrate that the group with disconnected furrows is stratigraphically below the group with connected glabellar furrows and there is an overlap or transition zone between the two. Comparison of the Texas cranidia with Resser's and Grant's illustrations indicate that *Drumaspis* is represented by two moderately variable species that succeed one another in time.

Three described species are included in *Drumaspis: D. walcotti* Resser (1942b), *D. texana* Resser (1942b), and *D. idahoensis* Resser (1942b).

D. walcotti, the type species, seems to be of mixed morphologic character; the holotype (Resser, 1942b, pl. 4, figs. 37–39) has disconnected glabellar furrows, whereas the paratype (pl. 4, figs. 40, 41) has one pair of connected furrows. As Grant (1962, p. 984) mentioned, the paratype is smooth, whereas the holotype has an ornamented occipital ring and border. Lochman & Hu (1959, p. 416, pl. 60, figs. 1–14) discussed and illustrated specimens of *D. walcotti* from near the type locality in Idaho. Their illustrated specimens include both morphologic forms. Grant (1962, p. 984; 1965, p. 115) found the two forms associated at about the midpoint of the range of *Drumaspis,* and he thinks they may not be conspecific.

When compared with the Texas cranidia, the holotype of *D. walcotti* can be included in the hypodigm of *D. texana* and the paratype can be included in the hypodigm of *D. idahoensis* from low in its range. If subsequent investigation of the genus indicates that *Drumaspis* is composed of only two geographically widespread chronospecies that are distinguished by means of disconnected-connected glabellar furrows, the lower species would include the holotype of *D. walcotti* and would bear that name; the paratype would be included in the stratigraphically higher species with connected glabellar furrows, and, because of Palmer's work (1968, p. B85), the correct name would be *D. idahoensis.*

Drumaspis idahoensis Resser

Pl. 2, figs. 8–10.

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

Remarks.—Drumaspis idahoensis is distinguished by its connected posterior one or two pairs of glabellar furrows. Although the connection is faint on specimens from low in the range, it is quite distinct on stratigraphically higher specimens. The glabella is quadrate to almost equidimensional and can be slightly tapered. Width of fixigenae at the base of the palpebral lobes ranges from one-fourth to one-third the basal glabellar width on specimens from the transition zone and low in the range of the species; in stratigraphically higher specimens, the fixigenae are at least one-third as wide as the base of the glabella. Low in the range, the exoskeleton and particularly the occipital ring may be covered with a subtle ridge-and-pit pattern of ornament; internal molds and exoskeletons of specimens from high in the range are smooth.

D. idahoensis is common in the upper *Idahoia* Zone and scarce in the middle part of the *Ellipsocephaloides* Zone. It occurs above *D. texana* and is distinguished from it by the connected glabellar furrows. In the transition zone or overlap interval, specimens of *D. idahoensis* can have some features normally associated with *D. texana:* ornament, narrower fixigenae, slightly longer frontal area, and tapered glabella.

A few fragmentary specimens from the middle of the fossiliferous part of the *Ellipsocephaloides* Zone appear to straddle the gap between *Drumaspis* and *Dartonaspis.* Two of these specimens are illustrated (pl. 2, figs. 9, 10).

Occurrence.—Common in the *Idahoia* Zone at

CO-193, 202, 219; E-930, 932, 934, 935; GM-615; GR-195; JR-195, 195.5, 196, 200, 202, 204; LL-738, 741, 750; SK-248, 260, 264, 265, 266; SS-109, 111, 116, 119, 120, 138.5; TC-1015-1025, 1017, 1022, 1025; WC-968, 977. Scarce in the *Ellipsocephaloides* Zone at MC-1095-1100, 1100.

Drumaspis texana Resser

Pl. 2, figs. 6, 7.

Drumaspis texana Resser, 1942b, p. 32, pl. 5, figs. 27–30; Bell & Ellinwood, 1962, p. 391, pl. 52, figs. 7–9, 13, 14; Grant, 1965, p. 114.
Drumaspis osella Resser, 1942b, p. 32, pl. 5, figs. 17–20.
Drumaspis clara Resser, 1942b, p. 33, pl. 5, figs. 23–26.
Drumaspis nitida Resser, 1942b, p. 34, pl. 5, figs. 34, 35.
Drumaspis wichitaensis Resser, 1942b, p. 33, pl. 5, figs. 21, 22.
Drumaspis briscoensis Resser, 1942b, p. 30, pl. 5, figs. 4–8; Grant, 1965, p. 115, pl. 14, figs. 7–9.
Drumaspis maxwelli Resser, 1942b, p. 31, pl. 5, figs. 12, 13.
Drumaspis sabulosa Grant, 1962, p. 984, pl. 139, fig. 6.

Remarks.—*Drumaspis texana* is distinguished by discontinuous glabellar furrows. Fixigenae at the base of the palpebral lobes are less than one-third and usually about one-fourth the basal glabellar width. Shape of the glabella ranges from nearly quadrate to slightly elongate and tapering; anterior end of glabella normally is rounded-truncate but a few specimens have distinctly truncated and medially indented glabellae. Although most specimens have three pairs of glabellar furrows, there may be as few as two or as many as four pairs of furrows.

Distinct granules or vermiform ridges and granules normally cover all areas of the exoskeleton. Although most of the cranidium can be nearly smooth, the occipital ring will be distinctly ornamented. Internal molds can be partially imprinted with exoskeleton ornament or can have a roughened appearance. Ornament becomes less distinct in the upper part of the range.

The holotype of *D. texana* Resser (1942b, pl. 5, fig. 29) illustrates the glabellar furrows, relatively narrower fixigenae, and granular ornament common to the Texas cranidia. Most of the cranidia in the collections have glabellae that are not quite so tapered or anteriorly rounded, and they have relatively shorter frontal areas (Bell & Ellinwood, 1962, pl. 52, figs. 7–9).

The variation of the Texas cranidia includes the morphologies of the holotypes of all species placed in synonymy, even the rather distinctive *D. osella,* with its straight-sided, tapering glabella and longer frontal area.

Occurrence.—Common in the lower one-half of the *Idahoia* Zone at B-357.5, 364.5, 377.5; CO-176, 184; CR-743-747, 765; E-904, 916, 917, 920; EC-36, 38; GM-604, 606; GR-180, 183, 185; JR-188, 189, 195, 196; LL-738; MC-712, 714, 718, 721; SK-245, 248, 260; SS-109, 111; ST-541; SU-116; TC-1003, 1009, 1017; WC-950, 968.

Subfamily Eurekiinae Hupé, 1953

Diagnosis.—Ptychaspididae with tapered and rounded to truncate glabella, frontal area variable, palpebral area generally small and close to the glabella, with distinct palpebral furrow, and posterior limbs straplike. Pygidium with prominent axis, distinct axial rings and pleurae; margin with spines.

Remarks.—The composition of this subfamily is essentially that of the family Eurekiidae of Hupé (in Harrington *et al.,* 1959, p. 0325). Because of its probable relation to *Conaspis,* this group of genera is included in the same family.

Genus Bayfieldia Clark, 1924

Bayfieldia Clark, 1924, p. 31; Rasetti, 1944, p. 239; Winston & Nicholls, 1967, p. 83.

Type species.—*Bayfieldia tumifrons* Clark, 1924, p. 31, pl. 4, fig. 6.

Diagnosis.—Eurekiinae with anteriorly rounded glabella; glabellar furrows, if present, shallow and recurved. Occipital furrow broad, shallow, laterally bifurcating. Fixigenae and palpebral lobes narrow. Posterior limbs long and wide; posterior border furrow shallow and wide. Cranidium smooth or granulose. Pygidial axis elevated, terminal axial piece can be binodose. All furrows on the pygidium deep and wide. At least three pairs of marginal spines are present.

Remarks.—This genus differs from *Eurekia* in its bifurcate occipital furrow, shallow or obsolete glabellar furrows, wider (exsag.) posterior limbs, and nearly flat palpebral areas of the fixigenae. *Bayfieldia* differs from *Corbinia* in its bifurcate occipital furrow, anteriorly rounded glabella, and generally shallower axial, occipital, and border furrows.

Four species are included in *Bayfieldia: B. barabuensis* (Whitfield), 1878, *B. binodosa* (Hall), 1863, *B. tumifrons* Clark, 1924, and *B. simata* Winston & Nicholls, 1967. *B. ulrichi* Rasetti, 1945b, and *Bayfieldia* sp. undet. Rasetti, 1959, belong in *Corbinia* (Winston & Nicholls, 1967, p. 85, 86).

Bayfieldia binodosa (Hall)

Pl. 3, figs. 13, 14.

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 finkelnburgi CLARK, 1924, p. 32, pl. 4, fig. 7.
Eurekia finkelnburgi (Clark) RESSER, 1935, p. 28.
Bayfieldia binodosa (Hall) WINSTON & NICHOLLS, 1967, p. 83, pl. 9, figs. 1, 2.
Corbinia implumis WINSTON & NICHOLLS, 1967, p. 86, pl. 9, fig. 3.

Remarks.—This species is very common in the *Saukiella pyrene* and *Saukiella junia* Subzones. *Bayfieldia binodosa* exhibits considerable variation, particularly in the glabellar furrows, the ornament, and the rounding of the front of the glabella. Most specimens have anteriorly rounded glabellae, but some are rounded-truncate. Glabellar furrows are usually absent, but a few specimens have one or two pairs of faintly impressed, strongly recurved furrows as in *Eurekia*. Although most specimens are smooth, some are granulate (pl. 3, figs. 13, 14). Because these three variable features exhibit neither correlation with one another nor stratigraphic trend, I attribute them to either intraspecific variation or sexual dimorphism.

Corbinia implumis Winston & Nicholls was described from one collection (TC-1290) from the middle of the range of *Bayfieldia binodosa* in that section. The features mentioned by Winston and Nicholls as diagnostic of *Corbinia implumis* occur on specimens of *Bayfieldia binodosa* in varying quantities and qualities. I place *C. implumis* in synonymy with *B. binodosa*.

The associated pygidium has a high axis, an articulating half ring, one well-defined axial ring, two axial rings partly fused together, and a binodose terminal axial piece that is fused to the third axial ring. The four or five pairs of marginal spines are pointed.

Bayfieldia binodosa is associated with *Eurekia granulosa* Walcott and is distinguished from all species of *Eurekia* by its weak, but usually absent, glabellar furrows, a bifurcating occipital furrow, and broad posterior limbs with medium to small posterior fixigenae.

Occurrence.—Common to locally abundant in the *Saukiella pyrene* Subzone at BC-23, 34, 36, 41, 42; JR-357, 369.5, 394; SPH-93, 95, 96.5, 98, 99, 103, 114, 114.5, 140; SS-356; TC-1237, 1265, 1286, 1287. Common in the *Saukiella junia* Subzone at BC-70; JR-459; TC-1290, 1291, 1305, 1305-1310.

Bayfieldia simata Winston & Nicholls

Pl. 4, fig. 12.

Bayfieldia simata WINSTON & NICHOLLS, 1967, p. 84, pl. 9, figs. 20, 23–26.

Remarks.—Although a few representatives of this species occur in the *Saukiella junia* Subzone, it is quite abundant in the *Saukiella serotina* Subzone. *Bayfieldia simata* is characterized by its medially expanded glabella, long and nearly flat frontal area, elongate palpebral lobes and fixigenae, bifurcate occipital furrow, and stout, nearly parallel-sided posterior limbs. The only variable part of the cranidium is the frontal area. Two types of variation are recognized. In one, the facial sutures diverge slightly, and a faint, arcuate, anteriorly bowed border furrow is present (Winston & Nicholls, 1967, pl. 9, fig. 20). In the second, the facial sutures are parallel, and the anterior border furrow is bowed backward, terminating laterally at or close to the anterior corners of the cranidium (Winston & Nicholls, pl. 9, fig. 24). Both types occur throughout the range of *B. simata* and may be an expression of sexual dimorphism. The figured specimen has the recurved anterior border furrow.

Occurrence.—Scarce in the *Saukiella junia* Subzone at BC-109-110, 149; CC-27; JR-481; LCS-11, 31; SH-12.6; SS-356, 360.5. Common in the *Saukiella serotina* Subzone at CC-58.2, 61; JR-484, 519, 532, 536; LC-32; LCS-32, 33, 33.5, 34-36, 35.7, 40, 44, 44.5, 45, 45.4; SH-52, 52.6, 65.5; SS-375, 381, 383, 398; TC-1357-1363, 1368-1374, 1379-1385, 1379-1385a, 1387.5, 1388, 1391.5, 1392, 1393, 1394, 1395, 1400.

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

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

Remarks.—This possible link between *Bayfieldia binodosa* and *B. simata* is recognized by its pygidium with long and bluntly rounded marginal spines and two nodes on the terminal axial piece. The few cranidia with preserved frontal areas have recurved anterior border furrows; an equal number of cranidia do not have the frontal area preserved. I hesitate to suggest that all *B. simata* var. A have this type of frontal area until more material is collected.

Occurrence.—Locally common in the *Saukiella junia* Subzone at BC-109-110; JR-481; SH-12.6; SS-356.

Genus CORBINIA Walcott, 1924

Corbinia WALCOTT, 1924b, p. 55; 1925, p. 81; Lochman in HARRINGTON *et al.*, 1959, p. 0325; WINSTON & NICHOLLS, 1967, p. 85.

Type species.—*Corbinia horatio* Walcott, 1924b, p. 55, pl. 10, fig. 5.

Remarks.—Winston & Nicholls (1967, p. 85) have given the most comprehensive diagnosis for *Corbinia*.

Corbinia apopsis Winston & Nicholls

Corbinia apopsis Winston & Nicholls, 1967, p. 86, pl. 11, figs. 13, 14, 17, 22.

Remarks.—This is the most abundant species in the *Corbinia apopsis* Subzone, where it occurs in coquinoid profusion through as much as 8 feet of section. An addition to Winston and Nicholls' description is that the pygidial exoskeleton is covered with granules and the margin ornamented with coarse terrace lines that zigzag in and out of the marginal spines.

Occurrence.—Very abundant in the *Corbinia apopsis* Subzone at CC-67, 69.5; JR-538, 539, 539.5, 540, 542, 543, 545; LC-48; LCS-53, 53.3, 53.5, 53.8, 55, 55.5, 56; SH-72; SS-411, 413, 416; TC-1402, 1409.

Genus Eurekia Walcott, 1924

Eurekia Walcott, 1924b, p. 56; 1925, p. 89; Resser, 1935, p. 28; Lochman in Harrington *et al.*, 1959, p. 0325; Winston & Nicholls, 1967, p. 84.

Type species.—Eurekia granulosa Walcott, 1924b, p. 56, pl. 12, fig. 1.

Remarks.—Winston & Nicholls (1967) give the most complete diagnosis for this genus.

Eurekia eos (Hall)

Pl. 4, fig. 15.

Conocephalites eos Hall, 1863, p. 151, pl. 7, figs. 24, 25; pl. 8, figs. 8, 9.

Eurekia eos (Hall) Walcott, 1925, p. 89 (list); Resser, 1935, p. 28 (list); Winston & Nicholls, 1967, p. 85, pl. 10, figs. 15, 17.

Remarks.—Eurekia eos has been well described and illustrated by previous workers. I am repeating the discussion of the species in central Texas because more concrete range data are available.

Eurekia eos is quite abundant in the *Saukiella serotina* Subzone, with few specimens in the underlying and overlying subzones. Two cranidia from TC-1352-1357 and one poorly preserved pygidium from TC-1346 listed by Winston and Nicholls occur in the *S. junia* Subzone. The holotype of *S. junia* (Walcott) has a well-preserved specimen of *Eurekia eos* next to it. No specimen of *E. eos* was identified below the upper part of the *S. junia* Subzone. Only one collection of *E. eos* occurs in the base of the *Corbinia apopsis* Subzone.

Further preparation and examination of stratigraphically lower specimens assigned by Winston and Nicholls to *E. eos* revealed that those from the *Saukiella pyrene* Subzone and lower *S. junia* Subzone belong to *E. granulosa* Walcott. Three specimens assigned to *E. sedgwicki* (Billings) by Winston and Nicholls are also placed in *E. granulosa.*

The pygidium is characterized by the binodose terminal axial piece, rugged appearance, and unusual configuration of the marginal spines. The four or five pairs of spines look like silhouettes of feet, with the toes pointing toward the axis (pl. 4, fig. 15). Internal molds can be covered with closely spaced pits.

Occurrence.—Scarce in the *Saukiella junia* Subzone at TC-1346-1352, 1352-1357. Common in the *Saukiella serotina* Subzone at BC-149; CC-63±; JR-529, 532; LC-32; LCS-32, 35.7, 39, 40, 44; SH-52, 52.6, 53.5, 54, 55, 65.5; SS-375, 398, 409; TC-1357-1363, 1368-1374, 1379-1385, 1391.5, 1392, 1393, 1394, 1395. Scarce in the *Corbinia apopsis* Subzone at LCS-54.

Eurekia granulosa Walcott

Pl. 3, figs. 15–17.

Eurekia granulosa Walcott, 1924b, p. 57, pl. 12, fig. 1; 1925, p. 90, pl. 16, figs. 13–17; Resser, 1935, p. 28.

Eurekia sedgwicki (Billings) Winston & Nicholls, 1967, p. 85, pl. 10, figs. 12, 16.

Remarks.—Eurekia granulosa, the type species, is characterized by its divergent anterior facial sutures, recurved border, moderately tapered and rounded-truncate glabella, deep, recurved glabellar furrows, coarse surface granulation, relatively broad and convex anterior fixigenae, and narrow eyes, posterior fixigenae, and posterior limbs. *E. granulosa* is distinguished from *E. eos* by divergent anterior facial sutures, larger anterior fixigenae, and a recurved anterior border. If these features are not preserved, the more tapered and not so truncate glabella will distinguish *E. granulosa.*

E. granulosa is associated with another eurekiid, *Bayfieldia binodosa,* from which it is distinguished by its deep, recurved glabellar furrows, deep, nonbifurcate occipital furrow, narrow raised palpebral area, and very slender posterior limbs. There is only one binodose pygidium associated with these two species, and I have concluded that it belongs to *B. binodosa.* A pygidium with the cropped spines of *E. granulosa* Walcott (1925, pl. 16, fig. 17) has not been found in central Texas or in Oklahoma (Stitt, in press).

E. granulosa ranges through the *Saukiella pyrene* Subzone, and one collection comes from the base of the *Saukiella junia* Subzone. The shape of the anterior end of the glabella is the most variable feature, ranging from broadly rounded to truncate (pl. 3, figs. 15–17). Most specimens are more or less truncate. I have assigned the specimens identified as *E. sedgwicki* (Billings) by Winston and Nicholls to *E. granulosa.* The status of *Menocephalus sedgwicki* Billings is uncertain because of poor material, but I doubt that it should be placed in *Eurekia;*

the glabellar furrows are like those of *Eurekia*, but all other features of the cranidium are not.

Occurrence.—Common in the *Saukiella pyrene* Subzone at BC-23, 41, 42; JR-354, 374.5; SPH-91, 94, 95, 96.5, 106.5, 110; TC-1244, 1287. Scarce at the base of the *Saukiella junia* Subzone at TC-1291.

Subfamily PTYCHASPIDINAE Longacre, n. subfam.

Diagnosis.—Ptychaspididae with prominent, very well-defined, anteriorly rounded glabella that usually tapers or is parallel-sided; anterior lobe of glabella usually swollen in later genera; at least two pairs of distinct glabellar furrows, posterior pair commonly connected, second pair may connect; frontal area variable, preglabellar field commonly absent; fixigenae variable; eye ridges and palpebral lobes commonly distinct. Pygidium with usually well-defined axis that is narrower than pleural region; axial rings and pleural furrows normally distinct; border furrow absent or very shallow; margin smooth.

Remarks.—This is the only subfamily represented throughout the Ptychaspid Biomere (text-fig. 1). I have relied on studies in the Upper Mississippi Valley (Nelson, 1951; Bell, Feniak, & Kurtz, 1952) to demonstrate the lineage from *Conaspis* through *Eoptychaspis* to *Ptychaspis*. Morphologically and temporally, it is logical that *Euptychaspis* was a derivative of *Ptychaspis*. I think *Ptychaspis* is the ancestor of *Keithia* and *Keithiella* rather than the East Asian genus *Andersonella*. I think *Macronoda* probably represents an offshoot from *Euptychaspis*.

Genus CONASPIS Hall, 1863

Conaspis HALL, 1863, p. 152; WALCOTT, 1914, p. 357 (footnote); RESSER, 1937, p. 6; BERG, 1953, p. 560; Lochman in HARRINGTON *et al.*, 1959, p. 0320.

Type Species.—*Conocephalites perseus* Hall, 1863, p. 152, pl. 7, fig. 17; pl. 8, fig. 33.

Remarks.—Berg (1953) gives the most complete cranidial diagnosis. The only pygidium assigned to *C. perseas* Hall is the one that Hall (1863, p. 153) described and assigned to *Conocephalites perseus* but that Berg (1953, p. 562) assigned to *Conaspis tumidis*. Bell & Ellinwood (1962, p. 403, pl. 58, figs. 5, 9) described and illustrated pygidia they assigned to *Conaspis masonensis*.

Conaspis leptoholcis Longacre, n. sp.

Pl. 1, figs. 19–21.

Description.—Cranidium strongly convex longitudinally and transversely. Glabella strongly convex, anteriorly downsloping, tapered, gently rounded to slightly truncated in front. Three pairs of glabellar furrows: posterior pair well impressed, recurved, and usually not connected; middle pair shallow and slightly recurved; anterior pair composed of faint, anteriorly directed depressions that are not connected with the axial furrow. Axial furrow distinct, with faint fossulae at anterior corners of the glabella. Preglabellar furrow faint to obsolete. Occipital furrow distinct, curved forward medially and laterally. Laterally tapered occipital ring has a very low occipital node. Preglabellar field strongly deflected downward, almost at the same angle as the front of the glabella. Anterior border furrow distinct and broadly curved. Anterior border gently convex, crescentic, slightly longer (sag.) than preglabellar field. Frontal area less than one-fourth cranidial length. Fixigenae narrow, gently convex, with a slight bulge where an ocular ridge would be. Palpebral furrow distinct, complete. Palpebral lobes narrow and elongate. Posterior area of fixigenae triangular. Posterior border furrow broad, shallow, and almost straight; posterior border widens laterally. Anterior facial sutures slightly divergent in front of palpebral lobes. Exoskeleton and internal molds smooth.

Librigena and pygidium unknown.

Available material.—8 cranidia, well preserved.

Holotype.—BEG 36479, from B-316.

Etymology.—*leptos*, Greek, fine, weak, thin; *holcos*, Greek, furrow; named for its weak to nearly obsolete preglabellar furrow.

Remarks.—*Conaspis leptoholcis* is distinguished from all other species of *Conaspis* by its weak to almost obsolete preglabellar furrow. Its faint fossulae, subequal preglabellar field and anterior border, and gently tapered, crescentic anterior border also characterize this species. It is distinguished from the associated *C. testudinatis* by its smooth exoskeleton and crescentic border. It differs from the stratigraphically higher *C. masonensis* by its downsloping frontal area and relatively narrower fixigenae.

C. leptoholcis is distinguished from the holotype of *C. perseas* (Hall) (Berg, 1953, pl. 60, fig. 5) by its convexity, glabellar shape, and wider fixigenae. It differs from *C. parvafrons* Kurtz (in Bell, Feniak, & Kurtz, 1952, p. 185, pl. 31, figs. 7a-b) in having a distinct anterior border furrow. The closest resemblance is to *C. tumidis* Kurtz (in Bell, Feniak, & Kurtz, 1952, p. 185, pl. 31, fig. 5), but *C. leptoholcis* can be distinguished by its longer frontal area, wider fixigenae, more rounded and tapered glabella, and laterally tapered occipital ring.

C. leptoholcis occurs in the lower part of the *Taenicephalus* Zone only on the eastern side of the Llano Uplift. It ranges through a maximum interval of 10 feet, beginning at the top of the

range of *Taenicephalus gouldi* and extending into the lower part of the range of *T. shumardi*. *C. leptoholcis* can be associated with *C. testudinatis*.

Occurrence.—Scarce in the lower *Taenicephalus* Zone at B-316; CO-131; E-852; PK-888; SU-61; WC-895.

Conaspis masonensis Ellinwood

Conaspis masonensis Ellinwood in Bell & Ellinwood, 1962, p. 403, pl. 58, figs. 1–9.

Remarks.—*Conaspis masonensis* is well described and illustrated by Bell & Ellinwood (1962). Its lowest occurrence is normally about 40 feet above the base of the *Taenicephalus* Zone, and in one section it has a range of 7 feet. *C. masonensis* occurs in association with *Taenicephalus* sp. and *T. shumardi*. It does not occur with *Idahoia lirae*, although the two species may be separated by as little as 1 foot of section.

At JR-169, *C. masonensis*, *Taenicephalus* sp., and *T. shumardi* occur with *Saratogia americana*, one of the earliest species of the *Idahoia* Zone; the first occurrence of *Idahoia lirae* is at JR-172. The association of *Saratogia americana* with *Taenicephalus* sp. and other taxa characteristic of the highest *Taenicephalus* Zone may represent the stratigraphic interval through which the transition from *Taenicephalus* sp. to *S. americana* occurs.

Occurrence.—Locally abundant at the top of the *Taenicephalus* Zone at E-875; JR-168, 169; SS-90; TC-975, 982.

Conaspis parvafrons Kurtz

Pl. 2, fig. 3.

Conaspis parvafrons Kurtz in Bell, Feniak, & Kurtz, 1952, p. 185, pl. 31, figs. 7a, b; Berg, 1953, p. 561, pl. 60, fig. 9.

Remarks.—One internal mold is assigned to *Conaspis parvafrons*, a species distinguished from all others assigned to *Conaspis* by its unfurrowed frontal area. It is also characterized by its rectangular glabella, faint and gently curved palpebral furrows, and markedly divergent anterior facial sutures.

The specimen in the Texas collections is slightly different from the holotype. Neither the smooth frontal area nor the anterior end of the glabella are quite so convex, the fossulae are absent, all furrows are shallower, and the posterior areas of the fixigenae are longer (exsag.). The Texas cranidium closely resembles the paratype and is almost identical to the cranidium figured by Berg (1953). The differences separating the Texas cranidium from those in the Upper Mississippi River Valley are small. The cranidium has the same stratigraphic position in Texas as has *C. parvafrons* in Minnesota and Wisconsin. Although this specimen may be a geographic variant, I think it is at least conspecific with *C. parvafrons*. Additional material is necessary to say more about its subspecific status.

C. parvafrons occurs at the very top of the *Taenicephalus* Zone in association with *C. masonensis* and *Taenicephalus* sp. The base of the *Idahoia* Zone is 2.5 feet above this unique occurrence of *C. parvafrons*.

Occurrence.—Scarce at the top of the *Taenicephalus* Zone at SS-90.

Conaspis testudinatis Ellinwood

Pl. 1, figs. 17, 18.

Conaspis testudinatus Ellinwood in Bell & Ellinwood, 1962, p. 404, pl. 58, figs. 10–13.

Remarks.—The coarse granular ornament on external surfaces of *Conaspis testudinatis* is reflected on internal molds as reduced, yet distinct, pustules. Two partly exfoliated cranidia (pl. 1, figs. 17, 18) illustrate the ornament of the internal mold. The granules on the specimen in figure 17 are obvious. On the two exposed surfaces visible in figure 18, low pustules crest the palpebral area of the left fixigena, and distinct granules ornament the anterior end of the right fixigena. The internal mold figured by Bell & Ellinwood (1962, pl. 58, fig. 13) is in fact granulate. As Bell & Ellinwood (1962, p. 404) stated, internal molds do look much like the two cranidia assigned to *C. perseas* (Hall) by Berg (1953, pl. 60, figs. 6, 7), but they differ somewhat from the holotype of *C. perseas* (Berg, 1953, pl. 60, fig. 5).

The range of *C. testudinatis* overlaps that of *C. leptoholcis;* the former is distinguished by its granular ornament, lesser glabellar convexity, deeper glabellar furrows, almost straight anterior border furrow, and bluntly pointed anterior border. *C. testudinatis* occurs through a 6 to 8 foot interval from the middle of the range of *Taenicephalus gouldi* up to the first occurrence of *T. shumardi*. In one collection (GR-144), *C. testudinatis* and *Wilbernia halli* var. A occur about 20 feet above the range base of *T. shumardi;* this may represent an extremely late occurrence of these two associates, or it may be a misnumbered collection.

Occurrence.—Scarce in the lower *Taenicephalus* Zone at CO-131; E-852, 855; GM-555; GR-126, 144; JR-126; LL-686; PK-888; SK-206; TA-10; TC-944.5; WC-895.

Genus Euptychaspis Ulrich, 1931

Euptychaspis Ulrich in Bridge, 1931, p. 217; Lochman in Harrington *et al.*, 1959, p. 0322; Winston & Nicholls, 1967, p. 78.

Type species.—*Euptychaspis typicalis* Ulrich in Bridge, 1931, p. 218, pl. 19, figs. 5–7.

Diagnosis.—Glabella parallel-sided up to the generally inflated anterior glabellar lobe; two pairs of usually connected glabellar furrows present, and a third pair may be present. Frontal area usually undivided, downsloping. Fixigenae variable in width and topography. Occipital ring expands back into bluntly pointed spine. External surface smooth or ornamented with elongate ridges or vermiform ridges. Librigena and pygidium unknown.

Remarks.—The discussion by Ulrich (in Bridge, 1931, p. 217) and the diagnosis by Lochman (in Harrington *et al.*, 1959, p. 0322) are based only on the type species and therefore are limited in their application. Winston & Nicholls (1967, p. 78) have given a good description of differences among the included species. I find that *E. jugalis* Winston & Nicholls and *E. frontalis,* n. sp., occcur below *E. typicalis,* and I do not think that *E. typicalis* is the stem species from which the other species were derived.

Euptychaspis frontalis Longacre, n. sp.

Pl. 3, figs. 2–5.

Description.—Cranidium bluntly triangular, slightly longer than wide. Glabella elongate, parallel-sided, broadly rounded anteriorly; although some glabellae are rounded across the top, most are flattened. Glabella crossed by two pairs of furrows that are deep notches on the side, becoming shallower across the top; if a third pair is present, they are shallow, straight, and do not connect. Axial furrow deep and wide posteriorly, becoming shallower around anterior end of glabella. Occipital furrow wide, well impressed; occipital segment tapers back into broad, blunt spine. The most variable feature is the length (sag.) of the preglabellar field—it can be about one-third as long as the glabella, gently sloping down to a thin (sag.), laterally tapering anterior border that is the same width (tr.) as the glabella; the preglabellar field can be absent, with the tapering anterior border separated from the glabella by the confluence of the preglabellar and anterior border furrows; intermediates between these two are common. This variation exhibits no trend or separation with respect to stratigraphic position or size of the cranidia. Anterior fixigenae one-fourth to one-half the width of the glabella. Palpebral lobes very narrow, short, upsloping, with posterior ends opposite second pair of glabellar furrows. Anterior facial sutures diverge slightly in front of palpebral lobes, then broadly sweep adaxially, giving the anterior one-half of the cranidium an elliptical appearance. Posterior facial sutures strongly divergent behind the palpebral lobes; posterior fixigenae broadly triangular. Posterior border furrow distinct, continuous into the occipital furrow without interruption at the juncture with the axial furrow; similarly, the posterior border continues unbroken into the occipital segment. All glabellae are notched in the front, particularly on internal molds. A strong vermiform ridge and pit pattern covers the exoskeleton. Internal molds may be smooth or carry a partial imprint of the vermiform pattern; the vermiform pattern may also be translated into pits on the molds, especially on the posterior fixigenae.

Librigena and pygidium unknown.

Available material.—55 cranidia, well preserved.

Holotype.—BEG 36504, from JR-369.3.

Etymology.—*frontalis,* named for its unusual frontal area.

Remarks.—This is, stratigraphically, the lowest species of *Euptychaspis* in central Texas. *E. frontalis* is characterized by its posteriorly parallel-sided and somewhat flattened glabella, its preglabellar field and anterior border, its broadly triangular posterior fixigenae, and its medially constricted cranidial outline. I think this species is the ancestral form for both *E. typicalis* and *E. jugalis.*

Occurrence.—Common in the *Saukiella pyrene* Subzone at BC-36, 41, 42; JR-369.5; SPH-140; SS-302.5, 307.5; TC-1237, 1238.

Euptychaspis jugalis Winston & Nicholls

Pl. 3, fig. 18.

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

Remarks.—Winston and Nicholls give a good description of this species. *Euptychaspis jugalis* is distinguished by its laterally expanded anterior glabellar lobe, posterior glabellar rings that are flattened across the top, and yoked outline of the cranidium. I agree with the statement that specimens in the *Saukiella junia* Subzone are intermediate between *E. jugalis* and *E. typicalis* and between *E. jugalis* and *E. kirki.*

One fragmental specimen has a rugose vermiform ridge and pit pattern (pl. 3, fig. 18). Almost all glabellae are notched in front, a character common to most Texas specimens assigned to *Euptychaspis.*

Occurrence.—Scarce in the *Saukiella pyrene* Subzone at JR-357. Scarce in the *Saukiella junia* Subzone at CC-27; TC-1303, 1341-1346, 1346-1352. Scarce in the *Saukiella serotina* Subzone at LCS-32.4; TC-1395.

Euptychaspis kirki Kobayashi

Euptychaspis kirki Kobayashi, 1935a, p. 56, pl. 10,

figs. 4, 5; WINSTON & NICHOLLS, 1967, p. 79, pl. 9, fig. 18.

Remarks.—This species is well described and illustrated by Kobayashi and by Winston and Nicholls. *Euptychaspis kirki* is confined to the *Saukiella serotina* Subzone and is associated with *E. jugalis,* but it is stratigraphically higher than *E. frontalis* and *E. typicalis.* The highly expanded and convex anterior glabellar lobe that overhangs the narrow frontal area distinguishes *E. kirki* from all other species of *Euptychaspis.*

Occurrence.—Common to locally abundant in the *Saukiella serotina* Subzone at CC-58.2, 61, 63±; JR-521.5, 529, 532, 536; LCS-32.4, 33, 35.7, 39, 40, 44, 45, 45.4, 45.8, 52; SH-52, 54, 55, 58.5-60, 61.5, 65.5, 71; SS-398, 409; TC-1368-1374, 1379-1385, 1388, 1391.5, 1392, 1395, 1400.

Euptychaspis typicalis Ulrich

Pl. 4, fig. 9.

Euptychaspis typicalis Ulrich in BRIDGE, 1931, p. 218, pl. 19, figs. 5–7; DAKE & BRIDGE, 1932, p. 740, pl. 12, fig. 3; RASETTI, 1959, p. 393, pl. 52, figs. 11–13; WINSTON & NICHOLLS, 1967, p. 78, pl. 9, fig. 17.

Remarks.—Several cranidia in the Texas collections have a short (sag.), smooth, flat anterior border that has not been previously noticed but can be seen in Winston & Nicholls' figure (pl. 9, fig. 17). This shelflike projection is difficult to expose, and none of the specimens have the complete border.

Euptychaspis typicalis is distinguished by the nearly parallel-sided posterior one-half of the glabella, the wide fixigenae, and the ornament on the frontal area. Although this ornament is usually a set of separated transverse ridges, a few specimens have a strong vermiform ridge pattern across the frontal area. *E. typicalis* occurs above *E. frontalis,* below *E. kirki,* and in association with *E. jugalis.*

Occurrence.—Scarce in the *Saukiella junia* Subzone at BC-109-110, 149; JR-479, 481; SH-12.6; SS-356, 372.5; TC-1301, 1305-1310.

Genus KEITHIA Raymond, 1924

Keithia RAYMOND, 1924, p. 451; Lochman in HARRINGTON *et al.,* 1959, p. 0322.

Type species.—*Keithia schucherti* Raymond, 1924, p. 452, pl. 14, figs. 5, 9.

Remarks.—The diagnosis given by Lochman (in Harrington *et al.,* 1959) summarizes the characteristics of this genus, which is closely related to *Keithiella* (see Rasetti, 1945b, p. 468, in discussion of *Keithia connexa*).

Keithia cf. *K. connexa* Rasetti

Pl. 2, figs. 20, 21.

Keithia connexa RASETTI, 1945b, p. 468, pl. 61, figs. 3–5.

Remarks.—*Keithia connexa* is characterized by its tumid, cylindrical glabella that drops steeply down to the preglabellar furrow, one pair of glabellar furrows that connect across the top and two faint pairs that are laterally impressed, no preglabellar field, and fixigenae that maintain their width and continue around and down into the anterior border. Internal molds are smooth.

Six cranidia seem to be identical with *Keithia connexa* except for the number of pairs of connected glabellar furrows and for the character of the frontal area and its continuation around into the anterior fixigenae. *K. connexa* has a wide border that is strongly deflected downward, and the anterior fixigenae are correspondingly wide. The Texas cranidia have relatively narrow borders and anterior fixigenae, and they are not quite so convex. *K. connexa* has one pair of connected glabellar furrows, whereas the Texas cranidia have two connected pairs. In all other features they appear to be identical with *K. connexa,* even to the fine granular ornament on the exoskeleton. I think these six cranidia may be conspecific with *K. connexa.* I refrain from making more precise alliances until more material is found in Texas and until more information is available on the stratigraphic position of *Keithia connexa.*

Occurrence.—Scarce in the *Saukiella pyrene* Subzone at BC-41; JR-351.

Genus KEITHIELLA Rasetti, 1944

Keithiella RASETTI, 1944, p. 243; Lochman in HARRINGTON *et al.,* 1959, p. 0322.

Type species.—*Arionellus cylindricus* Billings, 1860, p. 306, fig. 385.

Diagnosis.—Glabella parallel-sided to slightly tapering, downsloping in front; posterior glabellar furrow continuous, one to three additional pairs of short furrows may be present. Fixigenae elevated above axial furrow, anterior fixigenae deflected downward. No preglabellar field. Border separated from anterior fixigenae by anterior border furrow. Palpebral lobes small, ocular ridges can be present. Occipital node can be present.

Remarks.—*Euptychaspis* and *Ptychaspis* are closely related to *Keithiella,* but they can easily be differentiated from it by the moderately to deeply impressed anterior border furrow of *Keithiella* that separates border from the anterior fixigenae. *Keithiella* is distinguished from *Keithia* by its less tumid anterior part of the

cranidium, by the wider anterior fixigenae and anterior border, and usually by the more elongate glabella with a transglabellar furrow.

Eight described species are included in *Keithiella:* *K. cylindrica* (Billings), 1860; *K. depressa* Rasetti, 1944; *K. brevis* Rasetti, 1944; *K. maior* Rasetti, 1945; *K. speciosa* Rasetti, 1946; *K. scrupulosa* Ellinwood, 1962; *K. patula* Winston & Nicholls, 1967; and *K. scapane,* n. sp.

Keithiella patula Winston & Nicholls

Keithiella patula Winston & Nicholls, 1967, p. 79, pl. 10, figs. 4, 7.

Remarks.—This species occurs stratigraphically above *Keithiella scapane,* n. sp., and is distinguished from it by its lesser convexity, shorter anterior border, narrower anterior border furrow, and parallel-sided glabella.

Occurrence.—Locally common in the *Saukiella serotina* Subzone at JR-536; LCS-35.6, 39, 44; SH-54, 61.5-62; SS-409; TC-1400. One cranidium from the *Saukiella pyrene* Subzone at TC-1286.

Keithiella scapane Longacre, n. sp.

Pl. 3, figs. 8–10.

?*Keithiella* sp. Bell & Ellinwood, 1962, p. 405, pl. 58, fig. 18.

Description.—Cranidium elongate. Glabella transversely convex, tapering, slightly truncated, anterior end dropping quickly down to the preglabellar furrow; posterior pair of glabellar furrows very deeply impressed and posteriorly directed on the sides of the glabella but become shallower and continuous across the top; second pair of moderately deep notches do not connect; third and fourth pairs of glabellar furrows are short, very shallow, and anteriorly directed. Axial furrow deep, wide; preglabellar furrow not so wide or deep. Occipital furrow deep and wide, transverse medially but swings forward and becomes deeper at the lateral extremities. Occipital ring of uniform width medially but slightly tapered laterally; occipital node present. Anterior border furrow extremely wide and arcuate, with an indistinct posterior edge and a distinct anterior edge where the furrow rises up to the raised anterior border; row of granules just behind the anterior edge of the border furrow. Anterior border transversely and longitudinally convex, greatly expanded medially, and bluntly to sharply pointed anteriorly; slight medial expansion of the posterior edge of the border, giving the appearance of pointing to the rear; this posterior expansion usually obliterates the central part of the row of granules in the border furrow and is reflected in a small depression on the anterior end of the glabella. Fixigenae wider than one-half glabellar width, rising steeply out of axial furrow. Palpebral areas strongly elevated, almost as high as the glabella, crossed by distinct ocular ridges. Palpebral lobes narrow, opposite or behind glabellar midpoint; palpebral furrow distinct. Anterior fixigenae strongly deflected downward. Posterior area deflected down, posterior border furrow broad and distinct. Anterior facial sutures straight, divergent in front of palpebral lobes. Carapace smooth. Several of the internal molds have a very rough surface, suggesting that at least the inside of the exoskeleton was covered with shallow depressions or a coarse ridge and pit pattern.

Librigena and pygidium unknown.

Available material.—38 cranidia, many broken.

Holotype.—BEG 36510, from BC-32.

Etymology.—*skapane,* Greek, a digging tool, spade; named for its unusual anterior border that looks like a garden tool.

Remarks.—Cranidia have been collected from the *Saukiella pyrene* Subzone in four measured sections. *Keithiella scapane* is probably a stratigraphic associate of *K. scrupulosa* Ellinwood but is considerably lower in the section than *K. patula* Winston & Nicholls. With the exception of the expanded anterior border, this species conforms well with *Keithiella;* straight-sided and tapering glabella, deep glabellar furrows with the posterior pair continuous across the glabella, elevated fixigenae and palpebral lobes, divergent anterior facial sutures, and downward deflected anterior fixigenae. The anterior border furrow is deep and relatively wide; the angle subtended by the arc of the border furrow increases with an increase in the size of the specimens; curvature of this furrow on smaller specimens is comparable to other species of *Keithiella,* but it markedly increases with an increase in size. The expanded and bluntly to sharply pointed anterior border is unique for the genus. Although Rasetti specifically excludes ocular ridges and occipital spines from his generic concept, suggestions of ridges and occipital nodes can be seen on some of his illustrations (1944, pl. 39, figs. 39, 42; 1946, pl. 1, fig. 6). In spite of the unusual anterior border, this species is included in *Keithiella.*

Occurrence.—Locally common in the *Saukiella pyrene* Subzone at BC-23, 36, 41, 42; JR-369.5, 374.5, 394; SPH-93; TC-1237, 1244, 1263.

Keithiella scrupulosa Ellinwood

Keithiella scrupulosa Ellinwood in Bell & Ellinwood, 1962, p. 405, pl. 58, figs. 19–21.

Remarks.—This species occurs at the base of the *Saukiella pyrene* Subzone in only two sections. It is well described and illustrated by Bell and Ellinwood.

Occurrence.—Scarce in the *Saukiella pyrene* Subzone at MC-915±; SS-302.5, 307.5.

Genus Macronoda Lochman, 1964

Macronoda Lochman, 1964a, p. 53.

Type species.—*Macronoda prima* Lochman, 1964a, p. 53, pl. 14, figs. 12–23.

Remarks.—All that is known of this genus is discussed by Lochman (1964a, p. 53).

Macronoda cf. *M. prima* Lochman

Pl. 6, fig. 6.

Macronoda prima Lochman, 1964a, p. 53, pl. 14, figs. 12–23; Winston & Nicholls, 1967, p. 79, pl. 9, fig. 19.

Remarks.—Eleven cranidia are assigned to this species, with reservation. Although these granular cranidia are very much like those illustrated by Lochman, there are differences that should be mentioned. The swollen anterior glabellar lobe is somewhat square-cut anteriorly and tapers slightly posteriorly. The posterior glabellar lobe is flattened across the top, producing corners on its lateral edges as in *Euptychaspis jugalis.* As Winston and Nicholls mentioned, the Texas specimens lack palpebral lobes. The facial sutures swing slightly inward where an eye would be located, and there is a trace of an ocular ridge. The occipital ring lacks any trace of a node or spine, and thus the species is differentiated from any of *Euptychaspis.*

I think it is possible that monotypic *Macronoda* could be suppressed as a synonym of *Euptychaspis,* but more and better preserved material is needed.

Occurrence.—Scarce in the upper one-half of the *Saukiella serotina* Subzone at JR-521.5, 529; TC-1387.5, 1388, 1392, 1400.

Genus Ptychaspis Hall, 1863

Ptychaspis Hall, 1863, p. 170; Bell, Feniak, & Kurtz, 1952, p. 192; Lochman in Harrington *et al.,* 1959, p. 0320.

Type species.—*Dikelocephalus miniscaensis* Owen, 1852, p. 574, pl. 1, fig. 3a; pl. 1A, figs. 4, 5.

Remarks.—Except for the fact that the palpebral width of the fixigenae can be about one-half the basal glabellar width, Lochman (in Harrington *et al.,* 1959) has well summarized the characters of the genus. The generic discussion of Bell, Feniak, & Kurtz (1952) is concerned with the problem of which species is the type of the genus.

Ptychaspis bullasa Lochman & Hu

Pl. 2, figs. 4, 5.

Ptychaspis bullasa Lochman & Hu, 1959, p. 422, pl. 58, figs. 21–42; Bell & Ellinwood, 1962, p. 405, pl. 58, figs. 14–17.

Remarks.—*Ptychaspis bullasa* is represented by about 50 cranidia scattered through 11 measured sections; most specimens are internal molds and few are complete. These cranidia compare quite well with Lochman and Hu's illustrations but differ in one respect: the palpebral lobes are opposite the middle one-third or anterior one-half of the glabella, rarely the anterior one-third. Bell & Ellinwood (1962, p. 405) indicated that the occipital ring and lateral ends of the basal glabellar lobes are free of ornament, but the unexfoliated cranidium here illustrated (pl. 2, fig. 5) has granules on the back edge of the occipital ring.

P. bullasa is characterized by its nearly parallel-sided glabella that is higher than the flatly convex fixigenae, granules on most areas behind the ocular ridges, and transverse ridges across the steeply downsloping frontal area.

P. bullasa usually occurs in association with *Drumaspis texana,* but it can extend up into the range of *D. idahoensis.* High in its range, *P. bullasa* becomes rather variable: the back section of frontal area can be smoothed out, and the glabella can be more equidimensional (pl. 2, fig. 4). This variability may be intraspecific, or a few representatives of other species of *Ptychaspis* might be mixed with *P. bullasa.* These unusual forms come from TC-1025, ST-574.5, 578, and GR-195. These horizons should be intensively recollected in order to determine the source and continuity of the variation.

Occurrence.—Common in the *Idahoia* Zone at CR-743-747; EC-25, 26, 35; GM-604; GR-183, 195; LL-725-728; SK-245, 248; SS-101, 103, 109; ST-541, 574.5, 578; SU-116; TC-1003, 1025; WC-950, 968.

Ptychaspis sp.

Pl. 2, figs. 12–14.

Description.—Glabella subrectangular, may taper slightly, anteriorly rounded to rounded-truncate. Posterior glabellar furrow deep and angled back on the sides but shallower and continuous across the axis; middle furrow gently bowed back, continuous; if present, the anterior pair of furrows are short, shallow, and angled forward. Fixigenae wide, moderately convex, and raised, with the crests of the fixigenae slightly lower than the glabella. Frontal area convex and downsloping but not vertical. Palpebral lobes usually opposite glabellar midlength. Ornament on internal molds consists of granules on the palpebral areas of the fixigenae and on

the glabella in front of the posterior transglabellar furrow; although the preoccipital segment of the glabella is usually smooth, a few low granules can be scattered across this area. Ornament on frontal area unknown; it appears to be smooth. Ornament on exoskeleton unknown.

Remarks.—Above the range of *Ptychaspis bullasa* and in association with *Prosaukia* cf. *P. tuberculata, Dartonaspis wichitaensis, Chariocephalus whitfieldi,* and *Stigmacephaloides curvabilis* are fragments of 14 cranidia and several librigenae that are assigned to this genus. Although they cannot be included in any existing species of *Ptychaspis,* the specimens are too fragmentary to describe as a new species.

Ptychaspis sp. differs from *P. granulosa* (Owen) in ornament distribution, height of the glabella above the fixigenae, and slope of the frontal area. It differs from *P. arcolensis* Nelson in ornament distribution, in having two pairs of continuous glabellar furrows, and in biostratigraphic position. *Ptychaspis* sp. is a biostratigraphic equivalent of *P. miniscaensis* (Owen), the type species, from which it differs in ornament, shape and furrowing of the glabella, slope of the front of the cranidium, width of the fixigenae, and position of the palpebral lobes. From the stratigraphically lower *P. bullasa* this species differs in ornament distribution and in having relatively narrower fixigenae.

Occurrence.—Scarce in the middle *Ellipsocephaloides* Zone at MC-840, 844; TC-1095, 1095-1100, 1105; WC-1069.

Subfamily SAUKIINAE Ulrich & Resser, 1933

Remarks.—Ulrich & Resser (1933, p. 136) established the subfamily Saukiinae as part of the Dikelocephalidae, with the genus *Saukia* as the type of the subfamily. I think the subfamily Saukiinae is genetically part of the family Ptychaspididae (text-fig. 1). I recognize essentially the same genera in the subfamily as did Ulrich and Resser; because *Tellerina* does not occur in Texas, it is not discussed herein. Although Ulrich & Resser (1933, p. 137) discussed several differences between the Saukiinae and the Dikelocephalinae, they did not give a diagnosis of the Saukiinae. The diagnosis given by Lochman (in Harrington *et al.,* 1959, p. 0322) for the family Saukiidae can serve as the diagnosis for the subfamily Saukiinae, with two modifications: (1) surfaces can be smooth, granulose, or bear elongate ridges, and (2) the Saukiinae is derived from the Ptychaspidinae, possibly from *Ptychaspis.*

Saukia and *Calvinella* are morphologically quite similar, and they may be genetically more closely related to each other than they are to either *Prosaukia* or *Saukiella.* Similarly, *Prosaukia* and *Saukiella* may be more closely related to each other than they are to *Saukia* or *Calvinella.*

Genus CALVINELLA Walcott, 1914

Calvinella WALCOTT, 1914, p. 388; ULRICH & RESSER, 1933, p. 215; Lochman in HARRINGTON *et al.,* 1959, p. 0323.

Type species.—*Dikelocephalus spiniger* Hall, 1863, p. 143, pl. 10, figs. 1, 2, 3?.

Diagnosis.—Glabella subrectangular, slightly tapered, rounded-truncate anteriorly; two or three pairs of glabellar furrows, posterior pair usually connected, second pair may connect. Preglabellar field absent; anterior border furrow transverse, may be diagonal from corners of glabella to cranidial margin; anterior border of variable length (sag.). Width of fixigenae variable. Occipital ring spined. Librigenae with border furrows that connect, then fade on genal spine. Pygidium transversely elliptical, with prominent axis about one-half length (sag.) of pygidium; three to five axial rings, postaxial ridge extending out onto border; three to five unequally divided pleurae, with pleural furrows approaching anterior edge of pleurae; pleural furrows fade into border. Surfaces granulose or ornamented with raised, elongate ridges.

Remarks.—The unequally divided pleurae and the occipital spine distinguish *Calvinella* from other genera in the Saukiinae.

Calvinella prethoparia Longacre, n. sp.

Pl. 6, figs. 7–12.

Calvinella ozarkensis Walcott, WINSTON & NICHOLLS, 1967, p. 80, pl. 11, figs. 5, 9.

Description.—Cranidium subrectangular. Glabella almost straight-sided, tapering, strongly truncated, with moderate transverse convexity. Three or four pairs of glabellar furrows; posterior pair continuous and broad, deeply gouged laterally but shallower across the axis; second pair deep laterally, becoming shallower adaxially, may be continuous; third pair short, shallow, gently recurved, not connected, do not intersect the axial furrow; fourth pair, if present, narrow, faint, and anteriorly directed. Axial furrow broad and shallow; preglabellar furrow confluent with anterior border furrow. Occipital furrow broad and deep, recurved medially and curved forward laterally. Occipital ring long (sag.). Long, slender occipital spine projects up and back. The more robust the spine, the more medially expanded is the occipital ring and the more anteriorly bowed and shallower is the medial part of the occipital furrow. Preglabellar field absent. Anterior border furrow shallow, becoming relatively broader in larger specimens. Anterior border gently convex, slightly tapered

laterally, with broadly rounded or pointed anterior margin. Fixigenae wide and gently convex. Palpebral area usually between one-third and one-half the greatest width of the glabella; this ratio is greater than one-half for the relatively small specimens. Palpebral furrow broad and very distinct on exoskeleton but narrow on internal molds. Slender palpebral lobe tapered on both ends. Anterior fixigenae broad, flatly convex, gently downsloping. Posterior fixigenae broadly triangular, sloping both posteriorly and laterally. Posterior border furrow distinct, intersects axial furrow behind the occipital furrow. Posterior border of uniform width (exsag.). Anterior facial suture divergent to slightly convergent in front of palpebral lobes, becomes slightly more convergent just after passing the anterior border furrow, then cuts sharply toward the axis, where it can define a broad point. Posterior facial suture divergent, straight to slightly concave. Ornament on exoskeleton: glabella, occipital ring, and posterior border covered with coarse granules, some of which are elongate; fixigenae covered with vermiform ridges and granules that are longitudinal on the posterior and palpebral areas and become transverse on the front edge of the anterior fixigenae; vermiform ridges and granules traverse the anterior border; a row of squashed granules rim the inside edge of the palpebral lobe. Internal molds bear similar ornament; granules on the occipital ring and glabella can be swirled in a pattern reminiscent of a Bertillon ornament; vague impressions of the vermiform ridges and granules on fixigenae and anterior border. Internal molds of small specimens may be smooth, possibly because they lack ornament or because the ornament is too delicate to be easily preserved.

Pygidium transversely elliptical, length almost one-half width. Relatively broad, tapered axis consists of an articulating half ring, five axial rings, and a terminal axial piece that extends into the pleural field as a low postaxial ridge. Five well-defined, unequally divided pleurae; anterior pleural band of first pleura subequal to posterior band; anterior pleural bands of the more posterior pleurae progressively reduced and almost absent on the hindmost pleura. Furrows narrow and deep on convex area adjacent to axis, become shallower and fade out on the flatly concave margin. Posterior border furrow absent. Axial rings and pleurae covered with closely spaced granules. Elongate granules and low ridges swirl around the end of the terminal axial piece and along the concave margin. Internal molds preserve only the granules.

Available material.—42 cranidia, 3 pygidia, many well preserved.

Holotype.—UT 12589, from TC-1400.

Etymology.—pretho, Greek, swell, blow up, inflated; *pareion,* Greek, cheek, named for its enlarged fixigenae.

Remarks.—Calvinella prethoparia is characterized by its wide fixigenae, relatively narrow anterior border, relatively short, broad glabella with three or four pairs of glabellar furrows, and ornament on both cranidium and pygidium. These features serve to distinguish it from *C. procera* and *C. tenuisculpta,* both of which can occur with *C. prethoparia.*

C. prethoparia differs from *C. ozarkensis* Walcott. The fixigenae are wider, particularly in the juveniles; the frontal area is not divided into a preglabellar field and anterior border by a faint anterior border furrow; the glabella is more tapered and not so convex; and the long (trans.) anterior border has a nearly straight posterior edge and an anterior margin that comes to a slight point at the axial line.

C. prethoparia looks very much like *Saukia marica* Walcott (1914, p. 380, pl. 64, figs. 6, 6a). The fixigenae are of comparable width, and glabellar shape and furrows are similar. The holotype of *S. marica* cannot be located (Jesse Merida, U.S.N.M., letter of Nov. 9, 1967). *S. marica* does not come from the Dunderberg shale but from higher in the section (A. R. Palmer, letter of Oct. 23, 1967). *Bowmania americana* (Walcott) occurs with *S. marica* in Nevada (Walcott, 1914, p. 361) and with *C. prethoparia* in central Texas. These two nominal species could be conspecific, but, until the holotype is located and more complete specimens are available, they must remain separate.

Occurrence.—Common in the upper *Saukiella serotina* Subzone at CC-61, 63±; JR-529, 536; LCS-44, 45, 45.4, 45.8; TC-1388, 1400.

Calvinella procera Winston & Nicholls

Pl. 4, fig. 16.

Calvinella procera Winston & Nicholls, 1967, p. 80, pl. 10, fig. 22; pl. 11, figs. 1, 3.

Remarks.—Most specimens of *Calvinella procera* agree quite well with Winston and Nicholls' description. However, there are a substantial number that possess one or more of the outstanding features of its stratigraphic associate, *C. tenuisculpta.* The most commonly shared characters are a short, transverse anterior border furrow, more posterior palpebral lobes, a more rectangular glabella, and shorter (exsag.) posterior limbs. Similarly, there are specimens of *C. tenuisculpta* that possess such *C. procera* features as a longer (sag.), more rounded anterior border or stouter posterior limbs. I have left the two as separate species, although they may later be shown to be conspecific, and the

variation, the consequence of sexual dimorphism or intraspecific variation.

This species is distinguished from *C. spiniger* (Hall), the type species, by an inflated anterior border, a tapered glabella, and wider fixigenae.

Occurrence.—Common to locally abundant in the *Saukiella serotina* Subzone at LCS-32.4, 35.7, 39, 40, 45, 45.4, 45.8, 52-54; SH-52, 52.6, 54, 55; SS-383; TC-1357-1363, 1368-1374. Scarce in the base of the *Corbinia apopsis* Subzone at LCS-53.

Calvinella tenuisculpta Walcott

Pl. 4, fig. 17.

Calvinella tenuisculpta Walcott, 1914, p. 391, pl. 64, fig. 7a; Winston & Nicholls, 1967, p. 80, pl. 11, fig. 4.

Remarks.—Although *Calvinella tenuisculpta* is very similar to its stratigraphic associate, *C. procera*, it can be distinguished by a shorter frontal area with a nearly transverse anterior margin, by the more rectangular glabella with a transglabellar furrow, by the generally more posterior palpebral lobes, by shorter (exsag.) posterior limbs, and by the narrower anterior fixigenae.

The holotype, an internal mold, bears a Bertillon ornament on its glabella and occipital ring. Preservation of the Texas material usually is not good enough to show ornament, but vague impressions of a Bertillon pattern can be seen. Fragments of exoskeleton preserve a transverse set of ridges on the anterior border that are not preserved on the internal mold.

C. tenuisculpta is distinguished from *C. spiniger* (Hall) by its longer (sag.) anterior border and wider fixigenae.

Occurrence.—Scarce in the *Saukiella serotina* Subzone at JR-519, 521.5; LCS-33, 33.5, 35.7, 40; SS-375.

Genus Prosaukia Ulrich & Resser, 1933

Prosaukia Ulrich & Resser, 1933, p. 137; Lochman in Harrington *et al.*, 1959, p. 0324.

Type species.—*Dikelocephalus misa* Hall, 1863 (part), p. 144, pl. 8, fig. 15; pl. 10, figs. 4, 5.

Remarks.—The diagnosis of Lochman (in Harrington *et al.*, 1959) summarizes the characteristics of the genus.

Prosaukia is distinguished from *Saukia* and *Calvinella* by the presence of a preglabellar field. Possession of either an occipital spine, a granular ornament, or both, and a generally subequally divided frontal area on which the medial part of the anterior border furrow can be obsolete will distinguish species of *Prosaukia* from *Saukiella*. The lateral border furrow and the posterior border furrow on the librigenae of species of *Prosaukia* do not connect.

Prosaukia cf. *P. curvicostata* Ulrich & Resser

Prosaukia curvicostata Ulrich & Resser, 1933, p. 145, pl. 25, figs. 1–7; Nelson, 1951, p. 778, pl. 110, figs. 6, 16, 18; Raasch, 1951, p. 142 (synonymy to date).

Prosaukia cf. *P. curvicostata* Ulrich & Resser, Bell & Ellinwood, 1962, p. 406, pl. 59, fig. 1.

Remarks.—The specific assignment remains tentative until additional and better preserved material is available. The smooth exoskeleton, lack of an occipital spine, and gently convex and arcuate anterior border distinguish this species.

The three cranidia assigned to this species come from the highest *Ellipsocephaloides* Zone collections in the two sections; two of them are associated with *Idiomesus infimus*, n. sp.

Occurrence.—Very scarce in the *Ellipsocephaloides* Zone at JR-284, 284.5; TC-1142.

Prosaukia remora Longacre, n. sp.

Pl. 4, figs. 19–21.

Prosaukia longicornis Ulrich & Resser, Winston & Nicholls, 1967, p. 80, pl. 10, fig. 6.

Description.—Cranidium moderately convex, elongate. Glabella strongly convex, almost straight-sided, slightly tapering; anterior end truncated, but anterior corners rounded. Posterior glabellar furrow continuous, deep, and curved laterally but shallower and straight across the top; second and third pairs of furrows shallow and laterally impressed, second pair directed slightly back, third pair directed forward. Axial furrow broad and deep, widens to form fossulae at anterior corners of the glabella; preglabellar furrow broad and shallow. Occipital furrow as deep and wide as the transglabellar furrow, curved forward laterally, and slightly bowed forward medially. A broad, curved anterior border furrow divides the frontal area into a raised, thin, tapered border and a long (sag.), asymmetrically convex preglabellar field that is unusual for the genus. Some specimens appear to have a transverse, curved ridge crossing the preglabellar field; this represents the change in slope between the anterior edge of the broad preglabellar furrow and the posterior edge of the preglabellar field. Also present in this field may be two small longitudinal ridges that may extend from the glabella to the anterior border. These can be seen in many of Ulrich and Resser's figured specimens of *Prosaukia*. Fixigenae moderately wide, slope gently into the axial furrow; greatest width of palpebral area just opposite lateral ends of posterior transglabellar furrow. Palpebral furrow broad, palpebral lobes narrow. Anterior facial sutures

strongly divergent in front of palpebral lobes, curve downward, and swing adaxially before intersecting the border furrow. Posterior facial suture defines a broad (tr.) posterior fixigena but leaves a relatively stout, short posterior limb. All areas of exoskeleton granulate; internal molds may or may not preserve the ornament.

Librigena and pygidium unknown.

Available material.—7 cranidia, fairly well preserved.

Holotype.—BEG 36536, from LCS-40.

Etymology.—remora, Latin, delay, named for its occurrence late in the Trempealeauan.

Remarks.—Prosaukia remora occurs in the middle of the range of *Saukiella serotina,* n. sp., and its associates are Trempealeauan and not Franconian as are those of *Prosaukia longicornis. P. remora* differs from all other species of *Prosaukia* in that its preglabellar field is at least twice as long (sag.) as the anterior border. It also differs from *P. longicornis* in its granular ornament. Because of its convexity, long preglabellar field, and occipital spine, *P. remora* cannot be confused with either of Ulrich and Resser's two Trempealeauan species, *P. lodensis* (1933, p. 162, pl. 28, fig. 9) or *P. incerta* (1933, p. 161, pl. 28, figs. 12–17).

Occurrence.—Scarce in the middle of the *Saukiella serotina* Subzone at LCS-33, 40, 45; SH-55.

Prosaukia cf. *P. tuberculata* Ulrich & Resser

Prosaukia tuberculata Ulrich & Resser, 1933, p. 159, pl. 28, fig. 5; Decker, 1945, p. 39, pl. 9, fig. 14; Berg, 1953, p. 567, pl. 61, figs. 2–4; Raasch, 1951, p. 143, 149 (synonymy to date).

Prosaukia cf. *P. tuberculata* Ulrich & Resser, Bell & Ellingwood, 1962, p. 406, pl. 59, figs. 2, 3.

Remarks.—This taxon has recently been discussed and illustrated by Bell & Ellinwood (1962). I add the specific range data for the three cranidia.

Occurrence.—Very scarce in the *Ellipsocephaloides* Zone at JR-245, TC-1105, and Decker's locality 159T-5-50A.

Genus Saukia Walcott, 1914

Saukia Walcott, 1914, p. 373; Ulrich & Resser, 1933, p. 168; Lochman in Harrington *et al.,* 1959, p. 0323.

Type species.—Dikelocephalus lodensis Whitfield, 1880, p. 51; 1882, p. 188, pl. 10, fig. 14; p. 341, pl. 27, figs. 12, 13.

Diagnosis.—Glabella subrectangular, sides slightly converging or medially constricted; two pairs of glabellar furrows with at least the posterior pair connected; glabella anteriorly rounded-truncate; antero-lateral corners pointed or broadly rounded. Fixigenae narrow. No preglabellar field. Anterior border furrow confluent with at least the medial part of preglabellar furrow; anterior border of moderate length (sag.). Librigenae with posterior border furrow meeting lateral border furrow; genal spines long and slender. Pygidium transversely subelliptical, with strongly tapered axis; subequally divided pleurae die out on narrow, smooth, concave border. Surfaces granulate.

Remarks.—Saukia is distinguished from *Prosaukia* and *Saukiella* by its lack of a preglabellar field and by its granular ornament. The subequally divided pleurae and the lack of an occipital spine distinguish *Saukia* from *Calvinella.*

Saukia imperatrix Ulrich & Resser

Saukia imperatrix Ulrich & Resser, 1933, p. 192, pl. 31, figs. 21–25; Raasch, 1951, p. 144; Winston & Nicholls, 1967, p. 81, pl. 9, figs. 15, 16, 21.

Remarks.—A feature noticed on some of the Texas specimens is a small node on the occipital ring. This is difficult to see on large, granulate specimens (see Winston & Nicholls, pl. 9, fig. 15) but easy to see on the smaller ones. It is not found on all specimens, and I doubt that it should be construed as anything more than an interesting feature. If it seemed to be an important character or if it appeared on all specimens, a researcher might be tempted to place this species in *Calvinella,* but the associated pygidium is not calvinellid. The holotype and paratype cranidia do not possess the central segment of the occipital ring, so they are of no help in this matter. I conclude that this species belongs to the genus *Saukia.*

The axes of some pygidia have a partial fifth axial ring, as does *S. tumida.* Granules are present on the crests of the axial rings and pleurae.

Occurrence.—Locally common in the upper *Saukiella junia* Subzone and the lower *Saukiella serotina* Subzone at BC-109-110, 149; CC-58.2, 61; JR-484, 492; SH-12.6.

Saukia tumida Ulrich & Resser

Pl. 4, figs. 10, 11.

Saukia tumida Ulrich & Resser, 1933, p. 192, pl. 30, figs. 11, 12; Winston & Nicholls, 1967, p. 81, pl. 9, figs. 7, 9, 11.

Remarks.—Saukia tumida is characterized by its convex and steeply downsloping glabella and frontal area. The cranidium figured here (pl. 4, fig. 10) shows the granule-crested palpebral lobe separated from the narrow fixigena by a broad, steep-sided palpebral furrow. One of Winston & Nicholls' (pl. 9, fig. 11) figured specimens illustrates the slender, somewhat posteriorly directed posterior area.

Two fragments of librigenae are assigned to this species. The arrangement of a row of granules adjacent to the ocular furrow and the low, coarse, vermiform ridge pattern on the rest of the cheek provide a striking ornament (pl. 4, fig. 11). This librigena is distinguished from that of *S. imperatrix* by its narrower (tr.) posterior side of the inner area; other features of the two cheeks are similar.

On well-preserved pygidia there is an indication of two granules on the highest part of at least the first two axial rings. A fifth axial ring is suggested by an incomplete shallow furrow across the terminal axial piece.

S. tumida occurs stratigraphically below *S. imperatrix* and is distinguished from it by greater convexity, greater downward deflection of the frontal area, more rounded anterior end of the glabella, narrower fixigenae, and deeper glabellar furrows.

Occurrence.—Locally common in the *Saukiella junia* Subzone at JR-481; SS-356, 360.5; TC-1305-1310, 1320-1325.

Genus SAUKIELLA Ulrich & Resser, 1933

Saukiella ULRICH & RESSER, 1933, p. 194; Lochman in HARRINGTON *et al.*, 1959, p. 0325.

Type species.—Dikelocephalus pepinensis Owen, 1852, p. 574, pl. 1, figs. 9, 9a, 9b.

Remarks.—Ulrich & Resser (1933, p. 194) have given a complete and definitive diagnosis for this genus. The modification I make is that surfaces usually are not smooth; external surface ornament consists of elongate ridges on marginal cranidial features or a Bertillon pattern; internal molds generally bear only a partial imprint of the external ornament.

Saukiella is distinguished from *Saukia* and *Calvinella* by a preglabellar field, shallower furrows, ornament, and lack of a strong occipital node or spine. *Saukiella* is distinguished from *Prosaukia* by its relatively longer frontal area, nongranular ornament, lack of occipital spine, and confluent lateral border and posterior border furrows on the librigena.

Saukiella fallax (Walcott)

Pl. 5, figs. 1–3.

Saukia fallax WALCOTT, 1914 (part), p. 378, pl. 67, figs. 21, 21a (not 22, 22a = *Briscoia* sp.).

Description.—Cranidium quadrate, with low transverse convexity and moderate longitudinal convexity anterior to the palpebral lobes. Glabella subquadrate to subelongate, slightly tapered, truncate in front, with only the anterior corners showing any rounding. Axial furrow broad, straight along the anterior one-half of the glabella but bowed slightly outward posteriorly, resulting in a slight expansion of the posterior one-half of the glabella. This glabellar expansion is more noticeable in the small specimens. Posterior glabellar furrow continuous, deep on the sides, and shallower across the top; second pair of furrows very shallow, slightly recurved, connecting on some specimens. Occipital furrow transverse or bowed slightly forward medially, as broad and deep as the transglabellar furrow. Occipital ring of uniform width and almost as wide as the posterior glabellar lobe. Anterior border furrow broad and deep, bowed gently forward, confluent with preglabellar furrow across at least the middle one-third of the glabella. Anterior border highly raised, very narrow, and laterally tapering. Fixigenae narrow; palpebral area long, flat, sloping down laterally, widest point opposite junction of axial and transglabellar furrows. Palpebral furrow distinct; palpebral lobes broad, flat, and elongate. Anterior facial sutures divergent in front of palpebral lobes; anterior angles of cranidium rounded. Posterior facial sutures fairly straight to the posterior margin. Posterior areas of fixigenae tapering, crossed by broad, deep posterior border furrow. Surface of palpebral area, anterior fixigenae, and lateral part of the anterior border furrow covered with elongate ridges. Ornament continues up onto the anterior border and up the sides of the glabella. Other ornament unknown. Internal molds smooth.

Pygidium (pl. 5, fig. 2) transversely elliptical. Tapered axis consists of articulating half ring, three axial rings, a terminal axial piece that has a suggestion of a fourth axial ring on its anterior end, and a postaxial ridge that extends almost to the posterior edge. Four pleurae are subequally divided by pleural furrows on the convex part of the pleural region; pleurae fade out in the concave margin. Concavity of the margin decreases toward postaxial ridge, where the margin becomes slightly convex. Pleural furrows broad, deep; interpleural furrows shallower, with anterior edges quite sharply raised relative to the gentle upslope of the posterior part of the furrow. No border apparent on exoskeleton; small raised border may be present on molds in the vicinity of the postaxial ridge. Fine ridges ornament the pleural region on the exoskeleton; ornament on the axial region unknown. Internal molds smooth.

Remarks.—The holotype of *Saukiella fallax* (Walcott) came from the eastern side of the Llano Uplift. All of my specimens are from the western side, and comparison of these specimens with the holotype leaves no doubt that they are conspecific. I think this species belongs in *Saukiella* because of the short, flat preglabellar field

adjacent to the raised border, because of the ridged ornament, which is not granular as in *Saukia,* and because of the shape of the pygidium. The pygidium that I have assigned to *S. fallax* is not like that figured by Walcott, which I assign to *Briscoia* sp.

This is the stratigraphically lowest species of *Saukiella* found in central Texas, and it possibly is ancestral to the succeeding species, *S. pyrene.*

Occurrence.—Scarce in the basal *Saukiella pyrene* Subzone at JR-351, 354; SS-302.5, 307.5.

Saukiella junia (Walcott)

Pl. 5, figs. 12–21.

Saukia junia WALCOTT, 1914, p. 378, text-fig. 17.
Saukiella junia (Walcott) RESSER, 1938, p. 43; WINSTON & NICHOLLS, 1967, p. 81, pl. 9, figs. 8, 10, 12, 14, 22.

Description.—Several additions to Winston and Nicholls' descriptions should be made. In numerous medium-size (15-20 mm) specimens with anteriorly expanded and truncated glabellae, the preglabellar furrow is slightly recurved medially, producing a broad, shallow depression or notch on the front of the glabella (pl. 5, fig. 16). Almost all specimens have a second pair of short, narrow, very shallow glabellar furrows, many have a third pair of very faint furrows, and a few have a fourth, anteriorly directed pair.

Two slight changes in the pygidial furrows occur through the range of *Saukiella junia.* In the lower part of the range of *S. junia* var. B, the pleural furrow is almost as distinct as the interpleural furrow (pl. 5, fig. 18). The division of pleurae is unequal adjacent to the axis but more nearly equal farther out in the pleural field. Higher in the range the furrow becomes less distinct and the subdivision of the pleurae more nearly equal. Pygidia of *S. junia* var. A (pl. 5, fig. 21) have subequally divided pleurae, and the pleural furrow is reduced to a narrow groove relative to the broad, deep, straight-sided interpleural furrow. Many axes have a strong indication of a fifth axial ring.

Ornament is similar to that of *S. pepinensis.* Bertillon ornament covers the glabella, occipital ring, fixigenae, and librigenae; transverse ridges cross the anterior border. Pygidia appear to be smooth. The only ornament on some specimens is a set of terrace lines on the back end of the occipital ring; the rest of the cranidium is smooth. Impressions of the terrace lines and of the ridges and Bertillon pattern are preserved on the internal mold.

Remarks.—I agree with Winston & Nicholls' (1967, p. 82) interpretation of this species as one with a "rather broad range of characteristics" and with their subdivision into varieties that reflect stratigraphic shifts in morphology. In addition, I am willing to go one step farther and propose that the small specimens associated with *S. junia* var. B that look very much like *S. pepinensis* are not small representatives of the latter but rather juvenile *S. junia* var. B. Similarity of these smaller specimens (pl. 5, figs. 12, 14) with *S. pepinensis* is close, but the furrows are somewhat shallower and the border slightly longer. If a good collection of *S. junia* var. B is arranged in order of size and if the *S. pepinensis*-like specimens are included, it is reasonably easy to see that the smaller ones could mature into *S. junia* var. B. In addition, adults of *S. junia* var. B become less like adults of *S. pepinensis* the farther they range stratigraphically from *S. pepinensis* (pl. 5, figs. 13, 15, 17)—the border furrow, if present, becomes more obscure and the border becomes quite long (sag.) higher in the range of *S. junia.* Thus, I propose that *S. junia* is descended from *S. pepinensis;* they represent a cline or chronospecies.

Occurrence.—Locally abundant in the middle and upper *Saukiella junia* Subzone at CC-27; JR-479; SS-356, 370; TC-1301, 1303, 1305, 1305-1310, 1310-1315, 1315-1320, 1335-1340, 1341-1346.

Saukiella junia (Walcott), var. A, Winston & Nicholls

Pl. 5, figs. 19–21.

Saukiella junia (Walcott), var. A, WINSTON & NICHOLLS, 1967, p. 82, pl. 9, figs. 10, 12.

Remarks.—The smaller specimens are distinct from *Saukiella pepinensis.* The pygidia can be distinguished from those of *S. junia* var. B by the relatively obscure pleural furrow and the more equal subdivision of the pleurae.

Examination of the holotype of *S. junia* (Walcott) confirms Winston and Nicholls' statement that this variety most nearly resembles Walcott's species. To the right of the holotype is a cranidium of *Eurekia eos,* associated with *S. junia* var. A in central Texas. On another piece of matrix in Walcott's collection of *Saukia junia* is a pygidium of *Bayfieldia simata,* also associated with this variety.

Occurrence.—Scarce in the upper part of the *Saukiella junia* Subzone at TC-1341-1346.

Saukiella junia (Walcott), var. B, Winston & Nicholls

Pl. 5, figs. 12–18.

Saukiella junia (Walcott), var. B, WINSTON & NICHOLLS, 1967, p. 82, pl. 9, figs. 8, 14, 22.

Remarks.—Low in the range of *Saukiella junia* var. B, some adult and all the juvenile cranidia strongly resemble the stratigraphically lower *S. pepinensis,* but they can be distin-

guished by shallower furrows and slightly longer anterior borders. Higher in the range, the differences are more pronounced.

Pygidia of *S. junia* var. B have less equally divided pleurae and deeper pleural furrows than *S. junia* var. A, but the differences diminish as the lower variety ranges up toward the lowest occurrence of *S. junia* var. A.

Occurrence.—Abundant in the middle and upper part of the *Saukiella junia* Subzone at CC-27; JR-479; SS-356, 370; TC-1301, 1303, 1305, 1305-1310, 1310-1315, 1315-1320, 1335-1340.

Saukiella pepinensis (Owen)

Pl. 5, figs. 9–11.

Dikelocephalus pepinensis Owen, 1852, p. 574, pl. 1, figs. 9, 9a, 9b.
Saukia pepinensis (Owen) Walcott, 1914, p. 381, pl. 67, figs. 1–13, 13a (synonymy to date).
Saukiella pepinensis (Owen) Ulrich & Resser, 1933, p. 202, pl. 33, figs. 22–24; Raasch, 1951, p. 144; Winston & Nicholls, 1967, p. 82, pl. 9, figs. 4–6 (synonymy to date).

Remarks.—The Texas specimens provide additional information about ornament. Bertillon ornament on the exoskeleton covers the glabella, occipital ring, anterior border, all areas of the fixigenae, the librigenae, and at least the pleural region of the pygidium. On most specimens this pattern is a braided system of fine, distinct raised lines. On the largest cranidia with exoskeleton (pl. 5, fig. 9), the lines on the sides of the glabella are disconnected, irregular ridges; the ridges break up into smaller irregular bodies higher up on the glabella, finally culminating in coarse pustules on the crest of the glabella. Faint impressions of the Bertillon pattern are apparent on internal molds. On one large mold (unillustrated) the impression of a coarse pattern on the border showed pits. Most specimens have relatively longer borders than do those figured by Ulrich and Resser.

S. pepinensis occurs stratigraphically above *S. pyrene,* from which it differs in the much reduced to nonexistent preglabellar field, the proportionally longer border, and the wider fixigenae. There are collections stratigraphically between *S. pyrene* (s.s.) and *S. pepinensis* (s.s.) that suggest a phylogenetic relationship between the two.

S. pepinensis occurs stratigraphically below *S. junia* var. B and is distinguished by deeper furrows, a shorter anterior border, the distinct rise of the anterior border above the preglabellar field and anterior border furrow, giving a distinct posterior edge to the border, and the nearly equal division of the pleurae by the pleural furrows on the pygidia. These differences are subtle, especially when dealing with juvenile *S. junia* var. B or adult specimens from low in its range. Although more collections from the transition zone might be desirable, the present collections strongly suggest that the characters of the *S. pepinensis* population shifted toward longer borders and shallower furrows and culminated in a remarkably similar but distinct population named *S. junia* var. B, whose juveniles are nearly identical with the antecedent *S. pepinensis.*

Occurrence.—Common in the lower part of the *Saukiella junia* Subzone at BC-70; JR-453, 459, 460; LCS-32; TC-1291, 1293.

Saukiella planata Winston & Nicholls

Saukiella planata Winston & Nicholls, 1967, p. 82, pl. 11, figs. 2, 10.

Remarks.—*Saukiella planata* also has the Bertillon ornament common in the other *Saukiella* species. Faint impressions of these lines are obscure on internal molds but can be seen on the occipital ring, glabella, and anterior border. The ornament on the exoskeleton is distinct, especially on the occipital ring and the posterior glabellar lobe. Librigenae and pygidia are unknown.

S. planata occurs in the upper part of the range of *S. serotina,* and in one section it ranges slightly higher than does *S. serotina.*

Occurrence.—Locally common in the upper part of the *Saukiella serotina* Subzone at CC-61; LCS-44, 45, 45.8, 52; SH-61.5, 61.5-62, 65.5; TC-1400.

Saukiella pyrene (Walcott)

Pl. 5, figs. 4–8.

Saukia pyrene Walcott, 1914, p. 382, pl. 67, figs. 18–20.
Saukiella pyrene (Walcott) Ulrich & Resser, 1933, p. 204, pl. 34; pl. 35, figs. 1–8; Raasch, 1951, p. 145; Nelson, 1951, p. 783, pl. 110, figs. 4, 7.
Saukiella cf. *pyrene* Ulrich & Resser, 1933, p. 204, pl. 35, figs. 9, 11 (not 10).
Saukiella pyrene limbata Ulrich & Resser, 1933, p. 206, pl. 35, figs. 12–14.
Saukiella frontalis Ulrich & Resser, 1933, p. 207, pl. 35, fig. 22.
Saukiella indenta Ulrich & Resser, 1933, p. 208, pl. 35, figs. 23–30; pl. 36, figs. 1–3.
Saukiella indenta intermedia Ulrich & Resser, 1933, p. 208, pl. 36, fig. 4.
Saukiella norwalkensis Ulrich & Resser, 1933, p. 209, pl. 36, figs. 5–27.
Saukiella signata Ulrich & Resser, 1933, p. 206, pl. 35, figs. 15–21.
not *Saukiella norwalkensis* Ulrich & Resser, Winston & Nicholls, 1967, p. 82, pl. 11, figs. 6–8, 12.

Description.—Cranidium quadrate to elongate. Glabella elongate, well defined by axial furrows that usually are bowed outward along the posterior one-half and slightly divergent along the

anterior one-third of the glabella, resulting in a medial constriction. This constriction and the adjacent anterior expansion of the glabella are most obvious on the larger specimens; the smaller ones exhibit these features, but they are subtle. Some specimens have a slightly tapered glabella. At the anterior corners of the glabella, the axial furrow broadens and deepens, then becomes shallower across the front of the glabella. Posterior transglabellar furrow usually a deep gouge laterally that becomes shallower across the top; the lateral extremities of this furrow seldom intersect the axial furrow. A second pair of short, shallow glabellar furrows is located opposite the anterior edge of the palpebral areas. A third pair of furrows that are directed slightly forward is apparent on a few specimens. Occipital ring broad, uniform in width (sag.), well defined by transverse furrow or one that is bowed forward medially. Anterior border furrow bowed forward, narrow in smaller specimens but broader in larger ones. Convex anterior border short (sag.), tapers laterally in most specimens, and has a slight crescentic shape. The character of the preglabellar field is the most variable feature. The smaller cranidia have a definitely convex preglabellar field that is just as convex and almost as long (sag.) as the border and that extends laterally into the anterior fixigenae. The frontal area is biconvex. The larger the specimen, the less convex the preglabellar field. In the larger specimens, the anterior fixigenae fade into a nearly flat preglabellar field that is delineated by broad, very shallow preglabellar and border furrows. Anterior facial sutures are slightly divergent in front of palpebral lobes; anterior corners of cranidium are rounded. Anterior area of fixigena narrows just in front of palpebral area, widens anteriorly. Palpebral areas are long, relatively flat, and of moderate width. Palpebral furrows are distinct; palpebral lobes are long and broad. Posterior facial sutures swing in very close to axial furrows just behind the palpebral lobes, then strongly diverge, defining long, slender limbs. Posterior area of the fixigena is very narrow in front of posterior border furrow. Posterior border furrow is broad and deep, intersecting the facial suture near the midpoint of the limb.

The character of the associated free cheek is not clear because of poor preservation, but fragments appear to be like those illustrated by Walcott (1914, pl. 67, fig. 19) and Ulrich & Resser (1933, pl. 35, figs. 2–4).

Remarks.—The features used by Ulrich and Resser to separate the species I have synonymized are a combination of glabellar furrows, glabellar shape, and frontal area configuration. All five species are associated with one another, and many are from the same collections.

Four measured sections in central Texas yielded about 100 cranidia, 25 pygidia, and 15 free cheeks of this variable taxon. *Saukiella pyrene* occurs above *S. fallax* and below *S. pepinensis*. Within this taxon, all the pygidia are remarkably similar and agree quite well with those Ulrich and Resser assigned to *S. pyrene, S. signata, S. indenta,* and *S. norwalkensis*. Most of the free cheeks are like those of *S. pyrene* and *S. indenta;* there are two that look like those assigned to *S. norwalkensis*.

The cranidia demonstrate the greatest amount of variation, but even this is restricted to the frontal area and glabella. The two end members, with respect to variation in the frontal area (small ones with a biconvex frontal area and larger specimens with a planoconvex frontal area), and all gradations between them occur together in numerous collections from all four sections. The outline of the glabella ranges from straight-sided and slightly tapering to medially constricted and anteriorly expanded; the anterior end of the glabella ranges from broadly rounded to sharply truncated. There is always one pair of glabellar furrows, and they are joined across the top of the glabella. On most specimens there is a second pair of furrows, and these can be joined. A few specimens have a faint third pair that is anteriorly directed. I found no relation between number of glabellar furrows and shape of the glabella, and these features show no trend or separation with respect to stratigraphic position. I think that differences in the frontal area are a result of successive growth stages and that variations as a whole fall within the realm of intraspecific variation.

From a comparison of the Texas collections with Ulrich and Resser's type material of all taxa in the synonymy, I conclude that the type material and the Texas specimens belong to one variable species, for which the appropriate name is *Saukiella pyrene* (Walcott). *S.* cf. *pyrene, S. pyrene limbata, S. signata, S. indenta, S. indenta intermedia, S. frontalis,* and the three varieties of *S. norwalkensis* are junior synonyms of *S. pyrene*.

Saukiella pyrene is distinguished from the stratigraphically lower *S. fallax* by the character of the frontal area, by configuration of the glabella and glabellar furrows, and by the very slender posterior fixigenae. *S. pyrene* is distinguished from the stratigraphically higher *S. pepinensis* by the markedly shorter (sag.) anterior border and by possession of a definite preglabel-

lar field. There are a few specimens from Bluff Creek section that suggest that *S. pyrene* is a derivative of *S. fallax* and is ancestral to *S. pepinensis*. The relative position of *S. pyrene* and *S. pepinensis* opposes Ulrich and Resser's statement (p. 204) that *S. pyrene* is a derivative of *S. pepinensis;* rather, they indicate that the reverse may be true.

The matrix in which Ulrich and Resser's type material occurs contains remains of other species that are associated in the *Saukiella pyrene* Subzone: *Illaenurus quadratus* Hall, *Plethometopus convergens* Rasetti, and a eurekiid that is either *Bayfieldia binodosa* (Hall) or *Eurekia granulosa* Walcott. The same taxa occur with *S. pyrene* in central Texas.

Occurrence.—Common to locally abundant in the *Saukiella pyrene* Subzone at BC-34, 36, 37-37.5, 41, 42, 41.5-44; JR-394, 406.5; SPH-86, 110, 114, 114.5, 140; TC-1286, 1287.

Saukiella serotina Longacre, n. sp.

Pl. 6, figs. 1–3.

Saukiella norwalkensis Ulrich & Resser, WINSTON & NICHOLLS, 1967, p. 82, pl. 11, figs. 6–8, 12.

Description.—Cranidium low to moderately convex, length about twice glabellar width. Glabella subrectangular or slightly tapered; anterior end moderately convex, broadly rounded, or truncated at its tip. Most specimens have only one glabellar furrow, generally a posteriorly bowed transglabellar furrow that is deeply impressed laterally. Occipital furrow transverse or bowed forward medially, as well impressed as the transglabellar furrow. Occipital ring as broad as posterior glabellar lobe. Anterior border furrow curved, convex anteriorly. Anterior border raised, slightly convex, of uniform width or slightly tapering. Preglabellar field of approximately the same length (sag.) as the border, flat to slightly concave, though on some specimens this area is very slightly convex and appears as an adaxial extension of the anterior fixigenae. Palpebral area about two-thirds glabellar length and one-third glabellar width, rising gently out of axial furrow. Palpebral lobes maintain great width except for slight tapering on anterior end; they are separated from fixigenae by distinct but narrow palpebral furrows. Posterior facial suture swings in close to axial furrow just behind the palpebral lobe, then diverges, defining a very narrow posterior fixigena. Posterior limbs long and slender, angled slightly back, composed almost entirely of posterior border with only a very narrow posterior fixigena separated from the border by a short posterior border furrow. Anterior segment of the facial suture diverges moderately in front of the palpebral lobes; after passing the anterior border furrow, the suture swings adaxially. Bertillon ornament covers all areas of the exoskeleton and can be seen on some internal molds.

Librigenae (Winston & Nicholls, 1967, pl. 11, fig. 7) with sharply defined border furrow; border extends medially in front of facial sutures, maintains an even curvature back into long genal spine. Ocular field rises steeply above border furrow, covered with two intersecting sets of elongate ridges that do not seem to be preserved on internal molds. Ornament on border and genal spine unknown.

Pygidium (Winston & Nicholls, 1967, pl. 11, fig. 12) narrow and high for genus, with conical axis consisting of articulating half ring, four axial rings, long pointed terminal piece, and short postaxial ridge. Pleural regions convex, with four pleurae subequally divided by deep pleural furrows that are nearly straight, that angle sharply back, and that fade out on a wide, nearly flat margin. Internal molds smooth; ornament on exoskeleton unknown.

Available material.—264 cranidia, 79 pygidia, most well preserved.

Holotype.—BEG 36560, from CC-61.

Etymology. Serotinus, Latin, late, named for its occurrence late in the Trempealeauan.

Remarks.—Although the Texas specimens may conform in part to the concept of *Saukiella norwalkensis* Ulrich & Resser (see Winston & Nicholls, 1967, p. 82), they do not conform entirely; the faunal associates are entirely different, and the type material cannot be included within the hypodigm at hand (see remarks under *S. pyrene*). I have synonymized *S. norwalkensis* with *S. pyrene* and here erect a new species that is similar to but distinct from *S. pyrene. S. serotina* is distinguished from the stratigraphically lower *S. pyrene* by its straight-sided, tapering glabella with only one glabellar furrow, the crescentic shape of its frontal area, the exceedingly wide palpebral areas of the fixigenae and palpebral lobes, the wider anterior fixigenae, and the distinctly different pygidium. In the upper part of its range, *S. serotina* is associated with *S. planata.* Some of the other faunal associates are *Bayfieldia simata, Eurekia eos,* three species of *Calvinella,* and *Stenopilus latus.*

Occurrence.—Common to locally abundant in the *Saukiella serotina* Subzone at CC-58, 58.2, 61, 63±; JR-521.5, 529, 536; LC-32; LCS-33, 33.5, 35.7, 39, 40, 44, 45, 45.4, 52; SH-52, 52.6, 54, 55, 61, 61.5-62; TC-1379-1385, 1387.5, 1388, 1392, 1400. Scarce in the *Corbinia apopsis* Subzone at LCS-53, 54.

Family REMOPLEURIDIDAE Hawle & Corda, 1847

Genus APATOKEPHALOIDES Raymond, 1924

Apatokephaloides RAYMOND, 1924, p. 425.

Type species.—Apatokephaloides clivosus Raymond, 1924, p. 425, pl. 13, fig. 13 (not fig. 17 = *Bayfieldia ulrichi* Rasetti, 1945b, p. 465 = *Corbinia ulrichi* (Rasetti) Winston & Nicholls, 1967, p. 85).

Remarks.—Although Raymond's description (1924, p. 425) is brief, he does emphasize differences between *Apatokephaloides* and *Apatokephalus*. *Apatokephaloides* is not mentioned in the *Treatise* (Harrington *et al.*, 1959). Rasetti (1959, p. 387) assigned this genus to the Remopleurididae, and I have followed him in that assignment.

***Apatokephaloides clivosus* Raymond**

Apatokephaloides clivosus RAYMOND, 1924 (part), p. 425, pl. 13, fig. 13 (not fig. 17 = *Bayfieldia ulrichi* RASETTI, 1945b, p. 465 = *Corbinia ulrichi* (Rasetti) WINSTON & NICHOLLS, 1967, p. 85); RASETTI, 1963, p. 1010, pl. 130, figs. 19, 20; WINSTON & NICHOLLS, 1967, p. 86, pl. 11, fig. 11.

Remarks.—This is the second most abundant taxon in the *Corbinia apopsis* subzone and is distinguished from *C. apopsis* by its glabellar furrows that are more like gouges, by its greatly expanded palpebral lobes that almost or completely isolate the palpebral area of the fixigenae from the rest of the fixigenae, and by its depressed preglabellar field that is long (sag.) relative to the length of the raised border.

Occurrence.—Abundant in the *Corbinia apopsis* Subzone at CC-67; LC-48; SH-72; SS-411; LCS-53, 53.3, 53.5, 53-54, 55.

Family ?SHUMARDIIDAE Lake, 1907

Genus IDIOMESUS Raymond, 1924

Idiomesus RAYMOND, 1924, p. 397; RASETTI, 1946, p. 538; Poulsen in HARRINGTON *et al.*, 1959, p. 0245.
Stigmametopus RASETTI, 1944, p. 257.

Type species.—Idiomesus tantillus Raymond, 1924, p. 397, pl. 12, fig. 10.

Remarks.—Poulsen (in Harrington *et al.*, 1959) briefly summarizes the characteristics of this genus.

Although I recognize three species of *Idiomesus, I. infimus,* n. sp., *I. intermedius* Rasetti, and *I. levisensis* (Rasetti), I am not entirely convinced they are congeneric with *I. tantillus*. I have examined the holotype of *I. tantillus* (Yale Peabody Mus., no. 4726), several plesiotypes (Laval Univ., nos. 1042a, b), and several specimens in Raymond's support collections (now at Harvard, Mus. of Comparative Zoology). *I. tantillus* has two unique features: no lateral glabellar pits and thin, elevated posterior borders that continue across into the thin occipital ring without being interrupted by the axial furrows. At least five totally unfamiliar taxa were associated with the specimens of *I. tantillus*. The type locality for this species is the upper zone of the Gorge Formation at Highgate Falls, Vermont. *I. tantillus* may be a member of an extracratonic faunal complex. If future studies of *I. tantillus,* in both biostratigraphic and lithostratigraphic frameworks, indicate that it could be spatially, temporally, and possibly genetically related to the marginal cratonic species included in the genus, then my doubts are without foundation. If such a relationship cannot be postulated, *Stigmametopus* Rasetti (1944, p. 257) should be resurrected for the marginal cratonic species. Spatially, temporally, and morphologically the marginal cratonic species could be related to the Ptychaspididae.

***Idiomesus infimus* Longacre, n. sp.**

Pl. 2, figs. 15–19.

Description.—Cranidium semielliptical, moderately convex. Glabella transversely convex; posterior one-half of glabella parallel-sided or slightly tapering, whereas the anterior one-half is markedly tapered; anterior end truncate; width across base three-fourths glabellar length. Posterior glabellar furrow continuous, laterally deep and angled back, shallower and transverse across the axis. Second and third pairs of furrows are laterally impressed notches on the sides of the glabella; the posterior pair of notches are as deep or deeper than the anterior pair. Axial furrow very broad posteriorly, becomes narrower and steeper sided anteriorly; preglabellar furrow ranges from moderately impressed to obscure. Occipital furrow deep and oblique laterally, shallower and either transverse or bowed forward across the axis. Occipital segment medially expanded, posteriorly elevated, and longer (sag.) than the preoccipital glabellar segment; occipital node may be present. Frontal area gently convex, unfurrowed, downsloping. Anterior fixigenae as wide as frontal area is long, posteriorly increasing in convexity and height above axial furrow. Behind a faint ocular ridge, the fixigenae are very broad and convex, with steeply downsloping lateral margins. Palpebral lobes apparently absent. Posterior border furrow very wide, deep, and gently curved posteriorly. Posterior border seems to widen laterally. Anterior facial sutures smoothly curved from ocular ridges to the axial line. Behind area where palpebral lobes would be located, the posterior facial sutures diverge and curve broadly to the posterior margin. A row of widely spaced low granules rim the interior edges of the fixigenae; one or more granules can ornament the preoccipital glabellar segment.

Very fine concentric Bertillon-pattern lines cover the margins of the fixigenae and frontal area. Some or all of this ornament may occur on the internal mold. Several molds have a rough surface texture that could be granules or a precipitate; one of these rough surfaces has so regular a pattern as to suggest granulation. The occipital segments of one or two molds appear to be pitted.

Librigena and pygidium unknown.

Available material.—10 cranidia, most poorly preserved.

Holotype.—BEG 36497, from TC-1242.

Etymology.—infimus, Latin, lowest, named for its being the stratigraphically lowest species of *Idiomesus* in central Texas.

Remarks.—Idiomesus infimus is characterized by its stout, blunt glabella with two pairs of lateral glabellar pits, and by its medially expanded and elevated occipital segment, very wide posterior axial furrow, and granules on the inside edges of the fixigenae. These features easily separate *I. infimus* from *I. tantillus* Raymond and *I. intermedius* Rasetti. *I. infimus* is differentiated from the very similar *I. levisensis* (Rasetti) by its relatively shorter and wider glabella, broader posterior axial furrows, more convex, ornamented, and elevated fixigenae, and more medially expanded occipital segment.

I. infimus occurs in the highest *Ellipsocephaloides* Zone collections from three measured sections; faunal associates are *Briscoia* sp. and *Prosaukia* cf. *P. tuberculata.* From 50 to 90 feet of nontrilobite-bearing rock intervene between this species and the lowest *Saukia* Zone collections. Both *I. levisensis* and *I. intermedius* occur in the *Saukia* Zone.

Occurrence.—Scarce in the upper *Ellipsocephaloides* Zone at JR-284.5; MC-862; TC-1142, 1145.

Idiomesus intermedius Rasetti

Pl. 4, figs. 13, 14.

Idiomesus intermedius Rasetti, 1959, p. 393, pl. 51, figs. 25, 26; Winston & Nicholls, 1967, p. 73, pl. 10, fig. 21.

Remarks.—Idiomesus intermedius is well represented in the Texas collections. There is some variation in number of lateral glabellar pits, ranging from no readily apparent pits in two poorly preserved specimens, 34 with a suggestion of one pair of pits, 115 with one very distinct set of pits, and 56 with one distinct set of lateral glabellar pits and a faint to good indication of a second set of pits. Very generally, there is a stratigraphically upward trend toward fewer sets of glabellar pits, whether they are distinct or obscure.

Ornament on exoskeleton consists of a Bertillon ornament on the fixigenae that originates in the axial furrows, is directed forward and outward on the adaxial slope of the cheek, and curves around and becomes roughly parallel to the cranidial outline on the abaxial slope of the cheeks. Some of the pattern of the abaxial slope of the fixigena is continued around onto the frontal area. On internal molds, Bertillon ornament is vaguely apparent around the margin of the cranidium and up onto the crests of the fixigenae. The adaxial slope of the fixigena is finely pitted, and some specimens possess an occipital node.

Occurrence.—Scarce in the *Saukiella junia* Subzone at BC-109-110. Abundant in the *Saukiella serotina* Subzone at BC-149; CC-61, 63±; JR-521.5, 529, 532; LCS-32.4, 34-36, 39, 40, 44, 45, 45.4, 45.8, 52; SH-54, 58.5-60, 61.5, 61.5-62; SS-375; TC-1379-1385, 1392, 1394, 1400. Scarce in the *Corbinia apopsis* Subzone at CC-67; JR-539, 540; LCS-55.5; SS-411.

Idiomesus levisensis Rasetti

Pl. 3, figs. 6, 7.

Stigmametopus levisensis Rasetti, 1944, p. 257, pl. 37, figs. 8, 9.

Idiomesus levisensis (Rasetti) Rasetti, 1946, p. 539.

Remarks.—Idiomesus levisensis is scarce in the *Saukiella pyrene* and *Saukiella junia* Subzones and occurs stratigraphically below *I. intermedius.* Examination of Rasetti's and Raymond's types confirms the specific identification. *I. levisensis* is distinguished from *I. intermedius* Rasetti and *I. tantillus* Raymond not only by its two distinct pairs of glabellar pits but also by the relationship between the posterior one-half of the axial furrow and the fixigenae. In *I. intermedius* and *I. tantillus* the fixigenae rise immediately from a distinct axial furrow, giving the fixigenae the appearance of wrapping around the glabella. *I. levisensis* has a distinct axial furrow along the anterior one-half of the glabella, but it broadens posteriorly and merges with the fixigenae, so it is difficult to find a furrow along the posterior one-half of the glabella. In that posterior region the adaxial parts of the fixigenae are triangular, nearly flat shelves that slope gently down and intersect the glabella. These regions are in deep shadow in Rasetti's figures. These triangular regions can be pitted. Although it is difficult to see, there is a faint axial line or depression on the front of the glabella (pl. 3, fig. 7). This depression is also faintly impressed on the holotype of *I. intermedius.*

The glabella of *I. levisensis* is somewhat distinctive in that the posterior sides are nearly par-

allel or slightly divergent anteriorly, but anterior to the glabellar pits the sides are markedly convergent.

Occurrence.—Scarce in the *Saukiella pyrene* Subzone at BC-23, 41, 42; JR-369.5; SPH-85.5; SS-302.5, 307.5. Scarce in the *Saukiella junia* Subzone at JR-453, 460.

Family Uncertain

Genus Bowmania Walcott, 1925

Bowmania Walcott, 1925, p. 73; Rasetti in Harrington *et al.*, 1959, p. 0517.

Type species.—*Arethusina americana* Walcott, 1884, p. 62, pl. 9, fig. 27.

Remarks.—The diagnosis by Rasetti (in Harrington *et al.*, 1959) summarizes the characteristics of this genus.

***Bowmania americana* (Walcott)**

Arethusina americana Walcott, 1884, p. 62, pl. 9, fig. 27.

Bowmania americana (Walcott) Walcott, 1925, p. 73, pl. 15, figs. 15, 16; Winston & Nicholls, 1967, p. 89, pl. 10, fig. 18.

Remarks.—This species is represented by 11 cranidia from three measured sections. Exfoliated specimens exhibit an ornament ranging from fine granules to a fine vermiform ridge pattern; some specimens also have coarse pustules scattered on the fixigenae posterior to the ocular ridges and a few pustules on the anterior fixigenae or preglabellar field.

Bowmania americana is distinguished from *B. sagitta* Winston & Nicholls by its smoothly rounded frontal margin, tapering glabella, flat border, and gentle convexity. The only consistent difference between *B. americana* and *B. pennsylvanica* Rasetti is the tapering glabella of the former versus the anteriorly expanded glabella of the latter.

B. americana and *B. pennsylvanica* are stratigraphic associates, and the separation into two species may prove to be artificial. The material in Texas does not yet permit the two to be combined.

Occurrence.—Scarce in the *Saukiella serotina* Subzone at CC-63±; LCS-40, 45.8; SH-52, 54, 55, 61.5-62.

***Bowmania pennsylvanica* Rasetti**

Pl. 6, figs. 4, 5.

Bowmania pennsylvanica Rasetti, 1959, p. 395, pl. 55, figs. 1–5; text-fig. 1.

Remarks.—Eight cranidia from two measured sections are assigned to this species. They all have the anteriorly expanded glabella, strong convexity, coarse granules, and narrow, convex border characteristic of this species. Although *Bowmania pennsylvanica* occurs with *B. americana* and ranges close to *B. sagitta,* it is distinguished from the former by its expanded glabella, granules, convexity, and narrow border and from the latter by its smoothly rounded anterior margin of the cranidium.

Occurrence.—Scarce in the *Saukiella serotina* Subzone at CC-58.2, 61, 63; LCS-40.

***Bowmania sagitta* Winston & Nicholls**

Bowmania sagitta Winston & Nicholls, 1967, p. 89, pl. 10, figs. 19, 20.

Remarks.—All parts of the cranidium can be covered with scattered, medium-size granules. On the anterior fixigenae and preglabellar field, a subtle vermiform ridge pattern occurs between the granules and is directed toward the anterior border furrow. This pattern becomes more distinct in a band posteriorly adjacent to the anterior border furrow; few or no granules are in this area, and the posterior edge of the band is delineated by a slight ridge. The band can be seen in Winston and Nicholls' figure 20 of a paratype and is present also in the holotype (fig. 19), although it is not evident in the illustration.

Occurrence.—Locally common in the *Saukiella serotina* Subzone at LCS-45, 45.4, 45.8, 52; SH-58.5-60, 61.5-62, 65.5; TC-1392, 1400.

Genus Dellea Wilson, 1949

***Dellea? punctata* Palmer**

Pl. 1, fig. 1.

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

Remarks.—Two specimens from the *Eoorthis* coquina in two measured sections are assigned to this species. Although the pitted surface is difficult to see on one specimen, both have the bluntly rounded glabella and fossulae characteristic of the species. The brim-border ratio of one specimen is about 2:1; the ratio is about 1:1 in the other.

Stitt (in press) has found *Dellea? punctata* in the *Irvingella* coquina in Oklahoma. Although the specimens recorded here came from the stratigraphically higher *Eoorthis* coquina in central Texas, the species may range below that horizon.

I have followed Palmer (1965b) in his familial assignment of *Dellea.*

Occurrence.—Scarce at the base of the *Parabolinoides* Subzone at LL-671.8; WC-889.

Genus Ellipsocephaloides Kobayashi, 1935

Ellipsocephaloides Kobayashi, 1935b, p. 196; Resser, 1942b, p. 62; Rasetti in Harrington *et al.*, 1959, p. 0517.

Type species.—*Ellipsocephalus curtus* Whitfield, 1878, p. 58; 1882, p. 191, pl. 1, fig. 18.

Remarks.—The descriptions by Resser (1942b, p. 62) and Rasetti (in Harrington *et al.*,

1959) summarize the characteristics of this genus.

Ellipsocephaloides silvestris Resser

Ellipsocephaloides silvestris Resser, 1942b, p. 64, pl. 11, figs. 1–3; pl. 12, fig. 7; Bell & Ellinwood, 1962, p. 406, pl. 59, figs. 10–12 (synonymy to date); Grant, 1965, p. 143, pl. 14, fig. 31.

Remarks.—*Ellipsocephaloides silvestris* is characterized by a frontal area divided into a convex preglabellar field and a downsloping anterior border by a faint anterior border furrow that is slightly raised and posteriorly pointed on the axial line. This furrow is difficult to find on specimens preserved in siltstone. Because the ocular ridges in the Texas specimens range from distinct to weak, I agree with Bell and Ellinwood that *E. nitela* Resser, 1942b, is synonymous with *E. silvestris*.

Occurrence.—Scarce but locally common in the *Ellipsocephaloides* Zone at EC-55, 60; GR-204, 210, 214; JR-210, 232, 233, 255; LL-750; MC-750; SS-138.5.

Genus Heterocaryon Raymond, 1937

Heterocaryon Raymond, 1937, p. 1119.

Type species.—*Heterocaryon platystigma* Raymond, 1937, p. 1119, pl. 3, fig. 13.

Remarks.—The original description by Raymond (1937, p. 1119), the brief description by Rasetti (1944, p. 241), and the excellent description by Winston & Nicholls (1967, p. 76) have summarized all that is known of this rather rare genus.

Heterocaryon cf. *H. tuberculatum* Rasetti

Heterocaryon tuberculatum Rasetti, 1944, p. 241, pl. 36, fig. 55.

Heterocaryon cf. *H. tuberculatum* Rasetti, Winston & Nicholls, 1967, p. 76, pl. 11, figs. 15, 18.

Remarks.—The Texas cranidia are assigned to this species with uncertainty. The taxon is represented by only three cranidia from one measured section, and it is characterized by its tumid to overhanging, anteriorly expanded glabella, pitted anterior border furrow, coarse granular ornament, deeply notched glabellar furrows, and elevated fixigenae. *H.* cf. *H. tuberculatum* is distinguished from *Bowmania pennsylvanica* by its steeply downsloping frontal area, a glabella that rises vertically out of or overhangs the circumglabellar furrows, and the higher, more convex fixigenae.

I think this genus is closely allied to *Bowmania,* and I am uncertain about familial affinities of either genus.

Occurrence.—Scarce in the *Saukiella serotina* Subzone at TC-1392, 1400.

Genus Monocheilus Resser, 1937

Monocheilus Resser, 1937, p. 19; Bell, Feniak, & Kurtz, 1952, p. 191; Howell in Harrington *et al.*, 1959, p. 0288; Grant, 1962, p. 995.

Type species.—*Conocephalites anatinus* Hall, 1863, p. 153, pl. 7, figs. 34, 35.

Diagnosis.—Medium cranidium with large anteriorly rounded or truncate glabella; glabellar furrows faint to absent. Anterior border furrow very faint to absent. Fixigenae narrow. Palpebral lobes broad, arcuate, from one-half to almost the full length of the glabella. Posterior limbs narrow. Surface smooth or granulate.

Remarks.—As Nelson (1951, p. 778), Bell, Feniak, & Kurtz (1952, p. 191), and Grant (1962, p. 995) stated, *Monocheilus* is similar to *Stigmacephalus* but differs from it in having longer palpebral lobes and narrower posterior limbs. Spatially and temporally the two could be genetically related. Grant (1962, p. 995) describes significant differences between them and between *Monocheilus* and most other genera of the Anomocaridae. It is interesting that, according to the *Treatise, Monocheilus* is the only Upper Cambrian, North American genus in the Anomocaridae; four other Upper Cambrian genera are from Korea, China, and Russia; the rest of the family is Middle Cambrian. Because of morphological and spatial differences from the rest of the family, I have followed Grant (1962) in not assigning *Monocheilus* to any family.

Monocheilus truncatus Ellinwood

Monocheilus truncatus Ellinwood in Bell & Ellinwood, 1962, p. 389, pl. 52, figs. 1–3.

Remarks.—This species, one of the characteristic forms of the *Saukiella pyrene* Subzone in central Texas, is characterized by its low convexity, shallow furrows, nearly quadrate glabella with a rounded-truncate anterior end, very narrow fixigenae, and wide, arcuate palpebral lobes. There is a moderate amount of variation in the degree of truncation of the glabella and also in the degree of anterior tapering of the glabella. Because I view these differences in terms of intraspecific variation, I have not segregated the few variants. Many specimens in the two collections from the Camp San Saba measured section are granulate on all parts of the cranidium except the palpebral lobes. The furrows on internal molds are deeper than on the exoskeleton.

Occurrence.—Common at the base of the *Saukiella pyrene* Subzone at BC-23, 34, 41, 42; JR-351, 357; MC- 915±; SPH-87, 93, 96.5; SS-302.5, 307.5; TC-1233, 1237, 1268.

Genus TAENICEPHALINA Rasetti, 1945

Taenicephalina RASETTI, 1945b, p. 473; Lochman in HARRINGTON *et al.*, 1959, p. 0309.

Type species.—*Taenicephalina lechevalieri* Rasetti, 1945b, p. 473, pl. 62, figs. 6–8.

Remarks.—The descriptions by Rasetti (1945b, p. 473; 1963, p. 1012), combined with that of Lochman & Hu (1959, p. 424), have summarized the characters of the genus. The indefinite familial assignment follows that of Lochman & Hu (1959).

Taenicephalina globula Lochman & Hu

Taenicephalina globula LOCHMAN & HU, 1959, p. 424, pl. 57, figs. 34–43; BELL & ELLINWOOD, 1962, p. 406, pl. 59, figs. 13–15.

Remarks.—Fourteen small cranidia from four measured sections are assigned to this species. Between Lochman and Hu and Bell and Ellinwood, the species is well described and illustrated. The cranidia are not well enough preserved to show ornament.

Taenicephalina globula is distinguished from *T. lechevalieri* Rasetti (1945b, p. 473, pl. 62, figs. 6–8; 1963, p. 1012, pl. 130, figs. 1–4) by more distinct furrows and an anterior border furrow that, viewed from the front, rises to a point on *T. globula* but is gently arched on *T. lechevalieri*. The anterior border and furrow of *T. globula* and *T. levinsensis* (Rasetti) (1963, p. 1012, pl. 130, figs. 5–9) are similar, but *T. globula* has a longer (sag.) preglabellar field, wider fixigenae, and less distinct glabellar and circumglabellar furrows.

T. globula occurs in association with *Drumaspis texana* and ranges into the zone of transition from *D. texana* to *D. idahoensis*.

Occurrence.—Scarce in the *Idahoia* Zone at CR-743-747; JR-195.5; TC-1009; WC-968.

Genus WESTONASPIS Rasetti, 1945

Westonaspis RASETTI, 1945b, p. 474; in HARRINGTON *et al.*, 1959, p. 0521.

Type species.—*Westonaspis laevifrons* Rasetti, 1945b, p. 475, pl. 62, figs. 16, 17.

Remarks.—Both of Rasetti's diagnoses summarize the characteristics of this genus.

Westonaspis? *texana* Longacre, n. sp.

Pl. 6, figs. 16–18.

Description.—Cranidium wider than long, transversely convex. Glabella moderately convex, slightly tapered, slightly rounded to truncate anteriorly. Two or three pairs of faint glabellar furrows are present; the posterior pair is short and shallow and angles posteriorly, almost isolating triangular basal lobes; second and third pairs are shallow, broad lateral notches. Axial furrow wide and deep posteriorly, becoming shallower and narrower anteriorly; very shallow preglabellar furrow. Occipital furrow deep, with the lateral ends angled forward. Occipital ring broadest in the center, narrow and curved forward laterally. Fixigenae wider than one-half glabellar width, rise sharply out of the axial furrows, slope downward laterally. Fixigenae crossed by faint ocular ridges that merge into short, upraised palpebral lobes that are opposite or anterior to the glabellar midpoint. Preglabellar field short, moderately convex, with shallow axial groove between glabella and anterior border. Thin, convex, and laterally tapered anterior border well defined by transverse anterior border furrow that may be slightly recurved medially, making the border appear to be pointed or expanded on its posterior edge. Anterior facial sutures convergent, broadly rounded. Posterior facial sutures directed straight laterally behind palpebral lobes, defining wide (tr.), very stout posterior limbs with a length (exsag.) about one-half that of the cranidium and a transverse width about 1.5 times the width of the occipital ring. Posterior border furrow deep, becoming broader and shallower as it gently curves backward; posterior border broadens and flattens laterally. Low scattered granules on glabella, preglabellar field, fixigenae and posterior limbs.

Librigena and pygidium unknown.

Available material.—3 cranidia.

Holotype.—BEG 36574, from SS-411.

Etymology.—*texana,* named for its occurrence in Texas.

Remarks.—The cranidia upon which *Westonaspis*? *texana* is based are very similar to *W. laevifrons* Rasetti (1945a, b), except in the character of the frontal area, the wider fixigenae, the more anterior eyes, and the lesser curvature of the posterior limbs. I have assigned this species to the heretofore monotypic *Westonaspis,* but the assignment is tentative because of the anterior border furrow in the Texas specimens, a feature that is lacking in Rasetti's species, and because the Texas cranidia exhibit a slight axial groove across the preglabellar field.

Occurrence.—Scarce in the *Corbinia apopsis* Subzone at SS-411.

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EXPLANATION OF PLATE 1

FIG. *1—Dellea? punctata* Palmer. Partly exfoliated cranidium, ×2 (BEG 36461), from LL-671.8.

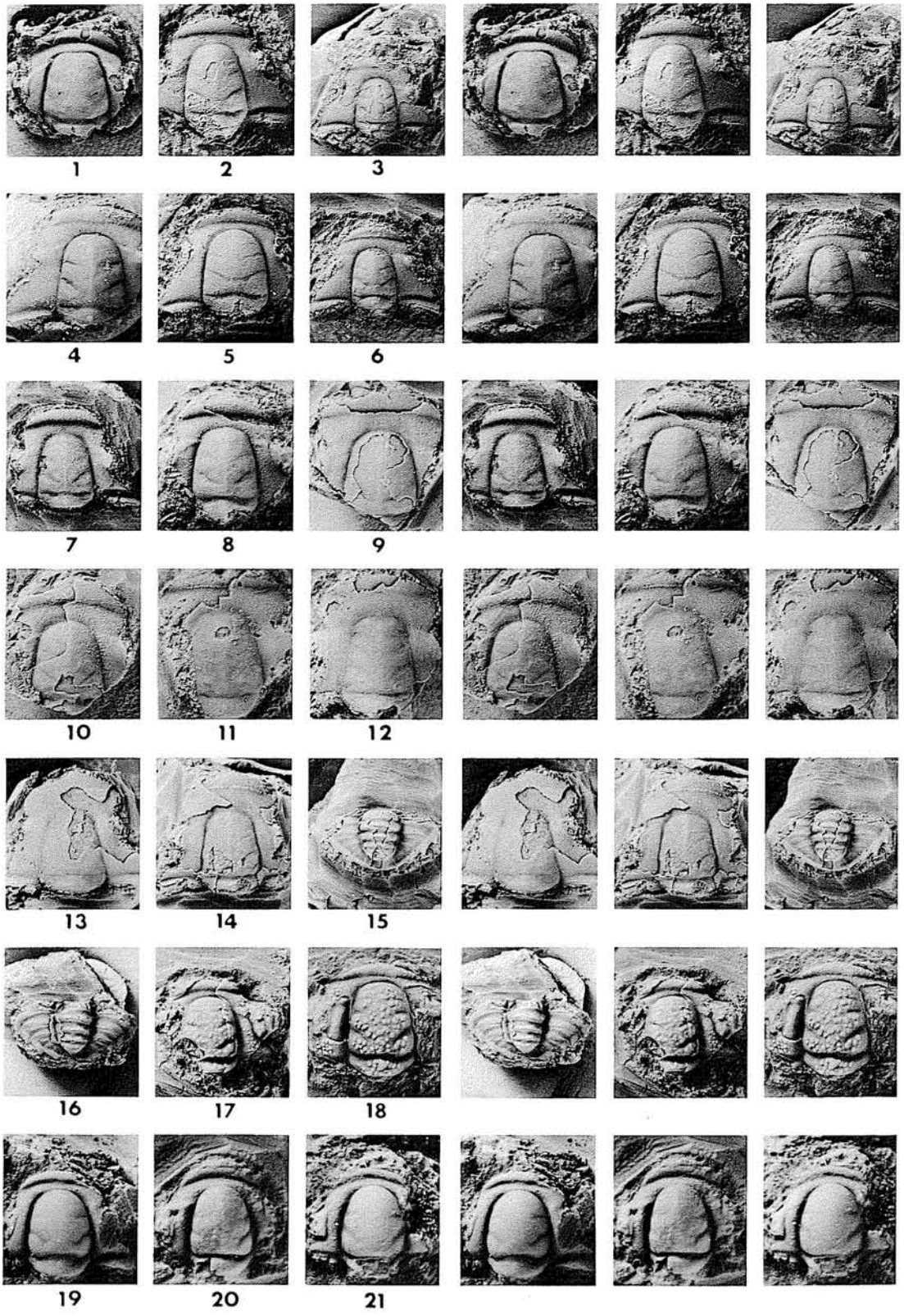
2–6—Parabolinoides contractus Frederickson. *2,* unexfoliated medium cranidium with smooth test, ×2.5 (BEG 36462), from JR-122. *3,* unexfoliated small cranidium showing ornament, ×2 (BEG 36463), from CO-124. *4,* internal mold of large cranidium showing upturned anterior border and puckered anterior border furrow, ×2 (BEG 36464), from TC-935.25. *5,* internal mold of medium cranidium showing low granules in anterior border furrow, ×2.5 (BEG 36465), from JR-121. *6,* internal mold of small cranidium showing ornamented frontal area, ×2.5 (BEG 36466), from SS-47.

7–10—Orygmaspis llanoensis (Walcott), var. A, Longacre, n. var. *7,* unexfoliated medium cranidium showing strong anterior border furrow, upturned anterior border, and large eyes, ×2 (BEG 36467), from JR-124. *8–10,* partly exfoliated small cranidia showing large eyes, variation in depth of anterior border furrow, and topography of frontal area that can occur in one collection, ×4 (BEG 36468), ×2.5 (BEG 36469), ×3 (BEG 36470), all from GR-120 (as are figs. 11, 12).

11–16—Orygmaspis llanoensis (Walcott). *11,12,* partly exfoliated medium cranidia showing internal and external ornament, shallow furrows, and topography of frontal area, ×3 (BEG 36471), ×2.5 (BEG 36472), both from GR-120 (as are figs. 8–10). *13,* partly exfoliated large cranidium showing ridge on external surface dividing frontal area into brim and border and also showing transverse ridge across posterior border, ×1.5 (BEG 36473), from LL-676. *14,* partly exfoliated medium cranidium showing maximum development of ornament on the internal mold, ×2 (BEG 36474), from B-316. *15,16,* partly and almost completely exfoliated pygidia showing slender and stout marginal spines, ×1 (BEG 36475), from JR-132, ×1.5 (BEG 36476), from CO-129.

17,18—Conaspis testudinatis Ellinwood. Partly exfoliated cranidia showing pustulose test and internal mold, ×5 (BEG 36477), from TA-10, ×5 (BEG 36478), from LL-682.

19–21—Conaspis leptoholcis Longacre, n. sp. *19,* unexfoliated large cranidium showing smooth surface and shallow preglabellar furrow, ×5 (BEG 36479, holotype), from B-316. *20,* internal mold of medium cranidium showing shallow preglabellar furrow, ×6 (BEG 36480), from SU-61. *21,* unexfoliated medium cranidium, ×7 (BEG 36481), from PK-888.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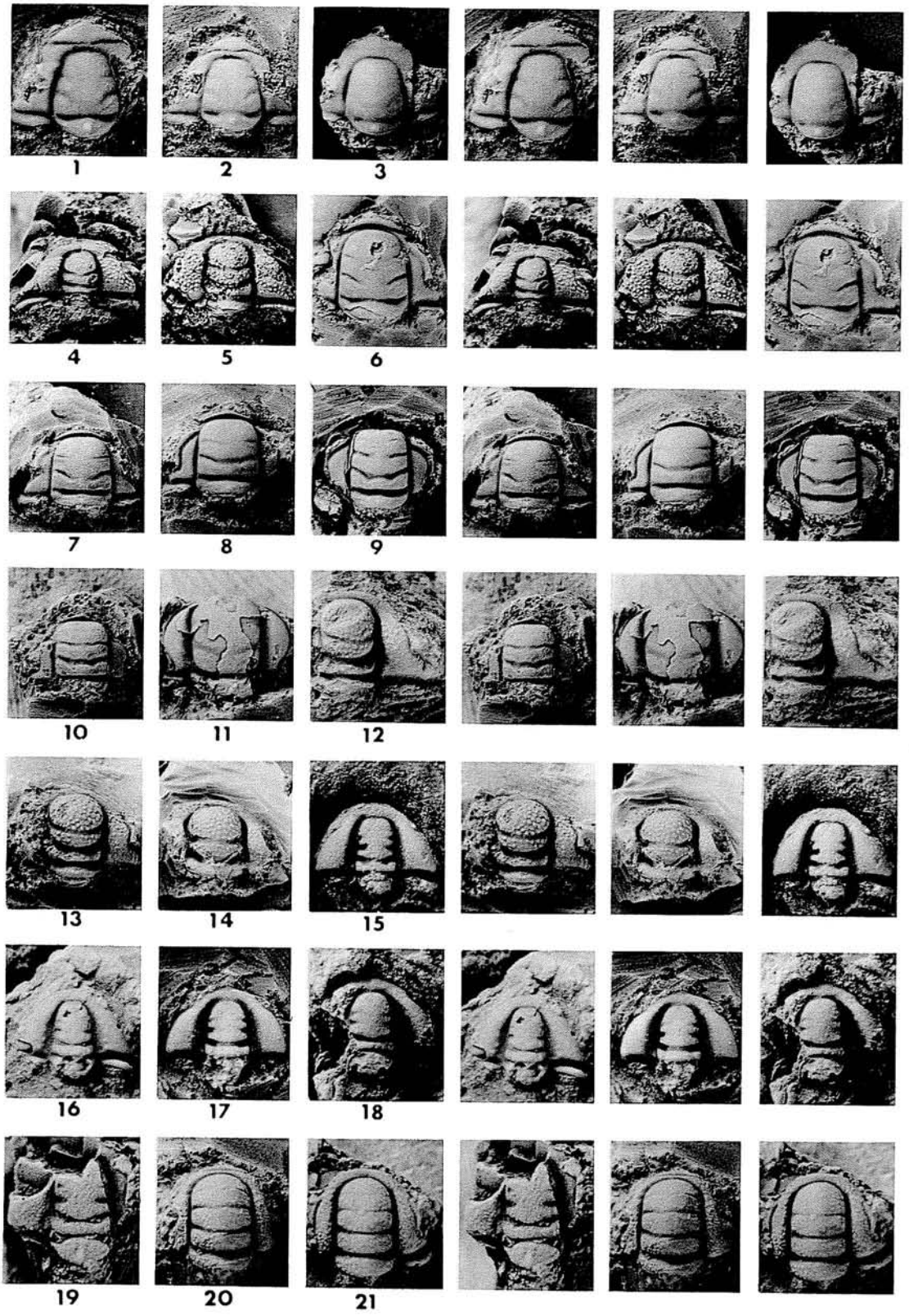
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EXPLANATION OF PLATE 2

FIGS. *1,2—Taenicephalus* sp. Bell & Ellinwood. *1,* internal mold of small cranidium showing straight anterior border furrow and medially expanded anterior border, ×6 (BEG 36482), from CO-143. *2,* unexfoliated small cranidium showing anterior and posterior expansion of the anterior border along the axial line, ×5 (BEG 36483), from GM-575.

3—Conaspis parvafrons Kurtz. Internal mold of small cranidium, ×4 (BEG 36484), from SS-90.

4,5—Ptychaspis bullasa Lochman & Hu. *4,* partly exfoliated small cranidium showing equidimensional glabella common to specimens from high in the range, ×5 (BEG 36485), from GR-195. *5,* partly exfoliated large cranidium showing granulate occipital ring, ×1.5 (BEG 36486), from WC-968.

6,7—Drumaspis texana Resser. Unexfoliated medium cranidia showing ornament and glabellar shape common to the Texas cranidia, ×3 (BEG 36487), ×2 (BEG 36488), both from E-917.

8–10—Drumaspis idahoensis Resser. *8,* internal mold of medium cranidium, ×3 (BEG 36489), from CO-219. *9, 10,* partly and almost completely exfoliated medium cranidia from high in the range showing wide fixigenae and possible affinities to *Dartonaspis,* both ×3 (BEG 36490) (BEG 36491), both from TC-1100 (approx.).

11—Dartonaspis wichitaensis (Resser). Partly exfoliated medium cranidium showing pitted fixigenae, ×5 (BEG 36492), from MC-844.

12–14—Ptychaspis sp. *12,* internal mold of medium cranidium showing elevated fixigenae and ornament, ×3 (BEG 36493), from TC-1095. *13,* internal mold of small cranidium, ×3 (BEG 36494), from TC-1105. *14,* almost exfoliated large cranidium, ×1.5 (BEG 36495), from WC-1060-1075.

15–19—Idiomesus infimus Longacre, n. sp. *15,* internal mold of large cranidium showing deep and narrow axial furrow, ×6 (BEG 36496), from JR-284.5. *16,* partly exfoliated large cranidium showing large granules on interior edge of fixigenae, ×7 (BEG 36497, holotype), from TC-1242. *17,18,* internal molds of medium cranidia showing relatively wide and deep axial furrows, ×5 (BEG 36498), ×6 (BEG 36499), both from JR-284.5. *19,* fragment of a partly exfoliated cranidium showing inflated occipital ring with node, ×6 (BEG 36500), from MC-862.

20,21—Keithia cf. *K. connexa* Rasetti. Internal molds of large and small cranidia showing granular ornament, ×5 (BEG 36501), from JR-351, ×8 (BEG 36502), from BC-41.

EXPLANATION OF PLATE 3

FIG. *1*—*Rasettia magna* Ellinwood. Internal mold of small pygidium showing smooth curvature of anterior edge of pleural field and the binodose terminal piece, ×1 (BEG 36503), from TC-1258.

2–5—*Euptychaspis frontalis* Longacre, n. sp. *2,* unexfoliated small cranidium showing ornament and preglabellar field, ×7 (BEG 36504, holotype), from JR-369.5. *3,* internal mold of small cranidium showing that internal mold can be smooth, ×5 (BEG 36505), from TC-1237. *4,* partly exfoliated small cranidium showing ornament and no preglabellar field, ×6 (BEG 36506), from BC-42. *5,* partly exfoliated small cranidium showing large occipital spine, ×8 (BEG 36507), from BC-41.

6,7—*Idiomesus levisensis* (Rasetti). *6,* internal mold of small cranidium showing low fixigenae, glabellar shape, and pitted fixigenae, ×7 (BEG 36508), from BC-41. *7,* almost exfoliated large cranidium showing pitted fixigenae and depression on the front of the glabella, ×4 (BEG 36509), from BC-41.

8–10—*Keithiella scapane* Longacre, n. sp. *8,* internal mold of large cranidium showing greatly expanded anterior border, ×1.5 (BEG 36510, holotype), from BC-32. *9,* internal mold of medium cranidium, ×1.5 (BEG 36511), from JR-369.5. *10,* almost exfoliated small cranidium showing reduced curvature of anterior border furrow, ×3 (BEG 36512), from BC-41.

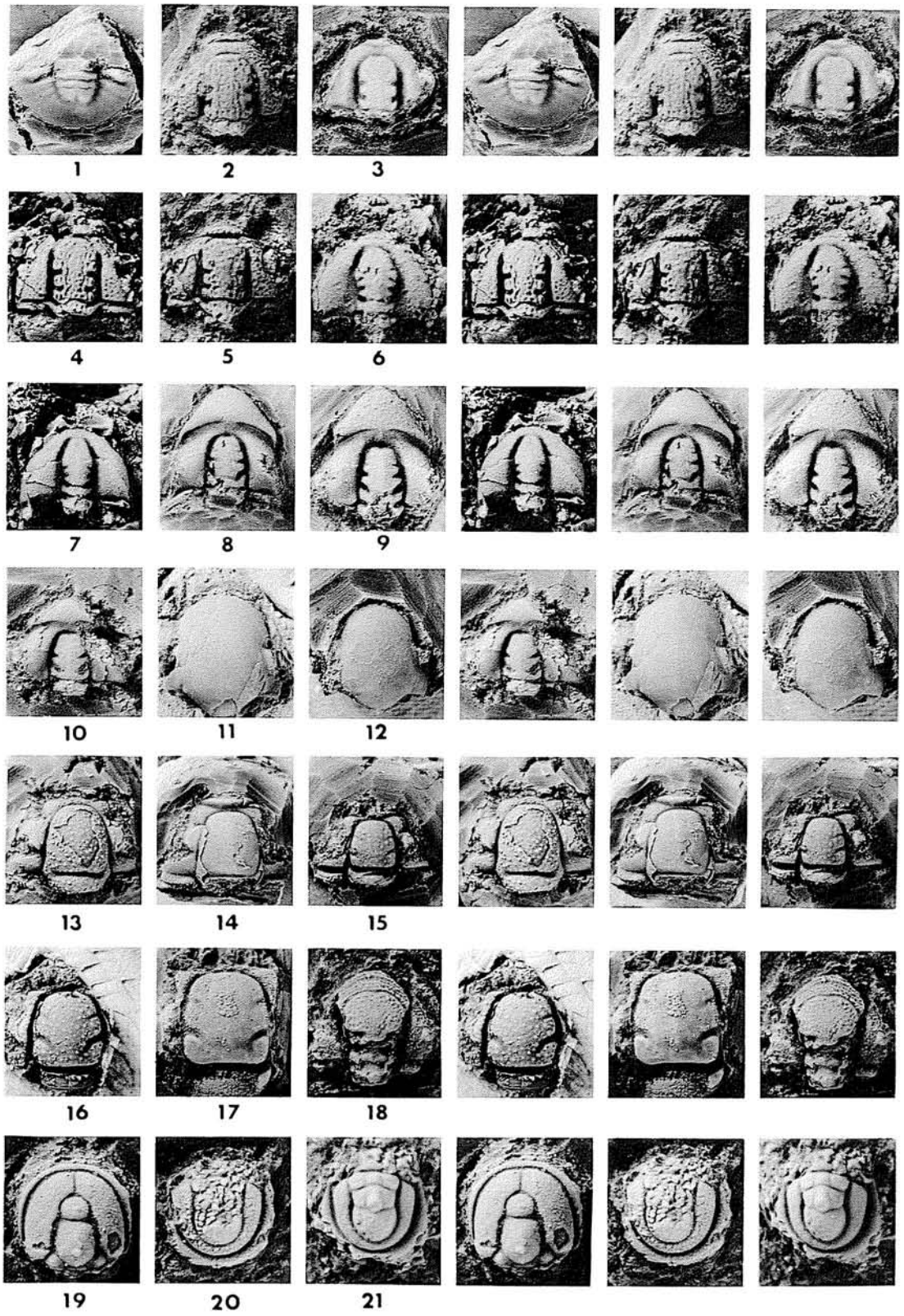
11,12—*Plethometopus convergens* (Raymond). *11,* partly exfoliated large cranidium, ×2 (BEG 36513), from JR-532. *12,* internal mold of medium cranidium, ×2.5 (BEG 36514), from JR-529.

13,14—*Bayfieldia binodosa* (Hall). Partly exfoliated medium and large cranidia showing granular and smooth surface ornament, laterally bifurcate occipital furrow, and recurved anterior border furrow, ×2 (BEG 36515), from JR-369.5, ×1 (BEG 36516), from JR-357.

15–17—*Eurekia granulosa* Walcott. *15,* internal mold of small cranidium showing wide anterior fixigenae, ×2 (BEG 36517), from BC-41. *16,* partly exfoliated medium cranidium showing anteriorly rounded glabella, ×2 (BEG 36518), from BC-23. *17,* internal mold of large cranidium showing divergent anterior facial sutures and glabellar shape of specimens from high in the range, ×2 (BEG 36519), from SPH-110.

18—*Euptychaspis jugalis* Winston & Nicholls. Partly exfoliated large cranidium showing ornament, ×5 (BEG 36520), from CC-27.

19–21—*Geragnostus? insolitus* Grant. *19,20,* partly exfoliated cranidium and pygidium, both ×8 (BEG 36521) (BEG 36522), both from BC-41. *21,* internal mold of small pygidium, ×10 (BEG 36523), from BC-42.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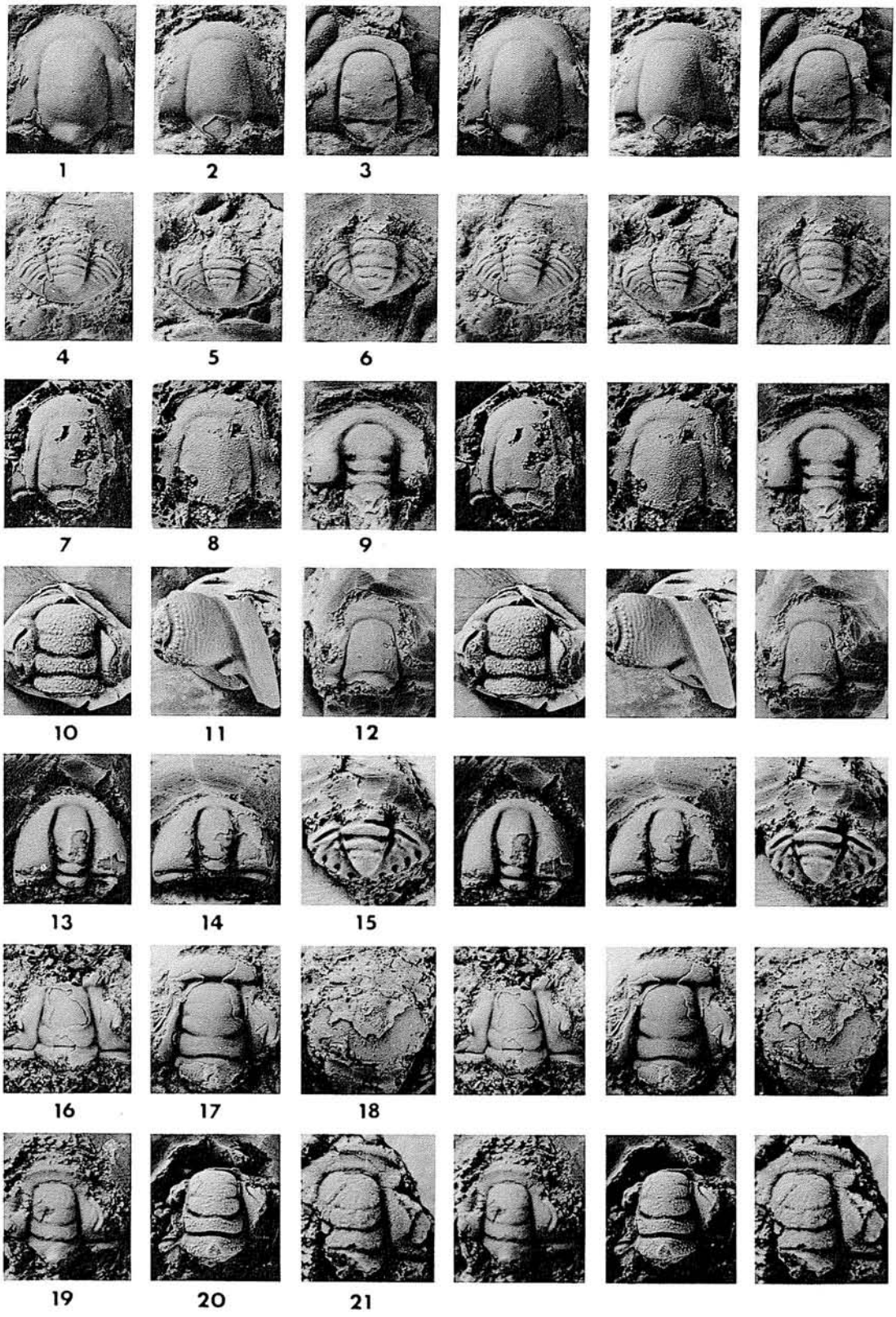
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EXPLANATION OF PLATE 4

FIGS. *1,2,4,5—Plethopeltis saratogensis* (Walcott). *1,* internal mold of large cranidium, ×1.5 (USNM 58558, holotype). *2,* partly exfoliated medium cranidium, ×2 (MCZ 1730, holotype of *P. walcotti* Raymond). *4,* partly exfoliated medium pygidium, ×2 (USNM 58560, paratype). *5,* partly exfoliated medium pygidium, ×2 (MCZ 1731, paratype pygidium of *P. walcotti* Raymond). All from Hoyt's Quarry, 4 miles west of Saratoga Springs, New York.

3,6—Plethopeltis granulosa Resser. *3,* unexfoliated medium cranidium showing granulo-striate ornament, originally figured by Walcott (1912) as *P. saratogensis,* later made holotype of *P. granulosa,* ×3 (USNM 58561). *6,* internal mold of medium pygidium, ×2 (USNM 58565, paratype). Both from Hoyt's Quarry, 4 miles west of Saratoga Springs, New York.

7,8—Plethopeltis sp. *7,* partly exfoliated medium cranidium, ×3 (BEG 36524). *8,* internal mold of medium cranidium showing terrace lines on the anterior border and granular ornament, ×3 (BEG 36525). Both from MC-1065.

9—Euptychaspis typicalis Ulrich. Internal mold of large cranidium showing the shelflike anterior border and striations across the preglabellar field, ×4 (BEG 36526), from SS-345±.

10–11—Saukia tumida Ulrich & Resser. Internal molds of large cranidium and librigena showing ornament, both ×1 (BEG 36527) (BEG 36528), both from JR-481.

12—Bayfieldia simata Winston & Nicholls. Internal mold of medium cranidium showing recurved anterior border furrow, ×1.5 (BEG 36529), from SS-360.5.

13–14—Idiomesus intermedius Rasetti. Partly exfoliated medium cranidia showing Bertillon ornament on fixigenae and frontal area, ×5 (BEG 36530), from LCS-32.4, ×4 (BEG 36531), from CC-61.

15—Eurekia eos (Hall). Internal mold of large pygidium showing unusual marginal spines and pitted surface, ×2 (BEG 36532), from SS-409.

16—Calvinella procera Winston & Nicholls. Partly exfoliated large cranidium showing delicate vermiform ridge ornament on test, ×1.5 (BEG 36533), from TC-1368-1374.

17—Calvinella tenuisculpta Walcott. Partly exfoliated small cranidium showing transverse ridges on the test fragments of the anterior border and the ridges on the occipital-ring fragment, ×3 (BEG 36534), from LCS-33.

18—Rasettia wichitaensis (Resser). Partly exfoliated pygidium, ×1.5 (BEG 36535), from SH-52.

19–21—Prosaukia remora Longacre, n. sp. *19,* internal mold of medium cranidium, ×5 (BEG 36536, holotype), from LCS-40. *20,* partly exfoliated cranidium showing granular ornament, ×3 (BEG 36537), from LCS-33. *21,* internal mold of medium cranidium, ×6 (BEG 36538), from LCS-45.

EXPLANATION OF PLATE 5

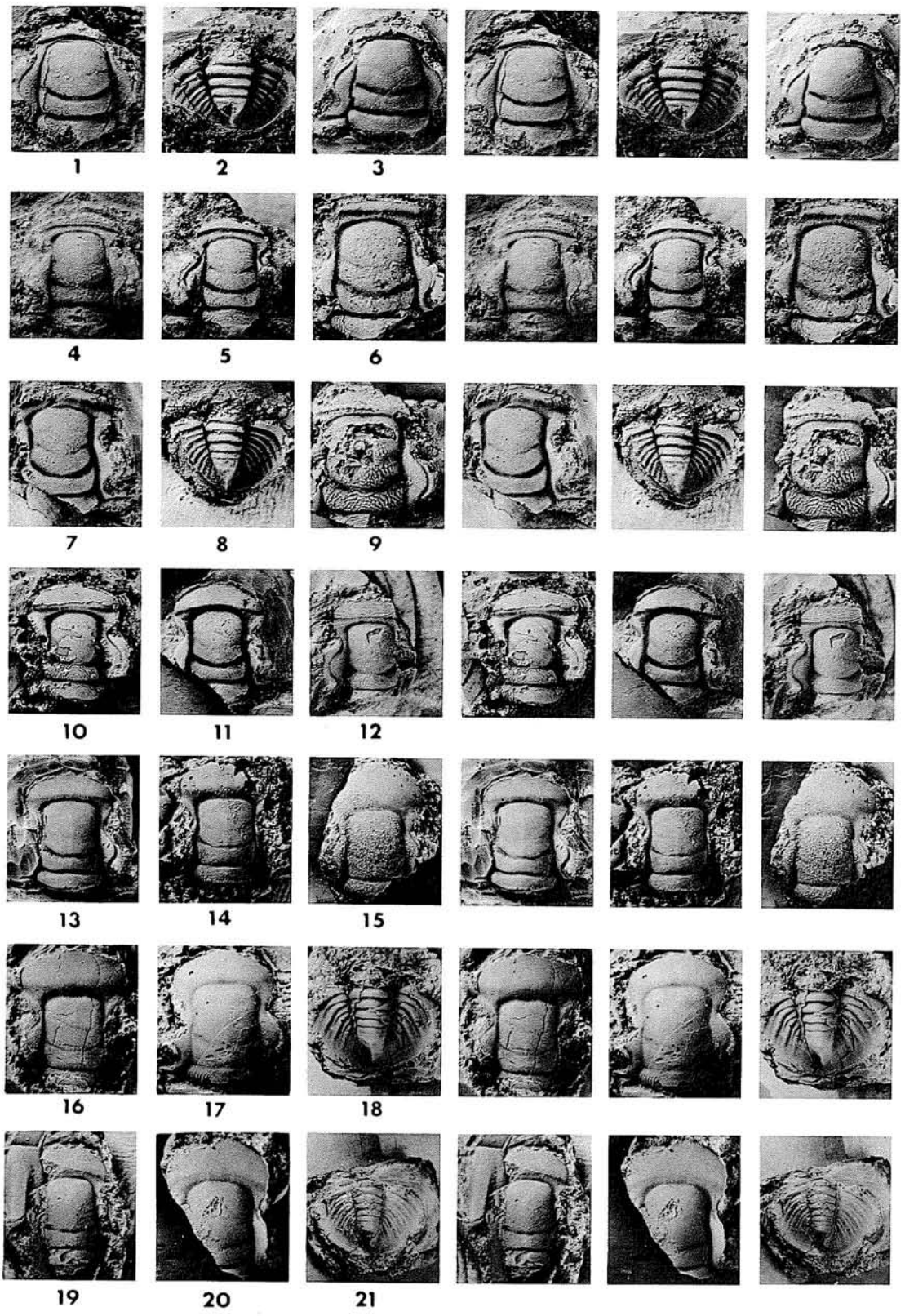
FIG. *1–3—Saukiella fallax* (Walcott). *1,* partly exfoliated medium cranidium, ×3.5 (BEG 36539), from SS-307.5. *2,* partly exfoliated medium pygidium, ×2 (BEG 36540), from JR-354. *3,* internal mold of large cranidium, ×2 (BEG 36541), from JR-354.

4–8—Saukiella pyrene (Walcott). *4–7,* internal molds of small to large cranidia showing variation in glabellar shape and frontal area topography, ×5 (BEG 36542), from JR-394, ×3.75 (BEG 36543), from JR-394, ×2.5 (BEG 36544), from SPH-140, ×2 (BEG 36545), from SPH-140. *8,* internal mold of medium pygidium, ×2.5 (BEG 36546), from SPH-140.

9–11—Saukiella pepinensis (Owen). *9,* internal mold of large cranidium showing spectacular ornament, ×1.5 (BEG 36547), from TC-1293. *10,* partly exfoliated medium cranidium showing ornament and distinct anterior border furrow, ×2 (BEG 36548), from JR-460. *11,* internal mold of large cranidium showing vague Bertillon ornament on the glabella, deep glabellar furrows, and distinct anterior border furrow, ×1.5 (BEG 36549), from TC-1291.

12–18—Saukiella junia (Walcott), var. B, Winston & Nicholls. *12,13,* small partly exfoliated and medium completely exfoliated cranidia from the base of the species range showing shallower furrows and close affinities to *S. pepinensis,* ×3 (BEG 36550), from TC-1301, ×1 (BEG 36551), from TC-1303. *14,15,* internal molds of medium and large cranidia from low in the species range showing reduced convexity, shallower furrows, and longer frontal areas than figures 12 and 13, both ×2 (BEG 36552) (BEG 36553), both from TC-1305. *16,* internal mold of medium cranidium from the middle of the species range, ×2 (BEG 36554), from TC-1310–1315. *17,* unexfoliated large cranidium from the middle of the species range showing ornament on the occipital ring, ×1 (BEG 36555), from TC-1310–1315. *18,* partly exfoliated medium pygidium from low in the species range, ×1.5 (BEG 36556), from TC-1305–1310.

19–21—Saukiella junia (Walcott), var. A, Winston & Nicholls. *19,20,* internal molds of small and large cranidia, ×2.5 (BEG 36557), ×1 (BEG 36558). *21,* partly exfoliated large pygidium showing almost equally divided pleurae, ×0.5 (BEG 36559). All from TC-1341–1346.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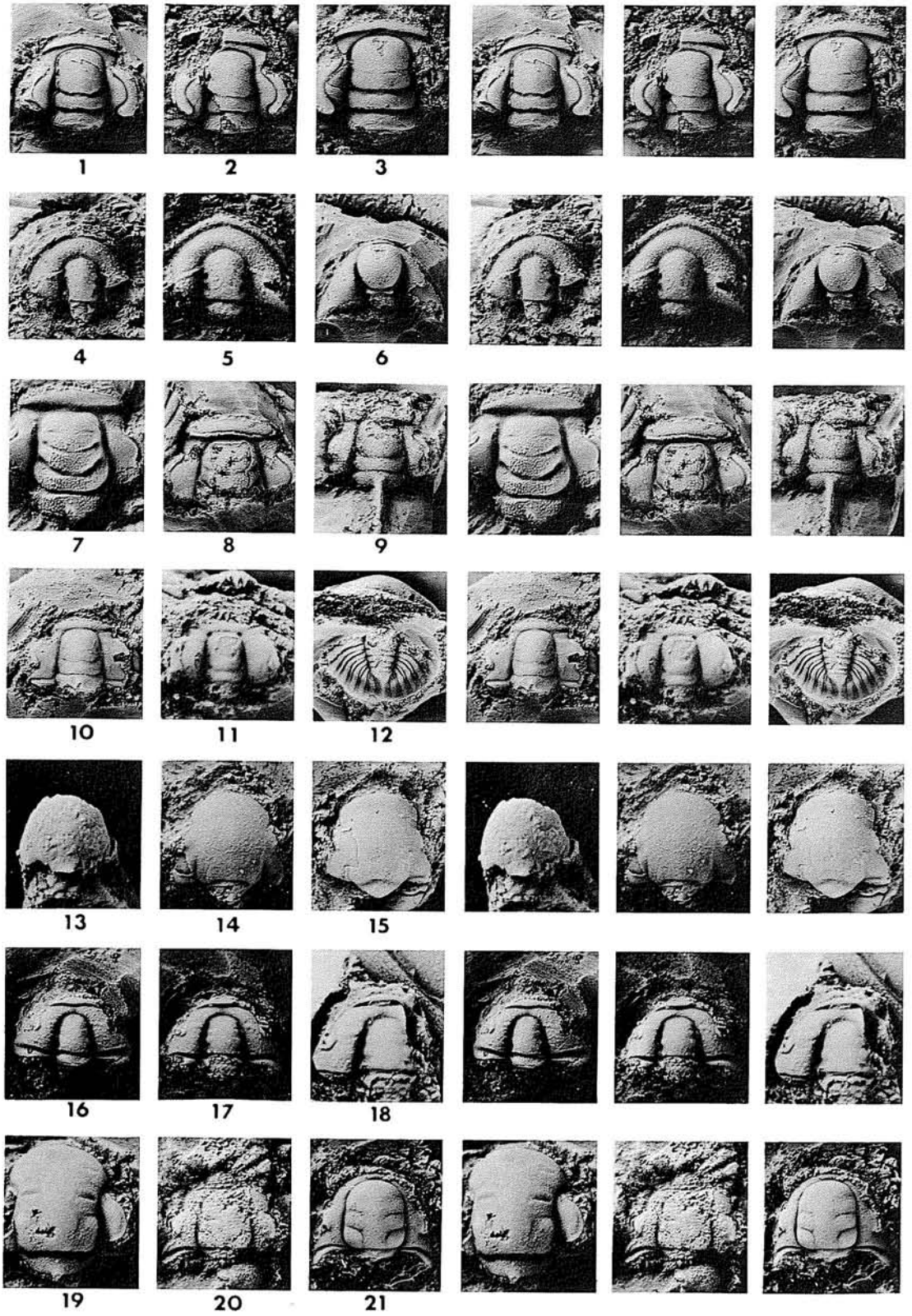
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EXPLANATION OF PLATE 6

FIGS. *1–3—Saukiella serotina* Longacre, n. sp. *1,* partly exfoliated medium cranidium showing spectacular ornament and large palpebral areas of the fixigenae, ×2 (BEG 36560, holotype), from CC-61. *2,* internal mold of medium cranidium, ×2.5 (BEG 36561), from SH-61.5. *3,* partly exfoliated medium cranidium, ×2 (BEG 36562), from JR-521.5.

4,5—Bowmania pennsylvanica Rasetti. Internal molds of large and medium cranidia showing anteriorly expanded glabellae and ornament, ×2.5 (BEG 36563), ×4 (BEG 36564), both from LCS-40.

6—Macronoda cf. *M. prima* Lochman. Partly exfoliated large cranidium showing granular ornament, squared anterior end of the glabella, and posterior glabellar flattening, ×2.5 (BEG 36565), from TC-1388.

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