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OF
TENNESSEE AND OKLAHOMA

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Norman, Oklahoma

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MICROPALEONTOLOGY OF THE FERNVALE FORMATION

OF

TENNESSEE AND OKLAHOMA

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MICROPALEONTOLOGY OF THE FERNVALE FORMATION

OF TENNESSEE AND OKLAHOMA

ABSTRACT

Kenneth V. Bordeau

A Richmond conodont faunule is reported and described from six Central Tennessee Fernvale sections. A conodont faunule and an ostracode faunule of probable Eden Age is reported and described from six sections of uppermost Viola and Fernvale strata of Oklahoma.

The following conodont species were recovered from Tennessee Richmond strata: Amorphognathus ordovicica, Aphelognathus grandis, Cordylodus delicatus, Cordylodus plattinensis, Cordylodus sp., Cyrtoniodus flexuosus, Dichognathus extensa, Drepanodus concavus, Drepanodus homocurvatus, Drepanodus sp., Eoligonodina richmondensis, Eoligonodina robusta, Falodus ? sp., Icriodina superba acuta, Ligonodina cf. fairmontensis, Oistodus abundans, Oistodus forceps, Oulodus mediocris, Ozarkodina concinna, Ozarkodina robusta, Ozarkodina tenuis, Panderodus gracilis, Panderodus panderi, Panderodus unicostatus, Phragmodus undatus, Prioniodina delecta, Prioniodina oregonia, Prioniodina oregonia var., Rhipidognathus symmetrica, Rhipidognathus paucidentata, Sagittodontus robustus, Scandodus, sp., Scyphiodus cf. primus, Trichonodella recurva, Trichonodella cf. recurva, Trichonodella undulata, Trichonodella sp. A, Zygognathus deformis, Zygognathus pyramidalis, Zygognathus sp.

The following conodont species were recovered from the Viola-Fernvale of Oklahoma: Acontiodus sp., Ambalodus triangularis, Amorphognathus ordovicica, Belodina compressa, Belodina diminutiva, Belodina inclinata, Belodina ornata, Cordylodus delicatus, Cyrtoniodus flexuosus, Dichognathus extensa, Drepanodus cavus, Drepanodus concavus, Drepanodus homocurvatus, Drepanodus sp., Falodus prodentatus, Keislognathus gracilis, Lepodus sp. A, Lepodus sp. B, Oistodus forceps, Ozarkodina concinna, Panderodus acostatus, Panderodus compressus, Panderodus gracilis, Panderodus panderi, Panderodus unicostatus, Phragmodus undatus, Plectospathodus sp., Ptiloncodus sp., Scolopodus insculptus, Scolopodus cf. quadraplicatus, Trichonodella sp. B.

The following ostracode species were recovered from the Oklahoma Fernvale strata: Eohollina cf. depressa, Eurychilina sp., Thomasatia sp. A, Thomasatia sp. B. ? Euprimitia labiosa, Ceratopsis chambersi, Tallinella sp., Tetradella septinoda, Tetradella ulrichi, Aparchites cf. fimbriatus, Aparchites suborbicularis, Aparchites macrus, Aparchites sp., Cryptophyllus sp., Primitiella sp., Schmidtella cf. affinis, "Bythocypris" cylindrica, "Bythocypris" cf. cylindrica, "Bythocypris" cf. furnishi, Macrocyproides cf. trentonensis, Punctaparchites cf. rugosus.

The Fernvale of the Arbuckle Region of Oklahoma is recognized as a lithologic facies of the conformably subjacent Viola with which it interfingers. A probable Eden Age is assigned to it. The Fernvale of Northeast Oklahoma, containing similar conodonts and ostracodes, is correlated to the Upper Viola-Fernvale phase of the Arbuckle Mountains.

An approximate correlation of the Fernvale Limestone of Oklahoma to the Cape Limestone of Illinois and Missouri and its equivalents is postulated.

The age of the Sylvan Shale, long considered Richmond Age because of the assignment of the underlying limestone to the Richmond, is now open to reinterpretation, because it is concluded in this investigation that the Fernvale of Oklahoma is of probable Eden Age and does not correlate with the Fernvale of Richmond Age at the type area in Central Tennessee.

MICROPALEONTOLOGY OF THE FERNVALE FORMATION

OF

OKLAHOMA AND TENNESSEE

INTRODUCTION

Objectives

The purpose of this investigation is to study the lithology, and describe and compare the microfossils of strata assigned to the Fernvale Formation of Oklahoma and Tennessee, hopeful of discovering valid lithologic and paleontologic subdivisions of local and regional extent. The microfauna will be compared to other Ordovician microfaunas in order to evaluate age relationships. An attempt will be made to recognize lithologic and paleontologic characteristics that might assist potentially in the recognition of Fernvale strata from subsurface samples, and thus furnish an accurate, simple, and ready means of distinguishing them from similar cuttings and cores.

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HISTORY OF PREVIOUS INVESTIGATIONS

A brief summary of the historical development and background of studies relating to the "Fernvale" Formation of Oklahoma and the Fernvale of Tennessee is presented in chronologic sequence. Because the stratigraphic interpretation of a formation depends in part upon its relationships to beds above and below it, this summary includes information concerning strata subjacent and superjacent to the Fernvale.

Safford (1861, p. 206) assigned "Blue Limestone" Ordovician strata at Clifton, Tennessee, to the Hudson River Group; and in 1869 (p. 281-283) he described as "marble" some beds in Franklin, Maury, and Davidson Counties, Tennessee, which are now included in the Fernvale sequence.

Foerste (1901, p. 432) named the Leipers Creek Formation from outcrops along Leipers Creek, Maury County, Tennessee. Other beds, exposed between Maury and Sumner Counties were referred to the Richmond Group.

Taff (1902, p. 3) named the Viola Formation from the now no longer existent village of Viola, which was located near the outcrop of the formation, five miles west of Wapanucka, Oklahoma. The texture of these rocks was described as dense for the most part, with some beds (probably topmost Viola or "Fernvale") ". . . coarsely crystalline, as though composed of shells and shell fragments." Chert appeared to be more abundant in the middle and lower portions. Taff reported a thickness of approximately 700 feet for the Viola Formation ". . . containing an abundant fauna of Lower Silurian (Ordovician) age."

Foerste (1903, p. 40) suggested the name Mannie Shale for shaly clay beds that constitute the upper part of the Richmond Group in western Tennessee. He referred to a particular outcrop that extended from a point three-fourths of a mile west of Riverside (north side of road) to Flat Woods (east of the mouth of Trace Creek). The Mannie Shale was correlated with shales overlying the Leipers Creek Limestone along Leipers Creek. The two units of Leipers Creek Limestone and Mannie Shale were considered by Foerste as the Richmond Group (Uppermost Cincinnatian) in the Tennessee Valley area.

Hayes and Ulrich (1903, p. 2) proposed the Fernvale Formation for ". . . soft, chocolate and green shales commonly containing one or more layers of coarsely crystalline, flesh-colored limestones." The type locality is on South Harpeth River, approximately one mile south of Fernvale Springs, Williamson County, Tennessee. Foerste's Leipers Creek Limestone was changed simply to Leipers by Hayes and Ulrich, and they designated it Maysville in age. Beds of the Arnheim Formation were mapped as either Leipers or Fernvale. According to Wilson (1949, p. 208), western tongues of the Sequatchie Formation and the Mannie Shale are included in the Fernvale of Hayes and Ulrich.

Taff (1903, p. 4) recognized in the Arbuckle area of Oklahoma three subdivisions of the Viola Limestone, each embracing approximately one-third of the formation. The lower and upper thirds of the formation were reported to be thicker and less evenly stratified than the middle third. Three faunal subdivisions were noted, closely corresponding to the three lithological members; the youngest member was reported to be the least fossiliferous ". . . except in the upper twenty-five feet." Taff cited the following fossils from this member (which currently includes the Fernvale):

Pachydicta gigantea

Ptilotrypa obliquata

Plectambonites sp.

Strophomena wisconsinensis

Leptaena unicostata

Orthis kankakensis sweenyi

Dinorthis subquadrata

Dinorthis proavita

Dalmanella macrior

Platystrophia acutilirata

Rhynchotrema capax

Parastrophia divergens

Taff noted that this Oklahoma upper Viola fauna occurs also in the Fernvale Formation of central Tennessee and the Polk Bayou Formation of northern Arkansas. He stated that the fauna is exceptionally widespread and ". . . certainly the easiest to recognize in Ordovician rocks."

Nickels (1903, pp. 206-210), in describing the Richmond Group of Ohio and Indiana, noted that *Rhynchotrema capax* and *Streptelasma rusticum* are the most characteristic fossils of the group. He recognized the following subdivisions of the Richmond Group (ascending):

Waynesville (Bythopora meeki beds), Liberty (Strophomena planumbona beds), Whitewater (Homotreta wortheni beds), and Madison.

Ulrich (1904, p. 97) noted that the Izzard Limestone of northern Arkansas and northeastern Oklahoma corresponds lithologically and stratigraphically with upper Viola beds of the Arbuckle and Wichita Mountains. The Izzard is overlain by a member of the Richmond Group that Banner termed Polk Bayou Limestone. Ulrich reported the following characteristic fossils from the Polk Bayou:

Leioclema wilmingtonense

Monotrypella quadrata

Dalmanella jugosa

Dalmanella macrior

Platystrophia acutilirata

Plectorthis kankakensis

Dinorthis proavita

Rafinesquina kingi

Rhynchotrema capax

Bead-like crinoid joints (highly characteristic)

This fauna was considered to be characteristic of the Richmond ". . . most of it from that phase of the group which is developed chiefly west of the 87th meridian. The Fernvale of Middle Tennessee represents practically the same horizon." A stratigraphic break representing most of Trenton time was postulated, although the unconformable contact was reported to be inconspicuous in the field. Locally, the Fernvale is overlain by the Carson Shale, or by younger beds.

Taff (1905) proposed the Tyner Formation for a shale and limestone sequence separating the Burgen Sandstone from the overlying Silurian St. Clair Marble of the Oklahoma Ozark area. Certain Tyner beds exposed on Barren Fork and Tyner Creek ". . . and probably Baumgarner Hollow" of northeastern Oklahoma were considered to be Lorraine in age, and stratigraphically higher than Tyner (Black River or Trenton) exposures along the Illinois River. Lorraine fossils from Barren Fork and Tyner Creek areas were listed as follos:

Psiloconcho inornata

Psiloconcho sinuata

Psiloconcha subovata

Rhytimya sp.

Whiteavesia sp.

Black River-Early Trenton fossils from the Illinois River Tyner section were listed as:

Camarocladia rugosa

Orthis tricenaria

Liospira americana

Lophospira sp. cf. *L. perangulata*

Hormotoma gracilis var.

Leperditia sp. cf. *L. fabulites*

Leperditia sp. (5 mm in length)

Ceraurus pleuexanthemus

Taff's Tyner Formation included the Fite and Fernvale Limestones as currently mapped.

Weller (1907, p. 520) recognized two Richmond facies that he designated as two substages. The first, Richmond proper, is characteristic about Richmond, Indiana, and includes Rhynchotrema capax as a most characteristic species. The second, Maquoketa beds of northwestern Illinois and eastern Iowa, contain abundant small pelecypods:

Cleidophorus spp.

Ctenodonta spp.

Cleidophorus neglectus

The pelecypod fauna is not uniform throughout the Maquoketa, and locally, it includes R. capax and other fossils typical of the Richmond fauna. In the southern part of the Mississippi Valley, a typical Maquoketa fauna (including abundant Cleidophorus neglectus) is characteristic of shale beds overlying a limestone containing abundant R. capax. This association indicated to Weller (p. 520) that the Maquoketa is equivalent or younger than the Richmond proper.

Weller reported an abrupt faunal break between the Trenton and overlying Richmond, the two faunas displaying very little or nothing in common. A physical unconformity was postulated, based upon the following evidence:

(1) A section on Madison Creek, south of Batchtown, reveals the Maquoketa separated from the underlying Kimmswick by a red, residual clay (p. 521) ". . . conclusive evidence of the existence of an area of dry land in the Mississippi Valley."

(2) In several exposures about St. Louis, an unconformity between the Kimmswick Limestone and superjacent Richmond strata is incicated by the fact that southward the Richmond overlies successively

higher members of the Kimmswick. It should be noted that the various members of the Kimmswick were recognizable by differences in bryozoan, trilobite, pelecypod, and Receptaculites faunules.

Savage (1910) introduced the term Fernvale in Illinois to include two limestones currently recognized as a basal Maquoketa limestone bed in southern Illinois and a middle Maquoketa limestone bed, Fort Atkinson Limestone of Templeton and Willman (1963, p. 134).

In describing the distribution and geologic history of the Fernvale Formation, Ulrich (1911) noted its occurrence on the eastern and southern flanks of Ozarkia. In this area, the Fernvale Limestone rests upon Mohawkian strata, and locally, it overlaps beyond to rest upon older rocks. Fernvale outcrops are traceable for miles along some bluffs south of St. Louis, Missouri, where it rests upon peneplaned Kimmswick of Middle Mohawkian age. Between Sulphur Springs and Spencer Station, the Fernvale is succeeded by 16 to 25 feet of Maquoketa Shale, which is overlain by Kinderhook sandstones of variable thickness. One-half mile farther south, the Maquoketa Shale is absent, so the Fernvale is in direct contact with overlying Kinderhook strata. Within the next two miles southward, any one of the lower ledges, even Keokuk, may rest upon the Fernvale. Ulrich stated that at all these points the Fernvale is approximately two feet thick, being no thicker beneath Ordovician Maquoketa than beneath Mississippian Keokuk. He expressed amazement that an erosional hiatus of essentially two periods had failed to remove a bed of limestone less than five feet in thickness.

In the same publication Ulrich (p. 303) described the Fernvale of the Arbuckle area as a thin bed (two to three feet) at the top of the

Viola Limestone ". . . that is characterized by the same lithologic and faunal characters that mark it in southeastern Missouri." Ulrich considered the Sylvan Shale to be a southward extension of the Maquoketa Shale of Iowa. He also noted similarities between the Maquoketa-Sylvan faunaule and that of the Utica Shale. He stated that unless the two faunules are thoroughly compared, their distinctions may be overlooked; hence, it is not surprising that they have been considered contemporaneous. He emphasized (p. 301) ". . . Sylvan and Maquoketa Shale overlie unquestionable Richmond faunas, while the Utica lies just above the Trenton at the base of the Cincinnatian Series."

Miser (1920, p. 28) in a stratigraphic survey that outlined the distribution of Ordovician strata of the Ozark area, stated that the Fernvale and the overlying Cason Shale rest upon the Kimmswick. He mentioned that some early reports had included the Fernvale with the so-called St. Clair of northern Arkansas, and that other reports had included it in the upper part of the Polk Bayou.

Gould (1925, pp. 15, 16) reported the occurrence of 500 to 750 feet of massive, homogeneous Viola Limestone in the Arbuckle Mountains of Pontotoc, Johnston, Murray, and Carter Counties of Oklahoma. The Viola crops out typically as a series of bare, rounded limestone knobs lying outside of the eroded Simpson Valley. Three outlying knobs in the vicinity of Rainy Mountain, Kiowa County, in the Wichita Mountains, were reported as Viola.

Characteristic fossils of the Viola were listed as follows:

Lower Viola:

<u>Tetradium columnare</u>

Phylloporina _reticulata_

Rhinidictya _mutabilis_

Escharopora _subrecta_

Rhynchotrema _increbescens_

Vanuxemia _gibbosa_

Cyrtolites _retrorsus_

Protowarthia _pervoluta_

Bumastus _trentonensis_

Middle Viola:

Diplograptus _pristis_

Climacograptus _typicalis_

_C_. _bicornis_

Schizotreta _minutula_

Rafinesquina _deltoidea_

Cornularia _trentonensis_

Trinucleus _concentricus_

Proetus _parviusculus_

Upper Viola:

Pachydicta _gigantea_

Ptilotrypa _obliquata_

The Viola was reported to be Middle Ordovician (Mohawkian) in age, and correlative with the Bigfork Chert, upper part of the Stringtown Shale, and lower part of the Talihina Chert of the Ouachita Mountains, and lower part of the Tyner Formation of northeastern Oklahoma.

The Fernvale sequence was not described by Gould.

Sylvan Shale (60 to 300 feet in thickness) was reported outside the row of rounded Viola hills in Pontotoc, Johnston, Murray, and Carter Counties. Here the Sylvan greenish to greenish-blue shales typically weather to form long, narrow valleys. Sylvan fossils were recorded (after Taff) as follows:

Diplograptus sp.

Climacograptus cf. typicalis

Lingula sp.

Leptobolus sp.

Conularia sp.

Conodonts, several species.

White (1926, p. 112) suggested that some of the limestone designated by Taff as Tyner, should receive separate formational names. He noted also that although Taff had considered the Viola Limestone as topmost Ordovician, Ulrich referred uppermost Viola strata (Fernvale) and the overlying Sylvan Shale to the Richmond "Lower Silurian."

White further noted that Taff in 1905 had erroneously included uppermost Viola (Fernvale) strata with the Tyner; and regarding this he stated, "All authorities agree that the upper Viola is Richmond in age." He suggested that the Ordovician-Silurian boundary be placed at the base of the Richmond, because the upper portion of the Viola is so much more widespread than the lower and thicker portions, and because ". . . the Viola-Sylvan contact is conformable."

Ulrich (1927, table, p. 30) placed the Sylvan Shale and Fernvale Limestone in the Richmond Group, unconformably overlying the Viola, which was considered Eden and Early Maysville in age. He postulated questionable

Brassfield beneath the St. Clair Marble (p. 30) ". . . below which, unconformably are thin representatives of Cincinnatian and Black River age included in the Tyner Formation." The Richmond Fernvale Limestone was considered to be basal Silurian (Ontarian) in Tennessee, Missouri, Arkansas, Oklahoma, and Texas. The Sylvan Shale of Oklahoma was correlated with the Maquoketa Shale of Missouri and the Cason Shale of Arkansas.

Edson (1927, p. 969) stated that two limestone members of the Viola, recognizable in the Arbuckle Mountains, crop out near Tahlequah, Oklahoma. The upper member is coarsely crystalline, and the lower member of Black River or Early Trenton age is lithographic. Fossils of the upper member, ". . . evidently not seen in the original survey nor described by Taff in the Tahlequah folio" were identified as Richmond by G. S. Buchanan. Absence of the middle Viola member was interpreted as confirmation of a hiatus between the Richmond and lower part of the Viola in the Arbuckle Mountains. These two members described by Edson are currently mapped as coarsely crystalline Fernvale resting unconformably upon the lithographic Fite Limestone.

Taff (1928) reported abundant fossils in the upper twenty-five feet of Viola in the Arbuckle area. These included fossils previously listed in his 1902 publication, plus Rafinesquina n. sp. cf. R. camerata. He again emphasized that the fauna occurs in the Polk Bayou Limestone of northern Arkansas and in the Fernvale Formation of central Tennessee.

McClellan (1930) projected the subsurface Tyner Formation and Arbuckle Siliceous Limestone northward from Oklahoma into Kansas. A green shale from a well in Riley County, Kansas, was stated to be identical lithologically to the Tyner Shale of Oklahoma. It was characterized by a bryozoan fauna with abundant Escharopora and Rhinidictya ". . . strongly suggestive of Decorah (Black River) age." He reported the 100- to 180-foot Urschel Limestone, typically developed and overlying Simpson strata in the Salina Basin of Central Kansas, to be similar lithologically to the Lower Richmond Fernvale of Oklahoma. Fossils from an Urschel Limestone core were reported by R. L. Kidd as Richmond in age. Finely crystalline, cherty limestones overlie the subsurface Fernvale in Central Kansas. McClellan discovered that both the cherty limestones and the subjacent Fernvale become thinner northward, in contrast to an underlying unit (probably Galena) that becomes thicker northward. The Urschel Limestone is probably not correlative in its entirety with either the Galena of Iowa nor with the Viola-Fernvale of Oklahoma.

Edson (1930) listed several subsurface unconformities within the Ordovician System of Oklahoma. Among those listed were the post-Viola-pre-Fernvale (post-Cincinnatian-pre-Richmond) and the post-Fernvale-pre-Sylvan (intra-Richmond). Edson stated that these angular unconformities are recognizable by all Mid-continent stratigraphers familiar with Lower Paleozoic sediments.

Croneis (1930, p. 31) noted that the Fernvale was regarded formerly as the upper part of the Polk Bayou, and correlative with the St. Clair Limestone. He noted that locally the Fernvale contains nodules and irregular masses of grey and brown chert. The formation is fossiliferous throughout, particularly in its basal and uppermost beds, Rhynchotrema capax, Dinorthis subquadrata, Strophomena planodorsata, and Plectambonites praecosis being characteristic fossils. The Fernvale, apparently representing initial Richmond deposition in Arkansas, Missouri, and Oklahoma, rests unconformably upon Jasper Limestone in Newton County, Arkansas; but ordinarily the formation rests disconformably upon the Kimmswick Limestone.

Cram (1930), generally credited for having extended the term Fernvale into northeastern Oklahoma, listed Fernvale sections in the Ozark area. A thickness of ten feet was reported, and it was said to be replete with well preserved fossils. Upon the basis of personal communication with Ulrich, Cram correlated the Fernvale with the Lower Richmond Fernvale of Tennessee.

Cram stated that the Fernvale is unconformable with subjacent beds throughout Oklahoma and the Mississippi Valley. He considered it to be the uppermost bed of the Viola in the Arbuckle Mountains.

Cram named and described the Fite Limestone of northeastern Oklahoma; stating that the irregular, unconformable Fite-Fernvale contact is readily discernible at most exposures, although not marked by discordance of dip. Cram stated that Ulrich considered the Fite to be Richmond in age, and that because of this age assignment, the "Dense Limestone" of the subsurface (probable equivalent of the Fite) apparently lenses out southward, because no pre-Fernvale strata of Richmond age are recognizable in the Arbuckle area. Certain dense limestones of the Ada area resemble the subsurface "Dense Limestone" near Seminole, but these Ada limestones reportedly contain a different microfauna ". . . that affords ready correlation with beds which lie below the Viola Seminole Sand and above the Simpson Wilcox Sand of the St. Louis-

Seminole area." Cram interpreted such subsurface evidence as corroboration of Ulrich's assignment of the Fite to Richmond, rather than to Black River. The possibility remains, however, that the "Dense Limestone" of the subsurface is Black River or Early Trenton in age.

Edson (1931) stated that Eden strata are absent essentially throughout the United States, except upon the Cincinnati Arch. Its single definite occurrence in the Mid-continent is in the Arbuckle Mountains, where Eden deposits are represented in the 700 feet of Viola Limestone. Bore holes a few miles north of the mountains indicate that the Eden is absent.

Edson stated also that there is very little Maysville strata in the United States, except again, upon the Cincinnati Arch.

Richmond strata in the United States, however, were deposited in extraordinary distribution. The Fernvale and Sylvan-Maquoketa were referred to the Richmond by Edson. The Fernvale has a remarkably uniform thickness of 40 feet throughout the Ozark region of Kansas and Missouri, where it rests discordantly upon underlying strata.

Discordance is observable also at the roof of the Fernvale Limestone in Oklahoma, proof of which was discovered in the subsurface of the Marshall Oil Field of Southern Oklahoma. Here, bore holes reveal the Fernvale upon the flanks and near the crest of the anticline. Two of the borings upon the crest of the structure, however, reveal the Fernvale missing. One of these two borings revealed that the entire Fernvale Formation, plus 75 feet of underlying Black River sequence, had been eroded (an off-set boring recorded 61 feet of Fernvale overlying

125 feet of Black River Limestone). Edson interpreted the missing Fernvale interval as evidence of discordance between the Fernvale Limestone and overlying Sylvan Shale in Southern Oklahoma.

McFarland (1931) listed and figured the following Richmond fossils from Kentucky:

Leptaena richmondensis precursor
Platystrophia clarksvillensis
Heterospongia knotti
Rhynchotrema dentatum arnheimensis
Zygospira kentuckiensis
Heterospongia subramosa
Cyphotrypa clarksvillensis
Platystrophia ponderosa
Cyclonema bilix fluctuatum
Constellaria polytomella
Homotrypa wortheni
Homotrypa bassleri
Stigmatella dychei
Dalmanella meeki
Hebertella insculpta
Strophomena mutans
Strophomena sulcata
Strophomena planumbona
Platystrophia cypha
Dinorthis subquadrata
Dinorthis corleyi

<u>Hallopora subnodosa</u>

<u>Bythopora meeki</u>

<u>Strophomena venusta</u>

<u>Beatricia nodulifera intermedia</u>

<u>Calapoecia cribriformis</u>

<u>Plectambonites rugosus</u>

<u>Rhynchotrema capax</u>

<u>Homotrypa austini</u>

<u>Rhombotrypa subquadrata</u>

<u>Rhombotrypa quadrata</u>

<u>Protarea richmondensis</u>

<u>Columnaria alveolata</u>

Cram (1932) stated that characteristic coarsely crystalline lithology and distinctive microfossils constitute sufficient criteria for tracing the Fernvale from northeastern Oklahoma into the Arbuckle Mountains. The Simpson Burgen Sandstone and superjacent Tyner Formation of northeastern Oklahoma, however, are only imperfectly correlated with the Simpson section of the Arbuckle area. Characteristic Ostracoda permit tracing the Fite (overlying the Tyner) into the Seminole subsurface area; but southward, it is difficult to determine its relationship to the Viola. "The best though inconclusive evidence indicates that the Fite is Bromide Black River-Trenton in age, instead of Richmond, as the meager fauna collected at the outcrop suggests." Harris (1957) apparently supported Cram's assignment of the Fite to Black Riverian-Trentonian age, in tentatively correlating it with the Corbin Ranch of the Arbuckle Mountains.

Bassler (1932) subdivided the Richmond Group of the Central Tennessee Basin into the Fernvale Formation and subjacent Arnheim Formation, and interpreted it as Early Silurian in age. The Fernvale was portrayed as overlapping and resting upon older strata of various ages in Tennessee, having been deposited in shallow troughs of pre-Arnheim origin. Bassler's faunal list of the Fernvale and overlying Mannie Shale includes the following forms:

Crania laelia

Dalmanella tersa

Dinorthis proavita

Dinorthis subquadrata

Hebertella insculpta

Hebertella sinuata

Leptaena unicostata

Lingulops cliftonensis

Platystrophia acutilirata var.

Rafinesquina alternata

Rhynchotrema manniense

Rhynchotrema perlamellosum

Sowerbyella (*Plectambonites*) *saxea*

Strophomena odessae

Strophomena planodorsata

Zygospira recurvirostris var.

Anaphragma mirabile

Analotichia ponderosa

Constellaria polystomella

<u>Corynotrypa</u> <u>turgida</u>

<u>Crepipora</u> <u>hemispherica</u>

<u>Goniotrypa</u> <u>bilateralis</u>

<u>Lioclemella</u> <u>bifurcata</u>

<u>Pachydictya</u> <u>grandis</u>

<u>Peronopora</u> <u>decipiens</u>

<u>Ptilotrypa</u> <u>obliquata</u>

<u>Rhombotrypa</u> <u>quadrata</u>

<u>Cyclonema</u> <u>bilix</u>

<u>Cyclora</u> <u>minuta</u> (with associated dwarf gastropods)

Bead-like crinoid columnals (characteristic of Fernvale)

Bassler (p. 130) contended that the Fernvale fauna is "undoubtedly of Arctic origin," because representatives of this fauna are traceable in the same or closely allied formations northward into Alaska and Greenland, whereas, southward, both the formation and the fauna cease in "bay-like areas." This distribution suggests that North America was tilted northward during deposition of the Fernvale. Such northward tilting, however, is not in harmony with the statement of Bassler (p. 125) that Fernvale strata occur in West Texas, New Mexico, and along the eastern side of the Rocky Mountains. Bassler admitted, however, that exact correlation of these strata is doubtful because of the absence of bryozoans.

Decker (1933, p. 1408), in a comprehensive description of the Viola Limestone, recognized Viola and Sylvan equivalents in the Atoka area of Oklahoma. The Viola was observed in gradational contact with overlying coarsely crystalline, dark gray limestones typical of the Fernvale phase; accordingly, the Fernvale was considered as the uppermost member of the Viola. The Fernvale, in turn, apparently grades from coarsely crystalline, through argillaceous limestones, into calcareous shales of the overlying Sylvan. A single exposure of exceptionally thin (24 feet) Fernvale revealed considerable pyrite and limonite as possible evidence of an unconformity at the "rough contact with the Sylvan Shale." Variation in thicknesses of the Fernvale within relatively short distances is further evidence of disconformable relationship. Decker included Taff's (1928) list of characteristic Fernvale fossils, and noted the persistence of graptolites and trilobites throughout the Viola sequence. He agreed with Taff in the assignment of Viola (and its uppermost Fernvale) to the Trenton-Richmond, noting that Cryptolithus tesselatus ranges from a position near the base of the Viola into the Richmond Fernvale phase at the top. The following Fernvale fossils were reported:

Diplograptus peosta

Lingula sp.

Small brachiopods (three)

Isotelus maximum

Small, fragmentary cephalopods (three)

Cryptolithus tesselatus

Decker stated that in the Arbuckle area, the Fernvale with its typical Richmond fauna probably should be separated from the Viola as a formation (rather than member), because elsewhere in its wide distribution the Fernvale is recognized as a separate formation. He concluded, however, that from the standpoint of local stratigraphy alone, it would seem most natural to consider the Fernvale a phase of the Viola.

In three uppermost Viola exposures in the Criner Hills of southern Oklahoma, Decker observed no Fernvale strata.

Foerste (1935, p. 93) described and illustrated the cephalopod Deckeroceras adaense from Fernvale exposures near Ada, Oklahoma. This occurrence was reported later by Amsden (1957, p. 35).

Ireland (1936) suggested that the Fite Limestone and the persistent subsurface Simpson "Dense Limestone" of Oklahoma should be included with the Fernvale as a post-Trenton unit. According to Ireland, the Trenton Viola and part of the subjacent Black River Tyner (Simpson) were removed by erosion before the Fite was deposited unconformably upon the eroded Tyner surface.

Dott (1941, chart, p. 1937) correlated the Fernvale with basal Maquoketa strata of the Mississippi Valley. An unconformity was postulated between the Fite and Fernvale of the Ozark area; none was indicated, however, between the Viola and Fernvale of the Arbuckle area.

McFarland (1943, p. 27) included the Arnheim and overlying Fernvale in the Richmond Group of Kentucky. He noted that although most charts show the Arnheim as Early Richmond, it was included originally with the Maysville, and later again referred to Maysville by Cummings and Galloway in 1913.

Branson (1944) reported that the Fernvale in most localities in Missouri is less than four feet thick; and in localities where the Fernvale is absent, the Maquoketa rests directly upon the Kimmswick. He noted that Weller and St. Clair (1928, p. 92) had reported unconformable relationship of the Fernvale and underlying Kimmswick, although but few exposures reveal this relationship clearly. The Fernvale is also in unconformable relationship with the overlying Maquoketa. Branson noted that the Fernvale of Missouri is continuous with the Fernvale of Arkansas and Illinois, and is correlative with part of the Arnheim of Kentucky. The following fossils have been reported from Fernvale strata (Weller and St. Clair, 1928; Gregger and Born, 1936):

Abundant crinoid stems

Dalmanella tera

Dinorthis proavita

Glyptorthis insculpta

Hebertella insculpta

Hesperorthis tricenaria

Leptaena cf. unicostata

Orthorhynchula linneyi

Parastrophia divergens

Plaesiomys subquadrata

Platystrophia foerstei

Plectorthis? sp.

Rafinesquina spp. (two)

Rhynchotrema capax

Rhynchotrema manniense

Sowerbyella saxea

Strophomena odessa

Strophomena cf. planodorsata

Strophomena planumbona

Vellamo americana

Diplotrypa dubia

Ptilotrypa obliquata?

Bryozoans

Isotelus sp.

Pterygometopus sp.

Sphaerocoryphe sp.

Dubois (1945) considered the Fernvale of Illinois to be a facies of the Richmond Maquoketa of the Upper Mississippi Valley. He suggested that the name Fernvale in Illinois be abandoned. (Templeton and Willman in 1963 changed the name of the Fernvale in southern Illinois to the Cape Limestone.)

Wengard (1948), in studying insoluble residues of the Fernvale and Viola Formation of South-central Oklahoma, recognized four subdivisions of the Viola. In subsurface, the lower and upper subdivisions become thinner and disappear northeastward upon the Seminole Platform, where coarsely crystalline, crinoidal Fernvale Limestone rests unconformably in local anomalous thickening upon the Viola. The Fernvale transgresses the Viola Limestone from the southwest in the Arbuckle Basin, where the formation rests upon Viola Subdivision No. 1. Northeastward, on the Seminole Platform, the Fernvale rests upon Viola Subdivision No. 2. Wengard concluded that the Viola insoluble residue subdivisions are recognizable in the Arbuckle Basin and upon the Seminole Platform simply upon the basis of qualitative/quantitative logging of the chert in subsurface samples.

Wilson (1949, p. 214) reported that the Fernvale Limestone of Tennessee normally overlies the Sequatchie tongue (if present) although eastward, it grades into the middle of the Sequatchie. Elsewhere, the

Fernvale overlaps the Sequatchie tongue to rest unconformably upon the Arnheim or the Leipers along the southeasternmost edge of the Richmond Group. The Fernvale is overlain conformably ? by the Richmond Mannie Shale, or unconformably by Silurian Brassfield Limestone or the Chattanooga Shale.

Wilson reported an abrupt change of lithology at the Arnheim-Fernvale contact ". . . and some differences are observable in the faunas." He stated, however, that the two faunas had not been carefully differentiated, because Bassler's Arnheim collection included fossils from both the Arnheim and the western tongue of the Sequatchie; the true fauna of the Arnheim of Tennessee is undescribed. He listed and figured the following species from the Richmond formations:

Strophomena planumbona

Rhynchotrema capax

Rhynchotrema sp.

Plectambonites saxea

Plectambonites clarksvillensis

Leptaena richmondensis

Rhynchotrema dentatum

Streptelasma rusticum

Cyclonema fluctuatum

Platystrophia acuminata

Platystrophia cummingsi

Platystrophia annieana

Platystrophia foerstei

Platystrophia foerstei ampla

Platystrophia ponderosa auburnensis

Hebertella insculpta

Hebertella sinuata

Dalmanella meeki

Dinorthis subquadrata

Lantz (1952), in correlating the Fernvale of Arkansas with the upper part of the Viola, reported the Fernvale resting unconformably upon the Kimmswick Limestone. He stated that the Kimmswick Limestone probably rests unconformably upon the Plattin Limestone in northeastern Arkansas. The Plattin, in unconformable relationship with the underlying St. Peter, was correlated with the lower part of the Viola Limestone ("Viola Dense") of Oklahoma.

Decker (1952, chart, p. 135) reported the Fernvale to be Richmond in age, and the subjacent Viola, Upper Trenton (Utica, Frankfort, and Lorraine).

Cooper (1956, p. 658) recorded and illustrated the brachiopod Lepidocyclus (Rhynchotrema) sp. 1 from Fernvale outcrops in the brick pit at Lawrence, Oklahoma. This occurrence was listed later by Amsden (1957, p. 35).

Amsden (1957, p. 35) recorded all the Middle and Upper Ordovician fossils which have been described and/or illustrated from Oklahoma. Fossils reported only in faunal lists were not included, because in many instances it was impossible to check the identification or determine whether an identification was made by the author citing the species or merely copied from an earlier publication. The only specimens from the "Fernvale" limestone of Oklahoma that Amsden recorded are Lepidocyclus sp. 1 (Cooper, 1956, p. 658, Pl. 130, G, figs. 36, 37) and *Deckeroceras alaense* (Foerste, 1935, p. 93, Pl. 21, fig. 4).

Huffman, *et al*. (1958), in a comprehensive survey of the geology of the Oklahoma Ozark region, summarized Ordovician stratigraphy. In ascending order, the Cotter Dolomite, Burgen Sandstone, Tyner Formation, Fite Limestone, Fernvale Limestone, and Sylvan Shale comprise the Ordovician System of the area. Huffman depicted the Fite as Late Black River or Early Trenton in age, and considered it equivalent to the Upper Bromide "dense" (Corbin Ranch) of the Arbuckle Mountains, the upper part of the Platteville of the Upper Mississippi Valley, part of the Plattin of Missouri, and the Witten of Virginia. The Fernvale, unconformable upon the Fite, was depicted as Richmond in age. The Fite-Fernvale unconformity is evidenced in the Ozark area by abrupt faunal and lithologic changes, and, locally, by the presence of a welded contact. Silicified shells of *Lepidocyclus* (*Rhynchotrema*) *capax* and *Plaesiomys subquadratus* are abundant upon upper surfaces of Fernvale beds. The formation is correlative with the Fernvale of the Arbuckle Mountains and Tennessee. Normally, the Fernvale is succeeded conformably by the Sylvan Shale; although northeast of Tahlequah, it is overlain unconformably by the Chattanooga Shale. The following species were reported:

Austinella kankakensis

Austinella whitfieldi

Glyptorthis pulchra

Hebertella occidentalis var. *sinuata*

Hebertella frankfortensis

Hesperorthis sp. aff. H. *tricenaria*

Lepidocyclus (Rhynchotrema) capax

Lepidocyclus (Rhynchotrema) laddi

Onniella quadrata

Plaesiomys bellistriatus

Plaesiomys subquadratus

Plectambonites clarksvillensis

Plectambonites rugosus

Strophomena cf. S. incurvata

Tetraphalerella planodorsata

Eohippiorthoceras laddi

Gutstadt (1958) proposed the Templeton and Willman manuscript name, Cape, for the Fernvale Limestone of Illinois, and correlated it with limestones in the middle portion of the Maquoketa; Templeton and Willman (1963), however, disagreed with the correlation. Gutstadt postulated Maysville age, instead of Richmond, for the Cape Formation.

Moore (1958), in his Historical Geology Text, depicted the Arbuckle Group of Oklahoma as Canadian in age; the Simpson and Viola as Champlainian; and the Fernvale and Sylvan as Cincinnatian Richmond.

Frezon and Glick (1959) reported the occurrence of Fernvale outcrops in northern Arkansas.

Mairs (1962) described the subsurface occurrence and distribution of the Viola and Fernvale Formations in Oklahoma. He postulated that a regional disconformity separated the two formations, based upon ". . . changes in the type of limestone and faunal content (quoting Decker's 1933 faunal list) from the Trenton Viola to the Richmond Fernvale . . . with further evidence in progressive northward overlap of upper Viola members by the Fernvale." Mairs distinguished uppermost Viola and Fernvale samples primarily on differentiation of lithology, fossils, and chert content.

Fox (1962) noted that in Indiana, formation and/or member names had been applied to Richmond strata that were lithologically indistinguishable. Fox proposed a new formation, Tanners Creek, to replace the three Richmond "little formations", Arnheim, Waynesville, and Liberty; all three lithologically indistinguishable, yet separated upon the basis of index fossils (essentially a single species in each unit).

Templeton and Willman (1963) stated that the Fernvale Limestone of Illinois and Missouri is the initial Cincinnatian deposit that may be the equivalent or older than basal Cincinnatian beds in the type area about Cincinnati, Ohio. The Fernvale of Illinois and Missouri appears to be older than the Fernvale of the Richmond Group in Tennessee. Accordingly, Templeton and Willman (p. 131) elaborated upon the name, Cape Limestone, that Gutstadt (1958) had proposed for the so-called Fernvale of Illinois and Missouri. The type Cape Limestone underlies brown and black shales that Templeton and Willman considered equivalents of the Fulton Shale at the base of the Eden in Ohio.

Templeton and Willman correlated the Cape Limestone of Illinois with the Fernvale of Oklahoma, in unconformable relationship with the subjacent Viola Limestone. ". . . the name, Ada Limestone, proposed for the Fernvale of Oklahoma by Shideler in 1937, is pre-empted." It is essentially because of correlation of the so-called Fernvale (Cape) Limestone of Oklahoma with the Fernvale of Tennessee, and thence with the Waynesville of the Richmond Group of Ohio, that the Oklahoma Fernvale and overlying Sylvan Shale have been assigned to the Richmond. Because of lithologic similarity of the Sylvan and the Edenian Maquoketa Shale, Templeton and Willman (p. 192) surmised that the Sylvan embraced Edenian and Maysville strata, as well as Richmondian.

Templeton and Willman tentatively correlated the Cape Limestone of Illinois with the upper Catheys of Virginia. They considered Gutstadt's (1958) original application of the term, Cape, to middle Maquoketa limestones to be in error; these limestones (Ft. Atkinson, Waynesville, and Fernvale) represent simply reoccurrences of lithological and faunal types similar to those of the Cape Limestone. In the Mississippi Valley, wherever erosion has removed the Wise Lake, Dubuque, and uppermost Dunleith Formation of the Galena Group, the Cape Limestone rests unconformably upon various beds of the Dunleith. The Cape is overlain unconformably, or locally "cut out," by the Elgin Shale or Thebes Sandstone. The Nicholas Member of the Cynthiana of Kentucky was correlated tentatively by Templeton and Willman with the Cape Limestone of Illinois.

Bushbach (1964) noted in Illinois that the Neda Formation of Templeton and Willman appears to be a westward extension of the Queenstown Delta of New York. The irregular surface of the Maquoketa of Northern Illinois indicates uplift and erosion before Silurian deposition. The Maquoketa was recognized as a group containing five formations (ascending): Cape Limestone, Scales Shale, Ft. Atkinson Dolomite, Brainard Shale, and Neda Formation.

Statler (1965) noted that ". . . the upper few feet to several tens of feet of the Viola consists of a quite distinct lithology of white to pinkish, medium to coarsely crystalline, very fossiliferous limestone which is unconformable with the 'Trenton' Viola below and with Sylvan Shale."

Statler questioned Ulrich's correlation of Oklahoma "Fernvale" strata with the Fernvale Limestone of Tennessee; but he suggested Upper Ordovician age for the "Fernvale," based upon distinctive lithology, fauna, and stratigraphic relationships. He also correlated the "Fernvale" with the Cape Limestone of southeastern Missouri. The "Fernvale" and Viola were incorporated as an operational unit, because of difficulty of separating the two elements by methods other than that of sample study.

Statler (fig. 3, p. 167) correlated the Fite Limestone of northeastern Oklahoma with the Viola of the Arbuckle Mountains. Statler's diagram indicates that the Fite overlaps lowermost Viola beds; accordingly, Lower Viola beds of the Arbuckle Uplift are not represented in the Fite of northeastern Oklahoma. Statler questioned the correlation of the Fite with the Corbin Ranch and "Simpson dense" or "Bromide dense," which are based upon lithologic similarity and stratigraphic position. Instead, the Fite Formation and rocks of northeastern Oklahoma assigned to the Corbin Ranch by Frezon (1962) and Schramm (1964), are considered to be pre-"Fernvale" Viola. Such correlation requires but a single widespread hiatus (post-Bromide), while the correlation of the Fite with the Corbin Ranch requires two periods of erosion (pre-Corbin Ranch and pre-"Fernvale") separated by a widespread transgression of a thin carbonate unit far upon the shelf.

Schramm (1965, fig. 1), in a resumé of Simpson stratigraphy, repeated his 1964 assignment of the Viola to the Trenton. The Fite and Upper Tyner were correlated with the Corbin Ranch of Harris (1957).

Ireland (1965, table 1) correlated the Viola and Fite of northeastern Oklahoma, "Viola or Kimmswick" of Kansas, and Montoya of West Texas with the Viola Formation of the Arbuckle Mountains. The Burgen and Tyner Formations of northeastern Oklahoma were placed in the Chazyan Stage, Tulip Creek, and Bromide were considered Black River, and Viola assigned to the Trenton.

Huffman (1965) described Viola and "Fernvale" strata of northeastern Oklahoma in a brief, but comprehensive, study of the Simpson Group of that area. The outcrop from which the Highway 10 samples of this report were collected is displayed on p. 121, fig. 7; other outcrops with included "Fernvale" strata are pictured on p. 121, fig. 8. Three geologic maps are included, two of which show the distribution of the combined Tyner-Fite-"Fernvale" strata.

The Fite is succeeded by the Late Ordovician "Fernvale" Limestone and associated Sylvan Shale. Northward these units are beveled by pre-Chattanooga erosion; and the Sylamore Sandstone is observable in unconformably contact upon the "Fernvale" near Tahlequah. Northeastward, the Fite and Tyner are truncated; while near Flint, Delaware County, the Chattanooga rests directly upon the Burgen Sandstone.

In central Delaware County, the Sylamore Sandstone rests upon the eroded Cotter Dolomite; and Simpson strata occur only in isolated sink hole fillings in the Cotter.

Huffman included six measured stratigraphic sections, five of which (tables 2-6) contain "Fernvale" strata varying in thickness from 10 to 18 feet.

Peck (1966), because of lithologic similarities, included the Arnheim, Waynesville, Liberty, Elkhorn, and lower Whitewater of Kentucky in a single new formation, Bull Fork. He stated, "The terms Maysville and Richmond are inappropriate as rock-stratigraphic units in the Maysville area."

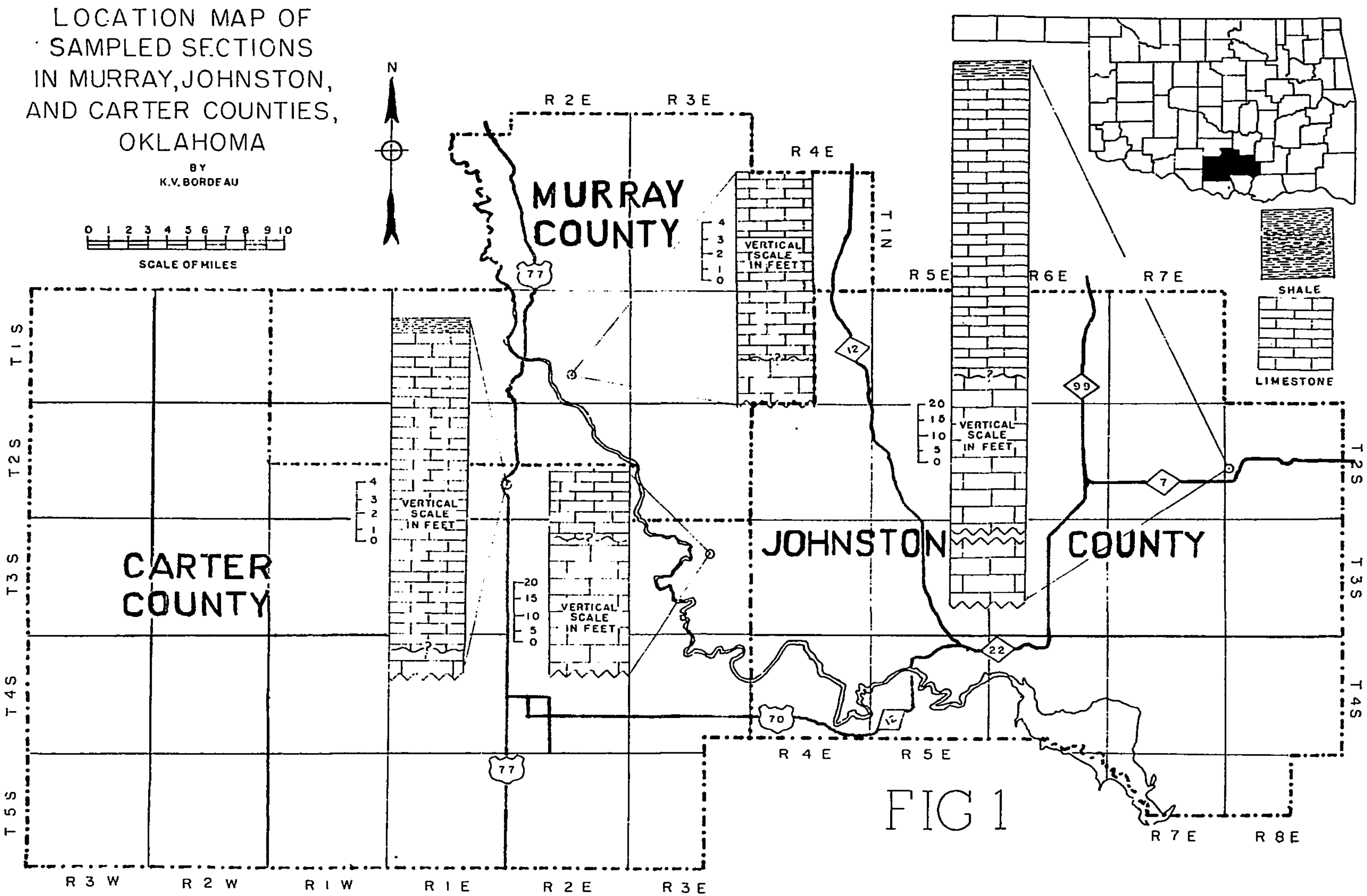
DESCRIPTION OF SAMPLED LOCALITIES

Twelve complete sections of the Fernvale Formation from different localities in Oklahoma and Tennessee were measured (figs. 1-4). Channel samples embracing intervals of two to six inches were collected and properly labeled consecutively from bottom to top of all sections. In field sampling, precaution was exercised to sample beds which displayed differences in macrolithology in such a manner as might isolate and emphasize these differences, as well as to insure that all possible environments be represented. The number of samples collected at each Fernvale section was determined in part by formational thickness, and in part, by the degree of lithologic variation exhibited by individual beds. Thinner sections were sampled bed by bed; thicker sections were sampled at slightly wider intervals. Samples for faunal comparison were collected from overlying and underlying strata at each locality. Although many of these non-Fernvale samples have proved to be barren of microfossils, those samples containing microfauna were processed and their fauna described.

The figured specimens are preserved at the School of Geology, University of Oklahoma.

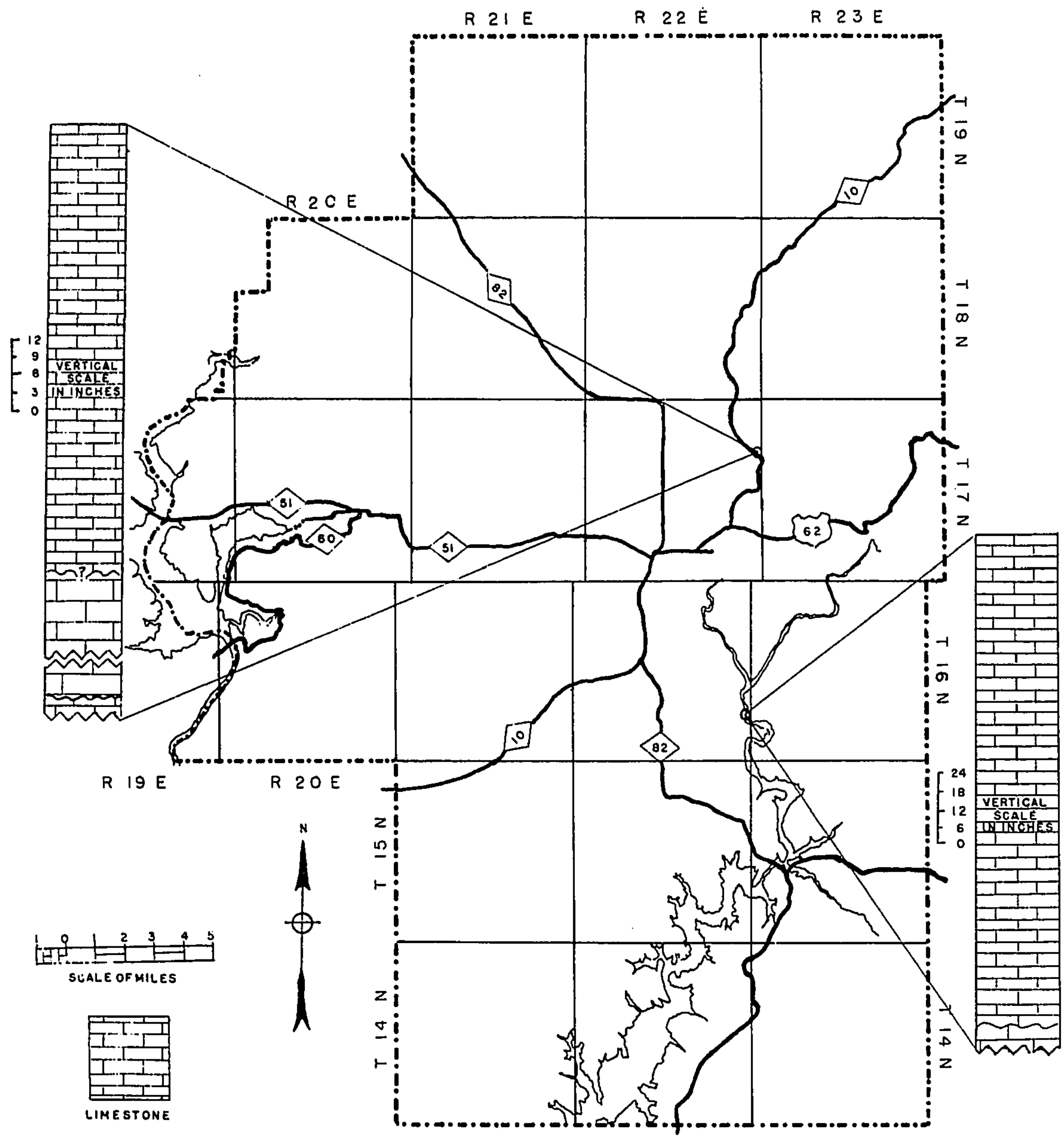
U. S. Highway 77 Section of Southern Oklahoma

Viola and Fernvale strata crop out along U. S. Highway 77, on the southern limb of the Arbuckle Anticline, in center S 1/2 NE 1/4



LOCATION MAP OF
SAMPLED SECTIONS
IN MURRAY, JOHNSTON,
AND CARTER COUNTIES,
OKLAHOMA
BY
K.V. BORDEAU
0 1 2 3 4 5 6 7 8 9 10
SCALE OF MILES
N
MURRAY COUNTY
CARTER COUNTY
JOHNSTON COUNTY
VERTICAL SCALE IN FEET
SHALE
LIMESTONE
R 2 E
R 3 E
R 4 E
R 5 E
R 6 E
R 7 E
R 8 E
R 3 W
R 2 W
R 1 W
R 1 E
T 1 N
T 1 S
T 2 S
T 3 S
T 4 S
T 5 S
77
70
12
99
7
22

FIG 1



LOCATION MAP OF
SAMPLED SECTIONS
IN CHEROKEE COUNTY,
OKLAHOMA

BY
K.V. BORDEAU

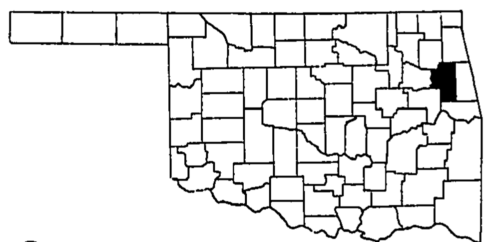
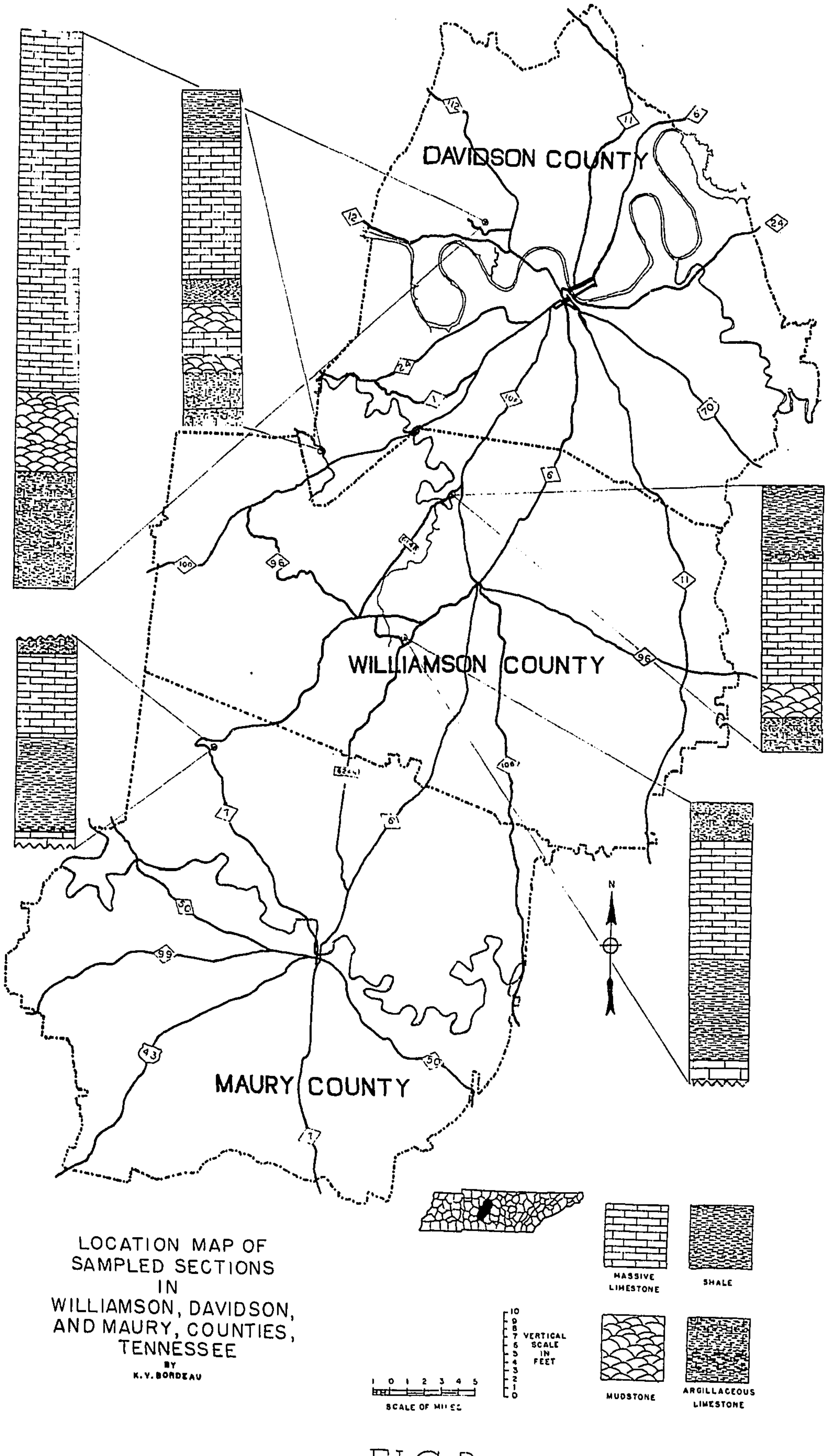
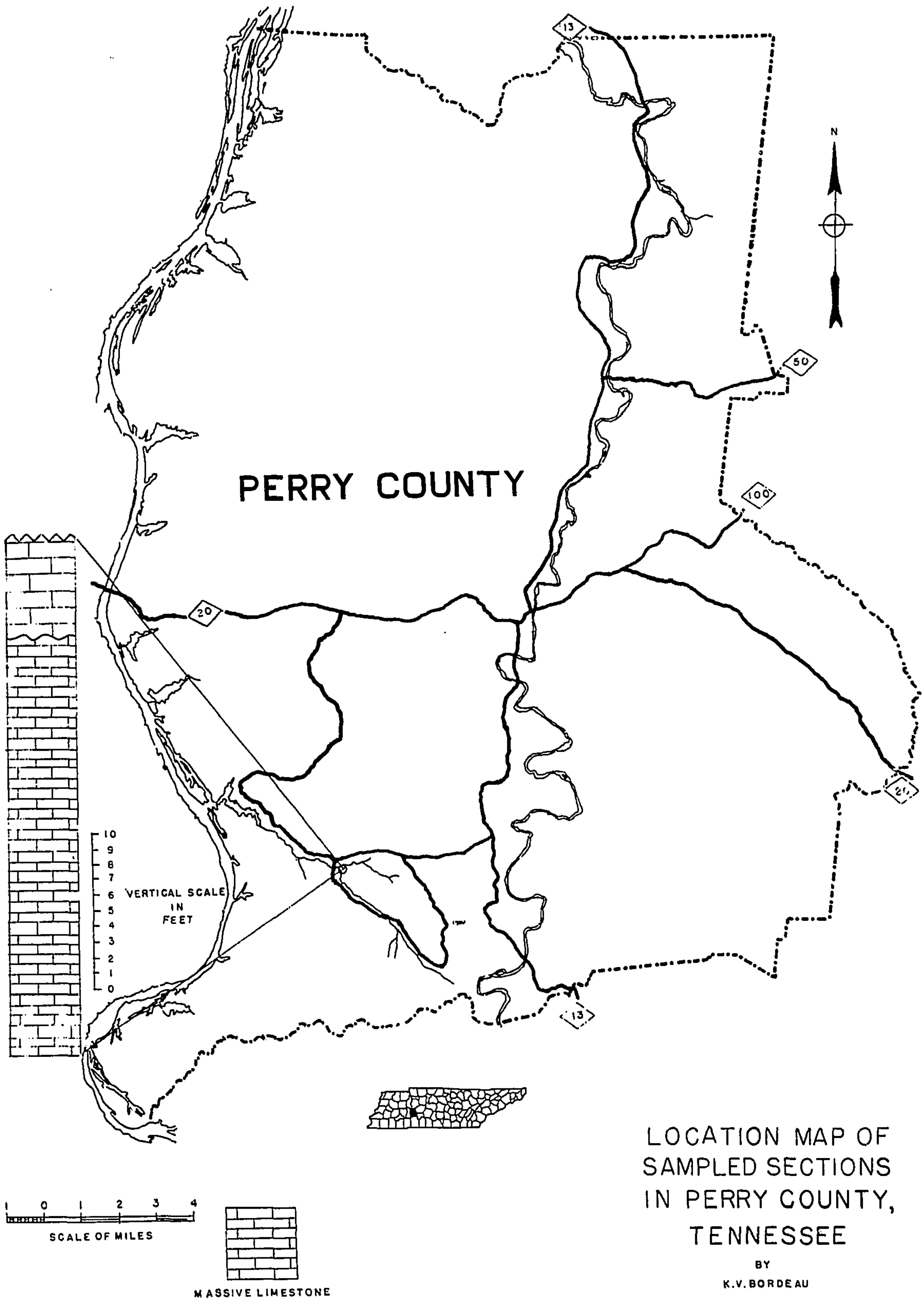


FIG 2



DAVIDSON COUNTY
WILLIAMSON COUNTY
MAURY COUNTY
LOCATION MAP OF
SAMPLED SECTIONS
IN
WILLIAMSON, DAVIDSON,
AND MAURY, COUNTIES,
TENNESSEE
BY
K. V. BORDEAU
MASSIVE LIMESTONE
SHALE
MUDSTONE
ARGILLACEOUS LIMESTONE
VERTICAL SCALE IN FEET
SCALE OF MILES
N

FIG 3



LOCATION MAP OF
SAMPLED SECTIONS
IN PERRY COUNTY,
TENNESSEE
BY
K.V. BORDEAU

FIG 4

sec. 25, T. 2 S., R. 1 E., Carter County, Oklahoma (fig. 1). The Viola-Fernvale sequence here erodes into characteristic rounded, gullied hills. The Fernvale Limestone, 21 feet in thickness, is grey-buff, medium to coarsely crystalline, and exceedingly crinoidal. Trilobite fragments are common, but unlike the crinoids, they do not comprise a significant percentage of the rock.

The most complete section of Fernvale at this locality is thirty to forty yards east of the highway, beyond the second gully incising the Viola hill. Here, the uppermost Fernvale, in contact with overlying Sylvan Shale, is more finely crystalline and stratigraphically higher than that along the highway.

Nineteen samples were collected at essentially uniform intervals across this section. Samples A to D were collected from uppermost Viola; samples E to J, from the coarsely crystalline Fernvale along the eastside of the highway; and samples K to S, from the more finely crystalline topmost Fernvale further east of the highway.

Some of the strata at this exposure have experienced incipient silicification; accordingly, some Fernvale samples have yielded a few silicified ostracodes that correspond closely with those of the northeastern Oklahoma Fernvale section.

<u>Robertson Creek Section of Southern Oklahoma</u>

This section is exposed along an unnamed creek flowing northward across Robertson Ranch, in W 1/2 NE 1/4 sec. 19, T. 2 S., R. 8 E., Johnston County, Oklahoma (fig. 1). Wengard (1948, p. 2201) reported 99 feet of Fernvale Limestone at this locality, consisting of coarsely crystalline and granular, pink to grey-buff beds containing abundant ostracodes, brachiopods, trilobites, crinoids, and gastropod casts; the crinoidal content was stressed.

There is some question regarding the exact basal Fernvale contact that Wengard selected at this locality, because of intergradation and alternation of coarsely crystalline Fernvale-like strata with finely crystalline Viola-like strata. The writer selected the Viola-Fernvale contact here between coarsely crystalline and finely crystalline limestone phases that most closely correspond with the base of the 99-foot section reported by Wengard. This procedure resulted in a Robertson Ranch Fernvale section of 92 feet.

Twenty-one samples were collected here; samples A to F were collected from uppermost Viola strata; fourteen Fernvale samples, G to T, were collected; and sample U was collected from the base of the Sylvan (no fossils were recovered from this sample).

Flying L Ranch Section of Southern Oklahoma

This section, described by Wengard in 1948, is on the south limb of the Dougherty Anticline, on the Flying L Ranch, NW 1/4 sec. 27, T. 1 S., R. 2 E., Murray County, Oklahoma. The beds here, exposed in a Dolese Company quarry, strike N. 51° W., and dip 64° SW.

Twelve feet of coarsely crystalline, dark buff, fossiliferous limestone represent the Fernvale Formation at this locality. The lower contact with the Viola is probably unconformable, although the evidence is not distinct. Wengard stated that the topmost few feet of Fernvale strata here are faulted out by a diagonal fault. The writer observed no faulting, but the contact with the overlying Sylvan Shale is sharp.

Six samples (A to F) were collected from topmost Viola; and sixteen samples (G to V) were collected across the Fernvale sequence at intervals of four to twelve inches.

Oklahoma Highway 18 Section of Southern Oklahoma

This section is along a small southward flowing stream at the base of the road cut of Oklahoma State Highway 18, in center SW 1/4 sec. 12, T. 3 S., R. 3 E., Carter County, Oklahoma (fig. 1). Wengard collected from this locality.

The 19-foot Fernvale sequence here is composed of medium to thick slabby beds of grey to buff, medium to coarsely crystalline and granular, fossiliferous limestone. The contact with the subjacent brown-grey to dark buff, finely crystalline to sublithographic Viola Limestone does not appear to be discordant.

The uppermost eight feet of Viola and the overlying basal bed of the Fernvale are characterized by Onnia sp. (perhaps the Cryptolithus tesselatus of earlier reports). Observable directly beneath the Onnia sp. zone in uppermost Viola are chert lenses that characterize the formation.

Twenty-two samples (A to Q, R-1 to R-4, and S) were collected from the uppermost 48 feet of Viola Limestone, care being exercised in obtaining representatives of all lithologic and faunal variations that could be recognized in the field. Seven samples (T to Z) were collected at two to three feet intervals from the Fernvale sequence; weathered material separating limestone strata was not sampled.

Oklahoma Highway 10 Section of Northeastern Oklahoma

This section is northeast of Tahlequah, in road cut on the east side of Oklahoma State Highway 10, 3.4 miles north of its junction with Oklahoma State Highway 62, in sec. 12, T. 17 N., R. 22 E., Cherokee County, Oklahoma (fig. 2). A photograph of the Fite-"Fernvale" sequence at this locality is to be seen in Huffman, 1965, p. 121, fig. 7.

At this locality, seven feet of coarsely crystalline, somewhat silicified, grey, fossiliferous Fernvale Limestone rests unconformably upon a four- to five-foot exposure of lithographic Fite Limestone. The Fernvale is more silicified here than at Horseshoe Bend, approximately twenty miles southeastward, although the silicification is not particularly evident upon eroded surfaces.

Three Fite samples (A to C) were collected; and fifteen samples (D to R) were collected at approximately six-inch intervals from the Fernvale sequence.

Horseshoe Bend Section of Northeastern Oklahoma

This section is along the west bank of the Illinois River, south of Tahlequah, in sec. 25, T. 16 N., R. 22 E., Cherokee County, Oklahoma (fig. 2).

Fourteen feet of coarsely crystalline, grey, fossiliferous Fernvale Limestone rest unconformably upon 14 feet of lithographic, grey Fite Limestone. Abundant encrinital debris characterizes the Fernvale here. A few localized veins of secondary white, opaque calcite were observable, although no sparry calcite was noted in the samples.

Incipient silicification is evident upon some rock surfaces, but only in a few samples had silica replaced fossils in the matrix proper.

Five samples (A to E) were collected from the Fite; and six samples (F to K) were collected at evenly spaced intervals from the Fernvale at this locality.

Adkins Branch Section of Tennessee

This section is at the head of a ravine, on the spur between Leipers Creek and Adams Branch, approximately 1.5 miles east of Fly, Maury County, Tennessee (fig. 3).

At this locality, 11.5 feet of coarsely crystalline, grey-buff (finer and darker toward top) Fernvale Limestone is overlain by 12 feet of soft, silty, yellow-green Mannie Shale. Silurian limestones overlie the Mannie Shale.

Five Fernvale samples (A to E) were collected; three samples of Mannie Shale (F to H) were collected; and seven samples (L to R) were collected from the Silurian Osgood and Laurel Limestones (the latter yielded no microfauna).

Franklin Section, Tennessee

This section is on the narrow spur overlooking and directly north of Harpeth River crossing, east of Hillsboro Pike, approximately two miles north of Forrest Home, and five miles northwest of Franklin, Williamson County, Tennessee (fig. 3).

At this exposure, 10.5 feet of Mannie Shale overlie 15 feet of coarsely crystalline, buff to dark grey, fossiliferous Fernvale Limestone. The Fernvale rests upon 5.6 feet of coarsely crystalline, dark grey Sequatchie limestones and silty shales (mudstone of Wilson, 1948). The slightly ferruginous Sequatchie limestone beds are stained yellow-brown on weathered surfaces. The Sequatchie rests upon 3.5 feet of coarsely crystalline, dark grey, slightly silty, fossiliferous Arnheim Limestone.

Samples A and B were collected from the Arnheim; five samples (C to G) were collected from limestone layers in the silty Sequatchie Shale; seven samples (H to N) were collected from the coarsely crystalline Fernvale Limestone.

Linton Section of Tennessee

This section (Wilson, 1949) is approximately 1 mile north of Linton, on a bluff near the South Harpeth River bridge on State Highway 100, Davidson County, Tennessee (Fig. 3).

Here, 19 feet of Fernvale is overlain by 8 feet of Mannie Shale; which in turn is overlain by the Silurian Brassfield Formation. The Fernvale rests upon 12 feet of Sequatchie; which in turn rests upon 5 feet of Arnheim.

The Fernvale is medium to coarsely crystalline, pink-buff limestone. The sequence here contains thicker shale intervals than at other localities observed in the field during this research; the microfauna is also sparser.

Sample A, collected from the Arnheim, is sparingly fossiliferous. Sample B, from a four-inch linestone layer near middle of Sequatchie, was also essentially barren of fossils. Four conodontiferous samples (C to F) were collected from the Fernvale at three- to five-foot intervals.

Mayberry Creek Section of Tennessee

This section is on the spur on the south side of Cedar Creek, in the town of Horner, opposite the mouth of Mayberry Creek, directly off Highway 6174, approximately 9 miles southwest of Linden, Perry County, Tennessee (fig. 4).

At this locality, the 27-foot Fernvale exposure (base covered) is coarsely crystalline, pink to rust-colored limestone, comprised essentially (over 90 percent) of encrinital debris. The Fernvale is overlain unconformably by green-grey, glauconitic, finely crystalline Brassfield Limestone, insoluble residues of which contain numerous arenaceous Foraminifera, the most common being *Ammodiscus incertus*.

Eleven samples (A to K) were collected from the Fernvale at intervals approximating two and one-half feet.

Jordania Section of Tennessee

This section (Wilson, 1949) is on the western slope of the prominent hill east of Eaton Road, along Eaton Creek, 1.2 miles north of Jordania, Davidson County, Tennessee (fig. 3).

The Fernvale consists of 45 feet of interbedded limestones and shales, although the upper half is soil-covered. Wilson's diagram (1949, p. 236) indicates that the Mannie Shale is absent. Accordingly, the Fernvale is overlain unconformably here by finely crystalline, dark grey, silty Silurian Brassfield Limestone. The Fernvale rests with apparent conformity upon 11 feet of Sequatchie, which in turn rests in apparent conformity upon 16 feet of Arnheim Limestone.

Three samples (A to C) were collected from the Arnheim; samples D and E were collected from the Sequatchie tongue; and seven samples (F to L) were collected at three-foot intervals from limestone ledges in the lower 25-foot exposure of the Fernvale.

Southall Section of Tennessee

This section is on the southwestern slopes of the prominent Twin Hills that overlook and separate Murphy Creek, Carter Creek, and the West Harpeth River, approximately 2 miles southwest of Southall, Williamson County, Tennessee (fig. 3).

The Richmond portion of the Southall section consists of 12 feet of Mannie Shale at the top, resting conformably upon 15 feet of Fernvale Limestone; which in turn rests unconformably upon 2 feet of Arnheim Limestone; which rests disconformably upon the Leipers Formation.

Evidence of the unconformable Arnheim-Fernvale relationship is based upon: 1) Fernvale overlap beyond the underlying Sequatchie tongue to rest upon the Arnheim along the southernmost edge of Richmond outcrops; 2) abrupt lithological change at the contact; and 3) faunal differences in the two formations, although both contain several species in common. Wilson (1949) stated that Arnheim and Fernvale faunas have not been differentiated carefully. The conodont faunas of the two formations at this locality are similar, most genera and many species being common to both formations; differences seem to be at subspecific level.

Three samples (A to C) were collected from the Arnheim Formation; seven (D to J), from the Fernvale Limestone; four (K to N), from limestones in the Mannie Shale; and four (O to R), from Silurian Brassfield limestones. Sample O, at the base of the Silurian sequence, is of interest because this sample of Brassfield Limestone does not contain the abundant *Ammodiscus incertus* fauna that characterizes basal Brassfield strata in other sections.

LABORATORY PROCEDURE

Preparation of Samples

Limestone and shale samples were brecciated with a mechanical rock crusher to fragmental sizes approximating three-quarters of an inch in diameter. The crusher was brushed carefully, and further cleaned with compressed air after preparation of each sample. As an additional precaution to prevent contamination, crushed fractions finer than 10-mesh screen size were discarded. This finer material is discarded for the further reason that it contains the greatest percentage of broken fossils; accordingly, a more efficient use of acid is permitted by discarding the finely crushed screenings.

One pint of each crushed sample was placed in glass and/or plastic containers and covered by one gallon of diluted acetic acid (one part glacial acetic acid to six parts water). Each sample was digested for twelve to twenty-four hours; after which time the sample was carefully decanted and washed twice in tap water to remove acetate salts and clay particles, which inhibit solution. Fresh acid was added; and for four to six times this digestion and washing process was repeated, until all the carbonate was dissolved. The point of complete digestion was determined by visual inspection, or in the case of shales and shaly limestones, by the degree of residual acidity in the solution after twelve-hour contact with the sample. Residual acidity is evident by distinctive odor and by observing the degree of action of the decantate upon chalk. Approximately one gallon of glacial acetic acid was required to digest each sample. Upon completion of the digestion process, the samples were washed gently several times, dried slowly over a low gas flame, and stored in labeled coin-type envelopes for microscopic examination.

Samples were examined at 30-power magnification with an American Optical Company Spencer binocular microscope. All microfossils were picked out with a moistened sable hair No. 00 art brush, and placed upon paleontological slides of the Franke type. The complete fauna of each slide was then further separated into species.

All fossils were then identified; and the species in each sample were counted, and their abundance recorded and tabulated.

Photography of Specimens

Selected specimens of each taxon were removed to individual Franke cells for photographing, description, and preservation as type specimens.

Photographs were taken with an Exacta 35 mm camera attached by means of a Tower microscope attachment and Tower accessory bellows to a monocular microscope of 16-power magnification. A diaphragm similar to that recommended by Fournier (1956) was inserted before the objective lens in order to increase depth of field. Fournier reports that some resolving power is sacrificed by use of the diaphragm, but that increased depth of perception far outweighs the loss.

Specimens selected for photographing were properly oriented and glued upon glass slides, the reverse side of which was blackened to reduce reflection of background light. The specimens were then illuminated by two high-intensity lamps with 6-volt bulbs, operated by means of transformers from 110-volt circuit.

The writer discovered by trial and error in photographing that the standard procedure of orienting the lights to present fossil pictures illuminated from the upper left seldom resulted in the most desirable representation of the fossil. This observation was reported also by Elias (1966) and Schenck and Adams (1943, p. 571). Accordingly, uniformity of illumination was abandoned, and each specimen was "posed" individually. Exposure time was determined experimentally, although exposure of one minute was satisfactory for most specimens, using the given apparatus and Kodak High Contrast Copy film. It should be impressed that standard developmental procedures should be established and strictly followed. Test film should reflect the exposure factor alone, and not be complicated by differences due to slight variations in the time and/or temperature of development.

Stereo-photographs were taken of specimens which were suitable for three-dimensional illustrations (relatively thick microfossils). For this purpose, a device similar to that proposed by Weinert (1960) was constructed. In principle the device is simply a tiny teeter-board fitted to the microscope stage. The teeter-board device utilizes the principle noted by Hughes (1957) that in photographing stereo-pairs of minute objects, it is unnecessary to make individual camera adjustments; instead, simply tilt the specimen for the two views. The average viewing distance for clear stereoscopic vision is ten inches, and at this distance, the parallax angle between the images is approximately 15 degrees.

Accordingly, the angle between the stereo-views should approximate 15 degrees; variation from 15 degrees will affect apparent height or thickness of the object in view (Hughes, 1957).

Weinert (1960) discovered by experimentation that the swing intercepted by the optical angle may range between 4 and 12 degrees in obtaining realistic stereo-pairs. Accordingly, specimens are placed over the fulcrum of the teeter-board, one side is lowered and a photograph taken; the opposite side is lowered, and the second of the stereo-pair is taken. The length of the beam of the balance determines the angle through which the specimen is tilted, and this in turn determines the perception depth of a given stereo-pair. The apparatus used in this research had a swing of 8 degrees.

All of the specimens were not photographed in stereo-pairs. Those forms which were so flattened that they would not yield stereo-pairs of significant value, were photographed in different views, thus conveying more information than their stereo-pairs.

Whitening of the conodonts with ammonium chloride or magnesium oxide was discovered to be unnecessary to record surface detail when illumination was properly adjusted in direction and intensity. Photographs of uncoated conodonts also reveal internal characteristics, and thus more closely resemble the actual specimens as observed with the binocular microscope. However, in the early stages of this investigation, before satisfactory illuminating techniques were established, some specimens were "whitened" by means of Triebel's (1947; Wetzlar, 1958) silver plating process. In this process, the specimen is moistened with 5 percent silver nitrate solution, then strongly heated; the nitrate is reduced, producing a silver plating upon the fossil. In this investigation, the hand-held heating unit described by Triebel was modified to free both hands of the operator. The apparatus, essentially a micro-hotplate, consists of a 1- X 3-inch sheet of mica encased by several windings of thin high-resistant wire. This coil was sandwiched between another 1- X 3-inch sheet of mica (serving as top of hotplate) and a thin asbestos sheet cut to the size of the removable glass plate on the stage of the binocular microscope. The three sheets were securely riveted together. In use, the glass stage of the microscope was replaced by the asbestos sheet with its attached coil. The chemically treated conodont specimen was placed upon the top of the micro-hotplate and heated under observation until the desired silver coating was obtained. The writer used a variable transformer to adjust the amount of electric current through the coil, and thereby vary the temperature of the micro-hotplate; but the same results may be obtained by the use of various resistances (e.g., light bulbs) wired in series to the heating unit.

The silver plating process possesses two inherent disadvantages: 1) the silver coating is permanent, which does not permit re-examination of the fossil in its original state; and 2) the specimen becomes tarnished after its silver coating and sulphur products in the air form dark silver sulphide.

Photographic Data

Development of the films required nine detailed steps of processing and washing: 1) the exposed films were developed in D-19 Kodak developer for six minutes at 68 degrees Fahrenheit; 2) treated with acid short-stop for one-half minute; 3) immersed in Kodak acid-fixer for seven minutes; 4) washed for five minutes in running water; 5) immersed in Kodak Hypo-eliminator for three minutes; 6) rewashed in running water for five minutes; 7) immersed for two minutes in Yankee Instant Film Dryer; 8) wiped with a moistened, pliable cellulose sponge; 9) and finally, hung to dry in a dust-free dark room.

Print enlargements were made upon glossy single-weight Kodabromide paper of contrast grades Nos. 3 and 4, developed in 1:2 Dektol solution. Printing exposure was regulated so that development was completed within forty to one-hundred-twenty-five seconds in order to obtain the most desirable copy from the film. There is always a loss of contrast and detail when errors in exposure of the film or of the print are compensated by under- and/or over-development. The technique of over-developing, and subsequently reducing the photo, is not recommended.

PALEONTOLOGY AND TAXONOMY

Conodont specimens of this report are considered taxonomically as form genera and form species, a procedure recognized by conodont specialists as supporting an artificial taxonomic system. The writer contends, however, that conodont elements comprising natural assemblages should receive individual designations, especially those assemblages which are statistically determined, without consideration of association and constant positional relationship of constituent elements.

The recognition of natural assemblages of conodonts is fundamental for eventual understanding of the animal, evolution of conodont elements, and ultimately narrowing of stratigraphic ranges. In this respect, some recent authors (inter alia, Webers, 1966; Bergström and Sweet, 1966; and Schopf, 1966) are to be commended for their research and reports regarding natural assemblages of Trentonian conodonts of the Upper Mississippi Valley, although they are not in complete agreement regarding assignment of specific conodont elements to statistical species. Such disagreement is only natural, however, as various specialists group these extinct elements into statistical species, for regardless of how well founded the stratigraphic, statistical, and morphologic data upon which a given statistical species be based, the final conclusion that a certain set of conodont elements represents a biological species is subjective, and, therefore, subject to dispute and individual interpretation. The dispute may well continue until the entire conodont assemblage be discovered with its various conodont elements in situ.

In the aforementioned recent reports, Webers (1966) and Bergström and Sweet (1966) considered their statistical units to be true species. Schopf (1966), however, carefully avoided assignment of taxonomic standing to his statistical units, yet his groups are derived by the same statistical methods as are species of Webers, and Bergström and Sweet. In the three publications of these authors, slight disagreement is observable in the assignment of certain form species into statistical groups; compare especially Tetraprioniodus delicatus (Branson and Mehl) Bergström and Sweet, 1966, Ligonodina delicata (Branson and Mehl) Webers, 1966, and Rosagnathus delicata (Branson and Mehl) Schopf, 1966.

Tables from Bergström and Sweet (1966), Webers (1966), and Schopf (1966) are included in this report to permit comparison of their statistically based species with conodont elements reported herein.

It should not be construed that the writer objects to the study and recognition of conodont groups; such is a forward step in conodont research. Individual elements of these groups, however, should receive individual designations, determined either formally or informally, so that individual conodont elements may be compared with other individual elements. Thus, constant nomenclature will remain stablized and not be subjected to change because of changes or differences in concepts as to which elements are or are not to be associated with it. This stability can be obtained only by recognizing the names of individual conodont elements as parataxa, a procedure not acceptable by the 15th International Congress of Zoology.

TABLE I

STATISTICAL AND COMPONENT CONODONT SPECIES FROM THE LEXINGTON LIMESTONE OF KENTUCKY AND LATERAL EQUIVALENTS IN OHIO AND INDIANA (modified after Bergström and Sweet, 1966, table 2)

Statistical Species	Component Form Species	Number Specimens
Acodus mutatus	*Acodus mutatus*	32
	Distacodus procerus	4
Acontiodus alveolaris	*Acontiodus alveolaris*	2
Amorphognathus ordovocica	*Amorphognathus ordovicica*	6,074
	Ambalodus triangularis	3,922
Belodina compressa	*Belodina compressa*	187
	Eobelodina fornicala	44
Belodina sp. cf. *B. inornata*	*B.* sp. cf. *B. inornata*	19
Bryantodina ? *abrupta*	*Ozarkodina* ? *abrupta*	279
	prioniodina-like element	
Bryantodina ? *staufferi*	bryantodina-like element	30
	ozarkodina-like element	16
	?trichonodella-like element	3
Cyrtoniodus flexuosus	*Cordylodus flexuosus*	9,657
	prioniodina-like element	500
Cyrtoniodus sp. nov.	*Cyrtoniodus* sp. nov.	5
Distacodus falcatus	*Distacodus falcatus*	17
Drepanodus suberectus	*Drepanodus suberectus*	592
	Oistodus inclinatus	973
	Drepanodus homocurvatus	6,106
Fibrous conodonts	Fibrous conodonts	112
Holodontus superbus	*Holodontus superbus*	91

TABLE I--(Continued)

Statistical Species	Component Form Species	Number Specimens
Icriodella superba	Icriodella superba	2,200
	Sagittodontus robustus	1,173
	Sagittodontus dentatus	248
	Rhynchognathus divaricatus	538
	Rhynchognathus typicus	544
Oistodus venustus	Oistodus venustus	19
Oulodus oregonia	Prioniodina oregonia	2,166
	Oulodus casteri	1,203
	Cordylodus excavatus	3,356
Ozarkodina ? obliqua	Ozarkodina obliqua	48
	Prioniodina robusta	102
	dichognathus-like element	35
Ozarkodina polita	Ozarkodina polita	6,170
Ozarkodina tenuis	Ozarkodina tenuis	7,900
Panderodus gracilis	Panderodus gracilis	1,082
	Panderodus compressus	485
Panderodus panderi	Panderodus panderi	44
Periodon grandis	periodon-like element	50
	falodus-like element	41
	prioniodina-like element	12
	ligonodina-like element	2
Phragmodus undatus	Phragmodus undatus	79,575
	Dichognathus brevis	18,916
	Dichognathus typica	18,932
	Oistodus abundans	25,327
Plectodina aculeata	Cordylodus aculeatus	98
	Trichonodella recurva	90
	Zygognathus illustris	29

TABLE I--(Continued)

Statistical Species	Component Form Species	Number Specimens
Plectodina furcata	*Prioniodina furcata*	5,380
	Cordylodus delicatus	16,859
	Trichonodella angulata	12,139
	Zygognathus mira	6,385
Plectodina ? *posterocostata*	hibbardella-like element	5
	trichonodella-like element	8
	cordylodus-like element	12
	zygognathus-like element	6
Polyplacognathus ramosa	*Polyplacognathus ramosa*	171
	Polyplacognathus bilobata	18
Rhipidognathus discreta	ozarkodina-like element	151
	prioniodina-like element	55
	trichonodella-like element	
Rhodesognathus elegans	*Ambalodus elegans*	600
	Ambalodus pulcher	553
Scandodus sp. cf. *S. dissimilaris*	*S.* sp. cf. *S. dissimilaris*	5
Scolopodus insculptus	*Scolopodus insculptus*	32
Synprioniodina sp. cf. *S. forsenta*	*S.* sp. cf. *S. forsenta*	48
Tetraprioniodus delicatus	*Ligonodina delicata*	603
	Tetraprioniodus superbus	433
	Hibbardella gracilis (incl. *Keislognathus simplex*)	1,204

TABLE II

STATISTICAL AND COMPONENT CONODONT SPECIES FROM THE TRENTON GROUP OF NEW YORK, SOUTHERN ONTARIO, AND QUEBEC
(modified after Schopf, 1966, table 2)

Statistical Species	Component Form Species	Occurrence Ratio
undatus-group	*Oistodus abundans* *Dichognathus brevis* and *D. typica* *Phragmodus undatus*	4:6:12
compressa-group	*Eobelodina fornicala* *Belodina compressa*	2:10
ramosa-group	*Polyplacognathus bilobata* *Polyplacognathus ramosa*	2:4
aculeatus-group	*Periodon aculeatus* *Falodus prodentatus*	6:8
ordovicica-group	*Ambalodus triangularis* *Amorphognathus ordovicica*	2:4
superba-group	*Sagittodontus dentatus* *Rhynchognathus typicus* *Sagittodontus robustus* *Rhynchognathus divaricatus* *Icriodella superba*	2:2:4:4:8
robusta-group	*Prioniodina robusta* *Ozarkodina* cf. *O. tenuis* (Wilderness type) *Trichonodella barbara* *Trichonodella recurra* *Zygognathus deformis* *Cordylodus delicatus* and *C. flexuosus*	2:4:2:2:2:6
pulcherrima-group	*Prioniodina pulcherrima* *Ozarkodina* cf. *O. tenuis* (Barneveld type) *Trichonodella exacta* *Trichonodella flexa* *Zygognathus* *Cordylodus*	2:6:2:2:2:10

TABLE III

STATISTICAL AND COMPONENT CONODONT SPECIES FROM MIDDLE AND UPPER ORDOVICIAN STRATA OF MINNESOTA
(modified after Webers, 1966, p.10-14)

Statistical Species	Component Form Species
Acodus mutatus	Acodus mutatus Distacodus procerus
Acontiodus alveolaris	Acontiodus alveolaris
Amorphognathus ordovicica	Amorphognathus ordovicica Ambalodus triangularis
Belodina compressa	Belodina compressa Eobelodina fornicata
Coelocerodontus trigonius	Coelocerodontus trigonius Coelocerodontus tetragonius
Cordylodus flexuosus	Cordylodus flexuosus
Cordylodus serratus	Cordylodus serratus Oulodus primus
Cordylodus grandis	Cordylodus grandis Zygognathus gyroides
Distacodus falcatus	Distacodus falcatus
Distacodus variabilis n.sp.	Distacodus variabilis n.sp.
Drepanodus excavatus n.sp.	Drepanodus excavatus n.sp.
Drepanodus suberectus	Drepanodus suberectus Drepanodus homocurvatus Oistodus inclinatus
Icriodella superba	Icriodella superba Rhynchognathodus typicus Rhynchognathodus divaricatus Sagittodontus dentatus Sagittodontus robustus

TABLE III--(Continued)

Statistical Species	Component Form Species
Ligonodina delicata	Ligonodina delicata
	Hibbardella diminutiva
	Keislognathus gracilis
	Tetraprioniodus superbus
Oistodus pseudoabundans	Oistodus pseudoabundans
Oistodus venustus	Oistodus venustus
Ozarkodina concinna	Ozarkodina concinna
Ozarkodina obliqua	Ozarkodina obliqua
	Prioniodina robusta
	dichognathid element
Panderodus arcuatus	Panderodus arcuatus
Panderodus compressus	Panderodus compressus
Panderodus feulneri	Panderodus feulneri
Panderodus gracilis	Panderodus gracilis
Panderodus panderi	Panderodus panderi
Phragmodus cognitus	Phragnodus cognitus
	Dichognathus brevis
Phragmodus inflexus	Phragmodus inflexus
	Dichognathus peculiaris
	Cordylodus elongatus
Phragmodus undatus	Phragmodus undatus
	Dichognathus typica
	Oistodus abundans
Polyplacognathus ramosa	Polyplacognathus ramosa
	bifurcatid element
Pravognathus idonea	Pravognathus idonea
	Pravognathus simplex
Scolopodus insculptus	Scolopodus insculptus

TABLE III--(Continued)

Statistical Species	Component Form Species
Scyphiodus primus	Scyphiodus primus
Tetraprioniodus breviconus n.sp.	tetraprioniodid element hibbardellid element
Trichonodella flexa	Trichonodella flexa Trichonodella exacta
Trichonodella recurva	Trichonodella recurva Trichonodella barbara
Bryantodina typicalis	Bryantodina typicalis Phragmodus inversus n.sp. Hibbardella variabilis Hibbardella varians Prioniodina polita
Chirognathus monodactyla	Chirognathus monodactyla Chirognathus admiranda Chirognathus delicatula Chirognathus multidens
Periodon aculeatus	Periodon aculeatus Periodon grandis Falodus prodentatus Hibbardella insolita Ligonodina tortilis Prioniodina araea n.sp
Zygognathus elongata	Zygognathus elongata Prioniodina pulcherimma Cordylodus delicatus ?
Zygognathus illustris	Zygognathus illustris Cordylodus aculeatus

Many scientists are in general agreement that taxa named in doctoral dissertations and later printed in limited quantities are not to be considered as validly published; however, such printed forms constitute potential danger of creating invalid new names. In order to prevent the possibility of establishing new taxa of dubious legality in this dissertation, no manuscript names are assigned to the new forms described herein.

Conodont genera are arranged in alphabetical order, because the natural classification of these form genera has not been established.

The Ostracoda are classified according to H. W. Scott's classification of ostracods as presented in the Treatise on Invertebrate Paleontology, Part Q, Arthropoda 3, R. C. Moore, Editor.

Order CONODONTOPHORIDA Eichenberg, 1930

Genus ACONTIODUS Pander, 1856

Type species: *Acontiodus latus* Pander, 1856

1856 *Acontiodus latus* Pander, Akad. Wiss., St. Petersburg, p. 28, Pl. 2, figs. 1a-c; Pl. A, fig. 7a.

Original description . . . "Unter den einfachen Zähnen bleiben noch drei Formen übrig, die äusserst selten vorzukommen scheinen; obgleich sie nicht vollkommen mit einander übereinstimmen and später von einander getrennt werden müssen, haben wir sie doch unter einem generellen Namen aufgeführt."

"Ihr Hauptcharakter besteht in der verhältnismässig starken Entwicklung des concaven Randes des Zahnes, der stark kielartig scharfzugespitzt ist, eine ebene oder mehr oder wenig concav ausgehöhlte Fläche bildet, die entweder glatt, wie bei Acontiodus triangularis ist, oder mit einem scharf hervorragenden Kiele, wie bei den beiden anderen Species, in ihrer Mitte besetzt ist. Die beiden Seitenflächen vereinigen sich am convexen Rande, entweder allmälig kreisförmig in einander übergehend, ohne durch einen Keil von einander geschieden zu werden, wie bei Acontiodus latus, oder unter einem gewissen, spitzen oder fast rechten Winkel, wie bei den beiden andern Arten."

A free translation of the generic description follows: Among the simple teeth, three remaining forms occur extremely rarely; even though they do not completely agree with one another and must be subdivided at some later date, we have listed them under a single general name.

Their chief characteristic is relatively strong development of the concave rim of the tooth, which is sharp and keel-like, and forms an even, more or less concave, hollowed posterior surface which is either smooth, as in Acontiodus triangularis, or has a sharp, protruding median costa, as in other species. The two posterior sides join at the concave rim either in gradual convexity, without being separated by a costa, as in Acontiodus latus, or at essentially right angles against the sharp median costa, as in the other two species.

The morphologic limits and the interpretation of the genus Acontiodus are somewhat confused. Pander referred three species to his genus, and he indicated that these should be differentiated at a later date. Two of Pander's species, _A_. _latus_ and _A_. _gracilis_, are quite similar, being simple conodont elements of bilateral symmetry, with rounded anterior faces, lateral keels, and with concave posterior faces separated by a median costa. The third species, _A_. _triangularis_, displays no median costa along the posterior face.

Ethington (1959) suggested the transfer of laterally compressed _A_. _gracilis_-like forms to _Distacodus_. Sweet and Bergström (1962) preferred Lindström's 1965 classification, and retained these bilaterally symmetrical elements in _Acontiodus_, rather than removing them to _Distacodus_, whose type species is asymmetrical.

ACONTIODUS sp.

Pl. 13, fig. 16

Conodont element consisting of a short, stout, evenly curved, symmetrical cusp: anterior face broadly rounded, terminating at each side in a sharp costa with post-jacent wide, shallow groove. The posterior face of the distal end of the cusp is so flattened that its cross-section is elliptical, with major axis extending laterally; the posterior face of the proximal portion of the cusp is sharply angular, the apex of the angle projecting slightly as a median keel. The lateral extension of each side of the posterior face ends abruptly in a narrow keel, which marks the posterior margin of the lateral sulcus and just slightly above it.

A single individual from Oklahoma Robertson Creek sample G represents this species.

Genus AMBALODUS Branson and Mehl, 1933

Type species: Ambalodus triangularis Branson and Mehl, 1933

1933 Ambalodus triangularis Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 127, 128, Pl. 10, figs. 35, 37.

1941 Ambalodus triangularis Branson and Mehl, Graves and Ellison, Missouri School of Mines and Metallurgy, Bull., Tech. Ser., vol. 14, p. 5, 7, Pl. 3, figs. 29, 33-35.

1953 Ambalodus triangularis Branson and Mehl, Rhodes, Phil. Trans. Roy. Soc. London, Ser. B, vol. 237, p. 280, Pl. 20, figs. 28-31.

1955 Ambalodus triangularis Branson and Mehl, Rhodes, Quart. Jour. Geol. Soc. London, vol. 111, p. 122, 123, Pl. 7, figs. 9-14.

1957 Ambalodus triangularis Branson and Mehl, Glenister, Jour. Paleontology, vol. 31, p. 722, Pl. 88, figs. 20 21.

1957 Ambalodus triangularis Branson and Mehl, Stone and Furnish, Jour. Paleontology, vol. 33, p. 219, Pl. 32, fig. 3.

1959 Ambalodus triangularis Branson and Mehl, Ethington, Jour. Paleontology, vol. 33, p. 269, Pl. 40, fig. 12.

1959 Ambalodus triangularis Branson and Mehl, Lindström, Micropaleontology, vol. 5, p. 435, 436, Pl. 2, figs. 1-11.

1959 Ambalodus triangularis Branson and Mehl, Sweet, *et al.*, Jour. Paleontology, vol. 33, p. 1040, Pl. 133, fig. 4.

1960 Ambalodus triangularis Branson and Mehl, Pulse and Sweet, Jour. Paleontology, vol. 34, p. 248, Pl. 35, fig. 16.

1965 Ambalodus triangularis Branson and Mehl, Barnett, Micropaleontology, vol. 11, p. 68, Pl. 2, fig. 8.

1966 Ambalodus triangularis Branson and Mehl, Schopf, New York State Mus. and Science Serv., Bull. 405, p. 39, Pl. 4, figs. 1-5.

1966 Amorphognathus ordivicica Branson and Mehl, Webers (in part), Minnesota Geol. Survey, Spec. Pub. SP-4, p. 22, 23, Pl. 13, fig. 16 (not Pl. 13, fig. 17).

1966 Amorphognathus ordovicica Branson and Mehl, Bergström and Sweet (in part), Bull. Am. Paleontology, vol. 50, no. 229, p. 308-311, Pl. 28, figs. 7, 8 (not Pl. 28, figs. 1-6).

The genus Ambalodus is recognized generally as a natural element of a conodont animal that includes also Amorphognathus (A. ordovicica). This is probably the most classical example of an established natural, statistical species of conodonts, the two elements undoubtedly belonging to the same organism. However, in the interest of consistency in the use of form species and genera throughout this work, the two artificial taxa are not combined in synonymy.

"More or less triangular or crescent-shaped platform-like dental units with excavated aboral surface, and slightly concave, smooth oral surface with a parapet-like row of closely crowded or fused denticles about the convex border, and a larger spike-like tooth at the apex of the angle of the parapet. On the outer side of the apical denticle is a process varying in length bearing one small denticle or several denticles forming a keel on a lanceolate plate."

AMBALODUS TRIANGULARIS Branson and Mehl, 1933

Pl. 9, figs. 18-21

This species (in association with _Amorphognathus ordovicica_) occurs relatively commonly in Upper Viola strata of the Arbuckle area. It is less abundant in the superjacent Fernvale of that area.

Although a few fragments of _Amorphognathus ordovicica_ were recovered from samples of the Tennessee Fernvale (Richmond) sequence, no specimens of _Ambalodus_ were observed.

A. triangularis is restricted to Eden and Early Maysville strata of the North American Midcontinent region (Sweet, _et al._, 1959).

Genus AMORPHOGNATHUS Branson and Mehl, 1933

Type species: _Amorphognathus ordovicica_ Branson and Mehl, 1933

1933 _Amorphognathus ordovicica_ Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 127, Pl. 10, fig. 38.

1941 _Amorphognathus ordovicica_ Branson and Mehl, Graves and Ellison, Univ. Missouri School of Mines and Metallurgy, Bull., Tech. Ser., vol. 14, p. 5, 7, Pl. 3, figs. 32, 36-38.

1953 _Amorphognathus ordovicica_ Branson and Mehl, Rhodes, Phil. Trans. Roy. Soc. London, Ser. B, vol. 237, no. 647, p. 283, Pl. 20, figs. 47-49.

? 1953 Balognathus expansus Rhodes, Phil. Trans. Roy. Soc. London, Ser. B, vol. 237, p. 285, Pl. 20, figs. 50-53, 57.

1955 Amorphognathus ordovicica Branson and Mehl, Rhodes, Quart. Jour. Geol. Soc. London, vol. 111, p. 123, Pl. 9, fig. 4.

1955 Amorphognathus duftonus Rhodes, Quart. Jour. Geol. Soc. London, vol. 111, p. 129, Pl. 9, figs. 1, 3, 5, 8.

1957 Amorphognathus adunca Glenister, Jour. Paleontology, vol. 31, p. 723, Pl. 88, figs. 23, 24.

1957 Amorphognathus ramosa (Stauffer), Glenister, Jour. Paleontology, vol. 31, p. 724, Pl. 88, fig. 27.

1959 Amorphognathus ordovicica Branson and Mehl, Stone and Furnish, Jour. Paleontology, vol. 33, p. 220, Pl. 32, fig. 12.

1959 Amorphognathus aff. A. duftona Rhodes, Ethington, Jour. Paleontology, vol. 33, p. 270, Pl. 40, fig. 11.

1959 Amorphognathus cf. A. ordovicica Branson and Mehl, Lindström, Micropaleontology, vol. 5, p. 436, Pl. 2, figs. 12-17.

1959 Amorphognathus sp. Lindström, Micropaleontology, vol. 5, p. 437, 438, Pl. 2, figs. 18, 19.

1959 Amorphognathus sp. Sweet, et al., Jour. Paleontology, vol. 33, p. 1040, 1041, Pl. 133, figs. 1, 2.

1960 Amorphognathus ordovicica Branson and Mehl, Pulse and Sweet, Jour. Paleontology, vol. 34, p. 248, 249, Pl. 37, figs. 13, 15.

? 1960 Amorphognathus ordovicica Branson and Mehl, Winder, Jour. Paleontology, vol. 40, p. 54, Pl. 10, figs. 18, 19.

1964 Amorphognathus ordovicica Branson and Mehl, Bergström, Acta Univ. Lund, sec. II, no. 3, pub. no. 128, p. 15-17, text fig. 5.

1964 Amorphognathus sp. Walliser, Abh. Hess. L.-Amt, Bodenforsch., vol. 41, p. 27, Pl. 4, fig. 1; Pl. 10, figs. 25-27.

1965 Amorphognathus sp. Barnett, Micropaleontology, vol. 11, p. 68, Pl. 2, fig. 20.

1966 Amorphognathus ordovicica Branson and Mehl, Schopf, New York State Mus. and Science Serv., Bull. 405, p. 40, Pl. 3, fig. 1-7.

1966 Amorphognathus ordovocica Branson and Mehl, Webers, Minnesota Geol. Survey, Spec. Pub. SP-4, p. 22, Pl. 13, figs. 16, 17.

1966 Amorphognathus ordovicica Branson and Mehl, Bergström and Sweet, Bull. Am. Paleontology, vol. 50, no. 229, p. 308-311, Pl. 28, figs. 1-6.

"Irregular branched asymmetrical dental plates with rays or branches of varying size and extending in varied directions with a common basal place that is arched or flat. The rays are more or less lanceolate, usually with a raised margin on the oval surface and a conspicuous longitudinal median crest on the oral side that is crenulate, nodose, or is constructed of more or less fused denticles."

AMORPHOGNATHUS Branson and Mehl, emended Lindström, 1959

". . . *Amorphognathus* be restricted to species with a more or less straight central axis consisting of an anterior and posterior process and with lateral processes that may be bilobate, the lateral process of one side being situated somewhat more anteriorly than those of the other."

AMORPHOGNATHUS ORDOVICICA Branson and Mehl, 1933

Pl. 1, figs. 1-10; Pl. 9, fig. 15; Pl. 10, fig. 19

The following description is based upon a perfectly preserved specimen.

This conodont may be considered as a slightly sinuous bar, the shorter, narrower end with narrow, basally fused denticles that increase in height towards the center of the bar. The distinctly denticulate anterior process is narrow and pointed. The posterior end of the bar is wider, longer, less abruptly pointed, and bears a low ridge with minute, fused denticles that are highest and most distinct in the middle of the process and lowest and indistinct at the proximal end of the process, thus resulting in a shallow, non-denticulate area (slightly eccentric) along the bar. A third short, narrow, fragile, denticulate process extends at right angles from the proximal end of the anterior process, and a short, denticulate lobe rises from the same junction to bisect the angle between this lateral process and the posterior process. This lateral process and lobe are extremely fragile and delicate and, accordingly, are readily broken in many specimens.

From the opposite side of the bar, extending from a shallow to flattened central area, is a second bilobate, lateral process resembling the anterior process in size, shape, length, and dentition. It is angled at approximately 60 degrees to the anterior process. The short, sparingly denticulate lobe upon this process is essentially equal in width and length; it extends from the lateral process at approximately 60 degrees, and is angled at 60 degrees to the posterior process. Both dextral and sinistral elements were observed.

This species was recovered from Upper Viola and Fernvale strata in all Arbuckle Mountain sections except that of Robertson Creek. The Flying "L" Ranch section contains this species in relative abundance, and in an exceptionally fine state of preservation. Infrequent fragments of the species were encountered also in samples from the Arnheim Formation in the Mayberry and Southall sections of Tennessee.

Genus APHELOGNATHUS Branson, Mehl, and Branson, 1951

Type species: Aphelognathus grandis Branson, Mehl, and Branson, 1951.

"Elongate, sheath-like teeth, straight or laterally sinuous and more or less arched. Blunt oval edge produced, with discrete low denticles nearly circular in cross section; one of which, commonly the largest, marks the highest point, typically not at mid-length. Aboral edge laterally flaring and deeply excavated, particularly wide and deep near midlength, with diminishing excavation toward the termini. Lateral walls thin, expanded laterally to half-cones below the largest denticle."

APHELOGNATHUS GRANDIS Branson, Mehl, and Branson, 1951

Pl. 8, figs. 1, 2, 5-7; Pl. 12, figs. 11-13

1951 Aphelognathus grandis Branson, Mehl, and Branson, Jour. Paleontology, vol. 25, p. 9, Pl. 2, figs. 11-14.

Forms assigned to this Richmond species are so variable in morphology that some specimens would not have been assigned to the species except for complete series of gradational specimens. The original authors suggested that the form developed from Dichognathus; but in specimens examined herein, the less robust members morphologically resemble Ozarkodina, rather than Dichognathus.

Branson, et al. reported this species from the Oregonia and Sunset members of the Arnheim Formation and from the Whitewater, Waynesville, Liberty, and Elkhorn Formations of Kentucky and Indiana.

Representatives of A. grandis were scattered through the samples of the Fernvale and Arnheim of Tennessee: none were obtained from Oklahoma.

Genus BELODINA Ethington, 1959

Type species: <u>Belodus grandis</u> Stauffer, 1935 = <u>Belodus compressus</u> Branson and Mehl, 1933

Complex dental units having an anteriorly-directed horizontal cusp whose distal portion shows marked oral curvature. Lateral faces of the cusp may be smooth or carinate and are unequally developed in most species, so that the unit is longitudinally asymmetrical. The oral edge of the cusp bears a series of prominent laterally compressed denticles which may penetrate well into the cusp. Anterior and posterior edges of the denticles are fused throughout the greater part of their length. The base of the cusp, arbitrarily considered to be posterior in position, is expanded orally to form a prominent "heel" behind the first oral denticle. Two conical basal cavities extend anteriorly into the cusp. The lower cavity is slender and penetrates more deeply into the cusp; it tapers distally to form a thread-like extension which curves orally parallel to the axis of the cusp. The upper cavity is laterally compressed and in most specimens penetrates into the cusp as far as the base of the posterior terminal oral denticle.

BELODINA COMPRESSA (Branson and Mehl, 1933)

Pl. 2, figs. 3, 7, 8, 13, 14

1933 <u>Belodus compressus</u> Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 114, Pl. 9, figs. 15, 16.

1935 Belodus grandis Stauffer, Jour. Paleontology, vol. 9, p. 603, 604, Pl. 72, figs. 46, 47, 49, 53, 54, 57.

1935 Belodus wykoffensis Stauffer, Jour. Paleontology, vol. 9, p. 604, Pl. 72, figs. 51, 52, 55, 58, 59.

1936 Belodus compressus Branson and Mehl, Furnish, et al., Am. Assoc. Petroleum Geologists, Bull., vol. 20, p. 1334, Pl. 1, fig. 10; Pl. 2, fig. 13.

1944 Belodus compressus Branson and Mehl, Branson, Univ. Missouri Studies, vol. 19, p. 81, 89, Pl. 12, figs. 9, 10.

1957 Belodus dispansus Glenister, Jour. Paleontology, vol. 31, p. 729, 730, Pl. 88, figs. 14, 15.

1959 Belodina compressa (Branson and Mehl), Stone and Furnish, Jour. Paleontology, vol. 33, p. 220, Pl. 31, fig. 14.

1959 Belodina dispansa (Glenister), Stone and Furnish, Jour. Paleontology, vol. 33, p. 220, Pl. 31, fig. 11.

1959 Belodina compressa (Branson and Mehl), Sweet, et al., Jour. Paleontology, vol. 33, p. 1042, Pl. 133, figs. 12, 15.

1959 Belodina grandis (Stauffer), Ethington, Jour. Paleontology, vol. 33, p. 272, Pl. 40, fig. 14.

1959 Belodina wykoffensis (Stauffer), Ethington, Jour. Paleontology, vol. 33, p. 272, Pl. 40, fig. 16.

1959 Belodina sp. aff. B. dispansa (Glenister), Ethington, Jour. Paleontology, vol. 33, p. 272, Pl. 40, fig. 15.

1959 Belodina dispansa (Glenister), Ethington and Furnish, Jour. Paleontology, vol. 33, p. 542, Pl. 73, figs. 12, 13.

1960 Belodina compressa (Branson and Mehl), Carlson, North Dakota Geol. Survey, Bull. 35, p. 71, Pl. 2, fig. 19.

1962 Belodina grandis (Stauffer), Sweet and Bergström, Jour, Paleontology, vol. 36, p. 1224, Pl. 170, figs. 16, 17.

1963 Belodus compressus Branson and Mehl, Cygan and Koucky, Guide Book, First Joint Field Conf. Wyoming Geol. Assoc., Billings Geol. Soc., Northern Powder River Basin, p. 33, 34, Pl. 1, fig. 11.

1965 Belodina compressa (Branson and Mehl), Barnett, Micropaleontology, vol. 11, p. 68, Pl. 1, fig. 20.

1966 Belodina compressa (Branson and Mehl), Schopf, New York State Mus. and Science Serv., Bull. 405, p. 41, Pl. 1, figs. 1, 3, 4, 6.

1966 Belodina dispansa (Glenister), Schopf, New York State Mus. and Science Serv., Bull. 405, p. 55, Pl. 1, fig. 16.

1966 Belodina compressa (Branson and Mehl), Webers, Minnesota Geol. Survey, Spec. Pub. SP-4, p. 24, Pl. 6, figs. 2, 6, 7, 13, 15.

1966 Belodina compressa (Branson and Mehl), Bergström and Sweet (in part), Bull. Am. Paleontology, vol. 50, no. 229, p. 312, 315, Pl. 31, figs. 14-19 (not Pl. 31, figs. 12, 13).

Specimens referable to this species were recovered from Fernvale samples of Northeastern Oklahoma, particularly from samples of Oklahoma

Highway 10 section. A few specimens were obtained from the lowermost Fernvale of the Mayberry section of Tennessee, and the Robertson Creek section of the Arbuckle Mountains.

BELODINA DIMINUTIVA (Branson and Mehl, 1933)

Pl. 2, figs. 2, 6, 10-12, 16

1933 Belodus diminutivus Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 125, Pl. 10, fig. 27.

1957 Belodus ornatus Branson and Mehl, Glenister (in part), Jour. Paleontology, vol. 33, p. 730-731, Pl. 87, fig. 7 (not Pl. 87, figs. 9, 10).

1966 Belodina diminutiva (Branson and Mehl), Schopf (in part), New York State Mus. and Science Serv., Bull. 405, p. 42, Pl. 1, figs. 5, 8, 12.

This form, characterized by its smooth inner face and grooved, flat outer surface, is similar to Belodina inclinata. It is differentiated from that species by its greater height in relation to its length. Fernvale specimens are quite variable in height and width, and it is possible that exceptionally narrow specimens assigned to this species should be assigned to B. inclinatus.

Forms typical of this species, and associated narrow forms, occur throughout the Fernvale and Upper Viola sections of the Arbuckle area.

BELODINA INCLINATA (Branson and Mehl, 1933)

Pl. 2, fig. 9

1933 Belodus inclinatus Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 125, 126, Pl. 10, fig. 24.

1957 Belodus ornatus Branson and Mehl, Glenister (in part), Jour. Paleontology, vol. 31, p. 730, 731, Pl. 87, fig. 10 (not Pl. 87, figs. 7, 9).

1960 Belodina inclinata (Branson and Mehl) Ethington and Furnish, Jour. Paleontology, vol. 34, p. 269, Pl. 38, fig. 13.

1966 Belodina inclinata (Branson and Mehl), Schopf, New York State Mus. and Science Serv., Bull. 405, p. 43, Pl. 1, figs. 2, 9.

Specimens referred to Belodina inclinata are longer than high, quite asymmetrical, and display a grooved, flat outer lateral surface and a smooth, slightly incurved inner face.

This species occurs infrequently in the Fernvale of the Ozark area.

BELODINA ORNATA (Branson and Mehl, 1933)

Pl. 1, fig. 1; Pl. 2, figs. 1, 4, 15

1933 Belodus ornatus Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 124, 125, Pl. 10, figs. 26, 28.

1957 Belodus ornatus Branson and Mehl, Glenister (in part), Jour. Paleontology, vol. 31, p. 730, Pl. 87, fig. 9 (not Pl. 87, figs. 7, 10).

1966 Belodina ornata (Branson and Mehl), Schopf, New York State Mus. and Science Serv., Bull. 405, p. 44, Pl. 1, fig. 11.

The specimen from Oklahoma, illustrated herein, displays four denticles instead of the usual three; but, otherwise, it is identical to forms figured by Branson and Mehl and Glenister.

This species was recovered from samples D and E of Oklahoma State Highway 10 section. It has been reported previously from the Thebes Formation of Missouri and from the Maquoketa Formation of Iowa; a few specimens have been reported from Spring Valley, Minnesota (Glenister, 1957, p. 731).

BELODINA PROFUNDA (Branson and Mehl, 1933)

Pl. 2, fig. 5

1933 Belodus profundus Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 125, Pl. 10, fig. 25.

1959 Belodina profunda (Branson and Mehl), Stone and Furnish, Jour. Paleontology, vol. 33, p. 31, figs. 16, 17.

A single specimen of Belodina clearly referable to this species was discovered in sample F of the Adkins section of Tennessee. It has been reported previously from the Maquoketa Formation of Missouri and from the Bighorn Formation of Wyoming. Its presence in the Richmond of Tennessee is interpreted as a result of recycling and it is accordingly not recorded in the range chart.

Genus COELOCERODONTUS Ethington, 1959

Type species: Coelocerodontus trigonius Ethington, 1959

1959 Coelocerodontus trigonius Ethington, Jour. Paleontology, vol. 33, p. 273, Pl. 39, fig. 14.

1966 Coelocerodontus trigonius Ethington, Schopf, New York State Mus. and Science Serv., Bull. 405, p. 45, Pl. 5, fig. 9.

1966 Coelocerodontus trigonius Ethington, Webers (in part), Minnesota Geol. Survey, Spec. Pub. SP-4, p. 25, Pl. 2, figs. 12? 13a, b (not Pl. 2, fig. 14).

". . . simple hollow horn-shaped cones. Lateral walls are thin and enclose a central cavity which extends to the tip of the tooth. Edges of the tooth are keeled."

As in Panderodus, species of this genus are distinguished by the profile of the cross-section.

COELOCERODONTUS TETRAGONIUS Ethington, 1959

Pl. 13, fig. 18

1959 <u>Coelocerodontus</u> <u>tetragonius</u> Ethington, Jour. Paleontology, vol. 33, p. 273, Pl. 39, fig. 15.

1966 <u>Coelocerodontus</u> <u>trigonius</u> Ethington, Webers (in part), Minnesota Geol. Survey, Spec. Pub. SP-4, p. 25, Pl. 2, fig. 14 (not Pl. 2, figs. 12, 13a, b).

1966 <u>Coelocerodontus</u> <u>tetragonius</u> Ethington, Schopf, New York State Mus. and Science Serv., Bull. 405, p. 45, Pl. 5, fig. 8.

Infrequent specimens of this species were discovered in lowermost Silurian samples overlying the Fernvale Limestone in the Mayberry section of Tennessee. The species is associated with <u>Panderodus</u> <u>gracilis</u> and <u>C</u>. <u>trigonius</u>. The latter species is more abundant than <u>C</u>. <u>tetragonius</u>, although <u>P</u>. <u>gracilis</u> is the major element in this sparse Silurian conodont fauna.

COELOCERODONTUS TRIGONIUS Ethington, 1959

Pl. 9, figs. 6-9

Webers (1966) placed <u>Coelocerodontus</u> <u>tetragonius</u> Ethington into synonymy with <u>Coelocerodontus</u> <u>trigonius</u>, stating that although this species is rare throughout its range, it displays a narrow stratigraphic distribution.

The forms illustrated herein were obtained from basal Silurian limestones resting upon the Fernvale Formation of Tennessee. This species, C. tetragonius, and Panderodus gracilis, a morphologically inclusive species, comprise the sparse conodont fauna in the Silurian Brassfield Limestone that overlies many Fernvale outcrops in Tennessee.

CORDYLODUS Pander, 1856 - Subcordylodus Stauffer, 1935

Type species: Cordylodus angulatus Pander, 1856

1856 Cordylodus angulatus Pander, Acad. Wiss. St. Petersburg, p. 33.

"Compound teeth with very long, compressed and high base. A big, rather flat smooth cusp with smoothly curved lateral faces and almost flat anterior and posterior margins arises from the base, at first more or less vertically, always, however, curved toward the point. Several small teeth emerge from the base at the concave margin of the big tooth, beneath one another and side by side. . . . to judge from the superficial appearance, one might mistake this genus for Belodus. The microscopical structure is, however, entirely different" (translated by Lindström, 1955, p. 150, 151).

Ellison (1946, p. 108, 110) stated that Subcordylodus is a junior synonym of Cordylodus, and Lindström (1955, p. 151) agreed with him. Later authors have followed this interpretation; herein the two genera are considered synonymous.

CORDYLODUS DELICATUS Branson and Mehl, 1933

Pl. 11, figs. 2-5, 7-11

1933 Cordylodus (?) delicatus Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 129, Pl. 10, figs. 14, 15.

1941 Cordylodus (?) delicatus Branson and Mehl, Graves and Ellison, Univ. Missouri School of Mines and Metallurgy, Tech. Ser., vol. 14, no. 2, p. 25, Pl. 3, fig. 23.

1957 Cordylodus (?) delicatus Branson and Mehl, Glenister, Jour. Paleontology, vol. 31, p. 731, 732, Pl. 88, fig. 5.

1957 Cordylodus delicatus Branson and Mehl, Sweet, et al., Jour. Paleontology, vol. 33, p. 1044, 1045, Pl. 132, figs. 12, 14, 17.

1960 Cordylodus delicatus Branson and Mehl, Pulse and Sweet, Jour. Paleontology, vol. 34, p. 251, Pl. 36, figs. 4, 7.

1964 Cordylodus delicatus Branson and Mehl, Bergström, Acta; Univ. Lund, sec. 2, no. 3, pub. no. 128, p. 18-21, text figs. 6, 7.

1966 Cordylodus delicatus Branson and Mehl, Schopf, New York State Mus. and Science Serv., Bull. 405, p. 45-47, Pl. 2. figs. 22-27.

1966 Cordylodus delicatus Branson and Mehl, Barnett, Micropaleontology, vol. 11, p. 69, Pl. 1, fig. 20; Pl. 2, fig. 1

Specimens of this species range throughout the Fernvale strata of Tennessee, being more or less common in all sections investigated.

Forms assigned to this species occur also in the Oklahoma State Highway 10 section, Horseshoe Bend section of northeastern Oklahoma, and in sections of the Flying "L" Ranch, Oklahoma State Highway 18, and Robertson Creek of the Arbuckle Mountain area. These Oklahoma forms are considered homeomorphs of the Tennessee forms, not truly representing the same biologic entity. On the other hand, identical morphological specimens from northeastern Oklahoma and Arbuckle Mountain sections represent the same biological species. The northeastern Oklahoma Fernvale conodont fauna (excluding exotic Devonian elements) apparently represents a sparse development of the Flying "L" Ranch and Robertson Creek fauna of Oklahoma. The latter Oklahoma Fernvale outcrops contain many faunal elements in common with the Upper Viola and "Fernvale" of other Arbuckle sections investigated (see conclusions).

CORDYLODUS PLATTINENSIS Branson and Mehl, 1933

Pl. 7, figs. 9-12

1933 Cordylodus plattinensis Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 116, 117, Pl. 8, figs. 34, 36.

1959 Cordylodus plattinensis Branson and Mehl, Stone and Furnish, Jour. Paleontology, vol. 33, p. 221, Pl. 32, fig. 10.

? 1959 Cordylodus excavatus Sweet, et al., Jour. Paleontology, vol. 33, p. 1045, 1046, Pl. 132, fig. 16.

? 1960 Cordylodus excavatus Sweet, et al., Pulse and Sweet, Jour. Paleontology, vol. 34, p. 251, Pl. 35, figs. 11, 15.

1966 Oulodus oregonia (Branson, Mehl, and Branson), Bergström and Sweet (in part), Bull. Am. Paleontology, vol. 50, no. 229, p. 342-347, Pl. 32, figs. 20, 21 (not Pl. 33, fig 5; Pl. 34, figs. 13-16).

Bergström and Sweet (1966) noted that Ordovician Cordylodus plattinensis elements are morphologically indistinguishable from older forms referred to Cordylodus serratus Stauffer and C. concinnus Branson and Mehl.

Unicostate, subsymmetrical specimens of Cordylodus from the Richmond Fernvale of Tennessee apparently grade through a complete series of intermediate elements into contemporary Eoligonodina by the development of a lateral carina (which in turn developed denticles).

Cordylodus forms are not as abundant in Tennessee samples as Eoligonodina forms, but they are not to be considered infrequent. They form a minor, albeit significant, portion of the Richmond conodont fauna. The species was not encountered in Oklahoma Fernvale samples.

CORDYLODUS sp. cf. C. sp. ? Branson, Mehl, and Branson, 1951

Pl. 11, fig. 1

Cf. 1951 Cordylodus sp. ? Branson, Mehl, and Branson, Jour. Paleontology, vol. 25, Pl. 4, fig. 17.

Small cordylodids which are apparently identical to that originally illustrated (although undescribed) by Branson, Mehl, and Branson, occur in the Mayberry section of Tennessee. The species somewhat resembles C. delicatus, but it is smaller and more fragile.

Small, asymmetrical, slightly recurved cusp, essentially straight, inclined posteriorly, strongly keeled anteriorly and posteriorly; cross-section is that of a positive lens, the inner side with shorter radius. Base wide beneath a short posterior bar which bears three to six, small, flattened, non-discrete denticles. Anterior margin of base curved downward and posteriorly, bearing the proximal part of a distinct anterior keel.

This species appears restricted to the Tennessee Mayberry section, which is distinguished from other Tennessee sections by its content of small, fragile species, all less robust than the coarser species that characterize most of the sections.

Genus CYRTONIODUS Stauffer, 1935

Type species: Cyrtoniodus complicatus Stauffer, 1935

1935 Cyrtoniodus complicatus Stauffer, Geol. Soc. America, Bull., vol. 46, p. 140, Pl. 11, figs. 44, 46, 48-51.

"Bar, or base, relatively thick, and deep anteriorly, tapering toward the posterior. It is slightly arcuate at right angles to the plane of the denticles. Underside of base is either notched or excavated throughout most of its length, with deepest portion of notch, or cavity, beneath the cusp at the anterior end. Cusp stout, flattened, keeled, curved out of line with the denticles, and extending to a blunt point below the bar. Denticles, flattened, usually five or six, perhaps more, directed toward the posterior, and sub-equal in size. Denticulated edge may be slightly arched."

This genus is considered ancestral to Cordylodus, differing therefrom essentially in its shorter posterior denticulate bar.

CYRTONIODUS FLEXUOSUS (Branson and Mehl, 1933)

Pl. 10, fig. 14

1933 Prioniodus (?) flexuosus Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 130, Pl. 10, fig. 16.

? 1933 Cordylodus (?) spurius Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 117, Pl. 10, fig. 4.

1935 Cyrtoniodus complicatus Stauffer, Geol. Soc. America, Bull., vol. 6, p. 140, Pl. 11, figs. 44, 46, 48-51.

? 1935 Subcordylodus sp. Stauffer, Jour. Paleontology, vol. 9, p. 618, Pl. 73, fig. 21.

1935 Cyrtoniodus apicalis Stauffer, Jour. Paleontology, vol. 9, p. 604, Pl. 73, figs. 1, 10, 43, 45.

1935 Plectodina glenwoodensis Stauffer, Geol. Soc. America, Bull., vol. 46, p. 152, Pl. 11, figs. 38, 39.

1935 Subcordylodus paratus Stauffer, Geol. Soc. America, Bull., vol. 46, p. 153, Pl. 10, fig. 48.

1935 Cyrtoniodus complicatus Stauffer, Stauffer, Jour. Paleontology, vol. 9, p. 604, Pl. 73, figs. 9, 11-13, 15, 16, 18-20, 25, 27, 32, 38, 41, 42, 47.

1953 Cordylodus ? spurius Branson and Mehl, Rhodes, Roy. Soc. London, Phil. Trans., Ser. B, no. 647, vol. 237, p. 301, Pl. 21, fig. 133.

1953 Cyrtoniodus complicatus Stauffer, Rhodes, Roy. Soc. London, Phil. Trans., Ser. B, no. 647, vol. 237, p. 302, Pl. 22, figs. 193-196.

1955 Cyrtoniodus complicatus Stauffer, Sweet, Jour. Paleontology, vol. 29, p. 254, Pl. 28, fig. 3.

1957 Cyrtoniodus complicatus Stauffer, Glenister, Jour. Paleontology, vol. 31, p. 732, Pl. 88, fig. 16.

1959 Cyrtoniodus complicatus Stauffer, Ethington, Jour. Paleontology, vol. 33, p. 274, Pl. 40, fig. 7.

1959 Cyrtoniodus complicatus Stauffer, Ethington and Furnish, Jour. Paleontology, vol. 33, p. 546, Pl. 73, fig. 4.

1959 Cordylodus cf. C spurius Rhodes, Lindström (in part), Micropaleontology, vol. 5, p. 438, Pl. 4, fig. 21 (not Pl. 4, figs. 19 20).

1959 Cyrtoniodus complicatus Stauffer, Stone and Furnish, Jour. Paleontology, vol. 33, p. 221, 222, Pl. 31, fig. 9.

1959 Cordylodus flexuosus (Branson and Mehl), Sweet, et al., Jour. Paleontology, vol. 33, p. 1045, Pl. 132, fig. 13.

1960 Cordylodus flexuosus (Branson and Mehl), Pulse and Sweet, Jour. Paleontology, vol. 34, p. 251, 252, Pl. 32, figs. 4, 7.

1965 Cordylodus flexuosus (Branson and Mehl), Barnett, Micropaleontology, vol. 11, p. 69, Pl. 1, fig. 4; Pl. 2, fig. 3.

1966 Cordylodus flexuosus (Branson and Mehl), Webers, Minnesota Geol. Survey, Spec. Pub. SP-4, p. 25, Pl. 8, fig. 8.

1966 Cordylodus flexuosus (Branson and Mehl), Schopf, New York State Mus. and Science Serv., Bull. 405, p. 47, Pl. 2, fig. 20.

1966 Cyrtoniodus flexuosus (Branson and Mehl), Bergström and Sweet (in part), Bull. Am. Paleontology, vol. 50, no. 229, p. 324-327, Pl. 32, figs. 9, 10 (not Pl. 32, fig. 11).

Infrequent specimens referred to this species occur in the lower portion of Richmond strata in the Tennessee Mayberry section. A few forms morphologically similar, but separable by minor morphologic details and preservational characteristics, occur in samples of the Robertson Creek section and along Oklahoma State Highway 18 (now U. S. Highway 177) of the Arbuckle Mountain area and in the northeastern Oklahoma Fernvale section. The Oklahoma forms are considered simply homeomorphs and not representing the same biological species as those from Tennessee.

Genus DICHOGNATHUS Branson and Mehl, 1933

Type species: Dichognathus prima Branson and Mehl, 1933

1933 Dichognathus prima Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 37, Pl. 1, fig. 27.

"Complex units consisting of an antero-posteriorly (?) elongate, arched row of denticles with deeply excavated and more or less laterally flared base: an approximately mid-length recurved denticle the largest. Lateral surface of unit markedly offset inward immediately anterior to largest denticle and aborally extended beneath outer side of largest denticle. Arch in front of and behind largest denticles of varied length and crowned with a few denticles."

DICHOGNATHUS EXTENSA Branson and Mehl, 1933

Pl. 9, fig. 25; Pl. 10, fig. 15

1933 Dichognathus extensa Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 114, Pl. 9, fig. 21.

1943 Dichognathus extensa Branson and Mehl, Branson and Mehl, Jour. Paleontology, vol. 17, p. 376, 387, Pl. 64, fig. 10.

1957 <u>Dichognathus</u> <u>extensa</u> Branson and Mehl, Glenister, Jour. Paleontology, vol. 31, p. 734, Pl. 88, figs. 11, 17.

1959 <u>Dichognathus</u> <u>extensa</u> Branson and Mehl, Sweet, <u>et</u> <u>al</u>., Jour. Paleontology, vol. 33, p. 1047, Pl. 132, figs. 2, 3.

1965 <u>Dichognathus</u> <u>extensa</u> Branson and Mehl, Mound, Tulane Studies in Geology, vol. 4, no. 1, p. 15, Pl. 1, fig. 27.

1965 <u>Dichognathus</u> <u>extensa</u> Branson and Mehl, Barnett, Micropaleontology, vol. 11, p. 70, Pl. 1, fig. 10.

This species may intergrade into <u>D</u>. <u>typica</u> (Sweet, <u>et</u> <u>al</u>., 1959, p. 1048), although herein the two species are considered distinct.

The Upper Viola of U. S. Highway 77 section contains these forms in limited numbers. A few individuals which are assigned to the species were encountered in the Franklin section of Tennessee. The specimen figured on Plate 9, fig. 25, displays the dichognathid fold which is characteristic of the genus. The figured specimen, Plate 10, fig. 15, reveals a broken portion, although the posterior bar displays exceptional length. Most specimens are broken, and display but one to three denticles upon either or both bars.

Genus DREPANODUS Pander, 1856, emended Lindström, 1954

Type species: <u>Drepanodus</u> <u>arcuatus</u> Pander, 1856

1856 <u>Drepanodus</u> <u>arcuatus</u> Pander, Akad. Wiss., St. Petersburg, p. 20, Pl. 1, figs. 2, 4, 5, 17, 30, 31.

1879 Drepanodus arcuatus Pander, Hinde, Quart. Jour. Geol. Soc. London, vol. 35, xiii, pt. 3, no. 139, art. 29, p. 357, Pl. 15, figs. 7, 8.

1926 Drepanodus arcuatus Pander, Ulrich and Bassler, U. S. Nat. Mus., Proc., vol. 68, art. 12, no. 2613, p. 7, fig. 2, subfig. 6.

1928 Drepanodus arcuatus Pander, Holmes, U. S. Nat. Mus., Proc., vol. 72, art. 5, no. 2701, p. 9, Pl. 1, figs. 30-37.

1931 Drepanodus arcuatus Pander, Harris, in Decker and Merritt, Oklahoma Geol. Survey, Bull. 55, p. 21, 24, 68, 95, Pl. 5, fig. 1a, b.

1932 Drepanodus arcuatus Pander, Harris, Oklahoma Acad. Science, Proc., vol. 12, p. 59, Pl. 1, fig. 1.

Original description: "Mehr oder weniger gekrümmte spitze Zähne, mit vorderen und hinteren gleich grossen scharfen Kielen und convexen, glatten symmetrischen Seitenflächen."

Free translation of the original description follows: More or less curved, pointed teeth with uniform, sharp anterior and posterior keels and convex, smooth, symmetrical sides.

As defined by Pander, Drepanodus is restricted to simple symmetrical cones with carinate anterior and posterior edges; but Pander included among the six original illustrations of Drepanodus arcuatus (type species since 1889) some figures not agreeing with his generic description. Therefore, Lindström (1954) designated as the type species Pander's illustrations on Pl. 1, figs. 4, 5. Defined thusly, Drepanodus represents essentially symmetrical, simple cones with smooth lateral faces and carinate anterior and posterior edges. Forms in which the posterior margin of the cusp joins the oral margin of the basal sheath at a sharp angle are referred currently to *Oistodus*, thus differing from *Drepanodus* with smoothly rounded oral curvature.

DREPANODUS CAVUS Webers, 1966

Pl. 9, fig. 11

1966 *Drepanodus cavus* Webers, Minnesota Geol. Survey, Spec. Pub. SP-4, p. 28-29, Pl. 2, figs. 4, 5.

Infrequent specimens of this subsymmetrical, simple cone occur in the Oklahoma State Highway 18 section of the Fernvale.

Webers noted that the species (represented by twenty-three specimens) ranges from the base of the Platteville to the top of the Dubuque Formation of Minnesota. He stated that no other form species are associated with this conodont.

This unusual and long ranging form is too infrequent in the Oklahoma "Fernvale" to be of stratigraphic worth.

DREPANODUS CONCAVUS (Branson and Mehl, 1933)

Pl. 5, figs. 1, 2, 4, 6-8

1933 Oistodus concavus Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 59, Pl. 4, fig. 6.

1938 Oistodus concavus Branson and Mehl, Furnish, Jour. Paleontology, vol. 12, p. 320, 327, Pl. 41, figs. 16, 17.

1957 Drepanodus concavus (Branson and Mehl), Glenister, Jour. Paleontology, vol. 31, p. 724, Pl. 86, fig. 10.

1965 Drepanodus concavus (Branson and Mehl), Barnett, Micropaleontology, vol. 11, p. 70, Pl. 1, fig. 17.

1965 Drepanodus concavus (Branson and Mehl), Mound, Tulane Studies in Geology, vol. 4, no. 1, p. 16, 17, Pl. 2, figs. 4-6.

1966 Drepanodus concavus (Branson and Mehl), Winder, Jour. Paleontology, vol. 40, p. 56, Pl. 9, fig. 18 (not p. 56, Pl. 1, fig. 18).

Winder (1966) placed Oistodus curvatus in his synonymy of Drepanodus concavus form species. These two species are morphologically similar; but until all drepanodid forms are completely revised, the specific assignments and taxonomy of these elements will remain subjective, and dependent upon individual interpretation. The writer agrees with Mound in referring O. curvatus to the synonymy of D.

homocurvatus, and in recognizing the latter species as distinct from D. concavus. D. concavus differs in possessing a singular degree of transparency at the proximal end, in contrast to "white matter" (Lindström) at the distal end of the cusp.

Drepanodus concavus occurs in limited numbers in the U. S. Highway 77 and Oklahoma State Highway 18 sections. A few specimens were observed in the lower portion of the Mayberry section of Tennessee.

DREPANODUS HOMOCURVATUS Lindström, 1954

Pl. 5, figs. 3, 5; Pl. 12, figs. 1-9; Pl. 14, fig. 11.

1933 Oistodus curvatus Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 110, 111, Pl. 9, figs. 4, 10, 12.

1935 Oistodus curvatus Branson and Mehl, Stauffer, Geol. Soc. America, Bull., vol. 46, p. 146, 159, Pl. 12, figs. 20, 23, 27, 29, 30, 36.

? 1935 Oistodus curvatus Branson and Mehl, Stauffer, Jour. Paleontology, vol. 9, p. 609, Pl. 74, figs. 5, 10, 12.

? 1936 Oistodus curvatus Branson and Mehl, Furnish, et al., Am. Assoc. Petroleum Geologists, Bull., vol. 20, p. 1334, Pl. 1, fig. 8; Pl. 2, figs. 17, 18.

? 1941 Oistodus curvatus Branson and Mehl, Graves and Ellison, Missouri School of Mines and Metallurgy, Bull., Tech. Ser., vol. 14, p. 4, 6, 7, Pl. 1, fig. 8; Pl. 3, figs. 17, 21, 27.

1942 Oistodus curvatus Branson and Mehl, Amsden and Miller, Jour. Paleontology, vol. 16, p. 303, fig. 2B.

1944 Oistodus curvatus Branson and Mehl, Branson, Univ. Missouri Studies, vol. 19, p. 81, Pl. 11, figs. 8, 25, 31; Pl. 12, figs. 37, 38.

1953 Oistodus curvatus Branson and Mehl, Rhodes, Roy. Soc. London, Phil. Trans., Ser. B. no. 647, p. 295, Pl. 21, figs. 82, 89, 90; Pl. 22, figs. 157-161.

1954 Drepanodus homocurvatus Lindström, Geol. Fören, Förhandl., Stockholm, Bd. 76, p. 563; Pl. 2, figs. 23, 24, 29; text fig. 4D.

1955 Oistodus curvatus Branson and Mehl, Sweet, Jour. Paleontology, vol. 29, p. 251, Pl. 28, fig. 7.

1955 Drepanodus homocurvatus Lindström, Sannemann, Neues Jahrb. Geol. u. Paläont., Abh., Bd. 102, p. 26, Pl. 2, fig. 4; Pl. 1, fig. 14.

1957 Drepanodus homocurvatus Lindström, Glenister, Jour. Paleontology, vol. 31, p. 725, Pl. 86, fig. 13; Pl. 87, figs. 1-6, 8.

1959 Drepanodus homocurvatus Lindström, Ethington, Jour. Paleontology, vol. 33, p. 276, Pl. 39, fig. 16.

1959 Drepanodus homocurvatus Lindström, Sweet, et al., Jour. Paleontology, vol. 33, p. 1049, Pl. 130, fig. 7.

1960 Drepanodus homocurvatus Lindström, Pulse and Sweet, Jour. Paleontology, vol. 34, p. 252, 253, Pl. 35, figs. 4, 13.

1961 Drepanodus homocurvatus Lindström, Bergström, Arkiv. Mineral. Geol., Bd. 3, p. 39-41, Pl. 2, figs. 13, 14; Pl. 5, fig. 19; text figs. 3E, 4A.

1961 Drepanodus homocurvatus Lindström, Wolska, Acta, Palaeont. Polonica, vol. 6, p. 344, 348, Pl. 2, figs. 7a, b.

1962 Drepanodus homocurvatus Lindström, Sweet and Bergström, Jour. Paleontology, vol. 36, p. 1226, Pl. 169, fig. 9.

1964 Drepanodus homocurvatus Lindström, Ethington and Clark, Jour. Paleontology, vol. 38, p. 688, Pl. 113, figs. 13, 18.

1966 Drepanodus homocurvatus Lindström, Oberg, Jour. Paleontology, vol. 40, p. 137, Pl. 16, fig. 13.

In emending the genera, Oistodus and Drepanodus, Lindström transferred Oistodus curvatus Branson and Mehl to Drepanodus, in order to avoid synonymy with Drepanodus curvatus Stauffer 1932, the specific epithet of Branson and Mehl's species was designated homocurvatus.

This simple, morphologically distinctive species is quite variable, and widespread geographically and stratigraphically. Specimens comparing favorably to those assigned to the species by various authors were obtained from Oklahoma State Highway 18, now U. S. Highway 177, and U. S. Highway 77 sections of the Arbuckle region; the Horseshoe Bend and Oklahoma Highway 10 sections of the Ozark area; and the Southall, Linton, and Adkins sections of Tennessee.

DREPANODUS INCURVUS (Pander, 1856)

Pl. 3, figs. 1, 2; Pl. 4, figs. 12, 15, 16

1856 _Machairodus_ _incurvus_ Pander, Akad. Wiss., St. Petersburg, p. 23, Pl. 1, fig. 22.

1879 _Distacodus_ _incurvus_ (Pander), Hinde, Quart. Jour. Geol. Soc. London, vol. 35, p. 357, 358, Pl. 15, fig. 9.

1923 _Distacodus_ _incurvus_ (Pander), Parks 31st Ann. Rept. Ontario Dept. Mines, p. 36, Pl. 6, fig. 23.

1928 _Distacodus_ _incurvus_ (Pander), Holmes, U. S. Natl. Mus., Proc., vol. 72, p. 9, Pl. 1, fig. 12.

1933 _Oistodus_ _suberectus_ Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 111, Pl. 9, fig. 7.

1933 _Drepanodus_ _incurvus_ (Pander), Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 154, Pl. 12, fig. 13.

1935 _Oistodus_ _suberectus_ Branson and Mehl, Stauffer, Geol. Soc. America, Bull., vol. 46, p. 147, 159, Pl. 12, figs. 14, 19, 28, 31, 35.

1935 _Oistodus_ _suberectus_ Branson and Mehl, Stauffer, Jour. Paleontology, vol. 9, p. 611, Pl. 74, figs. 18, 42, 46.

1935 _Oistodus_ _giganteus_ Stauffer, Jour. Paleontology, vol. 9, p. 610, Pl. 74, fig. 45.

1935 _Oistodus_ _erectus_ Stauffer, Jour. Paleontology, vol. 9, p. 609, Pl. 74, fig. 50.

1936 _Oistodus_ _suberectus_ Branson and Mehl, Furnish, _et_ _al_., Jour. Paleontology, vol. 12, p. 1334, Pl. 1, fig. 9.

1941 Oistodus suberectus Branson and Mehl, Graves and Ellison, Missouri School of Mines and Metallurgy, Bull., Tech. Ser., vol. 14, p. 4, 7, fig. 32.

1943 Oistodus suberectus Branson and Mehl, Branson and Mehl, Jour. Paleontology, vol. 17, p. 376, Pl. 64, fig. 16.

1944 Oistodus suberectus Branson and Mehl, Branson, Univ. Missouri Studies, vol. 19, p. 89, 90, Pl. 13, fig. 40.

1951 Oistodus suberectus Branson and Mehl, Branson, Mehl, and Branson, Jour. Paleontology, vol. 25, p. 8, 9, Pl. 2, figs. 1-4.

1953 Drepanodus suberectus (Branson and Mehl), Rhodes, Roy. Soc. London, Phil. Trans., Ser. B, vol. 237, no. 647, p. 295, Pl. 21, figs. 93, 94; Pl. 22, figs. 166, 167.

1955 Drepanodus suberectus (Branson and Mehl), Lindström, Geol. Fören. Förhandl., Stockholm, Bd. 76, p. 568, Pl. 2, figs. 21,22.

1955 Drepanodus suberectus (Branson and Mehl), Sannemann, Neues Jahrb. Geol. u. Paläeont., Abh., Bd. 102, p. 27, Pl. 1, fig. 22; Pl. 2, fig. 1.

1957 Oistodus suberectus Branson and Mehl, Glenister, Jour. Paleontology, vol. 31, p. 726, Pl. 86, figs. 12, 14.

1959 Drepanodus suberectus (Branson and Mehl), Stone and Furnish, Jour. Paleontology, vol. 33, p. 222, Pl. 31, fig. 7.

1959 Drepanodus suberectus (Branson and Mehl), Ethington, Jour. Paleontology, vol. 33, p. 276, Pl. 39, fig. 17.

1959 Drepanodus suberectus (Branson and Mehl), Sweet, et al., Jour. Paleontology, vol. 33, p. 1049, Pl. 130, fig. 4.

1959 Drepanodus sp. Lindström (in part), Micropaleontology, vol. 5, p. 439, Pl. 3, figs. 3,4.

1960 Drepanodus suberectus (Branson and Mehl), Carlson, North Dakota Geol. Survey, Bull. 35, Pl. 2, fig. 10, tab. II.

1960 Drepanodus suberectus (Branson and Mehl), Pulse and Sweet, Jour. Paleontology, vol. 34, p. 253, Pl. 35, figs. 2, 7.

1961 Drepanodus suberectus (Branson and Mehl), Wolska, Acta. Palaeont. Polonica, vol. 6, no. 4, p. 349, Pl. 1, figs. 8a, 8b.

1962 Drepanodus suberectus (Branson and Mehl), Bergström, Arkiv. f. Mineralogi och Geologi, vol. 3, no. 1, p. 41, Pl. 5, fig. 7, text figs 3k, 4b (preprints dated 1961).

1962 Drepanodus suberectus (Branson and Mehl), Sweet and Bergström, Jour. Paleontology, vol. 36, p. 1226, Pl. 169, fig. 8.

1964 Drepanodus suberectus (Branson and Mehl), Ethington and Clark, Jour. Paleontology, vol. 38, p. 689, 690, Pl. 113, fig. 18.

1965 Drepanodus suberectus (Branson and Mehl), Barnett, Micropaleontology, vol. 11, p. 70, Pl. 1, figs. 29; Pl. 2, fig. 22.

1966 Drepanodus suberectus (Branson and Mehl), Schopf, New York State Mus. and Science Serv., Bull. 405, p. 54, 55, Pl. 5, fig. 25.

1966 Drepanodus suberectus (Branson and Mehl), Bergström and Sweet (in part), Bull. Am. Paleontology, vol. 50, no. 229, p. 330-333, Pl. 35, figs. 22, 23 (not Pl. 35, figs. 24-27).

1966 Drepanodus suberectus (Branson and Mehl), Webers (in part), Minnesota Geol. Survey, Spec. Pub. SP-4, p. 29, 30, Pl. 6, fig. 9 (not Pl. 6, figs. 11, 14, 16).

Drepanodus incurvus and Drepanodus homocurvatus, representing conservative elements of the conodont animal, are widespread geographically, and also stratigraphically through the Ordovician system. As is true of many of the conodonts, especially simple forms, a re-evaluation of specific criteria and revision of the species would probably result in the creation of a number of new form species of more limited stratigraphic distribution.

Bergström and Sweet (1966) placed Drepanodus incurvus (D. suberectus), Drepanodus homocurvatus, and Oistodus inclinatus in synonymy, because they considered them to be intergradational morphologically, with the same stratigraphic range, and to be associated in samples. They are also similar in size and color. Mound (1965) recognized Drepanodus suberectus as a junior synonym of Drepanodus incurvus, and such synonymy is accepted herein; however, inclined Oistodus inclinatus and curved Drepanodus homocurvatus are not included herein with D. incurvus. Each of these form species is interpreted as a basic element that may be further separated into subspecies upon the basis of individual variation. Some of these more closely defined morphological subspecies may prove to be of significant stratigraphic value.

Forms which fall within the morphologic range displayed by ubiquitous D. incurvus form species were recovered in limited numbers scattered through samples from every section examined in this research. It is nowhere abundant, but special mention should be made of its occurrence in samples from the Linton, Southall, and Mayberry sections of Tennessee. Because this form represents a conservative element of the conodont animal, it is likely to be polyphyletic, in that it and similar form species of Drepanodus and Oistodus may occur in related (yet distinct) biologic species of the conodont animal. This possibility was indicated by Webers (1966, p. 6) who stated, "A homeomorphic form species could conceivably be found in more than one natural assemblage, causing discrepancies in stratigraphic distribution and abundance ratios. Moore (1962) states this possibility, and it might be expected with respect to evolutionary trends."

DREPANODUS sp.

Pl. 4, fig. 13

Asymmetrical, lanceolate cusp, slightly flexed inward, broad at the base and abruptly tapering to a point, anterior and posterior margins edged with a sharp, broad keel. Axis of cusp angled at approximately 45 degrees with the straight basal margin. Anterior margin practically straight, but displaying slight sigmoidal curvature. Posterior margin evenly curved at the base, abruptly straightening distally. Cross-section of distal part of cusp that of a biconvex lens, proximally the cross-section is similar, but with produced keels at anterior and posterior margins. Basal cavity deepest in axis of cusp, apex of cavity not recurved anteriorly.

The highlight upon the anterior face of the figured specimen presents the false illusion of an edge or keel along the side of the cusp.

A single individual represents this species in the Linton section of Tennessee.

Genus EOLIGONODINA Branson, Mehl, and Branson, 1951

Type species: Eoligonodina robusta Branson, Mehl, and Branson, 1951

1951 Eoligonodina robusta Branson, Mehl, and Branson, Jour. Paleontology, vol. 25, p. 15, Pl. 4, figs. 33, 35-37.

"Complex dental units consisting of a relatively long, slender, recurved terminal denticle with deeply excavated thin-walled base expanded in the plane of the curvature and extended on the oral edge into a denticulate bar, at approximately a right angle to the denticle; from the opposite anterior-aboral edge of the expanded base the main denticle is continued as a denticulate bar in the same plane as the denticle and its other denticulate bar and bears denticles directed about normal to this plane."

EOLIGONODINA RICHMONDENSIS Branson, Mehl, and Branson, 1951

Pl. 11, figs. 6, 12, 13, 15

1951 Eoligonodina richmondensis Branson, Mehl, and Branson, Jour. Paleontology, vol. 25, p. 15, Pl. 4, figs. 23-27.

1959 Eoligonodina richmondensis Branson, Mehl, and Branson, Ethington and Furnish, Jour. Paleontology, vol. 33, p. 543, Pl. 73, fig. 1.

1966 Eoligonodina richmondensis Branson, Mehl, and Branson, Oberg, Jour. Paleontology, vol. 40, p. 138, 139, Pl. 16, figs. 14, 17.

This species is less robust than E. robusta, and does not develop prominent denticles upon the lateral process. Most specimens display a prominent nondenticulate process or ridge; in a few specimens, the ridge, which represents a slightly developed process, is weakly developed, so such specimens resemble Cordylodus.

The species was obtained only from Tennessee sections, being most abundant in Franklin and Southall samples.

EOLIGONODINA ROBUSTA Branson, Mehl, and Branson, 1951

Pl. 11, figs. 14, 16, 17

This species appears typical of Richmond strata, not having been recovered from other Ordovician strata. It is larger and more robust than _E. richmondensis_, with which it commonly is associated. An intergradation of these two forms was not clearly indicated; however, in samples containing this species in relative abundance, other conodont associates were unusually robust. There is no indication by lithologic differences nor differences in the associated fossils that differential sorting has occurred, although this possibility cannot be ignored.

A few specimens were recovered from the Tennessee Southall, Franklin, Jordania, and Adkins sections. None were observed in the Mayberry section of Tennessee; nor were any obtained from Oklahoma sections.

EOLIGONODINA ? sp.

Pl. 1, fig. 22

This unit consists of a recurved cusp upon a short, wide base that bears a single, rather large, blunt, peg-like laterally-projecting denticle. The cusp is long and slender, gently recurved, subrounded in cross-section, with a trace of a keel extending along the cusp. The base is relatively uncompressed, wide in lateral view, evenly convex on the outer side, more flattened on the inner. The posterior bar appears to be broken.

A single fragmentary specimen represents this unusual _Eoligonodina_. It is figured here, because it represents one of the few forms recovered from the Fite Limestone (sample E) that underlies the "Fernvale" of the Horseshoe Bend section of northeastern Oklahoma.

Genus ERISMODUS Branson and Mehl, 1933

Type species: Erismodus typus Branson and Mehl, 1933

1933 Erismodus typus Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 25, 104, Pl. 1, figs. 9, 11, 12.

1945 Erismodus typus Branson and Mehl, Branson, Univ. Missouri Studies, vol. 19, p. 67, 70, Pl. 9, figs. 29, 30.

1955 Erismodus typus Branson and Mehl, Sweet, Jour. Paleontology, vol. 29, p. 234, Pl. 27, fig. 5; Pl. 29, figs. 7 8.

"More or less bar-like arched units with median or apical cone, the somewhat excavated base of which is emphasized by a buttress on each side, that of the outer face extending as a boss or process below the aboral margin of the arched bar. Oral edge of bar produced into a few low rounded denticles. In some species bars very short and nondenticulate. The bar excavated lengthwise on the aboral side to clasp the jaw."

ERISMODUS sp. cf. E. (?) DUBIUS Branson and Mehl, 1933

Pl. 9, fig. 24

cf. 1933 Erismodus (?) dubius Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 104, Pl. 9, figs. 5, 6.

A single specimen belonging to the genus *Erismodus* and morphologically resembling *E.* (?) *dubius* Branson and Mehl was obtained from the lowermost portion of the Franklin section of Tennessee (Arnheim Formation). This is undoubtedly a recycled specimen.

Genus FALODUS Lindström, 1955

Type species: *Oistodus prodentatus* Graves and Ellison, 1941

1941 *Oistodus prodentatus* Graves and Ellison, Univ. Missouri School of Mines and Metallurgy, Tech. Serv., vol. 14, no. 2, p. 13, 14, Pl. 2, figs. 6, 22, 23, 28.

1955 *Falodus prodentatus* (Graves and Ellison), Lindström, Geol. Fören. Förhandl., Stockholm, Bd. 76, p. 569, Pl. 5, figs. 21, 22, 30.

1957 *Falodus* sp. Lindström, Geol. Fören, Förhandl., Stockholm, Bd. 79, p. 173, Pl. 1, figs. 25, 26; text figs. 2-26.

1959 *Falodus prodentatus* (Graves and Ellison), Ethington, Jour. Paleontology, vol. 33, p. 277, 278, Pl. 39, fig. 18.

? 1961 *Falodus* sp. Wolska, Acta Paleont. Polonica, vol. 6, p. 350, Pl. 2, figs. 1a, b, 5.

1962 *Falodus prodentatus* (Graves and Ellison), Sweet and Bergström, Jour. Paleontology, vol. 36, p. 127-129, Pl. 170, figs. 2, 3; text fig. 2B.

1963 *Falodus parvidentatus* Sergeeva, Paleont. Zhurnal, no. 2, p. 103, 104, Pl. 8, figs. 4-7; text fig. 8.

1963 Falodus simplex Sergeeva, Paleont. Zhurnal, no. 2, p. 104, 105, Pl. 8, figs. 8-10; text fig. 9.

1965 Falodus prodentatus (Graves and Ellison), Mound, Tulane Studies in Geology, vol. 4, no. 1, p. 19, Pl. 2, figs. 15, 17, 20.

1966 Falodus prodentatus (Graves and Ellison), Schopf, New York State Mus. and Science Serv., Bull. 405, p. 56, Pl. 3, fig. 11.

1966 Falodus prodentatus (Graves and Ellison), Webers, Minnesota Geol. Survey, Spec. Pub. SP-4, p. 56, Pl. 12, figs. 6, 7.

"Compound conodonts with two basal processes, one anteriorly, with denticles, and one posteriorly, without. There are no other processes or definite costae."

FALODUS PRODENTATUS (Graves and Ellison, 1941)

Pl. 13, fig. 24

Falodus prodentatus was observed in limited numbers in samples from the Robertson Creek section of the Arbuckle Mountains. The species was not observed elsewhere.

FALODUS ? sp.

Pl. 9, figs. 17, 23

Immature forms with "germ denticles" have been identified questionably as Falodus ? sp. These were obtained infrequently from scattered samples throughout the Franklin section of Tennessee. They are not significant numerically nor stratigraphically.

Genus ICRIODINA Branson and Branson, 1947 = Icriodella Rhodes, 1953

Type species: Icriodina irregularis Branson and Branson, 1947

1947 Icriodina irregularis Branson and Branson, Jour. Paleontology, vol. 21, p. 551, Pl. 81, figs. 3-11, 18.

"Platform-like dental units with blunt, irregular node-like denticles which occupy most of the oral area and are connected crosswise and lengthwise by low narrow ridges. Sides below the denticles flaring outward slightly and very thin near the margins. Units spindle-shaped in oral view, in young specimens, becoming comparatively broader and nearly rhomboid in old age. Aboral side with a depression like the inside of a narrow rowboat, but triangular in cross sections in some specimens."

"Lindström (1964) published the synonymy of Icriodella and Icriodina, stating that type specimens of Icriodina are fragmentary, but topotypes display a posterior process identical with that of Rhodes' Icriodella.

The two genera are considered synonymous herein.

ICRIODINA sp. cf. I. SUPERBA var. ACUTA (Rhodes, 1953)

Pl. 14, figs. 22, 24

1953 Icriodella superba var. acuta Rhodes, Roy. Soc. London, Phil. Trans., Ser. B., no. 647, vol. 237, p. 288, Pl. 20, figs. 59, 60, 64, 66, 71-73.

The illustrated form is similar to the variety, but differs in that the flaring basal expansion is evenly developed on both sides (not abruptly truncated, and tapers gradually toward both ends of the unit.

The form is most typical of the Franklin section, where it occurs with Sagittodontus robusta, a form whose morphologic similarities are suggestive of possible relationship. It was not recovered from Fernvale sections of Oklahoma.

Genus ICRIODUS Branson and Mehl, 1933

Type species: Icriodus expansus Branson and Mehl, 1938, by original designation 1933.

1933 Icriodus expansus Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 225 (named, but not described until 1938).

1938 Icriodus expansus Branson and Mehl, Jour. Paleontology, vol. 12, p. 156, 158, 160, 161, Pl. 26, figs. 18-21.

1938 Icriodus expansus Branson and Mehl, Stauffer, Jour. Paleontology, vol. 12, p. 430, Pl. 52, figs. 2, 14, 16, 19, 20, 25, 33, 35.

1940 Icriodus expansus Branson and Mehl, Stauffer, Jour. Paleontology, vol. 14, p. 425, Pl. 60, figs. 40, 47, 59-64, 70, 71.

1940 Icriodus expansus Branson and Mehl, Grohskopf, Clark, and Ellison, Missouri Geology Survey and Water Res., 2nd Bienn. Rept., appendix 4, p. 15, 16, Pl. 2, figs. 1, 2, 5, 8, 11, 13.

1944 Icriodus expansus Branson and Mehl, Mehl and Quigley, in Branson, Univ. Missouri Studies, vol. 19, p. 153, Pl. 26, figs. 7-9.

1947 Icriodus expansus Branson and Mehl, Youngquist and Peterson, Jour. Paleontology, vol. 21, p. 246, Pl. 37, figs. 5-7, 10, 20.

Branson and Mehl proposed this genus in 1933, stating that I. expansus (then a nomen nudum) was to be type species. They described two other species of Icriodus at that time, but not I. expansus; it was described in 1938. The validity of I. expansus as type is questionable; however, it is not considered advisable to make taxonomic or nomenclatural changes in this quasi-published work.

"Platform-like teeth with high sides either straight or flaring near the lower margin, of more or less spindle-shaped or lachrymiform outline in superior view, and without a distinct anterior blade as in the polygnathids. The aboral side is deeply excavated along its entire length and the oval surface consists of two or more longitudinal rows of low sharp cusps."

Some species of the genus are modified by a laterally-projecting process at the posterior end.

Icriodids recovered in this research are considered representatives of stratigraphic leakage.

ICRIODUS sp. cf. I. EXPANSUS Branson and Mehl, 1938

Pl. 5, figs. 9-14

This species includes some forms which differ slightly from typical I. expansus in that the median row of denticles is considerably smaller, in some specimens represented by small, rounded pustules. A few individuals display no median row, but these are all excessively narrow and distorted forms (possibly abnormalities), in which the suppression of median denticles may be a result of lateral compression during growth.

Specimens were obtained in relative abundance from many "Fernvale" samples in the Oklahoma Highway 10 section of northeastern Oklahoma.

This species and associated specimens of Polygnathus in Fernvale samples undoubtedly represents stratigraphic leakage from younger marine sediments of Devonian age.

Leakage of younger conodonts into older strata is obviously not as common as the recycling of older sediments into younger, but such leakage is well documented and is recognized by conodont specialists as a potential source of error in making age determinations. Branson and Mehl (1941) discussed in detail the problem of admixed conodont faunas. They employed the term "phantom" formations for those formations once present in an area, but since eroded, whose presence is indicated by conodonts which have leaked through erosional channels or fractures into underlying strata.

There was no field evidence of Fernvale channeling noted during collecting of samples along Oklahoma Highway 10; however, after processing, many Devonian conodonts with attached sand grains were observable. Such grains are quite sparse as loose elements of the insoluble residues, so the association with conodonts is apparently more than fortuitous.

Devonian formations cropping out within five or ten miles of the outcrop are the Frisco Limestone, Sallisaw Formation, and the Sylamore Sandstone, the latter of Late Devonian or Early Mississippian age. It should be noted that phosphatic and conglomeratic Sylamore cuts into the Fernvale here.

Genus KEISLOGNATHUS Rhodes, 1955

Type species: *Keislognathus gracilis* Rhodes, 1955

1955 *Keislognathus gracilis* Rhodes, Quart. Jour. Geol. Soc. London, vol. 111, p. 131, Pl. 7, figs. 7-8.

1959 Keislognathus gracilis Rhodes, Sweet, et al., Jour. Paleontology, vol. 33, p. 105, Pl. 132, fig. 11.

1959 Keislognathus simplex Ethington, Jour. Paleontology, vol. 33, p. 280, 281, Pl. 40, figs. 9, 10.

1966 Keislognathus simplex Ethington, Winder, Jour. Paleontology, vol. 40, p. 57, Pl. 10, fig. 6.

1966 Tetraprioniodus delicatus (Branson and Mehl), Bergström and Sweet (in part), Bull. Am. Paleontology, vol. 50, no. 229, p. 403, Pl. 29, figs. 16, 17 (not figs. 14-15, 18-22).

1966 Ligonodina delicata (Branson and Mehl), Webers (in part), Minnesota Geol. Survey, Spec. Pub. SP-4, p. 32-34, Pl. 13, fig. 10 (not figs. 11, 13-15).

1966 Rosagnathus delicata (Branson and Mehl), Schopf (in part), New York State Mus. and Science Serv., Bull. 405, p. 76-77, Pl. 4, fig. 7.

"Complex dental units consisting of a stout fang and a denticulated posterior bar. On the anterior inner face of the fang a conspicuous pointed denticle is developed, which is extended downward into a long, straight, slender undenticulated aboral process. On the outer face of the fang an elongated, straight, denticulated outer lateral bar is developed. The aboral surfaces of the posterior and outer lateral bars and the anterior aboral processes are all deeply excavated."

Hindeodellid denticulation appears to be associated with this genus.

KEISLOGNATHUS GRACILIS Rhodes, 1955

Pl. 1, fig. 5; Pl. 4, fig. 20

The writer agrees with Webers (1966, p. 33) in placing <u>Keislognathus</u> <u>simplex</u> in synonymy with <u>Keislognathus</u> <u>gracilis</u>. Webers' examination of European and American reference collections revealed no significant differences between the two forms.

Winder (1966) noted that the species is identical in size and general morphology with <u>Eoligonodina</u> <u>delicata</u>, which differs from <u>Keislognathus</u> <u>gracilis</u> in the lack of an outer lateral process adjacent to the cusp.

<u>Keislognathus</u> is infrequent in Fernvale strata; however, the species was observed in three widely separated sections, Oklahoma Highway 18, Franklin of Tennessee, and Flying "L" Ranch of the Arbuckle area; the latter section yielded the most specimens (5).

Genus LEPODUS Branson and Mehl, 1933

Type species: <u>Lepodus</u> <u>minutus</u> Branson and Mehl, 1933

1933 <u>Lepodus</u> <u>minutus</u> Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 38, Pl. 1, figs. 33, 34.

"Comparatively broad, low cones with thin walls and deeply excavated base."

Webers (1966) considered these forms, which are commonly associated with conodonts, to be scales of unknown affinity.

LEPODUS sp. A

Pl. 3, fig. 7; Pl. 4, figs. 23, 24

? 1933 Oistodus (?) sp. Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 162, Pl. 9, fig. 3.

1966 Lepodus sp. Webers, Minnesota Geol. Survey, Spec. Pub. SP-4, p. 71, 72, Pl. 14, fig. 4.

Branson and Mehl questionably assigned to Oistodus some forms which are morphologically similar to Viola forms in the Arbuckle area and those reported from Minnesota by Webers. They noted that these forms are approximately the size and shape of the conical excavations of some of the larger oistodids. The description and figure of Webers compare closely with forms in Viola strata; and Branson and Mehl's original illustration indicates a close resemblance in shape, thinness of wall, and concentric ornamentation. The concentric ornamentation of these forms strongly resembles growth lines. It is not quite clear why Branson and Mehl did not assign the species to their established genus Lepodus.

Infrequent specimens of these fragile, scale-like units occur in the finely crystalline portions of the Upper Viola of the Arbuckle area; because of their fragility, they were probably macerated in processing, and accordingly, not fully represented in the faunal count.

LEPODUS ? sp. B

Pl. 4, figs. 21, 22

? 1933 Genus and species undetermined, Branson and Mehl, Univ. Missouri Studies, vol. 8, Pl. 10, fig. 13.

Simple patellate, asymmetrical, thin-walled cones, suboval in basal outline, approximately two-thirds as high as long. The wall of the blunt apex appears thicker than that of the lower portion.

Branson and Mehl considered their specimens as undeveloped oistodids. Herein these forms are assigned to the conodonts, and their oistodid ontogeny is questioned. They are probably related to Lepodus.

The forms are sparse in Fernvale and Upper Viola samples from the Arbuckle area.

Genus LIGONODINA Ulrich and Bassler, 1926

Type species: Ligonodina pectinata Ulrich and Bassler, 1926

1926 Ligonodina pectinata Ulrich and Bassler, U. S. Natl. Mus., Proc., vol. 68, art. 12, p. 13, Pl. 2, figs. 9, 10.

"General form of tooth as in Prioniodus but distinguished by development of a series of sucker-like impressions on one side of the downward extension of the main cusp."

LIGONODINA sp. cf. L. FAIRMONTENSIS (Pulse and Sweet, 1960)

Pl. 3, fig. 11

cf. 1960 Eoligonodina fairmontensis Pulse and Sweet, Jour. Paleontology, vol. 34, p. 253, 254, Pl. 35, fig. 17.

? 1966 Ligonodina fairmontensis ? (Pulse and Sweet), Webers Minnesota Geol. Survey, Spec. Pub. SP-4, p. 64, Pl. 10, fig. 12.

Infrequent specimens which resemble Ligonodina fairmontensis, but not co-specific, are encountered in samples from the Fernvale Limestone in the Southall section of Tennessee.

The forms here differ chiefly from L. fairmontensis in that a smaller angle separates the two bars. The posterior bar is broken in most specimens, but the anterior denticles upon it are smaller than those of L. fairmontensis. The form may be mistaken for associated Trichonodella with a broken lateral process; but careful examination of the inner lateral side shows no broken surface along the latero-basal margin. Morphologically the form is intermediate between Trichonodella and Eoligonodina.

LONCHODUS Pander, 1856

= Centrodus Pander, 1856 (pre-empted)

Type species: Centrodus simplex Pander 1856 (p. 31, 32)

1856 Centrodus simplex Pander, Akad. Wiss. St. Petersburg, p. 31, 32.

1856 Lonchodus simplex (Pander), Pander, Akad. Wiss. St. Petersburg, p. 80, 89, Pl. 2A; figs. 2-3, 5, 6.

On page 80 Pander (1856) recognized Centrodus as being preoccupied, and proposed the name Lonchodus in its place.

"Very slender vertical, inclined or curved denticles which point in several different directions and which rise from a horizontal base . . . . smaller denticles may occur between the larger ones . . . The general character of the genus may be given as slender pointed or laminar denticles occurring as a uniform series or alternating with smaller denticles of varying size and number, all of which originate in a horizontal or convex base . . ."

This genus includes a number of fragments whose exact nature is unknown. Ulrich and Bassler suggested that the genus be employed as a category for ". . . similarly imperfect and genetically indeterminable material." Lonchodid forms, not in association with more complex genera of which they might be fragments, occur in the Harding Sandstone of Colorado. Thus, the genus is probably a valid one, although many fragments of other genera may be misidentified and assigned to this genus.

The forms observed in this study quite possibly may be fragments of associated cordylodid, trichognathid, and/or zygognathid forms.

LONCHODUS spp.

Pl. 1, figs. 16-21

Several specimens assigned to Lonchodus occur throughout the Tennessee sections, and in lesser numbers in the sections of Oklahoma. There seems to be no valid stratigraphic nor paleontologic reason to describe these fragments as distinct species; the fragments are probably representative of several associated genera. However, in the interest of completeness, their occurrence is mentioned and documented by illustrations.

The species figured in Plate 1, figure 16, from sample C of Oklahoma Highway 10 section may have some stratigraphic significance. It is characterized by offset denticles. Most fragments of this form consist of only two or three denticles upon a straight bar.

Genus MICROCOELODUS Branson and Mehl, 1933

Type species: Microcoelodus typus Branson and Mehl, 1933

1933 Microcoelodus typus Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 89, Pl. 6, figs. 31, 32.

"Dental units consisting of a dominant median cone, which is recurved above its conspicuously expanded, deeply cupped base. This is laterally flanked by basal wings or bars of varying length but usually short, on each side, set with sharp discrete denticles of minor size. The main cone has more or less conspicuous lateral carinae and is somewhat flattened on the recurved side. A growth axis is evident throughout the length of the main core."

The genus differs from Ptiloconus in that the base of the latter is laterally compressed, and the denticulate wings are typically developed in the vertical plane.

MICROCOELODUS DUBIUS Branson and Mehl, 1933

Pl. 4, figs. 26, 27

1933 Microcoelodus dubius Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 96, Pl. 6, fig. 8.

A few specimens that appear most appropriately assigned to the species M. dubius were observed in the Fite Limestone in the lower part of the Oklahoma Highway 10 section. This Fite sample (sample B) underlies the Fernvale, and is probably equivalent to the Corbin Ranch Formation of southern Oklahoma. The occurrence of this "fibrous" conodont is not inconsistent with the assignment of the Fite to Late Black Riverian or Early Trentonian age.

Genus MULTIOISTODUS Cullison, 1938

Type species: Multioistodus subdentatus Cullison, 1938

1938 Multioistodus subdentatus Cullison, Jour. Paleontology, vol. 12, p. 226, Pl. 29, figs. 13a, b.

"Base lachryforme to subtriangular, narrows anteriorly, broadens posteriorly, deepest about center. The cusp is most prominent, usually bladelike to subtriangular in cross section, bearing one or more prominent carinae. The denticles, usually bicarinate, one or more in number, are outgrowths from the cusp, rather than from the area of the basal plane. The genus is established to include those species of a fibrous character that seem to be transitional between the simple bases and cusps of the genus Oistodus and the more complex dental units that have denticles and cusp arising directly from the base."

MULTIOISTODUS sp. cf. M. LATERALIS Cullison, 1938

Pl. 12, fig. 21

cf. 1938 Multioistodus lateralis Cullison, Jour. Paleontology, vol. 12, p. 222, 226, 227, Pl. 29, fog. 14.

cf. 1964 Multioistodus (Dirhadicodus) lateralis Cullison, Harris, Oklahoma Geol. Notes, vol. 24, p. 115, 116, Pl. 1, figs. 3, 4.

cf. 1965 Multioistodus lateralis Cullison, Mound, Tulane Studies in Geology, vol. 4, no. 1, p. 24, 25, Pl. 3, figs. 14-16.

Individuals which can be compared to M. lateralis were found infrequently in samples from the lowermost Mayberry section of Tennessee. The occurrence of this form genus so high in the stratigraphic section may be due to recycling.

Figure 21 illustrates one denticle; the second, although present, is obscure in the reproduced figure.

Genus OISTODUS Pander, 1856

Type species: Oistodus lanceolatus Pander, 1856

1856 Oistodus lanceolatus Pander, Akad. Wiss., St. Petersburg, p. 5-7, Pl. 2, figs. 17-19; Pl. 3, fig. 1.

1926 Oistodus lanceolatus Pander, Ulrich and Bassler, U. S. Nat. Mus., Proc., vol. 68, art. 12, no. 2613, p. 7, fig. 2, subfig. 8.

1928 Oistodus lanceolatus Pander, Holmes, U. S. Nat. Mus., Proc., vol. 72, art. 5, no. 2701, p. 15, Pl. 2, figs. 15-17.

1941 Oistodus lanceolatus Pander, Hass, Jour. Paleontology, vol. 15, p. 75, Pl. 15, fig. 1.

1944 Oistodus lanceolatus Pander, Branson and Mehl, in Shimer and Shrock, Index Fossils of North America, p. 239, 240, Pl. 93, fig. 23.

"A small group is formed by these simple teeth which rest on a very long, broad and hollow base. From among these only a single genus is provisionally established because the character of the different forms is quite similar. They are generally transparent, yellow and of horny appearance, although they contain lime."

Carinae on one or both lateral faces of the cusp, and an acutely angled posterior junction of tooth and oral edge of the posterior bar are now considered to be two other generic characteristics of the genus. Oistodus differs from Drepanodus Pander 1856 in that the cusp of Drepanodus, usually the more symmetrically biconvex of the two genera, joins the posterior bar in a graceful curve, not at an acute angle.

OISTODUS ABUNDANS Branson and Mehl, 1933

Pl. 4, fig. 14; Pl. 5, fig. 16; Pl. 12, fig. 10

1933 Oistodus abundans Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 109, Pl. 9, figs. 11-17.

1935 Oistodus abundans Branson and Mehl, Stauffer (in part), Jour. Paleontology, vol. 9, p. 609, Pl. 75, fig. 2 (not Pl. 75, figs. 7, 11-13, 19).

1935 Oistodus abundans Branson and Mehl, Stauffer, Geol. Soc. America, Bull., vol. 46, p. 146, Pl. 12, fig. 22.

1940 Oistodus abundans Branson and Mehl, Stauffer, Jour. Paleontology, vol. 14, p. 426, Pl. 60, fig. 20.

1955 Oistodus abundans Branson and Mehl, Sannemann, Neues Jahrb. Geol. u. Paläont., Abh., Bd. 102, p. 28, Pl. 2, fig. 8.

1957 <u>Oistodus abundans</u> Branson and Mehl, Glenister, Jour. Paleontology, vol. 31, p. 725, Pl. 86, fig. 5.

1959 <u>Oistodus abundans</u> Branson and Mehl, Ethington, Jour. Paleontology, vol. 33, p. 282, Pl. 39, fig. 21.

1959 <u>Oistodus abundans</u> Branson and Mehl, Sweet, <u>et al</u>., Jour. Paleontology, vol. 33, p. 1052, 1053, Pl. 130, fig. 3.

1960 <u>Oistodus abundans</u> Branson and Mehl, Pulse and Sweet, Jour. Paleontology, vol. 34, p. 254, 255, Pl. 35, figs. 1, 8.

1966 <u>Oistodus abundans</u> Branson and Mehl, Barnett, Micropaleontology, vol. 11, p. 71, Pl. 1, fig. 31; Pl. 2, fig. 10.

1966 <u>Oistodus abundans</u> Branson and Mehl, Schopf, New York State Mus. and Science Serv., Bull. 405, p. 59, 60, Pl. 1, figs. 10, 14· text fig. 7-f.

Schopf (1966) designated as lectotype for <u>O</u>. <u>breviconus</u> Branson and Mehl, 1933, the specimen illustrated on Plate 9, fig. 13. This form, recognized by Branson and Mehl as a species distinct from <u>O</u>. <u>abundans</u> was then placed in synonymy with <u>O</u>. <u>abundans</u> by Schopf, thereby relegating <u>O</u>. <u>breviconus</u> a junior synonym of <u>O</u>. <u>abundans</u>.

<u>Oistodus abundans</u> occurs infrequently in the Mayberry and Linton sections of Tennessee. Examination of larger quantities of sample may prove it to be present in other Fernvale strata of Tennessee.

OISTODUS FORCEPS Lindström, 1955

Pl. 5, figs. 15, 17

1955 Oistodus forceps Lindström, Geol. Fören. Förhandl. Stockholm, vol. 76, p. 574, Pl. 4, figs. 9-13.

1957 Oistodus forceps Lindström, Lindström, Geol. Fören, Förhandl. Stockholm, vol. 79, p. 174.

1962 Oistodus forceps Lindström, Sweet and Bergström, Jour. Paleontology, vol. 36, p. 1231, Pl. 168, figs. 14, 15.

1965 Oistodus forceps Lindström, Barnett, Micropaleontology, vol. 11, p. 71, Pl. 1, fig. 7.

1965 Oistodus forceps Lindström, Mound, Tulane Studies in Geol., vol. 4, no. 1, p. 27, Pl. 3, figs. 30, 33.

This form, which is similar to O. venustus and O. excelsus, differs by possessing an unequal cusp and base and a straight untwisted anterior edge.

In the samples examined in this study, these forms are generally smaller than typical forms. They occur infrequently in samples from all the Fernvale sections.

Genus OULODUS Branson and Mehl, 1933

Type species: _Oulodus_ _mediocris_ Branson and Mehl, 1933

1933 _Oulodus_ _mediocris_ Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 116, Pl. 10, figs. 8, 9.

"Complex dental pieces consisting of a bent and twisted denticulate bar. The longer limb of the bar is straight or slightly curved, and aborally grooved to clasp the oral edge of the mandible. At the apex of the bend is a large denticle directed appreciably forward, and beyond this is the short limb, which is bent aborally and more or less posteriorly, and is deeply grooved on the aboral side."

OULODUS MEDIOCRIS Branson and Mehl, 1933

Pl. 3, figs. 14-21; Pl. 9, figs. 3-5

1933 _Oulodus_ _mediocris_ Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 116, Pl. 10, figs. 8, 9.

1959 _Oulodus_ _mediocris_ Branson and Mehl, Stone and Furnish, Jour. Paleontology, vol. 33, p. 224, Pl. 32, figs. 4, 5.

? 1959 _Oulodus_ _mediocris_ Branson and Mehl, Sweet, _et_ _al_., Jour. Paleontology, vol. 33, p. 1054, Pl. 133, fig. 5.

This form displays variation in the amount of flexure, arching, and degree of expansion and depth of the basal cavity. Certain specimens approach _Prioniodina_ in morphology.

This species was reported originally from the Middle Ordovician Plattin Formation of Missouri. The form is a typical element of the Richmond Fernvale of Tennessee.

OZARKODINA Branson and Mehl, 1933

Type species: Ozarkodina typica Branson and Mehl, 1933

1933 Ozarkodina typica Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 51, 52, Pl. 3, figs. 43-45.

1944 Ozarkodina typica Branson and Mehl, Branson, Univ. Missouri Studies, vol. 19, p. 97, 110, Pl. 16, figs. 43-45.

"Compound dental units consisting of a thin, blade-like, denticulate arched bar with a denticle of superior size near mid-length and approximately an equal number of parallel subequal smaller denticles on either side of it. Denticles laterally compressed, sharp-edged, more or less confluent to actually sheathed. Base excavated beneath large denticle."

OZARKODINA CONCINNA Stauffer, 1935

Pl. 8, figs. 8-12; Pl. 10, figs. 1-7

1935 Ozarkodina concinna Stauffer, Geol. Soc. America, Bull., vol. 46, p. 148, Pl. 10, figs. 41, 45, 46.

? 1935 Ozarkodina amorphina Stauffer, Geol. Soc. America, Bull., vol. 46, p. 148, Pl. 10, fig. 50.

? 1935 Ozarkodina reperda Stauffer, Geol. Soc. America, Bull., vol. 46, p. 149, Pl. 10, fig. 37.

1955 Ozarkodina concinna Stauffer, Sweet, Jour. Paleontology, vol. 29, p. 260, Pl. 29, fig. 18.

1957 Ozarkodina inclinata Glenister, Jour. Paleontology, vol. 31, p. 735, Pl. 88, figs. 3, 7.

1959 Ozarkodina concinna Stauffer, Ethington, Jour. Paleontology, vol. 33, p. 283, Pl. 41, figs. 15, 16.

1959 Ozarkodina concinna Stauffer, Ethington and Furnish, Jour. Paleontology, vol. 33, p. 541, Pl. 73, fig. 16.

1966 Ozarkodina concinna Stauffer, Oberg, Jour. Paleontology, vol. 40, p. 140, Pl. 15, fig. 15.

1966 Ozarkodina concinna Stauffer, Webers (in part), Minnesota Geol. Survey, Spec. Pub. SP-4, p. 35, 36, Pl. 9, figs. 9-12.

Stauffer's original figures of this species depict such a variety of forms that considerable latitude of interpretation resulted. Accordingly, forms from many Ordovician localities, assigned to this species by various authors, show wide variation. Specimens from the Fernvale of Tennessee also display considerable morphologic variation. The most conspicuous variation in this species appears to be in the number of denticles and width of aboral surface. The writer agrees with Ethington (1959) that the number of denticles on a given specimen may be a function of growth stages. Ethington mentioned the presence of a "low knob" at the anterior end of many complete specimens and postulated that new denticles are added anteriorly. Illustrations of O. tenuis, Pl. 4, figs. 5, 21, show growth lines indicating that denticles are added anteriorly.

Webers chose to include several morphologic variants in his concept of the species, including O. robusta. Herein, however, O. robusta, O. tenuis, and O. concinna are retained as separate species.

Forms assigned to O. concinna have been reported from the Glenwood and Decorah Formations (Stauffer), the Harding Formation of Colorado (Sweet), Kimmswick of Missouri (Branson), and the Whitewood of South Dakota (Furnish, et al.). The correctness of the assignment of forms from the Dutchtown Formation to this species by Branson (1944) was questioned by Ethington (1959).

This species of Ozarkodina is characteristic of the Adkins, Linton, Southall, and to a lesser degree, the Franklin and Mayberry sections of Tennessee. It is the only member of the genus in the latter section, and it is absent from the Jordania section, in which more robust forms are present.

Specimens, questionably assigned to this species, occur abundantly in the Robertson Creek section of the Arbuckle Mountain area of Oklahoma, and are rather common in Upper Viola (samples A,B) of the Oklahoma Highway 18 (now U. S. Highway 177) section.

Ozarkodina was not observed in the U. S. Highway 77 section, nor in the Flying "L" Ranch section.

The Oklahoma Highway 10 section contains infrequent individuals which, except for the preservational feature of color, are indistinguishable from those of the Robertson Creek section.

The Oklahoma specimens are morphological equivalents to the Tennessee forms, but may not be identical.

OZARKODINA ROBUSTA Stauffer, 1935

Pl. 8, figs. 3, 4, 13

1935 Ozarkodina robusta Stauffer, Jour. Paleontology, vol. 9, p. 612, Pl. 71, figs. 1, 3, 7, 9-13, 15, 21.

1959 Ozarkodina robusta Stauffer, Sweet, et al., Jour. Paleontology, vol. 33, p. 1055, Pl. 133, fig. 14.

1960 Ozarkodina robusta Stauffer, Pulse and Sweet, Jour. Paleontology, vol. 34, p. 256, Pl. 35, figs. 18, 19.

1966 Ozarkodina robusta Stauffer, Barnett, Micropaleontology, vol. 11, p. 71, Pl. 1, fig. 23; Pl. 2, fig. 21.

Ozarkodina robusta has been placed in synonymy with O. tenuis by Bergström and Sweet (1966), and in synonymy with O. concinna by Webers. The forms, as observed in the material of this study, are variable, and the separation into three species is artificial, and in the case of a few intermediate forms, partially arbitrary. However, most individuals may be assigned readily into the more delicate O. concinna, or the relatively large and rugged O. robusta, or into the intermediate group O. tenuis. The writer is not convinced that the three types represent different growth stages, nor that they are different elements of the same organism. Throughout the Richmond samples examined, there is a clear correlation between the sizes of all elements of the conodont fauna in each sample. Thus, in certain samples, all conodonts of all genera were smaller or larger than corresponding genera and species in other samples. Differential sorting cannot be eliminated as a factor in such cases; but it can be pointed out that associated material (ostracode molds, bryozoan fragments, gastropod and pelecypod molds) do not indicate such sorting. On the other hand, it is inconceivable that some samples would be limited to juvenile forms, some to immature adults, and others, to fully mature forms. The problem becomes especially complex when the given form species involved represents several natural species. The writer favors the hypothesis that morphological variations are a result of ecologic variation which affected the growth of all conodont elements in the several taxa present. Thus, for example, if these conodont elements were supporting structures for respiratory organs, a difference in the amount of oxygen available to these forms in various areas might explain the differential development of these structures in the different, but related, organisms, i.e., a fauna of natural taxa of the conodont-bearing animal.

Ozarkodina robusta was obtained from the Jordania, Adkins, and Southall sections of Tennessee; none was obtained from Oklahoma samples.

OZARKODINA TENUIS Branson and Mehl, 1933

Pl. 3, fig. 6; Pl. 10, fig. 8; Pl. 14, figs. 1-6, 21

1933 Ozarkodina tenuis Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 128, Pl. 10, figs. 19-21, 23.

1941 Ozarkodina tenuis Branson and Mehl, Graves and Ellison, Univ. Missouri School of Mines and Metallurgy, Bull., Tech. Ser., vol. 14, p. 6, 7, Pl. 3, figs. 3, 6.

1953 Ozarkodina tenuis Branson and Mehl, Rhodes, Phil. Trans. Roy. Soc. London, Ser. B., vol. 237, p. 320, Pl. 20, figs. 187, 197-200.

1966 Ozarkodina sp. cf. O. tenuis Branson and Mehl, Schopf, New York State Mus. and Science Serv., Bull. 405, p. 63, Pl. 2, figs. 11-13.

1966 Ozarkodina tenuis Branson and Mehl, Bergström and Sweet (in part), Bull. Am. Paleontology, vol. 50, no. 229, p. 353-355, Pl. 31, figs. 1-5.

Although Bergström and Sweet included O. robusta in the synonymy of O. tenuis, the two forms are retained herein as separate morphological entities.

Specimens assigned to this species were observed only in samples from the Southall, Franklin, and Adkins sections of Tennessee. A few individuals, questionably assignable to the species, occur in the Jordania section. In this section, the entire conodont fauna consists of rugged O. robusta type species which, indeed, may be a robust expression of O. tenuis. The Mayberry section, on the other hand, contains small, flattened forms that are referred to O. concinna.

Gradations among O. concinna, O. tenuis, O. robusta, and Aphelognathus grandis cannot be proven, but the writer suspects this is in fact the case. However, the four are retained herein as separate form species.

Genus PANDERODUS Ethington, 1959

Type species: _Paltodus_ _unicostatus_ Branson and Mehl, 1933

1933 _Paltodus_ _unicostatus_ Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 42, Pl. 3, fig. 3.

1953 _Paltodus_ _unicostatus_ Branson and Mehl, Rhodes, Phil. Trans. Roy. Soc. London, Ser. B., no. 647, p. 298, Pl. 21, figs. 84, 85; Pl. 22, figs. 155, 156; Pl. 23, figs. 214-216.

1955 _Paltodus_ _unicostatus_ Branson and Mehl, Rhodes, Quart. Jour. Geol. Soc. London, vol. 111, p. 127, Pl. 10, figs. 1,3.

1957 _Paltodus_ ? _unicostatus_ Branson and Mehl, Glenister, Jour. Paleontology, vol. 31, p. 729, Pl. 85, fig. 1.

1959 _Panderodus_ _unicostatus_ (Branson and Mehl), Ethington, Jour. Paleontology, vol. 33, p. 284.

1959 _Panderodus_ _unicostatus_ (Branson and Mehl), Sweet, _et_ _al_., Jour. Paleontology, vol. 33, p. 1057, Pl. 31, fig. 3.

1961 _Panderodus_ _unicostatus_ (Branson and Mehl), Wolska, Acta Paleont. Polonica, vol. 3, p. 353, Pl. 4, figs. 3a, b.

1962 _Panderodus_ _unicostatus_ (Branson and Mehl), Sweet and Bergström, Jour. Paleontology, vol. 36, p. 1234, text fig. 1D.

1964 _Panderodus_ _unicostatus_ (Branson and Mehl), Bergström, Acta Univ. Lund, sec. 2, no. 3, pub. no. 128, p. 30, 31, text fig. 14.

Although Ethington (1959, p. 284) is the author of the genus Panderodus, a previous reference to it was made by Stone and Furnish (1959, p. 225).

Ethington defined the genus as follows: ". . . simple asymmetrical curved cones which have a deep, tapered, basal cavity generally extending to mid-height. Lateral faces are ornamented by costae or grooves; cross section of the tooth may be used for specific identification. Basal outline tends to be broadly rounded anteriorly and narrow posteriorly."

PANDERODUS ACOSTATUS (Branson and Branson, 1947)

Pl. 2, fig. 20

1947 Paltodus acostatus Branson and Branson, Jour. Paleontology, vol. 21, p. 554, Pl. 82, figs. 1-5, 23, 24.

This is a noncostate, subsymmetrical form, evenly curved from base to tip, with a deep basal cavity that occupies most of the cusp. The simple form probably occurs in the assemblages of a number of natural species, and the group is undoubtedly polygenetic.

This form has been recovered from all Fernvale sections of the Arbuckle area, being most abundant in the U. S. Highway 77 section.

PANDERODUS COMPRESSUS (Branson and Mehl, 1933)

Pl. 2, fig. 23; Pl. 3, fig. 3; Pl. 9, fig. 13;

1933 Paltodus compressus Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 109, fig. 19 (designated as lectotype by Bergström and Sweet, 1966, p. 355).

1935 Paltodus compressus Branson and Mehl, Stauffer, Geol. Soc. America, Bull., vol. 46, p. 150, Pl. 12, figs. 17, 26.

1935 Paltodus cornutus Stauffer, Jour. Paleontology, vol. 9, p. 612, Pl. 74, figs. 1, 2, 11, 13-15.

1940 Paltodus cornutus Stauffer, Stauffer, Jour. Paleontology, vol. 14, p. 427, Pl. 60, fig. 10.

1943 Paltodus compressus Branson and Mehl, Branson and Mehl, Jour. Paleontology, vol. 17, p. 386, Pl. 64, fig. 6.

1951 Paltodus compressus Branson and Mehl, Branson, Mehl, and Branson, Jour. Paleontology, vol. 25, p. 7, Pl. 1, figs. 16-22.

1959 Panderodus compressus (Branson and Mehl), Ethington, Jour. Paleontology, vol. 33, p. 284, Pl. 39, fig. 4.

1959 Panderodus compressus (Branson and Mehl), Ethington and Furnish, Jour. Paleontology, vol. 33, p. 541, Pl. 73, fig. 8.

1965 Panderodus compressus (Branson and Mehl), Barnett, Micropaleontology, vol. 11, p. 72, Pl. 1, fig. 28.

1966 Panderodus compressus (Branson and Mehl), Oberg. Jour. Paleontology, vol. 40, p. 140 Pl. 15, fig. 8.

1966 Panderodus compressus (Branson and Mehl), Schopf, New York State Mus. and Science Serv., Bull. 405, p. 65, Pl. 5, fig. 23.

1966 Panderodus compressus (Branson and Mehl), Webers, Minnesota Geol. Survey, Spec. Pub. SP-4, p. 38, Pl. 2, figs. 10, 11.

1966 Panderodus gracilis (Branson and Mehl), Bergström and Sweet (in part), Bull. Am. Paleontology, vol. 50, no. 229, p. 355-359, Pl. 35, figs. 1-4 (not Pl. 35, figs. 5, 6).

This form species includes all species assigned to it by Bergström and Sweet (1966); however, they place the form species in synonymy with P. gracilis to form their statistical species of P. gracilis. The writer follows the precedent of Webers (1966) in recognizing the two as separate entities.

These simple cone-like panderodids have been observed in limited numbers in Fernvale samples from all sections studied. They are long-ranging forms within the Ordovocian system, without special stratigraphic significance. A robust and exceptionally wide variant occurs in the Oklahoma Highway 10 Fernvale section, and a similar variety occurs in some Viola and Fernvale samples from the Arbuckle Mountains, notably the Robertson Creek section, where they comprise a minor, yet conspicuous, element of the conodont fauna.

PANDERODUS GRACILIS (Branson and Mehl, 1933)

Pl. 2, figs. 17-19, 22; Pl. 9, figs. 10, 12; Pl. 10, fig. 16; Pl. 14, figs. 7-10

1933 Paltodus gracilis Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 108, Pl. 8, figs. 20, 21.

1935 Paltodus elegans Stauffer, Jour. Paleontology, vol. 9, p. 612, 613, Pl. 74, figs. 4, 7.

1935 Paltodus striatus Stauffer, Jour. Paleontology, vol. 9, p. 613, Pl. 74, figs. 3, 16.

? 1935 Paltodus gracilis Branson and Mehl, Furnish, et al., Am. Assoc. Petroleum Geologists, Bull., vol. 20, p. 1334, Pl. 1, fig. 3.

1940 Paltodus striatus Stauffer, Stauffer, Jour. Paleontology, vol. 14, p. 428, Pl. 60, figs. 5, 12, 13, 17.

1941 Paltodus gracilis Branson and Mehl, Graves and Ellison (in part), Univ. Missorui School of Mines and Metallurgy, Bull., Tech. Ser., vol. 14, p. 6, 7, Pl. 3, fig. 10 (not Pl. 2, fig. 5; Pl. 3, figs. 4, 22).

1943 Paltodus gracilis Branson and Mehl, Branson and Mehl, Jour. Paleontology, vol. 17, p. 386, Pl. 64, figs. 7, 8.

1944 Paltodus gracilis Branson and Mehl, Branson, Univ. Missouri Studies, vol. 8, p. 80, 82, Pl. 12, figs. 20, 23.

1944 Paltodus elegans Stauffer, Branson, Univ. Missouri Studies, vol. 19, p. 81, 89, Pl. 12, figs. 25, 26.

1951 _Paltodus gracilis_ Branson and Mehl, Branson, Mehl, and Branson, Jour. Paleontology, vol. 25, p. 6, Pl. 1, figs. 1-8.

1953 _Paltodus equicostatus_ Rhodes, Roy. Soc. London, Phil. Trans., Ser. B, vol. 237, p. 297, Pl. 21, figs. 106-109; Pl. 22, figs. 162, 165.

1957 _Paltodus gracilis_ Branson and Mehl, Glenister, Jour. Paleontology, vol. 31, p. 728, Pl. 85, figs. 2-5.

1957 _Paltodus striatus_ Stauffer, Glenister, Jour. Paleontology, vol. 31, p. 729, Pl. 85, fig. 6.

1959 _Paltodus gracilis_ Branson and Mehl, Stone and Furnish, Jour. Paleontology, vol. 33, p. 225, Pl. 31, fig. 2.

1959 _Panderodus gracilis_ (Branson and Mehl), Ethington, Jour. Paleontology, vol. 33, p. 285, Pl. 39, fig. 1.

1959 _Panderodus gracilis_ (Branson and Mehl), Sweet, _et al._, Jour. Paleontology, vol. 33, p. 1056, Pl. 131, fig. 1.

1960 _Panderodus gracilis_ (Branson and Mehl), Pulse and Sweet, Jour. Paleontology, vol. 34, p. 256, Pl. 35, figs. 3, 6.

1961 _Panderodus gracilis_ (Branson and Mehl), Wolska, Acta. Paleont. Polonica, vol. 6, p. 353, Pl. 4, figs. 2a, b.

1962 _Panderodus gracilis_ (Branson and Mehl), Sweet and Bergström, Jour. Paleontology, vol. 36, p. 1233, text fig. 1H.

1964 _Panderodus gracilis_ (Branson and Mehl), Bergström, Acta Univ. Lund, sec. 2, no. 3, pub. no. 128, p. 32, text fig. 16.

1965 Panderodus gracilis (Branson and Mehl), Barnett, Micropaleontology, vol. 11, p. 72, Pl. 1, fig. 32.

1966 Panderodus gracilis (Branson and Mehl), Webers (in part), Minnesota Geol. Survey, Spec. Pub. SP-4, p. 39, Pl. 3, figs. 10-12.

1966 Panderodus gracilis (Branson and Mehl), Bergström and Sweet (in part), Bull. Am. Paleontology, vol. 50, no. 229, p. 355-359, figs. 5, 6 (not Pl. 35, figs. 1-4).

1966 Panderodus gracilis (Branson and Mehl), Oberg, Jour. Paleontology, vol. 40, p. 140, Pl. 16, fig. 3.

This form species includes most of the species placed in synonymy with it by Bergström and Sweet (1966). However, it does not include Panderodus compressus elements which Bergström and Sweet included in their statistical species of this name.

The species occurs throughout all sections studied, having representatives in almost every conodont-bearing sample. They are the predominant element of uppermost Fernvale strata of the Arbuckle area, especially in the U. S. Highway 77 section. The topmost bed of this latter locality contains a conodont fauna consisting essentially of small, thin, emaciated types of P. gracilis.

PANDERODUS PANDERI (Stauffer, 1940)

Pl. 2, figs. 21; Pl. 14, figs. 18-20

1940 Paltodus panderi Stauffer, Jour. Paleontology, vol. 14, p. 427, Pl. 60, figs. 8, 9.

1957 Paltodus panderi Stauffer, Glenister, Jour. Paleontology, vol. 31, p. 728, 729, Pl. 85, figs. 8. 9.

1959 Panderodus panderi (Stauffer), Ethington, Jour. Paleontology, vol. 33, p. 285, Pl. 39, fig. 5.

1959 Panderodus panderi (Stauffer), Stone and Furnish, Jour. Paleontology, vol. 33, p. 226, Pl. 31, fig. 4.

1959 Panderodus panderi (Stauffer), Ethington and Furnish, Jour. Paleontology, vol. 33, p. 541, Pl. 73, fig. 9.

1966 Panderodus panderi (Stauffer), Webers, Minnesota Geol. Survey, Spec. Pub. SP-4, p. 39, 40, Pl. 2, figs. 1-3, 6.

1966 Panderodus panderi (Stauffer), Schopf, New York State Mus. and Science Serv., Bull. 405, p. 66, Pl. 5, figs. 22, 24.

This species is one of the few that occurs in all three areas studied (Arbuckle, Ozark, and Central Tennessee). The morphology is so simple that it is quite possible that more than one natural species is represented.

PANDERODUS UNICOSTATUS (Branson and Mehl, 1933)

Pl. 10, figs. 17, 18

The Oklahoma State Highway 10 section and the Mayberry section of Tennessee supplied a few simple, asymmetrical, conical cusps, having a deep basal cavity and rounded anterior and posterior faces, one side smoothly convex, unornamented, the other with a longitudinal costa and post-jacent groove. The forms from these two sections, although morphologically not identical, are considered to belong to the same form species, although the natural species may be included in this form taxon. It should be noted that the taxonomy of simple, cone-like species of Panderodus and Paltodus needs revision.

Genus PHRAGMODUS Branson and Mehl, 1933

Type species: Phragmodus primus Branson and Mehl, 1933

1933 Phragmodus primus Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 98, Pl. 6, fig. 26.

"Vertically extended, laterally compressed dental units modified to sheathe the anterior end of the mandible. The inferior margin is continued anteriorly as an exceptionally long, straight or vertically curved denticle, and a similar denticle extends more or less vertically from the oral anterior corner of the sheath. The space along the anterior margin between the larger denticles is either smooth or set with a few small slender denticles. The oral margin is either short with few or no denticles, or produced into a posterior horizontal denticulate bar of appreciable length."

PHRAGMODUS UNDATUS Branson and Mehl, 1933

Pl. 4, figs. 1-11

1933 Phragmodus undatus Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 115, 116, Pl. 8, figs. 22-26.

1941 Phragmodus undatus Branson and Mehl, Graves and Ellison (in part), Univ. Missouri School of Mines and Metallurgy, Bull., Tech. Ser., vol. 14, p. 6, Pl. 3, figs. 7, 8 (not Pl. 2, figs. 10 26, 29).

1943 Phradmodus undatus Branson and Mehl, Branson and Mehl, Jour. Paleontology, vol. 17, p. 386, 387, Pl. 64, figs. 4, 5.

1960 Phragmodus undatus Branson and Mehl, Pulse and Sweet, Jour. Paleontology, vol. 34, p. 257, 258, Pl. 37, figs. 4, 16, 18, 19; text figs. 2A-2A.

1960 Phragmodus undatus Branson and Mehl, Ethington and Furnish, Jour. Paleontology, vol. 34, p. 272, Pl. 38, fig. 4.

1960 Phragmodus undatus Branson and Mehl, Carlson, North Dakota Geol. Survey, Bull. 35, p. 70, Pl. 2, figs. 5?, 14.

1964 Phragmodus undatus Branson and Mehl, Hamar, Norsk Geol. Tidsskr., vol. 44, p. 274, fig. 12.

1965 Phragmodus undatus Branson and Mehl, Barnett, Micropaleontology, vol. 11, p. 72, Pl. 1, figs. 16, 18; Pl. 2, fig. 2.

1966 Phragmodus undatus Branson and Mehl, Schopf, New York State Mus. and Science Serv., Bull. 405, p. 68, 69, Pl. 1, figs. 22, 23, 29.

1966 Phragmodus undatus Branson and Mehl, Webers (in part), Minnesota Geol. Survey, Spec. Pub. SP-4, p. 41-43, Pl. 10, fig. 13 (not Pl. 10, figs. 10, 11, 15).

1966 Phragmodus undatus Branson and Mehl, Bergström and Sweet (in part), Bull. Am. Paleontology, vol. 50, no. 229, p. 369-372, Pl. 28, figs. 15, 16 (not Pl. 28, figs. 13, 14, 17-20).

Specimens of this distinctive species occur in practically every conodont-bearing sample of Richmond Fernvale of Tennessee. They are also present in lesser abundance in the Upper Viola-Fernvale sections of the Arbuckle area. Those of the latter area are thinner and more fragile and delicate than the robust forms of Tennessee. They are readily separable; but these minor differences are not considered to be of specific value in establishing form species. Eventually this form species will probably be elevated to generic ranking, either as a form genus or as a key morphological component of a group of statistical species.

In the material studied, these units show considerable morphological uniformity and do not appear to intergrade into other morphological units.

Genus PLECTOSPATHODUS Branson and Mehl, 1933

Type species: Plectospathodus flexuosus Branson and Mehl, 1933

1933 Plectospathodus flexuosus Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 47, Pl. 3, figs. 31, 32.

"Compound dental units consisting of a thin, blade-like bar set with sharp-edged confluent 'sheathed' denticles with a larger denticle near mid-length; denticles perpendicular to bar or slightly inclined to somewhat divergent. Blade down-curved at the ends and one end flexed along the basal plane of the unit and more or less twisted. Base slightly excavated."

PLECTOSPATHODUS sp.

Pl. 13, fig. 19

A simple specimen of the genus was obtained from sample B of the Robertson Creek section of the Arbuckle region. It cannot be assigned to any known species of the genus.

Laterally compressed bar, with sigmoidal basal outline, flexed evenly and strongly inward, bearing a large, lanceolate denticle at approximately mid-length. Anterior portion of the bar bears two lesser, laterally compressed, partially confluent, denticles of approximately equal size; posterior portion bears several, small, laterally compressed, confluent denticles.

Genus POLYGNATHUS Hinde, 1879

Type species: Polygnathus dubius Hinde, 1879

1879 Polygnathus dubius Hinde (in part), Quart. Jour. Geol. Soc. London, vol. 35, p. 363, Pl. 16, fig. 18 (not Pl. 16, fig. 17; Pl. 16, figs. 6-16).

1889 Polygnathus dubius Hinde, Grabau, Buffalo Soc. Nat. Sci., vol. 6, p. 154, fig. 34m.

1928 Polygnathus dubius Hinde, Holmes, U. S. Nat. Mus., Proc., vol. 72, p. 17, Pl. 7, fig. 8.

1933 Polygnathus dubia Hinde, Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 146, 147, Pl. 11, fig. 5.

Polygnathus dubia, as originally illustrated by Hinde, embraces specimens of several genera (Branson and Mehl, 1933, p. 146). Miller (1889) designated P. dubia as the type species for the genus. Bryant (1921) reported some forms of P. dubia in synonymy with P. dubia pennata, and proposed P. pennata as type species. Roundy (1926, p. 9, 13) designated P. pennata Hinde (1879, Plate 16, fig. 17) as lectotype for P. dubia. Branson and Mehl (1933) pointed out, in agreement with Bryant, Ulrich and Bassler, and Roundy, that the original Polygnathus dubia should be utilized as type. Branson and Mehl suggested that Bryant's use of P. pennata as type species is "the best way out of a bad situation." Branson and Mehl, however, included Bryant's selected lectotype for P. dubia in synonymy with P. pennata, stating (p. 146)

". . . only figure 18 of Plate 16 remains to bear the name P. dubia and we are using that specimen as type."

P. dubia must remain the type species for the genus, because it was validly established by Miller in 1889.

Roundy's 1926 designation of P. pennata as lectotype for P. dubia conflicts with the rules of zoological nomenclature, which specify that lectotypes be selected from the original author's specimens when they are available. Although it may not be desirable, one of the forms originally defined by Hinde must be selected as type. Branson and Mehl's 1933 selection of Hinde's specimen on Plate 16, figure 18, as type represents the first valid selection of a lectotype for P. dubia, and this must stand. Most species assigned to the genus are atypical of the type, comparing more closely with P. pennata. As long as P. pennata and P. dubia are recognized as cogeneric, no taxonomic difficulties arise from these morphologic differences.

Ulrich and Bassler presented the following description for this genus: "Plate subsymmetrically lanceolate, traversed by a high median carina extending stalk-like from the broader end and reaching, although diminishing gradually in height, to the opposite usually pointed end, dividing the plate into two lateral subequal areas. The carina is also indicated by a corresponding ridge on the under side. On the upper surface the summit of the carina carries a row of closely approximated nodes and the depressed sides of the plate are variously ornamented with nodose ridges. The underside is smooth or with fine concentric lines."

Hinde's description (after Branson and Mehl, 1933) of the plates, one of which is the lectotype of the species, follows: "The small plates associated with the teeth in Polygnathus dubius are of an elliptical form with smooth edges (Pl. 16, fig. 18). One surface is slightly convex, with a slight longitudinal median ridge; the surface, as well as the ridge, is covered with small tubercles frequently with a linear arrangement; the reverse side of the plate is smooth, with faint traces of concentric lines; the two ends are slightly elevated, and there is a median ridge with a small diamond shaped pit in or near the center of the plate. Each plate is about 5/8 line long and 3/8 line wide."

POLYGNATHUS sp. cf. P. PENNATA Hinde, 1879

Pl. 9, figs. 14, 16

cf. 1879 Polygnathus pennatus Hinde, Quart. Jour. Geol. Soc. London, vol. 35, p. 366, Pl. 17, fig. 8.

cf. 1879 Polygnathus dubius Hinde (in part), Quart. Jour. Geol. Soc. London, p. 363, Pl. 16, fig. 17.

cf. 1887 Polygnathus pennatus Hinde, Clark, Sixth Ann. Rept., State Geologist New York, Pl. Al, fig. 9.

cf. 1899 Polygnathus pennatus Hinde, Grabau, Bull. Buffalo Soc. Nat. Sci., vol. 6, p. 156, fig. 39.

cf. 1921 Polygnathus pennatus Hinde, Bryant, Bull. Buffalo, Soc. Nat. Sci., vol. 13, p. 23, 24, Pl. 10, figs. 1-9.

cf. 1926 Polygnathus dubius Hinde, Roundy, U. S. Geol. Survey, Prof. Paper 146, p. 16, Pl. 3, fig. 9.

cf. 1928 Polygnathus pennatus Hinde, Holmes, U. S. Nat. Mus., Proc., vol. 72, p. 18, Pl. 7, figs. 10, 12.

cf. 1933 Polygnathus pennata Hinde, Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 144, Pl. 11, fig. 3.

The Fernvale sequence of Oklahoma Highway 10 supplied forms of this Devonian species which closely resemble P. pennata. Fernvale specimens are narrower, less symmetrical (slightly twisted along longitudinal axis) and one side of the platform is less robust than the opposite. A short, high posterior blade extends along the platform as a low denticulate keel; platform ornamentation consists of low, transverse ridges, somewhat broken into low knobs.

This form and other Devonian species, notably Icriodus sp., recovered from Fernvale strata, indicate stratigraphic leakage probably from the Sylamore Formation (see discussion of Icriodus).

Genus POLYPLACOGNATHUS Stauffer, 1935

Type species: Polyplacognathus ramosa Stauffer, 1935

? 1932 Polygnathus sp. Stauffer, Jour. Paleontology, vol. 6, p. 264, Pl. 40, figs. 36, 37.

1935 Polyplacognathus ramosus Stauffer, Jour. Paleontology, vol. 9, p. 615, Pl. 75, figs. 22, 28-31, 37.

? 1935 Polyplacognathus sp. a Stauffer, Jour. Paleontology, vol. 9, p. 615, 616, Pl. 75, figs. 32, 36, 38, 43, 48, 49, 62, 63.

1935 Polyplacognathus expansus Stauffer, Jour. Paleontology, vol. 9, p. 615, Pl. 75, figs. 27, 33.

1966 Polyplacognathus ramosa Stauffer, Webers, Minnesota Geol. Survey, Spec. Pub. SP-4, p. 43, Pl. 11, figs. 7, 8, 10.

1966 Polyplacognathus ramosa Stauffer, Schopf, New York State Mus. and Science Serv., Bull. 405, p. 70, Pl. 1, figs. 19-21.

1966 Polyplacognathus ramosa Stauffer, Sweet and Bergström, Bull. Am. Paleontology, vol. 50, no. 229, p. 386, Pl. 28, figs. 9, 10.

"Asymmetrical dental plates of few or many lobes, the larger of which tend to be wing-like. Under surface of plates smooth except for furrows, ridges, and growth-like lines; upper surface of each lobe has, or tends to have, a median nodose ridge, on both sides of which are less definite nodose ridges or groups of nodes or denticles. Any of these ridges may become a series of short, stubby denticles or may be formed by the lateral union of such a dental series. These ridges radiate irregularly from a central point which appears to be more or less the center of development of plate."

POLYPLACOGNATHUS ? sp.

P. 3, figs. 8, 10

Fragmentary specimens questionably referred to Stauffer's genus were recovered from the Oklahoma Highway 10 Fernvale section; the most complete specimens are illustrated. Comparison of this species with Stauffer's figures of P. expansus show considerable similarity. The figured Fernvale forms and less complete specimens are too scarce and fragmentary to synthesize a composite picture of specimens occurring in the northeastern Oklahoma section; even the generic identity is made with reservation. Other platform types with which this form may be compared, display less morphologic similarity to the species at hand.

This species is observed in association with known Devonian genera which are present in the Ordovician strata due to stratigraphic leakage, and it is probable that this species is of Devonian age and belongs to the Icriodus-Polygnathus fauna that represents the Sylamore formation in this area.

Genus PRIONIODINA Ulrich and Bassler, 1926

Type species: Prionidina subcurvata Ulrich and Bassler, 1926

1926 Prioniodina subcurvata Ulrich and Bassler, U. S. Nat. Mus., Proc., vol. 68, art. 12, no. 2613, p. 16, 18, 26, 36, 57, fig. 4, subfigs. 8, 9; Pl. 4; figs. 22-24.

"Base of tooth more or less curved, crowned with numerous, subparallel, rounded discrete denticles all inclined in one direction one of which located in the median third, is considerably larger than the others."

Ulrich and Bassler assigned Prioniodus geminus Hinde, 1900, P. recedens Bryant, 1921, and P. volborthis Pander, 1856, to their new genus.

Sweet, et al. (1959) interpreted the genus in the following manner, ". . . arched, blade-like compound conodont-elements with a large cusp and discretely denticulated anterior and posterior processes that are proximally continuous with more or less well defined anterior and posterior cusp carinae. The undersurface may either be deeply sheathed or the attachment surface may be 'inverted' and the basal cavity thus restricted to a pit or 'navel' beneath the cusp."

PRIONIODINA DELECTA (Stauffer, 1935)

Pl. 11, fig. 18

1935 Ozarkodina delecta Stauffer, Geol. Soc. America, Bull., vol. 46, no. 1, p. 148, Pl. 10, fig. 40.

1957 Ozarkodina delecta Stauffer, Glenister, Jour. Paleontology, vol. 31, p. 735, Pl. 88, figs. 8, 9.

1959 Ozarkodina ? delecta Stone and Furnish, Jour. Paleontology, vol. 33, p. 225, Pl. 32, figs. 1, 2.

1959 Prioniodina delecta (Stauffer), Sweet, et al., Jour. Paleontology, vol. 33, p. 1060, Pl. 131, fig. 11.

1959 Ozarkodina delecta Stauffer, Ethington, Jour. Paleontology, vol. 33, p. 283, 289, Pl. 41, fig. 17.

? 1959 Prioniodina pulcherrima Lindström, Micropaleontology, vol. 5, p. 442-444, Pl. 3, figs. 28-30.

1960 Prioniodina delecta (Stauffer), Pulse and Sweet, Jour. Paleontology, vol. 34, p. 258, 259, Pl. 36, figs. 10, 11.

1966 Prioniodina delecta (Stauffer), Barnett, Micropaleontology, vol. 11, p. 73, Pl. 1, fig. 27.

Bergström (1964) noted the similarity of the American species P. delecta and the Welsh species P. pulcherrima and placed them in questionable synonymy. Winder (1966) noted that the major difference between the two taxa is in the spacing of denticles, and suggested that this is insignificant; accordingly, he placed the two forms in synonymy.

There were no forms in the present material which could be assigned to P. pulcherrima, so the synonymy could neither be corroborated nor refuted; therefore, P. pulcherrima is placed questionably in the synonymy of P. delecta.

Forms assigned to this species are similar to more robust P. oregonia, and were more specimens at hand, they might prove intergradational.

The species occurs relatively infrequently in the Tennessee Fernvale samples; none were obtained from Oklahoma.

PRIONIODINA OREGONIA Branson, Mehl, and Branson, 1951

Pl. 3, fig. 9; Pl. 10, figs. 9, 12, 13; Pl. 12, figs. 14-17

1951 Prioniodina oregonia Branson, Mehl, and Branson, Jour. Paleontology, vol. 25, p. 15, 16, Pl. 3, fig. 18; Pl. 4, figs. 28-32.

1959 <u>Prioniodina</u> <u>oregonia</u> Branson, Mehl, and Branson, Ethington and Furnish, Jour. Paleontology, vol. 33, p. 545, Pl. 73, fig. 15.

1959 <u>Prioniodina</u> <u>oregonia</u> Branson, Mehl, and Branson, Sweet, <u>et</u> <u>al</u>., Jour. Paleontology, vol. 33, p. 1060, 1061, Pl. 132, fig. 18; Pl. 133, fig. 9.

1959 <u>Prioniodina</u> <u>rotunda</u> Sweet, <u>et</u> <u>al</u>., Jour. Paleontology, vol. 33, p. 1061, Pl. 131, fig. 12; Pl. 133, fig. 8.

1960 <u>Prioniodina</u> <u>rotunda</u> Sweet, <u>et</u> <u>al</u>., Pulse and Sweet, Jour. Paleontology, vol. 37, p. 259, Pl. 36, figs. 14, 16, 18.

1966 <u>Oulodus</u> <u>oregonia</u> (Branson, Mehl, and Branson), Bergström and Sweet (in part), Bull. Am. Paleontology, vol. 50, no. 229, p. 342-347, Pl. 33, fig. 5; text figs. 9g, 9h (not Pl. 32, figs. 20, 21; Pl. 34, figs. 13-16; text figs. 9i-91).

Representatives of this form species occur commonly in most of the conodont-bearing samples from the Fernvale of Tennessee. They are associated with cordylodid, subcordylodid, eoligonodid, trichonodellid, zygognathid, and oulodid elements.

Richmond species of these genera observed in this study resemble each other in such details as character of material, preservation, and dentition; they differ in degree of development of anterior (or lateral) process, combined with the degree and nature of "twist" or these processes, which in turn determines the symmetry of the element. Gradational forms, for instance between <u>Cordylodus</u> and <u>Eoligonodina</u>, and <u>Trichonodella</u>

and *Zygognathus* were observed. In other instances, where representatives are scarce, intergradation cannot be proved. Branson, Mehl, and Branson have mentioned the intergradation of such forms. It is quite possible that the Richmond species of these genera represent a plexus of equivalent morphologic forms.

PRIONIODINA OREGONIA Branson, Mehl, and Branson, 1951, var.

Pl. 14, figs. 12-17

This form is similar in size and general appearance to *Prioniodina oregonia*, except that the denticles of the posterior bar are fused along much or all of their height, forming, in extreme cases, an irregular ridge. The form appears to be a morphologic variation of *P. oregonia*; it also has the same distribution. It is recognized as a morphological variety and not as a subspecies.

Figure 17 illustrates an extreme variation of this form.

Prioniodina oregonia var. is unknown in the Oklahoma Fernvale; the form occurs in the Arnheim and Fernvale Formations of the Franklin, Linton, and Southall sections of Tennessee.

PTILONCODUS Harris, 1962

Type species: *Ptiloncodus simplex* Harris, 1962

1962 *Ptiloncodus simplex* Harris, Oklahoma Geology Notes, vol. 22, p. 207, Pl. 1, figs. 5 a-c, 6.

1965 Ptiloncodus simplex Harris, Mound, Tulane Studies in Geology, vol. 4, no. 1, p. 33, Pl. 4, fig. 20.

"Ptiloncodus has a simple, subcylindrical hooked-shaped, pointed cusp bearing two subflattened, auricular expansions attached to opposite sides of the base at right angles to plane of curvature of 'hook' (auricular "wings" are broken off most specimens). There is no basal escutcheon."

Harris noted a resemblance of this form to some recurved representatives of the Lower and Middle Ordovician fibrous genus Stereoconus Branson and Mehl, but distinguished his genus by its characteristic hook-shaped cusp and basal "wings."

Sweet (1963) and Lindström (1964) questioned the assignment of this form to the Conodontophorida; Sweet suggested possible affinity to the holothurians. Mound (1965) noted, however, that the material composing Ptiloncodus is similar in appearance and substance to that of the Joins conodonts. This is true also of the Viola-Fernvale material, which displayed the characteristic amber and white appearance of many conodonts. Mound further noted that the type species is composed of numerous apatite crystals and is fibrous in structure; accordingly, he concluded that the assignment of the genus to the conodonts is warranted. The writer concurs with this conclusion.

PTILONCODUS sp.

Pl. 1, figs. 11-14

Subcylindrical, apically pointed, hook-shaped shaft. Possibly slightly inflated basally, some specimens show faint lateral flattening of the hook. Two small rounded knobs characterize opposite sides of the shaft base at right angles to the plane of curvature of the hook; the knobs extend slightly beyond the end of the shaft and produce a forked appearance to the proximal end. The rounded basal knobs may represent attachment scars of lateral lobes.

This form is very closely related to Ptiloncodus simplex Harris. It is distinguished by the presence of knobs at the proximal end instead of subovate, auricular lobes. Harris noted that the "wings" are missing from the majority of Joins specimens; however, no specimen in the material studied lacked the characteristic knobs of the new species.

The species was observed in U. S. Highway 77 section, in the upper part of the Oklahoma Highway 18 section, and appears at random horizons, throughout the Flying "L" Ranch section of the Arbuckle Mountains. Ptiloncodus simplex was described from the Lower and Middle Joins Formation. The occurrence of this genus in the Upper Viola and Fernvale increases its known stratigraphic range considerably.

Genus RHIPIDOGNATHUS Branson, Mehl, and Branson, 1951

Type species: Rhipidognathus symmetrica Branson, Mehl, and Branson, 1951

1951 Rhipidognathus symmetrica Branson, Mehl, and Branson, Jour. Paleontology, vol. 25, p. 10, Pl. 2, figs. 29-37; Pl. 3, fig. 31.

"Erect dental units; more or less palmate, flat or concave posteriorly, fundamentally bilaterally symmetrical with slightly excavated or channeled aboral surface nearly straight to highly and sharply arched. Denticles more or less antero-posteriorly compressed, blunt to sharply pointed, rounded or sharp edged, partially fused, particularly near mid-width of unit. Posterior face of unit commonly marked by a short ridge, normal to the base, and by a transverse swelling, at the base of the denticles, parallel to but distinct from the oral edge. Anterior aboral edge of base commonly produced into a small trowel-like process, with the concavity or pit of attachment on the posterior side."

RHIPIDOGNATHUS SYMMETRICA Branson, Mehl, and Branson, 1951
Pl. 3, fig. 13; Pl. 4, figs. 28, 29; Pl. 9, figs. 1, 2, 22

This distinctive species occurs throughout the Fernvale of the Tennessee section. Bergström and Sweet (1966) reported it ranging from the Trentonian Hermitage Formation to the base of the Silurian.

RHIPIDOGNATHUS PAUCIDENTATA Branson, Mehl, and Branson, 1951

Pl. 3, figs. 4, 5; Pl. 4, figs. 17, 18

1951 _Rhipidognathus paucidentata_ Branson, Mehl, and Branson, Jour. Paleontology, vol. 25, p. 10, Pl. 2, figs. 18-28; Pl. 3, fig. 30.

Specimens of this species occur in most of the Fernvale sections of Tennessee. Some individuals approach _Ozarkodina_ in morphology.

Genus SAGITTODONTUS Rhodes, 1953

Type species: _Sagittodontus robustus_ Rhodes, 1953

1953 _Sagittodontus robustus_ Rhodes, Roy. Soc. London, Phil. Trans., Ser. B. vol. 237, no. 647, p. 311, Pl. 21, figs. 141, 142.

1953 _Sagittodontus robustus erectus_ Rhodes, Roy. Soc. London, Phil. Trans., Ser. B, vol. 237, no. 647, p. 311, Pl. 21, figs. 143, 151, 152.

1953 _Sagittodontus robustus distaflexus_ Rhodes, Roy. Soc. London, Phil. Trans., Ser. B, vol. 237, no. 647, p. 312, Pl. 21, figs. 137, 138.

1959 _Sagittodontus robustus_ Rhodes, Ethington, Jour. Paleontology, vol. 33, p. 287, 288, Pl. 39, fig. 12.

1959 Acodus robustus (Rhodes), Lindström, Micropaleontology, vol. 5, p. 433-435, Pl. 4, figs. 22-27.

1960 Sagittodontus robustus Rhodes, Winder, Jour. Paleontology, vol. 40, p. 60, Pl. 9, fig. 5; text figs. 3-5.

1965 Sagittodontus robustus Rhodes, Barnett, Micropaleontology, vol. 11, p. 73, Pl. 2, figs. 24, 27.

1966 Sagittodontus robustus Rhodes, Schopf, New York State Mus. and Science Serv., Bull. 405, p. 78, Pl. 5, fig. 31.

"General appearance barb-like; single, large, stout denticle, triangular in cross-section with three more or less flattened faces and sharp dividing edges. The lowest part of each face usually having a wide shallow depression. Unit expanded at base into hemi-pyramidal form. Edge gently curved. Irregular aboral margin; aboral surface deeply excavated so that whole unit is hollow."

SAGITTODONTUS ROBUSTUS Rhodes, 1953

Pl. 14, figs. 23, 25

1953 Sagittodontus robustus Rhodes, Roy. Soc. London, Phil. Trans., Ser. B, vol. 237, no. 647, p. 311, Pl. 21, figs. 141, 142.

1953 Sagittodontus robustus var. erectus Rhodes, Roy. Soc. London, Phil. Trans., Ser. B, vol. 237, no. 647, p. 311, Pl. 21, figs. 143, 151, 152.

1953 _Sagittodontus robustus_ var. _distaflexus_ Rhodes, Roy. Soc. London, Phil. Trans., Ser. B, vol. 237, no. 647, p. 312, Pl. 21, figs. 137, 138.

1959 _Sagittodontus robustus_ Rhodes, Ethington, Jour. Paleontology, vol. 33, p. 287, 288, Pl. 39, fig. 12,

1959 _Acodus robustus_ (Rhodes), Lindström, Micropaleontology, vol. 5, p. 433-435, Pl. 4, figs. 22-27.

1966 _Sagittodontus robustus_ Rhodes, Schopf, New York State Mus. and Science Serv., Bull. 405, p. 78, Pl. 5, fig. 31.

This species was encountered infrequently in association with _Icriodina_ in samples from the Tennessee sections; it occurs chiefly in the Franklin section. It resembles vaguely _Icriodina superbus acuta_ in its peculiar subdenticulate edge and broad, deep, thin-walled, basal sheath.

Genus SCANDODUS Lindström, 1955

Type species: _Scandodus furnishi_ Lindström, 1955

1955 _Scandodus furnishi_ Lindström, Geol. Fören Förhandl., Stockholm, Bd. 76, p. 592, Pl. 5, fig. 3.

1964 _Scandodus furnishi_ Lindström, Ethington and Clark, Jour. Paleontology, vol. 38, p. 698, Pl. 114, figs. 14, 24.

"Simple, unsymmetrical conodonts with anterior and posterior keels but no costae. The lack of symmetry chiefly consists in that the cusp is twisted relative to the base so that the latter opens to one side of the cusp. There may be broadly rounded median carina on one side, preferably the one toward which the basal cavity opens."

SCANDODUS sp.

Pl. 12, fig. 20

Cusp subtriangular in cross-section, abruptly recurved at a point approximately one-third the distance above the base, and continuing distally practically straight. Base subtriangular, anteriorly and posteriorly keeled, tapering gradually upward to approximately one-third the total length. Basal pit deep, occupying most of the base, terminating in the basal third of the cusp.

In shape, symmetry, and curvature of cusp and character of base, this form resembles the contemporary Multioistodus sp. cf. M. lateralis. The absence of basal denticles identifies the scanodid, possibly ancestral to the multioistodid.

A single specimen of this species was obtained from the basal portion of the Mayberry section (Arnheim Formation) of Tennessee.

Genus SCOLOPODUS Pander, 1856, emended Lindström, 1955

Type species: Scolopodus sublaevis Pander, 1856

1856 Scolopodus sublaevis Pander, Akad. Wiss., St. Petersburg, p. 25, 26, Pl. 2, fig. 3; p. 20 (Tab. A, fig. 5a).

Original description: "Schlanke, verschieden gelstaltete Zähne, mit abgerundeten vorderen und hinteren Kanten und convexen mehr oder weniger gerippten Oberflächen. Sie unterscheiden sich gleich beim ersten Anblick durch ihre festere Substanz, weisse Farbe, und Mangel der Kiele von der vorher beschriebenen."

Free translation of the original description follows: Slender, variously shaped teeth, with rounded anterior and posterior edges and more or less ribbed convex surfaces. They are differentiated readily from the previously described form by their sturdier appearance, white color, and lack of keels.

White opacity and hardness of these elements are no longer considered diagnostic characteristics. Rounded anterior and posterior margins and numerous costae characterize Paltodus.

Lindström (1955) expressed difficulty in separating Scolopodus and Paltodus. He concluded that Paltodus should be restricted to symmetrical, multicostate conodont elements, and Scolopodus should be restricted to asymmetrical, multicostate forms. Sweet, et al. (1959) stated that the costae of type Paltodus are asymmetrically disposed, in contrast to those of type Scolopodus that are equally developed and symmetrically arranged on opposite sides of the cusp. "Hence, it seems, that only bilaterally symmetrical, multicostate simple cones can be referred to this genus, whether or not the anterior and posterior margins are round or sharp" (Sweet, et al., 1959, p. 1063).

Sweet and Bergström described cusps displaying very similar shape, curvature, basal configuration, and basal cavity; yet such similar forms were separable into the genera Scolopodus and Paltodus by following strict definitions of these genera. The currently accepted separation of these genera, based upon symmetry, is followed herein.

SCOLOPODUS INSCULPTUS (Branson and Mehl, 1933)

Pl. 4, fig. 25

1933 _Phragmodus insculptus_ Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 124, Pl. 10, figs. 32-34.

1941 _Phragmodus insculptus_ Branson and Mehl, Graves and Ellison, Univ. Missouri School of Mines and Metallurgy, Bull., Tech. Ser., vol. 14, p. 6, Pl. 3, fig. 1.

? 1941 _Phragmodus dissimilaris_ Branson and Mehl, Graves and Ellison, Univ. Missouri School of Mines and Metallurgy, Bull., Tech. Ser., vol. 14, p. 6, 7, Pl. 3, fig. 9.

1953 _Phragmodus insculptus_ Branson and Mehl, Rhodes, Roy. Sox. London, Phil. Trans., Ser. B., vol. 237, p. 310, Pl. 21, figs. 136, 153, 154.

1955 _Phragmodus insculptus_ Branson and Mehl, Rhodes, Quart. Jour. Geol. Soc. London, vol. 111, p. 136, Pl. 10, fig. 17.

1959 _Distacodus insculptus_ (Branson and Mehl), Ethington, Jour. Paleontology, vol. 33, p. 275, 276, Pl. 39, fig. 10.

1959 _Scolopodus insculptus_ (Branson and Mehl), Sweet, _et al._, Jour. Paleontology, vol. 33, p. 1063, Pl. 130, fig. 6.

1960 _Distacodus insculptus_ (Branson and Mehl), Carlson, North Dakota Geol. Survey, Bull. 35, p. 71, Pl. 2, fig. 20.

? 1962 Scolopodus varicostatus Sweet and Bergström, Jour. Paleontology, vol. 36, p. 1247, 1248, Pl. 168, figs. 4-9; text figs. 1a, c, k.

1966 Scolopodus insculptus (Branson and Mehl), Winder, Jour. Paleontology, vol. 40, p. 60, Pl. 9, fig. 21; text figs. 3-21.

1966 Scolopodus insculptus (Branson and Mehl), Schopf, New York State Mus. and Science Serv., Bull. 405, p. 78, Pl. 3, figs. 20, 21.

1966 Scolopodus insculptus (Branson and Mehl), Webers, Minnesota Geol. Survey, Spec. Pub. SP-4, p. 46, Pl. 12, figs. 14, 15.

1966 Scolopodus insculptus (Branson and Mehl), Bergström and Sweet, Bull. Am. Paleontology, vol. 50, no. 229, p. 398-400, Pl. 34, figs. 26, 27; text fig. 13B.

Specimens assigned to this species were noted only in the northeastern Oklahoma Fernvale section. The species was described originally from the Thebes Sandstone (a facies of the Maquoketa); it occurs also in the Stewartville and Dubuque Members of the Galena Formation of Iowa and Minnesota. The species ranges from the middle part of the Shoreham Formation to the upper part of the Cobourg of New York. It has been reported from the following formations in Wales: Pen-y-garnedd, Gelli-grin, Birdshill, and Keisley (a single specimen).

SCOLOPODUS sp. cf. S. QUADRAPLICATUS Branson and Mehl, 1933

Pl. 13, fig. 25

1933 Scolopodus quadraplicatus Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 63, figs. 14, 15.

1938 Scolopodus quadraplicatus Branson and Mehl, Stone and Furnish, Jour. Paleontology, vol. 12, p. 332, Pl. 41, figs. 1-12.

1958 Scolopodus quadraplicatus Branson and Mehl, Sando, Geol. Soc. America, Bull., vol. 69, p. 842, Pl. 2, fig. 21.

1964 Scolopodus quadraplicatus Branson and Mehl, Ethington and Clark, Jour. Paleontology, vol. 38, p. 699, 700, Pl. 115, figs. 12, 25.

This form differs from the typical in that the longitudinal grooves are approximately equally spaced about the cusp, thus resulting in a quadrate cross-sectional profile; the thick costae occupy posterior, anterior, and lateral positions.

The species was obtained in limited numbers from Upper Viola samples of the Arbuckle area. The U. S. Highway 77 section yielded most of the specimens.

Genus SCYPHIODUS Stauffer, 1935

Type species: Scyphiodus primus Stauffer, 1935

1935 Scyphiodus primus Stauffer, Jour. Paleontology, vol. 9, p. 617, 618, Pl. 75, figs. 34, 40, 41, 46, 50-52, 57, 58.

"Rough-surfaced dental units with bar-like base tapering gradually to anterior but rather abruptly to posterior. Under side of base narrow, the grooved excavation beginning at anterior and expanding into a deep rounded cavity at posterior beneath cusp. Upper surface wide with three rows of widely spaced teeth that have lateral edges confluent across from row to row, giving the appearance of transverse ridges. Cusp short, posteriorly directed."

SCYPHIODUS sp. cf. S. PRIMUS Stauffer, 1935

Pl. 13, figs. 20, 22, 23

1935 Scyphiodus primus Stauffer, Jour. Paleontology, vol. 9, p. 617, Pl. 75, figs. 34, 40, 41, 45, 46, 50, 57, 58.

1966 Scyphiodus primus Stauffer, Webers, Minnesota Geol. Survey, Spec. Pub. SP-4, p. 45, Pl. 8, figs. 15a, b.

Forms assigned to this species are abundant in the Franklin section of Tennessee. They were not observed in any other section. The Fernvale strata of the Tennessee sections are lithologically distinctive and readily recognizable; the sections are not widely spaced, so the

Fernvale sections in Tennessee must be similar in age. In this event, the limited distribution of Scyphiodus in these strata is indicative of localized physical and/or biologic factors. This paleoecologic control of the Scyphiodus animal indicates that this conodont-bearing animal was more specialized in its ecologic requirements than many of the other conodont-animals with which it is associated, and which display wider distribution, i.e., the Phragmodus-bearing conodont animal.

Genus TRICHONODELLA Branson and Mehl, 1948

- Trichognathus Branson and Mehl, 1933 (not Trichognathus Berthod)

Type species: Trichognathus prima Branson and Mehl, 1933

1933 Trichognathus prima Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 36, fig. 12.

Branson and Mehl (1948) replaced the pre-empted designation Trichognathus with Trichonodella. The generic epithet Trichonodella had been applied previously to T. brassfieldensis, T. ? edentata, and T. carinata by Branson and Branson in 1947.

The type species is T. prima (not T. symmetrica, as stated by Branson and Mehl in Shimer and Shrock (1944), nor T. brassfieldensis, as chosen by Rhodes in 1953).

TRICHONODELLA RECURVA (Branson and Mehl, 1933)

Pl. 6, figs. 5, 6, 8, 12, 13, 14, 18; Pl. 7, figs. 5, 7, 8, 13

1933 *Trichognathus recurva* Branson and Mehl, Univ. Missouri Studies, vol. 8, p. 119, Pl. 10, fig. 6.

1935 *Trichognathus recurvus* Branson and Mehl, Stauffer (in part), Geol. Soc. America, Bull., vol. 46, Pl. 12, fig. 1 (not Pl. 12, fig. 2).

1935 *Trichognathus recurvus* Branson and Mehl, Stauffer (in part), Jour. Paleontology, vol. 9, Pl. 71, figs. 20, 27, 39, 41, 47; Pl. 72, fig. 48; Pl. 75, fig. 22 (not Pl. 72, fig. 56).

1965 *Trichonodella recurva* (Branson and Mehl), Barnett, Micropaleontology, vol. 11, p. 75, Pl. 1, fig. 25; Pl. 2, fig. 26.

1965 *Trichonodella angulata* Sweet, *et al.*, Barnett, Micropaleontology, vol. 11, p. 74, Pl. 1, fig. 24.

1966 *Trichonodella recurva* (Branson and Mehl), Schopf, New York State Mus. and Science Serv., Bull. 405, p. 81, Pl. 2, figs. 14, 15.

This asymmetrical trichonodellid differs from *Trichonodella flexa* in its cylindrical posterior process (not sharply flexed, with V-shaped cross-section).

In the samples examined, this form appears to be intermediate between symmetrical Trichonodella undulata and highly asymmetrical Zygognathus deformis. A complete gradational series could not be established, however, and most specimens could be assigned to one or the other species without difficulty.

This species does not occur in the Oklahoma Fernvale sections. In Tennessee, it occurs in all except the Mayberry section. Trichonodella recurva is one of the more frequently occurring trichonodellid forms of the Richmond Arnheim and Fernvale of Tennessee and represents a small, but conspicuous element in the total conodont fauna.

TRICHONODELLA sp. cf. T. RECURVA (Branson and Mehl, 1933)

Pl. 11, fig. 19

Infrequently occurring elongate trichonodellid specimens with deep, basal sheath, acutely angled lateral limbs, and long, stout, discrete, anteriorly-directed denticles are placed in this form species. Schopf assigned similar specimens to Trichonodella recurva, apparently considering the elongate, deep sheath of insufficient specific value. In Fernvale specimens, there are no intermediate morphological forms to connect them with T. recurva.

The figured specimen was obtained from sample F of the Tennessee Linton section. The infrequent form was not observed in samples other than those from the Linton section.

TRICHONODELLA UNDULATA Branson, Mehl, and Branson, 1951

Pl. 3, fig. 12· Pl. 6, figs. 1, 2, 7, 11, 16; Pl. 7, figs. 1, 2

1951 Trichonodella undulata Branson, Mehl, and Branson, Jour. Paleontology, vol. 25, p. 14, Pl. 3, figs. 24-26; Pl. 4, figs. 10, 11, 14, 22.

? 1966 Trichonodella sulcata Oberg, Jour. Paleontology, vol. 40, p. 144, Pl. 15, fig. 14.

Specimens included in this species vary in morphology from those identical with the original, to those which differ in the degree of crowding of denticles, development of the posterior bar, and denticles upon this bar. Some specimens of this series (Pl. 6, fig. 16) appear to be morphologically equivalent to Oberg's species. The forms are, therefore, placed in synonymy.

Plate 6, fig. 17, is a smaller (juvenile?) specimen, a denticle being broken.

Forms assigned to this species are relatively common in all conodont-bearing samples of the Tennessee sections.

TRICHONODELLA sp. A

Pl. 6, figs. 3, 4, 9, 10, 17; Pl. 7, figs. 3, 4, 6

A symmetrical form with thin, short posterior process, V-shaped in cross-section, bearing three to four small, closely set, laterally compressed, bead-like denticles. The large anterior processes, bearing long, discrete, peg-like denticles, are somewhat arcuate and join the cusp at approximately 60 degrees; the cusp, slender for the genus, is long, generally subcircular to oval in cross-section, the base being produced into the posterior bar.

This species occurs with T. recurva, T. undulata, and Zygognathus sp. in Richmond Fernvale samples in Tennessee.

TRICHONODELLA sp. B

Pl. 6, fig. 15

Unit symmetrical to slightly asymmetrical. Cusp long, recurved, strongly compressed laterally, sharp-edged anteriorly and posteriorly (not keeled). Short, nondenticulate posterior process, laterally compressed, slightly grooved on aboral side. Lateral processes, meeting at an angle of 60 to 75 degrees, are compressed, high, and beset with closely-spaced, discrete, long, compressed denticles.

Specimens of this form occur infrequently in the Oklahoma Highway 10 section of the Ozark area; it occurs in appreciable numbers in the Robertson Creek samples of the Arbuckle area.

The association of this species with O. concinna, and certain diagnostic Ostracoda, relates the "Fernvale" of northeastern Oklahoma to that of the Arbuckle area, especially to the Robertson Creek section.

Genus ZYGOGNATHUS Branson, Mehl, and Branson, 1951

Type species: Zygognathus pyramidalis Branson, Mehl, and Branson, 1951

1951 Zygognathus pyramidalis Branson, Mehl, and Branson, Jour. Paleontology, vol. 25, p. 12, Pl. 3, figs. 10-16, 21

1966 Zygognathus pyramidalis Branson, Mehl, and Branson, Oberg, Jour. Paleontology, vol. 40, p. 145, Pl. 15, fig. 13.

"Deeply excavated cone-like denticulate units that tip the distal ends of the somewhat compressed jaw rami and continue beyond the cone base for variable distances as a sheathing bar on each of the two edges of the ramus. The denticle terminating the cone, compressed and sharp-edged to nearly circular in transverse section, curves orad and stands nearly erect. The bar that sheathes the oral edge of the ramus bears pointed, laterally compressed, discrete erect denticles that lie in the same plane as the terminal denticle, and tend to parallel it. The inferolateral sheathing bar, commonly the longer of the two, has the free edge directed in a nearly perpendicular plane to that of the oral edge bar, bears inclined, discrete denticles that vary in cross section and are directed inward and slightly forward."

ZYGOGNATHUS DEFORMIS (Stauffer, 1935)

Pl. 4, fig. 19: Pl. 13, figs. 4-12

1935 Trichognathus deformis Stauffer, Geol. Soc. America, Bull., vol. 46, p. 155, 156, Pl. 12, fig. 3.

1953 Gyrognathus elongatus Rhodes, Roy. Soc. London, Phil. Trans., Ser. B, vol. 237, no. 647, p. 318, 319, Pl. 22, figs. 201, 202, 205, 206.

1955 Trichonodella deformis (Stauffer), Sweet, Jour. Paleontology, vol. 29, p. 257, Pl. 29, fig. 6.

1959 Gyrognathus elongata Rhodes, Ethington, Jour. Paleontology, vol. 33, p. 279, Pl. 40, fig. 13.

1959 Gyrognathus elongata Rhodes, Stone and Furnish, Jour. Paleontology, vol. 33, p. 223, Pl. 32, fig. 9.

1959 Gyrognathus elongata Rhodes, Ethington and Furnish, Jour. Paleontology, vol. 33, p. 543, Pl. 73, fig. 14.

1959 Zygognathus deformis (Stauffer), Sweet, Jour. Paleontology, vol. 33, p. 1066, 1067, Pl. 132, figs. 1, 5.

1960 Zygognathus deformis (Stauffer), Pulse and Sweet, Jour. Paleontology, vol. 34, p. 261, Pl. 37, figs. 1, 5.

1965 Zygognathus deformis (Stauffer), Barnett, Micropaleontology, vol. 11, p. 75, Pl. 1, fig. 5; Pl. 2, fig. 23.

1966 Zygognathus deformis (Stauffer), Oberg, Jour. Paleontology, vol. 40, p. 145, Pl. 15, fig. 18.

1966 Plectodina furcata (Hinde), Bergström and Sweet (in part), Bull. Am. Paleontology, vol. 50, no. 229, p. 377-382, Pl. 34, figs. 9-12, (not Pl. 32, figs. 17-19; Pl. 33, figs. 1-4, 14-21).

1966 Plectodina aculeata (Stauffer), Bergström and Sweet (in part), Bull. Am. Paleontology, vol. 50, no. 229, p. 373-377, Pl. 34, figs. 5, 6 (not Pl. 32, figs. 15, 16; Pl. 33, figs. 22, 23).

1966 Zygognathus deformis (Stauffer), Winder, Jour. Paleontology, vol. 40, p. 50 (table 1), Pl. 10, fig. 13.

1966 Zygognathus elongata (Rhodes), Webers, Minnesota Geol. Survey, Spec. Pub. SP-4, p. 59 Pl. 12, fig. 1.

1966 Zygognathus deformis (Stauffer), Schopf, New York State Mus. and Science Serv., Bull. 405, Pl. 4, figs. 25, 29, 34.

A wide latitude of morphologic variation is observable in the interpretation of this form species. The species is characterized by noticeable asymmetry. Lateral compression of the form crowds the denticles together on the inner side; a large denticle (approximating size of main cusp) is crowded against the cusp on the inner side. Less robust forms (Plate 4, fig. 9), when not fragmentary, display the morphology of "Gyrognathus".

This form occurs in relative abundance in most of the Richmond samples from Tennessee.

ZYGOGNATHUS ? ABNORMIS Branson, Mehl, and Branson, 1951

Pl. 10, figs. 10, 11

1951 *Zygognathus* ? *abnormis* Branson, Mehl, and Branson, Jour. Paleontology, vol. 25, p. 14, Pl. 3, fig. 20.

? 1935 *Ptiloconus* *robustus* Stauffer, Jour. Paleontology, vol. 9, p. 617, Pl. 75, figs. 15-17, 20, 21.

? 1942 *Ptiloconus* ? sp. Amsden and Miller, Jour. Paleontology, vol. 16, p. 305, fig. 2C.

? 1966 *Zygognathus* ? sp. cf. *Z*. ? *abnormis* Branson, Mehl, and Branson, Oberg, Jour. Paleontology, vol. 40, p. 145, Pl. 15, fig. 24; Pl. 16, figs. 8, 15.

A few specimens of this species were encountered in the Jordania section of Tennessee. It is differentiated from other zygognathids by the partial suppression of one of the lateral processes. The species is based upon a single specimen that Branson, *et al*. referred to "*Zygognathus* ?".

ZYGOGNATHUS PYRAMIDALIS Branson, Mehl, and Branson, 1951

Pl. 13, figs. 1-3

Specimens of *Zygognathus pyramidalis* were obtained from the Franklin, Southall, and Linton sections of Tennessee. The species was reported originally from the Whitewater and Liberty Formations of

Kentucky and Indiana; it was reported later from the Winnipeg Formation of Manitoba.

ZYGOGNATHUS sp.

Pl. 11, fig. 20

A single specimen of a deformed conodont was recovered from sample B of the Mayberry section of Tennessee. The form is illustrated to reveal individual modification that conodonts may display. This specimen appears to be an example of such extreme variation that it can not be assigned to any particular associated species of Zygognathus.

Subclass OSTRACODA Latreille, 1806

Order PALEOCOPIDA Henningsmoen, 1953

Suborder BEYRICHICOPINA Scott, 1961

Superfamily HOLLINACEA Swartz, 1936

Family HOLLINIDAE Swartz, 1936

Genus EOHOLLINA Harris, 1957

Type species: Beyrichia irregularis Spivey, 1939, by original designation, Harris, R. W., 1957, p. 207

1939 Beyrichia irregularis Spivey, Jour. Paleontology, vol. 13, p. 172, Pl. 21, figs. 1, 2.

1957 Beyrichia irregularis Spivey, Harris, Oklahoma Geol. Survey, Bull. 75, p. 207.

"Carapace small (generally less than 1 mm in length), ovate-elliptical to subquadrate in lateral profile, with definite forward swing; long, straight hingement depressed or channeled below umbonate anterior and posterior dorsal nodes; near-median sulcus with antero-jacent isolated, rounded knob; a prominent, umbonate, bulbous inflation lies on dorsum between sulcus and post-cardinal angle, a somewhat similar, lower inflation occurs behind antero-cardinal angle, subsulcate and post-ventral area of carapace strongly inflated with elongate, inclined, lobate swelling, peripheral flange about free margins, female with antero-ventral marginal 'brood pouch', entire surface otherwise smooth, punctate, granulose, pustulose, or reticulate."

EOHOLLINA sp. cf. E. DEPRESSA (Kay, 1940)

Pl. 15, fig. 8; Pl. 16, fig. 17

cf. 1940 Bromidella depressa Kay, Jour. Paleontology, vol. 14, p. 263, Pl. 34, figs. 12-15.

cf. 1962 Bromidella depressa Kay, Kraft, Geol. Soc. America, Mem. 86, p. 43, Pl. 15, figs. 8-17; text figs. 14g-h.

A few fragmental specimens of Eohollina sp. cf. E. depressa were obtained from the middle portion of the Fernvale sequence along Oklahoma State Highway 10 in northeastern Oklahoma. The form differs from the type in its semiquadrate (not subovate) outline, and less distinct lobation. The figured specimen (Pl. 15, fig. 8) is a valve with broken antero-dorsal node, and postero-cardinal angle of approximately 90 degrees. In the latter respect, the form resembles Kay's (1940) specimens more closely than those of Kraft (1962), with more obtuse posterior angle.

The genera Eohollina and Bromidella are so closely related, according to Kesling and Berda, that certain species of Eohollina appear bromidellid. Bromidella, however, displays a curved bar between the sulcate node and the postero-cardinal angle.

The close relationship of the two genera is unquestionable, but Fernvale species are definitely assignable to Eohollina, and Bromidella depressa is assigned to the genus Eohollina herein.

Family EURYCHILINIDAE Ulrich and Bassler, 1923

Genus EURYCHILINA Ulrich, 1889

Type species: Eurychilina reticulata Ulrich, 1889

1889 Eurychilina reticulata Ulrich, Geol. Nat. Hist. Survey Canada, Contr. Micro-Paleontology, pt. 2, p. 52, 53, Pl. 9, figs. 9, 9a.

1894 Eurychilina reticulata Ulrich, Ulrich, Geol. Nat. Hist. Survey Minnesota, Paleontology, vol. 3, pt. 2, p. 660, Pl. 44, fig. 1.

1901 Eurychilina reticulata Ulrich, Ruedemann, New York State Mus., Bull. 49, p. 76, Pl. 5, fig. 3.

1923 Eurychilina reticulata Ulrich, Ulrich and Bassler, Maryland Geol. Survey, Silurian vol., p. 303, text fig. 16 (fig. 5).

"Valves semicircular, suboval, or even nearly circular. Dorsal line straight. Generally with a well-defined sub-central sulcus and a more or less prominent node just behind it. A very broad convex border extends around the valves from the antero-dorsal to the postero-dorsal angle. The border is often striated in a radial manner and in most cases, terminated by a marginal 'frill', or by a plain narrow border, usually directed slightly outward. The main body of the border, however, curves inward to near the plain of contact between the two valves thus forming a deeply concave outer area. Hingement simple. Surface reticulate, granulose, or smooth."

EURYCHILINA sp.

Pl. 15, fig. 1

Shell of male, subovate-subelliptical in lateral view, with straight hinge line; maximum height at center; anterior cardinal angle unknown, posterior cardinal angle abruptly truncated at approximately 100 degrees; ventral contact margin broadly and evenly curved, anterior contact margin more acutely curved than posterior. The free margin is obscured in external lateral view by a velate frill that is separated slightly from the postero-dorsal margin (the frill is broken anteriorly on the single specimen obtained). The marginal velate frill is wide, slightly convex, and denticulate in the posterior portion. The smooth, decidedly convex shell body bears a deep, narrow S_2 with post-jacent prominent, bulbous subspherical node.

This Fernvale specimen resembles immature instars of E. indivisa Levinson; however, the sulcate node is more developed and bulbous in the Fernvale form.

A single male specimen of this distinctive and fragile form was obtained from sample J of the Oklahoma State Highway 10 Fernvale section of the Ozark area. In view of the fragility of this form, it is entirely probable that the single specimen reported here is not a true reflection of its relative abundance in the Fernvale Formation of northeastern Oklahoma.

Family BASSLERATIIDAE Schmidt, 1941

Genus THOMASATIA Kay, 1941

Type species: Thomasatia falcicostata Kay, 1934

1934 Thomasatia falcicostata Kay, Jour. Paleontology, vol. 8, p. 337, 338, Pl. 46, figs. 13-23.

1945 Thomasatia falcicostata Kay, Kay, Jour. Paleontology, vol. 14, p. 266, Pl. 34, fig. 29.

"Valves small, equal. Outline subrectangular to subelliptical, dorsally truncated; ends unequal, retral swing commonly obvious. Marginal ridge on posterior and ventral; elevated ridge within on the same borders, with distinct node within and just posterior to middle of valve. Contact obscured by overhanging or carinate border; plane, without thickening."

Kraft (1962, p. 51) noted that some forms of Thomasatia possess a faint median groove below the hingement, and fairly strong lobation; keels or depressions are secondary features of some species.

THOMASATIA sp. A.

Pl. 15, fig. 7

A few specimens of a new species of Thomasatia were recovered from the middle part of the Fernvale sequence on Oklahoma State Highway 10. The nearest morphologic equivalent of the new form is T. marginovelata Kraft; however, the Fernvale form differs in that shallow depressions of secondary magnitude appear upon the primary lobes.

The pre-sulcate node is inflated, resembling that of T. marginovelata, and in this respect, it differs from somewhat similar T. falcicostata. However, the few specimens at hand are quite variable in the degree of minor lobation, and it is quite possible that a great number of specimens would include some forms resembling more closely T. marginovelata.

THOMASATIA sp. B.

Pl. 16, fig. 15

A fragment, obtained from the Oklahoma State Highway 10 Fernvale section, differs from Thomasatia sp. A of this work in that the primary lobes lack shallow depressions superimposed upon them.

The central node of this fragmentary specimen is small, and a wide, thick marginal ridge apparently completely borders the free margin. The combination of small, central node, smooth, evenly-rounded lobes, and wide, strongly developed marginal ridge distinguishes this form.

? Family EURYCHILINIDAE Ulrich and Bassler, 1923

Genus EUPRIMITIA Ulrich and Bassler, 1923

Type species: Primitia sanctipauli Ulrich, 1894

1894 Primitia sanctipauli Ulrich, Geol. Nat. Hist. Survey Minnesota, Paleontology, vol. 3, pt. 2, p. 652, Pl. 43, figs. 73, 74.

1923 Euprimitia sanctipauli (Ulrich), Ulrich and Bassler, Maryland Geol. Survey, Silurian vol., p. 299, 300; text fig. 15 (fig. 5).

1940 Euprimitia sanctipauli (Ulrich), Kay, Jour. Paleontology, vol. 14, p. 252, Pl. 31, figs. 11-15.

"Like typical Primitia except that the carapace has a simple sulcus, reticulate ornamentation and an elevated false border around the free edge of the valve, making a bicanaliculate edge in the entire closed carapace."

? EUPRIMITIA LABIOSA (Ulrich, 1894)

Pl. 15, fig. 5.

1894 Halliella labiosa Ulrich, Geol. Nat. Hist. Survey Minnesota, Paleontology, vol. 3, pt. 2, p. 656, Pl. 46, figs. 43-46.

1934 Halliella labiosa Ulrich, Kay, Jour. Paleontology, vol. 8, p. 332-334, Pl. 44, figs. 17, 18.

1940 Euprimitia labiosa (Ulrich), Kay, Jour. Paleontology, vol. 14, p. 252, Pl. 31, figs. 16-18.

1957 Halliella labiosa Ulrich, Harris, Oklahoma Geol. Survey, Bull. 75, p. 200, 201, Pl. 6, figs. 14, 15, 16a-b.

A few individuals, herein questionably assigned to the distinctive species Euprimitia labiosa, were observed in samples from the middle portion of the Fernvale of the Oklahoma State Highway 10 section in the Ozark region; less frequent occurrences were observed in the Flying "L" Ranch and Oklahoma State Highway 18 sections of the Arbuckle Mountains.

Family QUADRIJUGATORIDAE Kesling and Hussey, 1953

Genus CERATOPSIS Ulrich, 1894

Type species: Beyrichia chambersi Miller, 1874

1874 Beyrichia chambersi Miller, Cincinnati Quart. Jour. Sci., vol. 1, p. 234, text fig. 27.

1890 <u>Tetradella</u> <u>chambersi</u> (Miller), Ulrich, Cincinnati Soc. Nat. Hist. Jour., vol. 13, p. 112.

1894 <u>Ceratopsis</u> <u>chambersi</u> (Miller), Ulrich, Geol. Nat. Hist. Survey Minnesota, Paleontology, vol. 3, pt. 2, p. 676, Pl. 46, figs. 19-22.

1912 <u>Ceratopsis</u> <u>chambersi</u> (Miller), Ruedemann, New York State Mus., Bull. 162, p. 121, Pl. 9, fig. 15.

1919 <u>Ceratopsis</u> <u>chambersi</u> (Miller), Bassler, Maryland Geol. Survey, Cambrian-Ordovician vol., p. 169, 182, 369, Pl. 55, fig. 34.

1923 <u>Ceratopsis</u> <u>chambersi</u> (Miller), Ulrich and Bassler, Maryland Geol. Survey, Silurian vol., p. 310, fig. 20 (fig. 5).

1931 <u>Ceratopsis</u> <u>chambersi</u> (Miller), Harris, Oklahoma Acad. Sci., Proc., vol. 11, p. 58, Pl. 2, fig. 7.

1951 <u>Ceratopsis</u> <u>chambersi</u> (Miller), Keenan, Jour. Paleontology, vol. 25, p. 564, Pl. 78, fig. 7.

"Valves somewhat obliquely subovate, widest posteriorly, straight dorsally, with a thick rounded semicircular marginal ridge, and two submedium ridges extending obliquely upward from the marginal ridge. The anterior one reaching the dorsal edge, the other shorter and smaller; post-dorsal end of marginal ridge raised into a strong spinelike, or mushroom-shaped process, beaded or fimbriated along one edge or around the flattened top. Free edges of carapace as in <u>Ctenobolbina</u>, being thick and having 'false borders'."

CERATOPSIS CHAMBERSI (Miller, 1874)

Pl. 15, fig. 2

Ceratopsis chambersi was recovered from all silicified portions of the Fernvale of Oklahoma. This distinctive species, althoug infrequent in numbers, is relatively abundant in the total sparse Ostracoda faunas of the Ozark and Arbuckle areas.

Ceratopsis chambersi is reported from the Middle Trenton of Minnesota, being more common in the upper third of the Trenton at Minneapolis, St. Paul, and Cannon Falls. It is a common fossil of the lower beds of the Cincinnati Group. It appears to be absent in the Galena Formation of the Minnesota region. Keenan reported its occurrence at the base of the Eden Group of Cincinnati, Ohio. A variety, C. chambersi robusta, occurs in the upper beds of the Cincinnati Group at Waynesville and Oxford, Ohio, and Richmond and Versailles, Indiana, and other localities in these two states.

Genus TALLINELLA Öpik, 1937

Type species: Tallinella dimorpha Öpik, 1937

1937 Tallinella dimorpha Öpik, Loodusuurijate Selts; Arunded, vol. 43, Pub. Geol. Inst. Univ. Tartu 50, Tartu, p. 24, 25, Pl. 2, figs. 1a-1b; Pl. 10, figs. 1, 2.

1951 Tallinella dimorpha Öpik, Kesling, Contr. Mus. Paleontology, Michigan Univ., vol. 9, no. 4, Pl. 12, figs. 1a, b, 2a-c (after Opik, 1937).

1957 Tallinella dimorpha Öpik, Jaanusson, Geol. Inst. Univ. Uppsala (Stockholm), Bull., vol. 37, p. 344-348, Pl. 9, figs. 1-9; text figs. 35A, 37.

"The lobation of this genus is closely related to Ceratopsis and Tetradella. But in the female the brood-pouch is of Primitiopsis-like structure. It is formed by the enlargement of the marginal border in the posterior part of the valves. As in Primitiopsis [cf. Bonnema (17)] this brood-pouch is open along the posterior margin of the carapace."

TALLINELLA sp

Pl. 16, fig. 11

Distinct lobes rise abruptly from the velar flange and tend to merge. L_1 is moderately broad and slightly lower than other lobes (lowest at dorsal margin), and merges ventrally into L_3 and L_4. L_2 is a knob rising slightly higher than L_1 and separated therefrom by a shallow, narrow sulcus; it is separated from L_3 by a deeper and broader sulcus. L_3 and L_4 are essentially merged, only a faint oblique sulcus separating them; L_3 projects slightly beyond the dorsal margin; L_4 approximates two-thirds the height of L_3.

This form, somewhat resembling the associated genus Thomasatia, is related to European Tallinella sebyensis, T. lata, and T. tumida, all of which are quite unlike the type species, T. dimorpha.

This European genus has not been recorded previously from North America.

The species occurs infrequently in middle Fernvale strata along Oklahoma State Highway 10.

Family TETRADELLIDAE Swartz, 1936

Genus TETRADELLA Ulrich, 1890

Type species: Beyrichia quadrilirata Hall and Whitfield, 1875

1875 Beyrichia quadrilirata Hall and Whitfield, Geol. Survey Ohio, Rept., vol. 2, pt. 2, Paleontology, p. 105, Pl. 4, figs. 6, 7.

1889 Strepula quadrilirata (Hall and Whitfield), Ulrich, Geol. Nat. Hist. Survey Canada, Contr. Micro-Paleontology, pt. 2, p. 54, Pl. 9, fig. 12.

1890 Tetradella quadrilirata (Hall and Whitfield), Ulrich, Cincinnati Soc. Nat. Hist., Jour., vol. 13, p. 112.

1894 Tetradella quadrilirata (Hall and Whitfield), Ulrich, Geol. Nat. Hist. Survey Minnesota, Paleontology, vol. 3, p. 2, p. 679, Pl. 46, figs. 1-11.

1908 Tetradella quadrilirata (Hall and Whitfield), Ulrich and Bassler, U. S. Nat. Mus., Proc., vol. 35, Pl. 39, figs. 4, 5.

1908 Tetradella quadrilirata (Hall and Whitfield), Cumings, Geol. Nat. Hist. Res. Indiana, 32nd Ann. Rept., p. 1048, Pl. 53, figs. 4, 4a.

1934 Tetradella ellipsilira Kay, Jour. Paleontology, vol. 8, p. 339, Pl. 45, figs. 10-15.

1940 Tetradella ellipsilira Kay, Kay, Jour. Paleontology, vol. 14, p. 265, Pl. 34, figs. 18-22.

The original description of the type species by Hall and Whitfield is as follows:

"Carapace minute, the larger individuals seldom exceeding three-hundreds of an inch in length, and often not more than that size. Form subquadrangular, longer than wide, the proportions being about as two to three, and a little the widest at the anterior third of the length. Dorsal margin straight, a little less than the greatest length of the valve; ends squarely rounded, and the basal line scarcely flattened. General surface of the valves scarcely flattened, but marked by transverse furrows, four in number, three of which are distinct and deep, extending across, or nearly across, the valve; the fourth is less distinctly marked, and extends but little more than half way across the valve. The furrows divide the surface of the valves into transverse ridges which are situated, one at each end, and one at each third of the length. Those situated at the end are narrow and abruptly elevated; that at the anterior third of the length does not reach quite to the dorsal margin; while that of the posterior third is much the strongest, rapidly widens in the lower part, and divided along the middle by the fourth or smaller furrow, which gives it the character of a strong ridge, bifurcating in the lower half. The central furrow is wider than the others, oblique in its direction, and somewhat curved in its course toward the ventral border. The margin of the valves is strongly and abruptly depressed below the general surface, forming a narrow, flange-like projection around the ends and basal portions, surface of the crust not spinose or granulose under a lens of moderate power."

Ulrich's (1889) revised description of the type species included dimensions of marginal loculi as a criterion for recognition of the form. These loculi, currently interpreted as sexual, dimorphic structures, were puzzling features at the time of Ulrich's revision.

Kesling and Hussey (1953) discussed current confusion among *Beyrichia quadrilirata* Hall and Whitfield and such equivalent and/or similar forms as *Strepula quadrilirata* Ulrich, *Tetradella quadrilirata* Ulrich, *Tetradella ellipsilira* Kay, and *Tetradella* cf. *T. quadrilirata* Kesling and Hussey. They stated that the original illustration and description of *Beyrichia quadrilirata* Hall and Whitfield were considered to be inaccurate and too comprehensive by Ulrich, who redrew and re-described the species as *Tetradella quadrilirata*. Ulrich's figure (1889, Pl. 9, fig. 12) is considered typical for the species. Ulrich, however, included in his concept of the species other forms which later authors have isolated. Among these were Trenton forms which Kay (1934) assigned to a new species, *T. ellipsilira*. Schmidt (1941; *fide* Kesling and Hussey, 1953), in agreeing with Ulrich, considered Kay's new species to be conspecific with *T. quadrilirata* (Hall and Whitfield), Ulrich, and questioned its validity.

Kesling and Hussey illustrated and described a species from the Richmond Group of Ohio as *Tetradella* cf. *T. quadrilirata* (Hall and Whitfield). They stated that the form was considered by Dr. Shidler to be conspecific with Tetradella quadrilirata (Hall and Whitfield). They noted, however, that the form is not identical to the illustration of Hall and Whitfield. Comparison of their illustrations to those of Hall and Whitfield indicates that this is an understatement, for the illustrations are not similar whatever, nor do they resemble the corrected illustration of the species which was redrawn by Ulrich (1889, Pl. 9, fig. 12), which Kesling and Hussey themselves placed in synonymy with Hall and Whitfield's species. Furthermore, T. cf. T. quadrilirata does not resemble T. quadrilirata Ulrich (1894, Pl. 46, figs. 1-5) nor figures of T. ellipsilira Kay, to which Ulrich's (1894, Pl. 46, figs. 1-5) have been compared. Thus, Tetradella cf. T. quadrilirata Kesling and Hussey (1953) does not even faintly resemble the figured specimen of T. quadrilirata. However, comparison of their forms with figures of T. lunatifera Ulrich, 1894 (not T. (S.) lunatifera (Ulrich, 1889), and T. ulrichi Kay, 1934 show considerable similarity. For that reason, the writer assigns. T. cf. quadrilirata Kesling and Hussey in synonymy (with question) with his specimens, and assigns both to Tetradella ulrichi Kay.

A completely satisfactory solution to problems of classification and taxonomy may be solved only when type specimens (where available) are examined and redescribed, and neotypes established for types no longer in existence.

Figure 12 of Plate 9 (Ulrich, 1889) may be considered as the holotype of Tetradella quadrilirata. It seems to be the first reasonable representation of the species, and is the illustration of the species utilized in the Treatise of Paleontology.

TETRADELLA SEPTINODA Keenan, 1951

Pl. 16, figs. 5, 9, 14

1944 Tetradella sp. Keenan, in Branson, Univ. Missouri Studies, vol. 19, p. 91, Pl. 14, figs. 24, 25.

1951 Tetradella septinoda Keenan, Jour. Paleontology, vol. 25, p. 571, Pl. 79, figs. 24, 25.

Specimens which are assigned herein to Keenan's species occur infrequently in the silicified middle portion of the Fernvale of the Oklahoma State Highway 10 section. The species is somewhat variable in the degree of lobation, the variation, in some cases, explainable by different growth stages or instars; in other cases, the cause may be inferred, perhaps as individual variation in response to environmental differences.

T. septinoda was reported originally from the Maquoketa Shale at Castlewood, Missouri.

TETRADELLA ULRICHI Kay, 1934

Pl. 15, figs. 12, 13; Pl. 16, figs. 18, 19

1894 Tetradella lunatifera Ulrich, Geol. Nat. Hist. Survey. Minnesota, Paleontology, vol. 3, p. 680, Pl. 46; text figs. 51a, b.

not 1889 Tetradella (Strepula) lunatifera Ulrich, Geol. Nat. Hist. Survey Canada, Contr., Micro-Paleontology, pt. 2, p. 56, Pl. 9, figs. 14-14b.

1934 Tetradella ulrichi Kay, Jour. Paleontology, vol. 8, p. 339, 340, Pl. 45, figs. 18-22.

1940 Tetradella ulrichi Kay, Jour. Paleontology, vol. 14, p. 265, Pl. 34, figs. 18-22.

? 1953 Tetradella sp. cf. T. quadrilirata Kesling and Hussey, Univ. Michigan, Mus. Paleontology, Contr., vol. 11, no. 4, p. 89-91, Pl. 2, figs. 1-24.

The synonymy of this species is included in the generic description.

Tetradella lunatifera Ulrich, 1894, which is synonymous with T. ulrichi Kay, 1934, is quite similar to T. quadrilirata; it differs in its six vertical ridges, instead of four.

Silicified specimens of this distinctive species characterize the middle portion of the Fernvale Formation along Oklahoma State Highway 10 in the Ozark area; lesser numbers were observed in the Fernvale sequence of the Flying "L" Ranch, Oklahoma State Highway 18, and U. S. Highway 77 sections of the Arbuckle Mountains. The species is associated commonly with Ceratopsis chambersi, thus indicating that both species required similar environments and that they each occupy their own peculiar ecologic niche in a particular paleo-biocoenosis.

The species has been reported from the Galena Shales near Cannon Falls, Minnesota; the upper beds of the Cincinnati or Hudson

River Formation at Oxford, Ohio; and Stony Mountain Formation, Manitoba. T. cf. quadrilirata Kesling and Hussey is reported from the basal Elkhorn Formation of Richmond Age. Dalve recorded T. quadrilirata from the Elkhorn, Waynesville, Liberty, and Whitewater Formations. T. ulrichi Kay is recorded from the Ion and Guttenberg Members of the Decorah of Iowa and Minnesota; and from the Sherman Falls and Hull Formations of Middle Trenton Age in Ontario.

Superfamily OEPIKELLACEA Janusson, 1957

? Family APARCHITIDAE Jones, 1901

Genus APARCHITES Jones, 1889

Emended Kraft, 1962

Type species: Aparchites whiteavesi Jones, 1889

1889 Aparchites whiteavesi Jones, Ann. Mag. Nat. Hist., ser. 6, vol. 3, p. 384, Pl. 17, fig. 10; text figs. 5, 6.

1923 Aparchites whiteavesi Jones, Ulrich and Bassler, Maryland Geol. Survey, Silurian vol., p. 296, text fig. 14 (figs. 10-12).

"Somewhat, but not quite, leperditian in outline and contour, the dorsal angles being nearly or quite absent, are generally much smaller than the above-mentioned forms" (Isochilina and Leperditia) "and are without either ocular or muscular spot, and have no overlap on the ventral margin, though sometimes thickened there."

Kraft (1962, p. 28) stated that most species of Aparchites possess a rabbeted inner marginal surface along the free margin of the right valve, a narrow marginal surface bordered by a narrow marginal ridge, a row of denticles or spines along the free margin of the left valve, and overlap of the left valve by the right along the entire free margin.

APARCHITES sp. cf. A. FIMBRIATUS (Ulrich, 1882)

Pl. 15, fig. 6; Pl. 16, fig. 3.

cf. 1892 Leperditia fimbriata Ulrich, Am. Geologist, vol. 10, p. 268, Pl. 9, figs. 34-36.

cf. 1894 Aparchites fimbriatus (Ulrich), Ulrich, Geol. Nat. Hist. Survey Minnesota, Paleontology, vol. 3, pt. 2, p. 645, Pl. 45, figs. 10-12.

cf. 1894 Leperditella canalis Ulrich, Geol. Nat. Hist. Survey Minnesota, Paleontology, vol. 3, pt. 2, p. 637, Pl. 43, figs. 1-3.

cf. 1940 Aparchites carinatus Kay, Jour. Paleontology, vol. 14, p. 244, Pl. 29, figs. 29-32.

cf. 1957 Aparchites fimbriatus (Ulrich), Swain, Jour. Paleontology, vol. 31, p. 561, Pl. 61, figs. 13a-e.

cf. 1961 Aparchites fimbriatus (Ulrich), Swain, et al., Jour. Paleontology, vol. 35, p. 351, 353, Pl. 46, figs. 1a-h; text fig. 2a.

cf. 1962 Aparchites fimbriatus (Ulrich), Kraft, Geol. Soc. America, Mem. 86, p. 28, 29, Pl. 2, figs. 1-11; Pl. 3, fig. 3; text figs. 7a-e.

cf. 1962 Aparchites fimbriatus (Ulrich), Kraft, Geol. Soc. America, Mem. 86, p. 28, 29, Pl. 2, figs. 1-11; Pl. 3, fig. 3; text figs. 7a-e.

Aparchites sp. cf. A. fimbriatus was obtained in limited numbers from the silicified middle part of the Fernvale along Oklahoma State Highway 10. A few specimens were observed in Fernvale samples of the U. S. Highway 77 section, and some questionable fragments were observed in the lower portion of the Fernvale of the Flying "L" Ranch section.

APARCHITES SUBORBICULARIS Kraft, 1962

Pl. 16, figs. 2, 16, 23

1962 Aparchites suborbicularis Kraft, Geol. Soc. America, Mem. 86, p. 31, Pl. 3, figs. 7-13; text figs. 7i, j.

Representatives of this form, as observed in this study, were associated with Aparchites sp. cf. A. fimbriatus. They appear to be somewhat less frequent, however, except in the Flying "L" Ranch section, where the occurrence of A. sp. cf. A. fimbriatus is questionable.

Kraft reported this species from the lower fifty feet of the Edinburgh Formation of Strasburg Junction, Virginia. The Edinburgh is considered by Cooper and Cooper (1946, p. 85) to be Black Riverian and Trentonian in age.

APARCHITES sp.

Pl. 16, fig. 21

Shell ovaloid in lateral view, dorsally truncated, maximum height through anterior end of straight hinge line equivalent to two-thirds of the length; dorsal margin straight; hingement contact slightly recessed; cardinal angles rounded at approximately 135 degrees; ventral border convex, anterior and posterior ends strongly and evenly rounded, the posterior end being slightly more acute. Valves essentially equal, although right valve slightly overlaps the left valve along the free margin; shell strongly convex, maximum thickness slightly below midline. Surface of shell smooth, without velate ridge and marginal denticles.

This form is more slender-elongate than other similar species of the genus, notably _A_. _ellipticoides_, _A_. _ellipticus_, and _A_. _simplex._ The single specimen at hand is a complete, closed carapace; therefore, the hingement cannot be examined. Species of the genus are hinged typically along a simple, straight, narrow bar.

The single specimen obtained from Fernvale sample J of the Oklahoma State Highway 10 section is somewhat smaller than typical adult specimens of the genus; the individual may represent an immature instar.

APARCHITES [LEPERDITELLA] MACRUS (Ulrich), Swain, et. al., 1961

Pl. 16, figs. 1, 12

1894 Leperditella macra Ulrich, Geol. Nat. Hist. Survey Minnesota, Paleontology, vol. 3, pt. 2, p. 638, Pl. 43, figs. 7-9.

1961 Aparchites macrus (Ulrich), Swain, et al., Jour. Paleontology, vol. 35, p. 353, Pl. 46, fig. 4.

Swain (1961, p. 354) noted that the lack of a median sulcus differentiates this species from the genus Leperditella; and its small size, lack of eye tubercles, and presence of strong dorsal overlap distinguishes it from members of the family Leperditiidae. Ulrich cited the short, high outline and posterior compression of the valves as being diagnostic. Swain reversed Ulrich's orientation of the carapace.

These small, short, high, smooth forms occur in limited numbers in the Fernvale sequence along Oklahoma State Highway 10. The species is so thin-walled and fragile that many were probably crushed or destroyed during sedimentation; extreme care must be exercised in processing samples to prevent maceration. For this reason, the species is probably under-represented in quantitative analyses of the samples.

The species has been reported from the middle third of the Decorah Formation at Minneapolis (Middle Trenton) by Ulrich; and Swain, et al. observed it near the base of the Decorah at St. Paul and Cannon Falls, Minnesota.

Suborder KLOEDENELLOCOPINA Scott, 1961

? Superfamily LEPERDITELLACEA Ulrich and Bassler, 1906

Family LEPERDITELLIDAE Ulrich and Bassler, 1906

Genus CRYPTOPHYLLUS Levinson, 1951

Type species: Eridoconcha oboloides Ulrich and Bassler, 1923

1923 Eridoconcha oboloides Ulrich and Bassler, Maryland Geol. Survey, Silurian vol., p. 296, fig. 14, fig. 6-8.

1951 Cryptophyllus oboloides (Ulrich and Bassler), Levinson, Jour. Paleontology, vol. 25, p. 558.

1957 Cryptophyllus oboloides (Ulrich and Bassler), Swain, Jour. Paleontology, vol. 31, p. 565, Pl. 62, figs. 15a-f.

"Carapace ovate to subquadrate, small to medium size, umbonate, subtriangular inflation or bilobed extension above the dorsum, if lobate, posterior swelling larger and higher than anterior, hinge straight, short to medium length, cardinal angles equal and rounded, venter usually elongate, parallel to hinge and rounding to cardinal angles; convexity of surface increases from marginal area to dorsal umbo, greatest thickness at umbo; short dorsal sulcus may be present, one or more wide concentric ridges parallel lower margins tending to converge at dorsum. The most ventral ridge borders the free margins of the valve; additional ridges, if present, separated one from another by narrow V-shaped grooves. Carapace equivalved. Hingement of left valve consists of a ridge running the length of the dorsal margin; dorsal to the ridge is a fine groove.

Hingement of right valve not observed. The hingement originally described as that of Eridoconcha (Levinson, 1950 b, p. 68, fig. 5) is now referred to the new genus Cryptophyllus. The grooves present at the dorsum may be the spacing between instars. Dimorphism present in some species, males more elongate than females."

"Number of ridges present dependent on number of retained molts. . . ."

CRYPTOPHYLLUS sp.

Pl. 15, fig. 4

Outline subquadrate to subovate, strongly umbonate, highest postero-medially, most specimens retaining several (4-6) molts. Anterior margin shorter than posterior; no sulcus observable; apex of umbonal area very near anterior dorsal angle. Hinge exceptionally long for the genus.

This species of Cryptophyllus is characterized by its subquadrate, elongate outline and high umbo situated in an extreme anterior position.

Cryptophyllus sp. comprises a minor, yet conspicuous part of the ostracode fauna obtained from the silicified middle portion (samples G to N) of the "Fernvale" sequence along Oklahoma State Highway 10; and is less frequent in the middle portion of the "Fernvale" phase of the Flying "L" Ranch section.

Genus PRIMITIELLA Ulrich, 1894

Type species: Primitiella constricta Ulrich, 1894

1894 Primitiella constricta Ulrich, Geol. Nat. Hist. Survey Minnesota, Paleontology, vol. 3, pt. 2, p. 647, Pl. 43, figs. 48-52.

1923 Primitiella constricta Ulrich, Ulrich and Bassler, Maryland Geol. Survey, Silurian vol., p. 297, 298, text fig. 15 (fig. 1).

1932 Primitiella constricta Ulrich, Bassler, Tennessee State Geol. Survey, Bull. 38, Pl. 10, fig. 13.

"Carapace usually oblong, equivalved, moderately convex; surface smooth or finely punctate; in the dorsal slope a broad, shallow and quite undefined depression represents an undeveloped mesial sulcus."

PRIMITIELLA sp.

Pl. 15, figs. 3, 11, 14

Carapace apparently equivalved, S_2 a narrow, shallow, short furrow below the hingeline, in some specimens the lower end of the sulcus terminates in a pit located slightly anterior to mid-length and directed downward or slightly forward. The posterior end of the carapace is slightly wider than the anterior end. The species is thinner anteriorly; the wall is smooth.

A few specimens of this form were observed in the middle part of the "Fernvale" sequence along Oklahoma State Highway 10 in the Ozark area.

Genus SCHMIDTELLA Ulrich, 1892

Type species: _Schmidtella crassimarginata_ Ulrich, 1892

1892 _Schmidtella crassimarginata_ Ulrich, Am. Geologist, vol. 10, no. 5, p. 269, 270, Pl. 9, figs. 27-30.

"Carapace small, rounded, moderately convex. Valves inflated in the dorsal region so that this part projects shoulder-like over and out from the nearly straight hinge line. Right valve slightly the larger, its ventral edge overlapping that of the left. No sulcus nor tubercles."

SCHMIDTELLA sp. cf. S. AFFINIS Ulrich, 1894

Pl. 16, fig. 8

cf. 1894 _Schmidtella affinis_ Ulrich, Geol. Nat. Hist. Survey Minnesota, Paleontology, vol. 3, pt. 2. p. 641, Pl. 43, figs. 45-47.

cf. 1931 _Schmidtella umbonata_ Harris (not Ulrich), Oklahoma Acad. Sci., Proc., vol. 12, p. 58, 59, Pl. 13, figs. 9a, b.

cf. 1931 Schmidtella affinis Ulrich, Harris, Oklahoma Geol. Survey, Bull. 55, p. 40, 89, 90, Pl. 11, figs. 4a, b.

cf. 1936 Schmidtella umbonata Harris, Harris, Oklahoma City Geol. Soc., Field Conf. Guidebook, Nov. 1936, p. 7, figs. 30, 30a.

cf. 1937 Schmidtella umbonata Harris, Harris, Oklahoma City Geol. Soc., Field Conf. Guidebook, March 1937, p. 4, 5, figs. 48a, b.

cf. 1941 Schmidtella affinis Ulrich, Triebel, Senckenbergiana, vol. 23, nos. 4-6, p. 302, Pl. 1, fig. 11.

cf. 1957 Schmidtella affinis Ulrich, Harris, Oklahoma Geol. Survey, Bull. 75, p. 162, 163, Pl. 3, figs. 12a-d, 14.

Outline subovate; dorsal margin slightly umbonate in projecting beyond short hinge; surface moderately convex, with maximum convexity above the middle. The specimens at hand display no channel to mark the edge of earlier instars, thus differing from S. affinis.

This simple, smooth species is a major component of the ostracode fauna of the Fernvale of the Arbuckle Mountains. Is is also a significant element in the northeastern Oklahoma Fernvale ostracode fauna.

Order PODOCOPIDA Müller, 1894

Suborder PODOCOPINA Sars, 1866

Superfamily BAIRDIADAE Sars, 1888

Family BAIRDIIDAE Sars, 1888

Genus BYTHOCYPRIS Brady, 1880

Type species: Bairdia bosquetiana Brady, 1866

1866 Bairdia bosquetiana Brady, Zool. Soc. London, Trans., vol. 5, p. 364, Pl. 57 (= juvenile Bythocypris reniformis Brady, 1880).

1880 Bythocypris reniformis Brady, Rept. Sci. Results Voyage H. M. S. Challenger, Zool. vol. 1, pt. 3, p. 46, Pl. 5, fig. 1a-l.

Brady's original description of Bythocypris embraced smooth, reniform or subreniform shells, with left valve much larger than the right and overlapping it on both dorsal and ventral margins.

Diagnostic generic criteria were based originally upon soft parts of Recent Bythocypris, rather than upon shell morphology. Bassler and Kellet (1934) revised the diagnosis of Recent forms to include Early Paleozoic species in Bythocypris:

"Shell smooth, reniform, ovate or elliptical; left valve larger than right, overlapping it usually on both the dorsal and ventral margins; dorsal margin convex, the ventral edge straight, sometimes concave."

Paleozoic shells assigned to this genus do not exhibit typical muscle scar pattern and internal marginal structures of Recent species. The genus is currently so comprehensive that Paleozoic species assigned to it are probably not cogeneric. For this reason, the generic designation is applied herein in quotes to indicate informal usage, and, accordingly, the synonymy of the type species is omitted.

"BYTHOCYPRIS" CYLINDRICA (Hall, 1871)

Pl. 16, fig. 4

1852 Cytherina cylindrica Hall, Nat. Hist. New York, Paleontology, vol. 2, p. 14, Pl. 4, figs. 8a, b.

1871 Leperditia [Isochilina] cylindrica (Hall), Hall, New York State Mus. Cab. Nat. Hist., 24th Ann. Rept. (Advance Sheets), p. 7, Pl. 4, fig. 12.

1872 Leperditia [Isochilina] cylindrica (Hall), Hall, New York State Mus. Cab. Nat. Hist., 24th Ann. Rept., p. 231, Pl. 8, fig. 12.

1875 Leperditia [Isochilina] cylindrica (Hall), Hall and Whitfield, Geol. Survey Ohio, Rept. Paleontology, vol. 2, p. 101, Pl. 4, fig. 5.

1889 Bythocypris cylindrica (Hall), Ulrich, Geol. Nat. Hist. Survey Canada, Contr. Micro-Paleontology, pt. 2, p. 48, Pl. 9, fig. 6.

1890 Primitia minuta Jones (in part), Geol. Soc. London, Quart. Jour., vol. 46, p. 7, Pl. 3, figs. 18, 19 (not figs. 21-23).

1894 Bythocypris cylindrica (Hall), Ulrich, Geol. Nat. Hist. Survey Minnesota, Paleontology, vol. 3, pt. 2, p. 687, Pl. 44, figs. 29-35.

1901-02 Bythocypris cylindrica (Hall), Ruedemann, New York State Mus., Bull. 49, p. 86, Pl. 7, figs. 26, 28.

1919 Bythocypris cylindrica (Hall), Bassler, Maryland Geol. Survey, Cambrian and Ordovician vol., p. 169, 182, 381, Pl. 55, figs. 28-31; Pl. 52, figs. 14-16.

1931 Bythocypris cylindrica (Hall), Harris, Oklahoma Acad. Sci., Proc., vol. 12, p. 57, 59, Pl. 12, figs. 3a, b.

1936 Bythocypris cylindrica (Hall), Harris, Oklahoma City Geol. Soc., Field Conf. Guidebook, Nov. 1936, p. 7 (table), fig. 5.

1937 Bythocypris cylindrica (Hall), Harris, Oklahoma City. Geol. Soc., Field Conf. Guidebook, March 1937, p. 4, 5, text fig. 21.

1951 Bythocypris cylindrica (Hall), Keenan, Jour. Paleontology, vol. 25, p. 567, Pl. 78, figs. 4, 8-13.

1957 Bythocypris cylindrica (Hall), Harris, Oklahoma Geol. Survey, Bull. 75, p. 258, Pl. 10, figs. 11a-c, 12.

A few specimens assignable to this smooth form occur infrequently in Fernvale strata in the Oklahoma State Highway 10 section of the Ozark area in association with other, somewhat more abundant and rather variable species of Bythocypris. These latter variable forms, although similar to Bythocypris cylindrica, differ sufficiently morphologically, expecially in marginal outline, to be assignable to B. sp. cf. B. cylindrica.

"B" cylindrica was observed only in the single aforementioned Fernvale section, but the associated variable bythocyprids display wider distribution.

The material at hand is insufficient to conclude whether or not these variable bythocyprids intergrade, or represent distinct species.

Simple, smooth, elongate B. cylindrica has been reported from many horizons throughout the Ordovician System.

"BYTHOCYPRIS" sp. cf. "B." CYLINDRICA (Hall, 1871)

Pl. 16, fig. 20

This form differs from typical B. cylindrica in its straighter dorsal and ventral margins. Specimens of this morphology were encountered in somewhat greater numbers than those of "B." cylindrica. They occur in the Oklahoma State Highway 10 section of northeastern Oklahoma, and in the lower portion of the Fernvale of the U. S. Highway 77, Oklahoma State Highway 18, and Flying "L" Ranch sections of the Arbuckle Mountains. They are most abundant in the Flying "L" Ranch section.

"BYTHOCYPRIS" ? sp. cf. "B." CYLINDRICA (Hall, 1871)

Pl. 15, fig. 9

This smooth, inornate form is larger and more arched dorsally and ventrally than typical Bythocypris cylindrica. The anterior end is blunter than the posterior; the maximum height is slightly anterior to mid-length, and maximum thickness is at the center, tapering gradually and evenly toward the margins.

Forms of this morphology were observed in limited numbers in the Oklahoma State Highway 10 section of the Ozark area and in the Flying "L" Ranch section of the Arbuckle Mountains.

"BYTHOCYPRIS" sp. cf. "B." FURNISHI Spivey, 1931

Pl. 15, fig. 10

cf. 1939 Bythocypris furnishi Spivey, Jour. Paleontology, vol. 13, p. 173, Pl. 21, figs. 36, 37.

The form described and illustrated herein differs from typical B. furnishi Spivey in its more symmetrical outline, a result of maximum height being near the middle of the valve. The form is slightly more slender-elongate and less angular than that figured by Spivey.

The species occurs sparsely in the Fernvale portion of the Oklahoma State Highway 10 section.

Genus MACROCYPROIDES Sp.vey, 1939

Type species: Macrocyproides clermontensis Spivey, 1939

1939 Macrocyproides clermontensis Spivey, Jour. Paleontology,

"Carapace reniform or sub-oval; moderately to strongly convex; valves unequal, with the right valve larger and overlapping the left on all margins except the postero-dorsal, where the margins may be equal or the overlap reversed. Dorsal margin arched, ventral margin straight or concave. Posterior end more broadly rounded and thicker than anterior."

Macrocyproides differs from Bythocypris in reversed overlap of the valves. It is also wider and blunter in outline than Bythocypris. Reversal of valve overlap appears to be insufficient justification to differentiate ostracode genera; some Cretaceous species of Cytheridea demonstrate optional overlap. In the absence of soft parts in extinct fossil Ostracoda, variation in valve outline, hingement detail, muscle scars, and internal shell structure are more reliable criteria for generic differentiation than overlap of valves.

MACROCYPROIDES sp. cf. M. TRENTONENSIS (Ulrich, 1894)

Pl. 16, fig. 13

cf. 1894 Aparchites minutissimus trentonensis Ulrich, Geol. Nat. Hist. Survey Minnesota, Paleontology, vol. 3, pt. 2, p. 646, Pl. 43, figs. 18-20.

cf. 1939 Aparchites minutissimus trentonensis Ulrich, Spivey, Jour. Paleontology, vol. 13, p. 165, Pl. 21, figs. 26, 27.

cf. 1940 Aparchites trentonensis Ulrich, Kay, Jour. Paleontology, vol. 14, p. 244, Pl. 29, fig. 33.

cf. 1961 Macrocyproides trentonensis (Ulrich), Swain, et al., Jour. Paleontology, vol. 35, p. 371, Pl. 48, fig. 11; Pl. 50, figs. 5a-d; text fig. 21.

cf. 1962 Macrocyproides trentonensis (Ulrich), Swain, Jour. Paleontology, vol. 36, p. 740, Pl. 111, figs. 2a-c.

This form was observed in Fernvale strata in the Oklahoma Highway 10 section of northeastern Oklahoma, and in limited numbers in the U. S. Highway 77, Oklahoma State Highway 18, and Flying "L" Ranch sections of the Arbuckle Mountains.

Genus PUNCTAPARCHITES Kay, 1934

Type species: Cytheropsis rugosus Jones, 1858

1858 Cytheropsis rugosus Jones, Ann. Mag. Nat. Hist., ser. 3, bol. 1, p. 249, Pl. 10, fig. 5.

1868 Primitia rugosa (Jones), Jones and Holl, Ann. Mag. Nat. Hist., ser. 4, vol. 2, p. 55.

1891 Cytherella (?) rugosa (Jones), Jones, Geol. Nat. Hist. Survey Canada, Cont. Micro-Paleontology, pt. 3, p. 99.

1894 Cytherella (?) rugosa (Jones), Ulrich, Geol. Nat. Hist. Survey Minnesota, Paleontology, vol. 3, pt. 2, p. 686, Pl. 43, figs. 21-24.

1931 Bythocypris arcuata (Ulrich), Harris, Oklahoma Acad. Sci., Proc., vol. 12, p. 58, 59, Pl. 13, fig. 8.

1934 Punctaparchites rugosus (Jones), Kay, Jour. Paleontology, vol. 8, p. 331, 332, Pl. 44, figs. 1-4.

1936 Bythocypris seminalis Harris, Okla. City Geol. Soc., Field Conf. Guidebook, Nov. 21, 1936, p. 7, fig. 17.

1940 Macronotella rugosa (Jones), Kay, Jour. Paleontology, vol. 14, p. 236, 245, Pl. 30, figs. 5, 6.

1957 Punctaparchites rugosus (Jones), Harris, Okla. Geol. Survey, Bull. 75, p. 262, 263, Pl. 10, figs. 15a-15b, 16.

"Valves small, equal, outline oval or suboval, dorsally truncated; hinge straight or slightly concave, surface regularly convex, with numerous distinct pits. Contact plane, valves exactly equal."

The assignment of P. rugosus to Macronotella by Kay (1940) was discussed briefly by Kesling, et al. (1960), with the conclusion that Punctaparchites should be retained as a valid genus.

PUNCTAPARCHITES sp. cf. P. RUGOSUS (Jones, 1858)

Pl. 16, figs. 6, 7, 10

Specimens assigned to this species differ from the type in their larger size and flat lateral surface. The pores of some immature instars are elongated and somewhat triangular or cuneiform. Some adult forms exhibit rounded pores with included plug, thus effecting an ornamentation of minute circles.

This species occurs in northeastern Oklahoma as one of the more common Fernvale ostracodes. It is present in limited, but significant numbers in the sparse Fernvale ostracode faunas obtained from the Arbuckle Mountains.

Phylum BRACHIOPODA

INARTICULATA

Genus CONOTRETA Walcott, 1889

Type species: Conotreta rusti Walcott, 1889

CONOTRETA ? sp.

Pl. 16, figs. 24, 25, 26

Dorsal valves of an inarticulate brachiopod (figs. 24, 25) occur rather commonly in most of the uppermost Viola limestones of the Arbuckle Mountains. The form has been referred to Conotreta with question. The genus is similar externally and internally to Acrotreta. However, the ventral valve of Conotreta is characterized by multibranched pallial lines. Shimer and Shrock (1944, p. 289) suggested that it is possible that Acrotreta is a junior synonym of Conotreta, because both genera have similar dorsal valves. Homotreta is a somewhat similar form, but of Middle Cambrian age. American species of Acrotreta first appeared in Cambrian strata, but the type is a European Ordovician form. Conotreta ranges from Middle to Upper Ordovician in age.

Deep conical shells (Pl. 16, fig. 26), identical in ornamentation (thin, close-set growth lines) and apparently of the same material as the dorsal valves of Conotreta ?, occur in association with the dorsal valves herein assigned to Conotreta ?. The apex of the slightly flattened cone is penetrated by a small, round pore. All specimens that were recovered were fragmentary, so that only a few approximated the diameter of the dorsal valve of Conotreta ?.

These conical forms undoubtedly represent the pedicle valve of Conotreta ? sp. The apical pore of the conical form is interpreted as the pedicle opening. The association of the two forms, and the similarity of shell material and structure, apparent under the binocular microscope, are considered to be adequate evidence for referring these two shells to the same brachiopod species.

Phylum ARTHROPODA

TRILOBITE FRAGMENTS

Pl. 16, fig. 22

Numerous, silicified trilobite fragments were recovered in association with silicified Ostracoda in the "Fernvale" along Oklahoma State Highway 10 of northeastern Oklahoma, and from the "Fernvale" sequence along Oklahoma State Highway 18, and in the Flying "L" Ranch in the Arbuckle Mountains.

One of several samples obtained from the U. S. Highway 77 section in early reconnaisance, preliminary to this study, was highly silicified and contained ostracode and trilobite fragments. Only a few of these were recoverable due to extensive silicification of the matrix, as well as the embedded fossils.

Trilobite fragments, although numerous, were not recovered in sufficient abundance to present reconstruction of the total animal. Samples in the order of one hundred pounds would be required to yield sufficient material to reconstruct most of the trilobite species present.

Pygidia are simple, inornate, and conservative, resembling those of several Ordovician families; they could not be identified with certainty. Infrequent hypostoma (Pl. 16, fig. 22) seemed to offer the best possibility for generic identification; unfortunately, the hypostoma of many species are yet unknown or undescribed, so the material of the present study cannot be assigned to known genera. Pleural segments are almost common in some samples; here, too, identification is uncertain.

No trace of Cryptolithus or Cryptolithus-like frill was observed in any northeastern Oklahoma sample. It may be assumed that this trilobite was infrequent or absent in the fauna of these silicified northeastern samples. A single fragment, a portion of a cephalon, displays a round, essentially spherical, pustulose glabella, which is reminiscent of the Cheirurina.

Samples of Upper Viola (Highway 18 and Flying "L" Ranch section of the Arbuckle Mountains), lower in the stratigraphic column than those of this report, contain abundant silicified Cryptolithus fragments. Readily identifiable by their porate frill, the form is represented further in samples by long, hollow genal spines of square cross-section; the matrix in which they are embedded is partly silicified, and they cannot be extracted, even after acid digestion.

Onnia sp. was encountered in uppermost finely crystalline Viola strata along Oklahoma State Highway 18. This megafossil was observed on the broken surfaces of the rock; it is not silicified; accordingly, there is no trace of it in the acid residue. This genus resembles Cryptolithus, but differs in its high, conical glabella with marginal frill almost as wide in front of the glabella as at the sides. The pores of _Onnia_ are of approximately the same size, those of the outer row of _Cryptolithus_ are larger. The number of rows of pores beyond the girder could not be determined because the girder is a feature of the low portion of the frill and only the upper portion of the shell is represented as an external mold impressed into the rock matrix.

ECOLOGY AND PALEOAUTECOLOGY OF OSTRACODA

Agar (1963), Benson (1961), Pokorny (1958), Grekoff (1956), and Matthes (1956) have discussed the occurrence, ecology, and paleoecology of Ostracoda. The following brief summary has been compiled from their more extensive works.

Ostracodal ecological information, from which ancient environemts may be deduced, is incomplete. Paleozoic and older Mesozoic ostracode paleoecology must be surmised, less directly, from evidence of faunules and sediments associated with the Ostracoda.

Recent Ostracoda abound in almost all waters, ranging from freshwater springs, lakes, ponds, and rivers, through brackish lagoons, estuaries, tidal pools, and salt marshes, to epicontinental seas and open oceans; some live in sulphur springs. Fossil Ostracoda may be recovered from sediments representing any of these environments. Most Ostracoda are benthonic, creeping or burrowing in muds and fine sands, swimming directly above the floor, or crawling upon algae or other aquatic flora.

Some idea of the environment of a given fossiliferous sediment may be obtained by study of its ostracode fauna. The nature of the sediment and that of all enclosed fossils must be considered in such reconstructions; but Ostracoda alone will yield much pertinent information.

Care must be exercised, however, to distinguish the endemic elements from the allochthonous.

Interpretation of extinct Paleozoic marine Ostracoda is based upon:

1) The comparison of carapace structure and shape with that of living forms, the majority of which are strikingly different. It is reasonable to assume that major protuberances and/or depressions of the ostracode carapace reflect irregularities of the enclosed anatomy that secreted and inhabited the carapace.

2) Speculation regarding functions of various features of the carapace.

3) Association of Ostracoda with other marine fossil organisms.

4) Association of Ostracoda with lithology.

Ostracoda are classified ecologically essentially upon the basis of two environments. A most common basis of classification involves the salinity of the water they inhabit; i.e., fresh-water, brackish water, and marine. A further classification is based upon the ostracode's mode of life; i.e., pelagic and benthonic. Benthonic forms are subdivisible into bottom swimmers, bottom creepers, burrowers, and epiphytic types. These two groupings (based upon salinity and mode of life) appear to be most practical.

Salinity appears to be more significant than temperature, in the distribution of Ostracoda. The density of population is less affected by salinity variables than is the faunal composition. Certain species that prefer particular salinities will attain maximum development and will dominate the assemblage at these salinities. Ostracoda in the Oklahoma Fernvale sea lived in marine water of normal salinity, according to their association with abundant Echinodermata, whose requirements are assumed to have been similar to those of living forms.

Other factors affecting the distribution of Ostracoda are: depth, temperature, redox potential, pH, food and nutrients, and plant dominance. Depth apparently exerts an indirect influence mainly through variation in light intensity, plant growth, and temperature; bathymetric pressure is apparently inconsequential.

In any given fossil assemblage, several environments may be represented, due to 1) subsequent gravitational accumulation of shells from several vertical life zones, 2) contamination by lateral transport of shells from nearby biocoenoses, and 3) recycling of older sediments. There is no evidence of recycling of Fernvale Ostracoda of Oklahoma, nor any indication that they represent allochthonous elements in the fauna. Limited evidence of recycling is indicated by a few conodont elements in basal portions of some of the Tennessee Fernvale sections. Because most Ostracoda are benthonic, the nature of the bottom sediment is a most significant ecological factor in determining the ostracodal content. A muddy or fine sand bottom is generally preferred by Ostracoda; such bottoms are also generally richer in food and nutrients. In the material studied, the coarse grained Fernvale of Oklahoma yielded silicified Ostracoda; the fine grained Upper Viola yielded but few. It should be noted that this observation is based upon the occurrence of silicified forms in the residue, and that the samples that yielded Ostracoda appear essentially barren of them before acid digestion. Glaser (1965) noted Ostracoda in minor numbers throughout Viola mudstones, and rarely in the laminites of the Viola; he stated that they are most numerous in some of the Viola calcarenites.

The shell shape and ornamentation may reflect the nature of the sediments; thus, shells with flattened venter or with alars were adapted for creeping over the sea floor.

Epiphytic ostracodes are affected indirectly by the nature of the bottom sediment, because of preference of plants for particular types of sediments.

The skeletons of many Paleozoic Ostracoda deviate so strikingly from those of Recent forms that their functional significance by actual comparison is only conjectural. Hollow spines of certain species of Aechmina, for example, may attain a size approximating that of the remainder of the shell. It is inconceivable that, with such spines, these animals could have moved with the facility of modern types. It has been suggested that such spines projected through the mud as the ostracode burrowed forward. A hydrostatic function has been postulated for similar structures observed upon Tricornina, and a pseudoplanktonic mode of life assumed. Pokorny (1958) stated that both Aechmina and Tricornina were burrowers, their spines possibly having served as anchors for the animals.

The "horns" of Ceratopsis chambersi, an Oklahoma "Fernvale" form, are unique features whose function is unknown. The closely related form, C. oculifera, has mushroom-shaped projections, instead of horns. Ecological variables could have influenced the development of these different specific features; yet the geologic time intervals occupied by these forms are identical, so apparently no radical change of function accounted for their morphologic differences. Therefore, any surmise as to the function of the "mushroom"-like process of one form should include also the "horn" of the other form. The morphologic differences between the two forms possibly evolved in response to fulfillment of a particular function more effectively or under different circumstances, rather than representing development of a new function for the processes.

Geologic evidence indicates that the marine environment was the first to be inhabited by Ostracoda. Furthermore, throughout the fossil record, the predominating marine forms display greatest diversity of size, shape, structure, and ornamentation of carapace.

Marine Ostracoda live from the shoreline to depths of several thousand meters, but they are most abundant in the phototropic zone; i.e., in the littoral and shallow neritic zone. Marine forms, in general, exhibit wide tolerance for temperature and salinity variation. Genera of wide distribution may encompass temperature ranges of 0 to 30°C, and salinities from 2 0/00 to 35 0/00 (normal sea-water). The area in which a given species multiplies is not necessarily identical with that in which it is able to survive.

The complicated shell shape of Recent marine Ostracoda is undoubtedly related to some unknown extent to the surrounding benthonic habitat, although the factors that modify the morphology in adaptation to certain environments are unknown. Furthermore, the geographic and environmental distribution of Recent marine Ostracoda is yet unknown, especially those deeper water forms which are relatively inaccessible.

Klie and Remane's (1930) research with North Sea Ostracoda and Elofson's (1941) research with Skagerrack forms are convincing that no precise relationship exists between Recent ostracodal shell form/sculpture and mode of life. Therefore, the paleontologist cannot deduce final ecological conclusions from the form and structure of the extinct Paleozoic ostracode carapace. Nevertheless, some useful observations are evident.

The shape, weight, thickness, and rigidity of the shells (plus hingement detail) are related to the type of sea floor inhabited by the burrowers, and to currents that affected the swimmers.

The length and shape of appendages appear to be directly affected by the particular ecologic niche of the animal; but as appendages are rarely ever preserved as fossil, it is of academic interest only, unless some definite relationship of appendages to shell structure can be established.

A pelagic mode of life is expressed in many shells through a decrease of specific weight (diminished lime deposits), and through the production of oil droplets, so that the animal can float passively. Some forms (Holocyprididae, Pyrocypris) secrete a heavy shell, and a pelagic way of life is possible only through active swimming. The carapace of swimmers is generally smooth; and high in proportion to length.

Carboniferous species of Cypridina and a few other fossil pelagic Ostracoda have been described; but most fossil marine Ostracoda were crawlers, burrowers, and/or near-bottom swimmers.

A discussion of brackish-water and fresh-water Ostracoda is beyond the scope of this paper.

PALEOAUTECOLOGY OF CONODONTS

In view of the fact that the conodont-bearing organism is unknown and the function of the conodont organ itself is uncertain, the autecology of the animal may be deduced only indirectly by its biostratinomy.

Conodont students recognize that conodonts occur in all facies of marine sediments; some authors contend that some conodonts lived also in brackish and fresh-water sediments. The abundance of conodonts in Upper Carboniferous black shales is noteworthy, especially where the elements are found in undisturbed spatial relationship to each other: in these instances, a quiet, low-energy seabottom is suggested.

Several conodont species display wide geographic distribution. The relative independence of conodont occurrence to lithofacies, and the wide-spread distribution of many forms has led to the conclusion that the conodont animal was pelagic (probably nektoplanktonic), living, for the most part, in shallow waters or in upper water layers, rather than benthonic.

Early research reported an abundance of conodont elements in black, fissile shales rich in organic matter and generally lacking in other marine invertebrates. However, later studies indicate that such lithologic association may be true largely for Devonian forms: although other types of sediments, especially limestones, equal or surpass black shales in number of indigenous conodonts. Collinson (1962) noted that the two most prevalent misconceptions concerning conodonts are, 1) that they are most abundant in shales and, 2) especially in black shales. He noted that limestones in general contain the most conodonts, although many shales contain abundant faunas. Black shales in general actually contain the fewest number of conodonts.

Webers (1966) stated that, although most conodonts are relatively independent of lithofacies (some quite ubiquitous), others demonstrate evidence of facies control. According to Webers (1966), differences in range and abundance of statistical conodont species appear to be regulated by the general shape of the form species comprising the statistical species. Webers suggested that this phenomenon could indicate a variation in environmental tolerance among the forms. Single cones have the longest geologic range, and in general are the most abundant. Statistical species with a predominance of blade-type elements have a somewhat longer range and are more abundant than complex platform types (with limited distribution). Webers postulated that the degree of environmental tolerance indicated by these morphological differences may be influenced directly or indirectly by bottom conditions.

In the present study, differences in size and degree of robustness of elements, which may be reflected in the specific taxonomy, are thought to reflect environmental differences. This aspect of the paleoecology of conodonts is discussed in detail in the discussion of Ozarkodina robusta.

Bergström and Sweet (1966) recognized three intergrading subprovinces of the Middle Ordovician Midcontinent conodont fauna. They were uncertain of the combination of environmental features which was responsible for the regionation of the Midcontinent fauna, but they suspected that water temperature and depth played significant roles.

Youngquist, et al. (1951) noted that conodonts are common in beds lacking other invertebrate fossils, are commonly associated with plant remains indicating a near-shore environment, and occur with fish remains so frequently that the association may not be accidental.

Lindström (1951) observed that conodonts in black graptolitic shales are commonly associated with benthonic faunules.

Müller (1956) contended that conodonts lived in shallow water, perhaps occasionally fresh water, probably near shore. They are frequently associated with cephalopod and fish remains. Abundant crinoids, corals, and brachiopods are not associated with conodonts. Conodonts are scarce in reef-deposits; water favorable to a flourishing benthonic fauna was not well suited for conodont deposition.

Lindström (1964) noted, however, contrary to Müller's observation, that bedded, brachiopod-bearing limestones, rich in corals and molluscan fossils, clearly formed in shallow, well oxygenated water are among the most prolific sources of conodonts in Middle-Upper Ordovician and Silurian strata.

The present study indicates that the conodont animal flourished in some environments which supported large numbers of Pelmatazoa.

Conodonts are known from some relatively deep water deposits, notably those of the lowermost Ordovician of the Baltic Region, where they are entombed in cherty deposits representing the first stage of geosynclinal sedimentation.

Lindström suggested that occurrence of conodonts with graptolites in black shales is suggestive of deposition in undisturbed, probably deep waters, far from land.

The frequent association of conodonts with glauconite and/or phosphorite suggests a shallow water environment; however, these minerals, as well as the conodont, were resistant to weathering and solution, and some of these deposits undoubtedly represent lag concentrates, rather than originally deposited sediments.

Lindström, and Cullinson, et al. independently concluded that conodont frequency in a sediment may be proportional inversely to the rate of sedimentation. Lindström suggested that although the conodont animal cannot be assumed to have been equally abundant everywhere, at all times, it is reasonable to conclude that, if they were nektonic, swimming about freely, that they would spread rather evenly over all oceans in a relatively brief geologic time. Thus, for geologically short intervals (e.g., 1,000,000 years), their variation in number would not have important effects on the conodont frequency in the sediment. Intervals of one million years may have been sufficiently long for the conodonts to spread rather uniformly over the sea floor, but too brief to register any significant fluctuations in frequency due to evolutionary causes; significant evolutionary trends might have required time intervals approaching an Epoch in length.

PALEOSYNECOLOGY OF THE FERNVALE FORMATION OF OKLAHOMA AND TENNESSEE

A knowledge of the ecology of living organisms is one of the most practical tools applicable to solving paleoecological problems of related fossil forms. In event of no living representatives of the fossil species whose paleoecology is being investigated, then indirect evidence from associated fossils and lithology must be applied in order to interpret living conditions of the extinct form. This is the case with conodonts. Lastly, utilizing petrological, geological, ecological, and paleoecological data, a synthesis of the physical and biological conditions which prevailed over an area during some past epoch may be deduced.

Paleosynecology of the Oklahoma "Fernvale"

The Fernvale Limestone of Oklahoma is a clean, mud free calcarenite (encrinital biosparite of Folk's terminology) largely composed of echinodermal debris. Glaser (1965) in a petrographic study of the Viola-"Fernvale" sequence of the Arbuckle Mountains suggested that 35% of the calcarenite is of echinodermal origin. A number of samples involved in this study contain a considerably higher proportion of encrinital debris.

Little information can be added to the paleoecologic setting described by Glaser, except to note that the Robertson Ranch conodont fauna, which differs in detail from those of the more western sections, may represent an ecological adaptation to the shelf facies suggested by Glaser for the northeastern Arbuckle area; the fauna in "Fernvale" sections along Oklahoma State Highway 18, U. S. Highway 77, and the Flying "L" Ranch may be adapted to Glaser's more basin-like facies.

The similarity of the Fernvale along Oklahoma State Highway 10 (Ozark area) and that of the Robertson Creek section (Arbuckle area) indicates that the platform facies extends northward and northwestward. Fernvale Ostracoda in both the Arbuckle area and Ozark area are more tolerant environmentally.

"Fernvale" megafossils in less abundance than Pelmatazoa are trilobites and brachiopods. Silicified Brachiopoda are observable upon weathered surfaces of most Fernvale outcrops. Glaser (1965), and Alberstadt (oral communication) reported the recovery of fine specimens preserved through silicification. The writer's material yielded only silicified brachiopodal debris; the silicification appeared essentially superficial at the outcrop.

Glaser reported the trilobites *Cryptolithoides* sp. and *Robergia* sp. The writer obtained a large (2.5 X 3 inches) smooth pygidium of *Isotelus* (*I. gigas*?) from the base of the "Fernvale" outcrop along U. S. Highway 77. Samples from the upper fine-grained Viola facies and the overlying coarse, granular "Fernvale" of the Oklahoma State Highway 18 section yielded small, frilled trilobite cephala of *Onnia*.

Ischadites and rugose corals were not observed in the writer's material; Glaser reported infrequent occurrences, especially in the Highway 99 section (not investigated in this research).

In consolidating the observed data and those reported by Glaser, the sedimentary and biological environment of the Oklahoma Fernvale may be summarized concisely as follows: Following a slightly deeper water phase of Early and Middle Viola time, the Late Viola and Fernvale sea was shallow, clear, marine (normal salinity), with moderate to active wave and current movement. The sea was well-aerated, well-lighted, and dominated in numbers and aspect by stalked echinoderms which extended in lesser numbers to the nearby deeper water of lesser energy and finer sediments. Articulate Brachiopoda rested upon the sea floor in areas where winnowing of fine material occurred; while nearby, in the deeper, quieter areas, where fine sediments provided muddy bottoms, inarticulate, linguloid brachiopods burrowed.

Algae were probably abundant, although no record of their presence remains today. A few sponges ? (Ischadites) were present. Ostracoda crept in and upon the bottom sediments, swam in the water, and perhaps lived upon algae and Pelmatazoa. Trilobites swam in the water, or crept along the bottom, perhaps acting as scavengers or feeding upon Ostracoda and algae. The conodont animal, unknown, although presumed to be nektonic, also swam in these waters. Environmental conditions were unfavorable for the establishment of bryozoan colonies and rugose corals, although their infrequent occurrence in the sediments testifies to their presence in nearby environments; Glaser (1965) reported a few rugose corals. Beerbower (1960, p. 277) noted that certain Bryozoa occur in limited habitats and are controlled by the nature of the sea floor. The distribution of corals is limited by temperature, salinity, and character of the bottom sediment. The absence of these forms in abundance in "Fernvale" strata is thought to be due to the nature of the bottom sediments, which were presumably quite mobile because of wave and current motion. The bryozoan trochophore larva and the coral polyp undoubtedly experienced difficulty in establishing themselves in such an environment.

Paleosynecology of the Tennessee Fernvale

The limestones of the Richmond Fernvale Formation of Tennessee display variation from outcrop to outcrop, yet they exhibit characteristic coarse, crystalline granularity. At the Mayberry section in Tennessee, the limestone is composed essentially of pelmatazoan debris, loosely cemented with sparry calcite; it is red-brown in color due to included ferruginous clay material. The Tennessee Linton samples are similar, although somewhat finer in grain size. The Adkins and Jordania sections of Tennessee contain lesser amounts of the iron-rich clay, so the rocks are only tinged with red. The limestones of the Tennessee Southall and Franklin sections are gray; however, small amounts of clay (more yellow than red) remain in acidized residues. The superficial resemblance of these limestones to those of the "Fernvale" of Oklahoma is striking; but the resemblance in both instances is caused by the high "crinoidal" content of the strata, which, in coarsely broken fragments, imparts a coarse-grained crystallinity to the rock unit.

The underlying Arnheim Formation of Tennessee appears more uniform, although detailed thin-sectional study may reveal faunal and lithologic differences not obvious in stereomicroscopic examination.

A few ostracode molds, unidentifiable to family or genus, occur in the Richmond Fernvale of Tennessee. Bryozoans are present; but they are not as numerous as in the underlying Arnheim. These bryozoans occur in washed residues as clay molds of the branching tubes of the zooaria. Several types are distinguishable; but they have not been identified.

The Tennessee Fernvale contains considerably more sparry calcite than the Oklahoma "Fernvale." No silicification was observed in any of the Tennessee samples, and no silicified fossils were obtained. Clay, presumably of terriginous origin, is present, locally abundant.

Articulate Brachiopoda are present in the Tennessee Fernvale strata; but they were not investigated in this problem. Inarticulate, phosphatic linguloid-like brachiopods where present are locally sparse in number.

The paleogeographic regional setting of the Fernvale Formation in Central Tennessee was outlined briefly by Wilson (1949, p. 342). He noted that after a period of erosion, estuarine channels accumulated clastic sediments during encroachment of the Early Richmond sea. Silt from the northeast, east, and southeast was washed about the Nashville Dome island, and incorporated with the limy matrix of the western tongue of the Sequatchie Formation. The amount of silt from the east became reduced abruptly, or its westward transportation abruptly blocked, so that the Richmond sea flooded the estuarine Fernvale channel sediments; and finally the entire Nashville Dome was submerged. During the accumulation of calcareous Fernvale ooze in the relatively silt-free water, silt from the east continued to accumulate in the northeastern part of Central Tennessee to form the sediments of the Sequatchie facies.

The environment of the Tennessee Fernvale Limestone was marine, fairly highly energized, somewhat turbid, of normal salinity, adequately aerated, and well oxygenated. Pelmatazoans were the most prevalent animals dominating the sea floor in the higher energy zones (near Mayberry) and sharing the dominant position with brachiopods and Bryozoa in quieter waters. The shallow waters were presumably near land; the turbidity appears insufficient to have affected animal life, and presumably did not adversely affect plant growth, upon which animal life ultimately depends. Nektonic creatures, including the conodont-bearing animal, swam the waters and scavenged the sea bottoms.

Bassler (1932) stated that the distribution of the Fernvale in Tennessee indicates that deposition occurred in embayments or bay-like indentations about the western half of the Nashville Dome. At the heads of these shallow troughs and along the borders, the rock units are thin and consist essentially of shale; but elsewhere the succession is limestone, followed by shale; locally the entire rock sequence is limestone. The environmental conditions postulated by the writer do not conflict with observations of Bassler.

DISCUSSION

Problems relating to Fernvale stratigraphy of Oklahoma include first, the Pre-"Fernvale" unconformity in Oklahoma (reported by many geologists); and secondly, the closely related problem concerning the age of the "Fernvale" sequence.

Taff (1902) reported the Viola-Fernvale as "Lower Silurian" (Ordovician) in age. Taff (1903), in recognizing a tripartite subdivision of the Viola Formation, stated that the upper subdivision ("Fernvale" in part) contains a fauna corresponding to that of the Fernvale of Tennessee. Ulrich (1904) noted that the Izzard Limestone of Arkansas correlated lithologically and stratigraphically with Upper Viola beds (Fernvale included) in the Arbuckle Mountains. Richmond fossils from the Polk Bayou (overlying the Izzard) were considered approximately equivalent to those of the Tennessee Fernvale. A hiatus representing most of Trenton time was postulated for the Izzard-Polk Bayou interval, in spite of inconspicuous field evidence of this unconformity.

Weller (1907) considered the Maquoketa to be a western facies of the Richmond. Shales containing characteristic Maquoketa fauna overlying a limestone with Rhynchotrema capax ("index Richmond fossil") convinced Weller that the Maquoketa was Richmond or younger. Weller reported an abrupt faunal break between Trenton and Richmond strata. A physical unconformity was postulated because of red residual clay between the Maquoketa and Kimmswick in a section south of Batchtown, plus the fact that Richmond strata overlies various faunas of the Kimmswick in a north-south line in the St. Louis area. These faunas were interpreted as stratigraphic members of different ages.

Ulrich (1911) recognized two to three feet of Fernvale Limestone at the top of the Viola Formation in the Arbuckle Mountains. He later (1927) assigned the Fernvale Limestone and overlying Sylvan Shale of Oklahoma to the Richmond Group, unconformably overlying the Viola of Eden and Early Maysville age. Influenced by Ulrich's correlation, Edson (1930) stated confidently that an angular Post-Viola-Pre-Fernvale unconformity was recognizable by all stratigraphers who were familiar with Lower Paleozoic sediments of the Mid-Continent.

Comparison of Tennessee Fernvale conodonts reveals close similarity to those described from the Fernvale of Indiana and Kentucky. *Aphelognathus grandis* and *Rhipidognathus symmetrica* (Richmond forms currently considered reliable index fossils) are fairly abundant in the Tennessee Fernvale sequence. *Amorphognathus ordovicica*, *Phragmodus undatus*, and *Belodina* sp.(generally considered Pre-Richmond conodonts) were observed in Tennessee Fernvale sections. The genus *Belodina* is represented by only four or five specimens; *Amorphognathus* is somewhat more abundant. In extending the stratigraphic range of these two conodont types, the absolute value of the forms as a guide to Pre-Richmond strata is lessened, although their occurrence in abundance may yet be considered valid evidence for Pre-Richmond age, because these less frequently occurring forms, if not recycled, may be interpreted as late members of species close to extinction. These forms, absent in most known Richmond strata, are generally abundant and wide-spread throughout strata of known Eden and Trenton age. The associated form, Phragmodus undatus, occurs in relative abundance in the Fernvale of Tennessee. Because of its frequency in these Richmond strata, the form has not only lost its value as a pre-Richmond index form, but the occurrence of its epibole is not restricted to Black River-Maysville time.

The possibility of recycling of older forms in the Tennessee Fernvale conodont assemblage cannot be eliminated. However, except for fragile Amorphognathus, which is normally recovered as fragments, there is no established evidence that any Tennessee Fernvale conodonts were recycled. P. undatus is recovered from strata high in the Fernvale section, not only at the base, as might be expected in the event of recycling.

The "Fernvale" sequence of the Arbuckle Mountains contains the same conodont faunas as underlying Viola strata. There is no evidence of a break or significant change in the conodont faunas of the two stratigraphic units. On the other hand, the conodont fauna presents clear testimony of essentially uninterrupted sedimentation. The writer observed local interfingering of Viola and Fernvale facies in the outcrop, which created a problem of determining the exact base of the Fernvale (see discussion of Robertson Ranch section). The interdigitation of dense Viola and coarse Fernvale strata has been recorded by Glaser (1965, p. 117). He observed no physical evidence for a Pre-

Fernvale unconformity, although he reserved final judgment pending completion of a biostratigraphic investigation.

The conodont faunas of the Richmond Fernvale of Tennessee and the "Fernvale" of Oklahoma are readily separable. A few long-ranging species occur in each section. Typical Richmond species, however, e.g., *Rhipidognathus symmetrica* and *Aphelognathus grandis*, do not appear in Oklahoma sections. *Amorphognathus ordovicica* and species of *Belodina* characterize the Oklahoma "Fernvale"; these forms are atypical of Richmond strata, but are characteristic of older strata (Upper Trenton-Maysville).

Bergström and Sweet (1966) noted the similarity of Indiana-Ohio Upper Trenton, Eden, and Maysville faunas in stating ". . . based on a consideration of conodonts alone, we are inclined to include all the rocks above the Kirkfield and below the top of the Lower Richmond "Arnheim" of Indiana and Ohio, and the temporal equivalents of all these strata, in a single stage, for which there is currently no name".

The Maysville fauna appears to be a depauperized continuation of the Edenian, with the addition of at least a half dozen new species. None of these Maysvillian species occur in the Oklahoma "Fernvale"; accordingly the conodonts supply some justification for eliminating Maysville as a possible age for the Oklahoma "Fernvale" sequence.

The presence of *Ptiloncodus* n. sp. in Oklahoma "Fernvale" strata, a genus previously reported only from Joins strata, imparts an older aspect to the "Fernvale" sequence of Oklahoma. The conodont fauna *per se* of the Oklahoma Fernvale sequence suggests to the writer an age of Upper Trenton-Eden. However, the conodont evidence permits a range of Upper Trenton, Eden, and Maysville.

A reported Fernvale Middle Eden graptolite zone of Ruedemann and Decker (1934) (fide Glaser, 1965) is not inconsistent with "Fernvale" conodont evidence. The two fossil types, conodonts and graptolites, if considered as unit evidence, then indicate Eden age for the Oklahoma "Fernvale" Formation, an upper and partially lateral facies of the uppermost Viola Formation.

CONCLUSIONS

The original purposes of this investigation have been achieved, in that:

1) Two distinct conodont microfossil faunules, containing sixty-two conodont form species, distributed among thirty-one form genera, have been recovered, described, and illustrated from "Fernvale" strata of Northeast Oklahoma and the Arbuckle Mountains, and the Central Basin of Tennessee. A silicified ostracode fauna of twenty-one species, distributed among fourteen genera, was recovered from the "Fernvale" of Oklahoma: this ostracode fauna is also described and illustrated. The occurrence of both Conodonta and Ostracoda is recorded upon a faunal range chart.

2) The age of the Tennessee Fernvale Formation is concluded to be Richmond, and that of the Oklahoma "Fernvale" is concluded to be Eden.

The "Fernvale" of Oklahoma is considered to be essentially equivalent to the Cape Limestone at the base of the Maquoketa in Illinois, as suggested by Templeton and Willman. In postulating Maysville age for the Cape Limestone, Gutstadt (1958) erroneously applied the formational name to limestones in the middle of the Maquoketa Formation. Templeton and Willman considered the Cape Limestone ("Fernvale") of Illinois and Missouri to be initial Cincinnatian (Eden) deposits, and equivalent (or older) to basal Cincinnatian beds of the Cincinnati type area. They suggested correlation with the upper part of the Catheys of Virginia. The Ordovician Subcommittee of the Committee on Stratigraphy of the National Research Council (1954) correlated the Upper Catheys Formation of Tennessee with the Cynthiana Formation of Kentucky, Ohio, and Indiana.

3) The Richmond Fernvale conodont fauna of Tennessee contains forty-three species and varieties distributed among twenty-five genera. The Eden "Fernvale" of Oklahoma contains thirty-one conodont species and varieties distributed among eighteen genera. The "Fernvale" of Oklahoma contains a silicified ostracode fauna of twenty-one species and varieties distributed among fourteen genera.

4) A Richmond conodont fauna, containing many elements of the Fernvale fauna of Kentucky and Indiana, reported by Branson, et al. (1951), was obtained from Arnheim and Fernvale strata of the Central Basin of Tennessee. Several characteristic Richmond forms were obtained from the Arnheim and Fernvale strata of Central Tennessee.

The Tennessee Richmond Fernvale fauna is dominated numerically and in visual aspect by zygognathid, trichonodellid, cordylodid, and eoligonodid elements, with subordinate Aphelognathus grandis and Rhipidognathus symmetrica.

5) The Eden "Fernvale" of Oklahoma contains a conodont fauna of thirty-one form species distributed among nineteen form genera.

Amorphognathus ordovicica and species of Belodina, although not dominating the fauna in number, occur in such numbers as to impart a characteristic aspect, and dominate the visual appearance of the fauna. Locally (Robertson Ranch and Oklahoma State Highway 10 sections), ozarkodinids dominate the fauna.

6) After eliminating from consideration recycled forms and simple conservative cusps of long stratigraphic range (probably polyphylogenic in origin), few form species remain which are common to both the Richmond Fernvale of Tennessee and the Eden "Fernvale" of Oklahoma. Of these remaining half dozen species, Ozarkodina concinna is of special interest. The species is considered to be homeomorphic, in that morphologic differences in specimens of this form are currently considered insufficient to separate it into different artificial form species. A wide latitude of specific variation is indicated by type descriptions and comparisons with forms assigned to O. concinna by various authors. Minute differences in representatives of this species may yet justify its separation into biological species. This form and related ozarkodinid species need restudy and complete re-evaluation of criteria useful for differentiating species. Such studies should proceed in conjunction with the study and establishment of statistical species, for neither methodology alone is likely to yield a universally acceptable solution to the problem of what elements constitute a natural conodont species.

The form species Cordylodus delicatus and Cyrtoniodus flexuosus may also be homeomorphic, although minor morphologic differences in representatives of these species are not as evident as in O. concinna.

7) The stratigraphic range of Phragmodus undatus has been extended into the Richmond. This conservative element, although morphologically distinctive, has never been considered a diagnostic species.

Bergström and Sweet (1966) zoned and correlated Lexington strata of Indiana and Kentucky, by utilizing the ratio of this American species to that of Amorphognathus ordovicica of European origin. Whether similar zonation and correlations are possible within the strata studied herein remains to be investigated; the fauna is too scarce, unless extraordinarily large samples be processed. The possibility of recycling of these forms is discussed in succeeding paragraphs.

8) The range of Amorphognathus, if not recycled, has been extended into Lower Richmond of Tennessee. The appearance of this form species, although sparse in Fernvale strata, decreases its absolute value as an index Pre-Richmond fossil, but the occurrence of the species in appreciable number may yet reliably indicate Pre-Richmond age. Certain elements of the Tennessee Richmond Fernvale are definitely recycled (Belodina). Recycled forms may include Amorphognathus ordovicica, which occurs in fragmentary form, and possibly Phragmodus undatus; however, the abundance of these two elements and their distribution high in the Fernvale sections of Tennessee, are cited.

9) The stratigraphic range of Belodina, if not recycled, has been extended also into Lower Richmond of Tennessee. However, arguments which apply to the index of Amorphognathus, apply with special force to this form, which appears in even lesser numbers and displays convincing evidence of having been recycled.

10) There is little or no evidence for recycling of conodont elements in the Eden "Fernvale" strata of Oklahoma.

11) The presence of Devonian forms in the Eden "Fernvale" strata along Oklahoma State Highway 10 is considered herein as representing stratigraphic leakage from the overlying Sylamore Formation through solution cavities, faults, or joints.

Huffman (1958, p. 39) noted similar local cavities of the Frisco Limestone filled with Sylamore Sandstone.

12) An Upper Ordovician silicified ostracode fauna, previously undescribed from Oklahoma, is described, illustrated, and recorded upon the faunal range chart. This fauna contains Maquoketa, Decorah, and a few older Ordovician species.

13) A silicified ostracode fauna, discovered to be characteristic of "Fernvale" sections in both Northeastern Oklahoma and the Arbuckle Mountains corroborates the long-standing correlation of the "Fernvale" strata of the two areas. Conodonts indicate that the "Fernvale" of the Ozarks is correlative with the "Fernvale" sequence of the Arbuckle area. The sparse Northeastern Oklahoma "Fernvale" conodont fauna correlates satisfactorily with that of the shelf facies of the Robertson Ranch section of the Arbuckle area.

14) The distinctive Upper Ordovician Ostracoda Ceratopsis chambersi and Tetradella ulrichi are reported and illustrated for the first time from Oklahoma strata.

15) The geographic range of the ostracode genus Tallinella, previously known only in Europe, has been extended to the Mid-Continent Region.

16) The geologic range of the "fish-hook" conodont Ptiloncodus has been extended from Ohazy into Eden.

17) Some evidence suggests ecological control for certain conodont elements. The easternmost Arbuckle section studied (Robertson Ranch) contains an ozarkodinid-cyrtoniodid fauna differing somewhat from the conodont fauna of other Arbuckle sections. This difference is interpreted as reflecting paleoecologic differences which are related to the basinal and shelf facies described by Glaser in 1965.

18) Zygognathid and trichonodellid conodonts display a tendency for intergradation; this also obtains for eoligonodinid and cordylodid elements. The gradation may be infinitely gradual, or it may represent a finite number of distinct growth stages. If gradation be infinitely gradual, then natural statistical species based upon the relative number of each of its form species in a given conodont sequence may vary from specialist to specialist, depending upon the number of stages recognized by a given specialist in the gradational sequence. Furthermore, it is possible that gradations represent direct response to environmental factors, and only indirectly represent genetic factors. Thus, for some natural statistical species of conodonts, it may prove impossible to establish a simple ratio for its component gradational form species, as has been accomplished in the case of those natural statistical species whose component form species are not morphologically intergradational.

19) A Post-Viola-Pre-"Fernvale" unconformity in the Arbuckle Mountains, postulated by some geologists as representing a hiatus of Eden-Maysville duration, appears nonexistent. Field evidence indicates interfingering of "Fernvale" and Viola strata; and conodont elements range across this boundary without significant change. The unconformity

separating the "Fernvale" of Northeastern Oklahoma from the underlying Trenton Fite disappears in the subsurface between the Ozark Uplift and Arbuckle Mountains.

20) The age of the Sylvan Shale is in need of reinvestigation. In this study, the assignment of the "Fernvale" of the Arbuckle area to the Eden indicates that Templeton and Willman's surmise that the Sylvan Formation contains Eden and Maysville strata is quite plausible.

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APPENDIX

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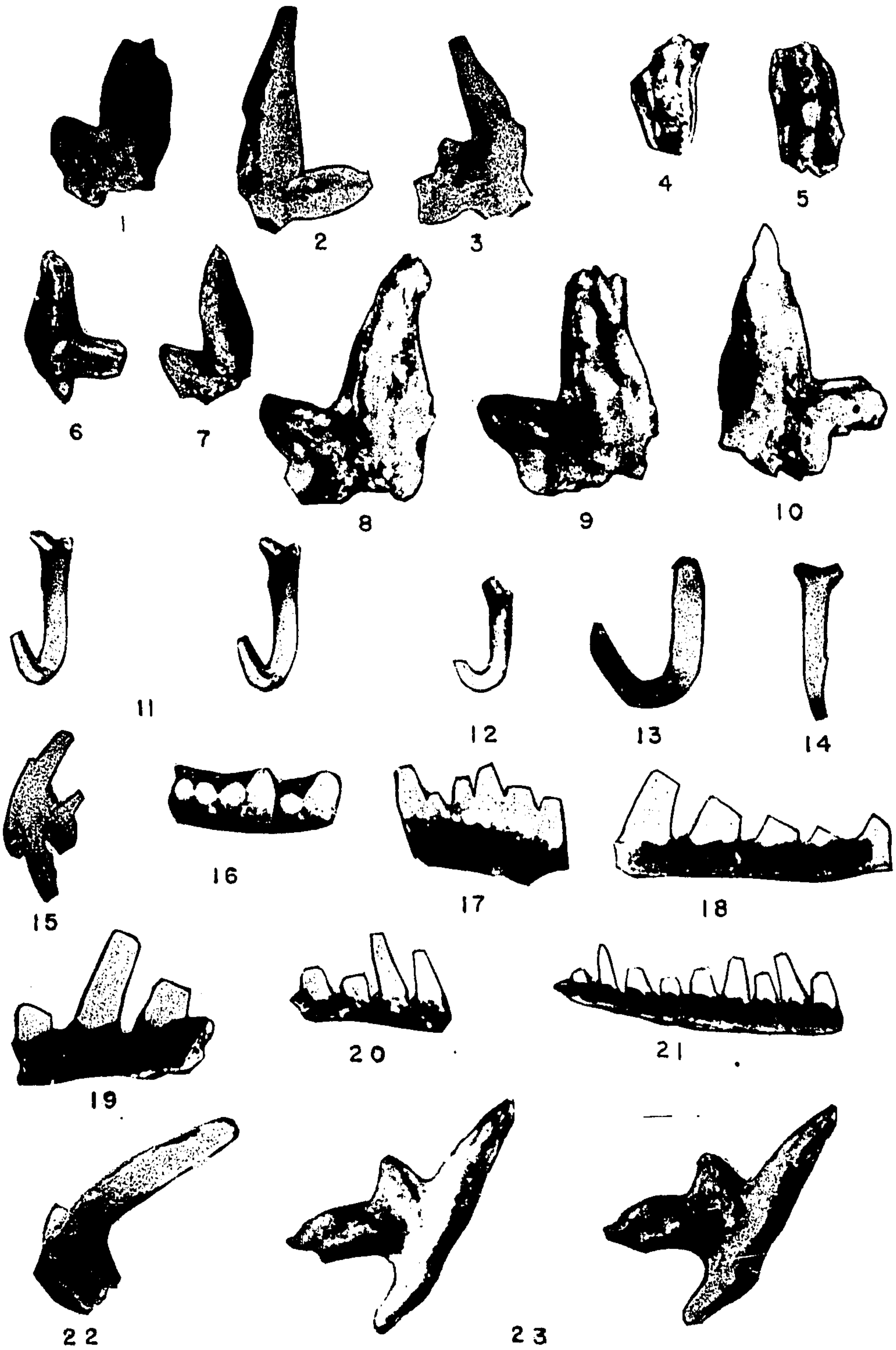
PLATE I



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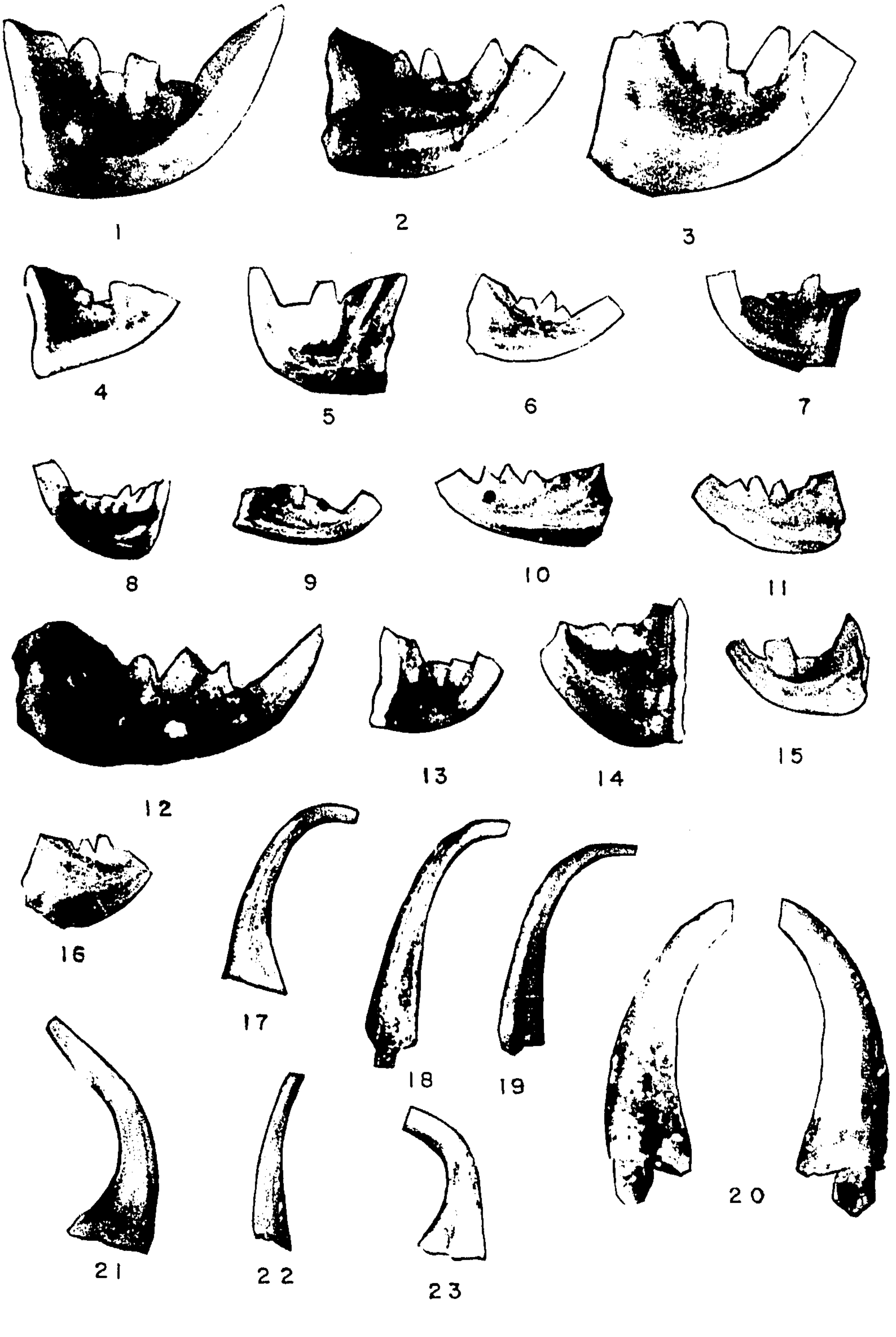

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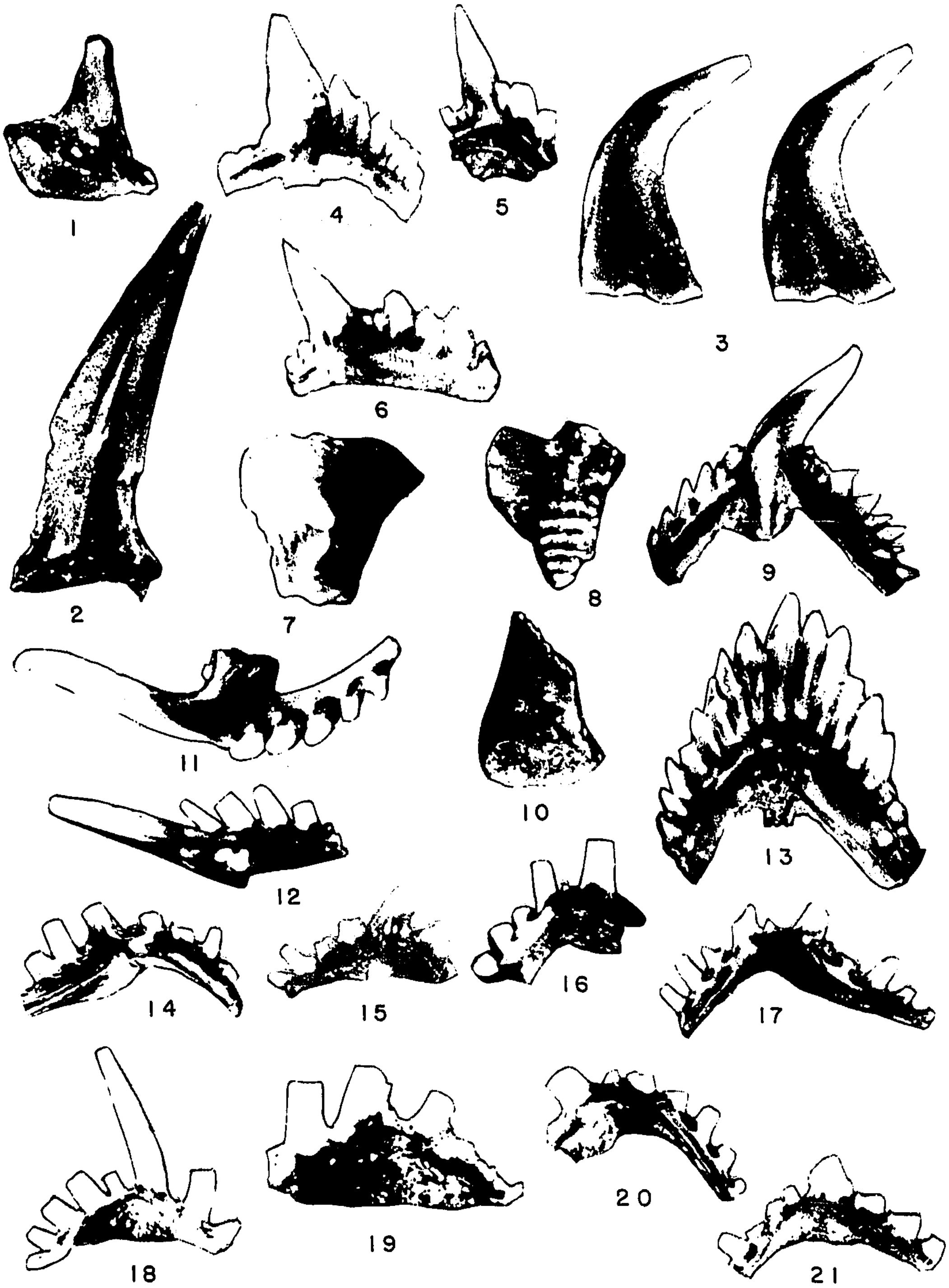
PLATE 3



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25	<u>Scolopodus insculptus</u> (Branson and Mehl)	165
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28	magnification 48X, Adkins section, sample A	
29	magnification 48X, Southall section, sample I	

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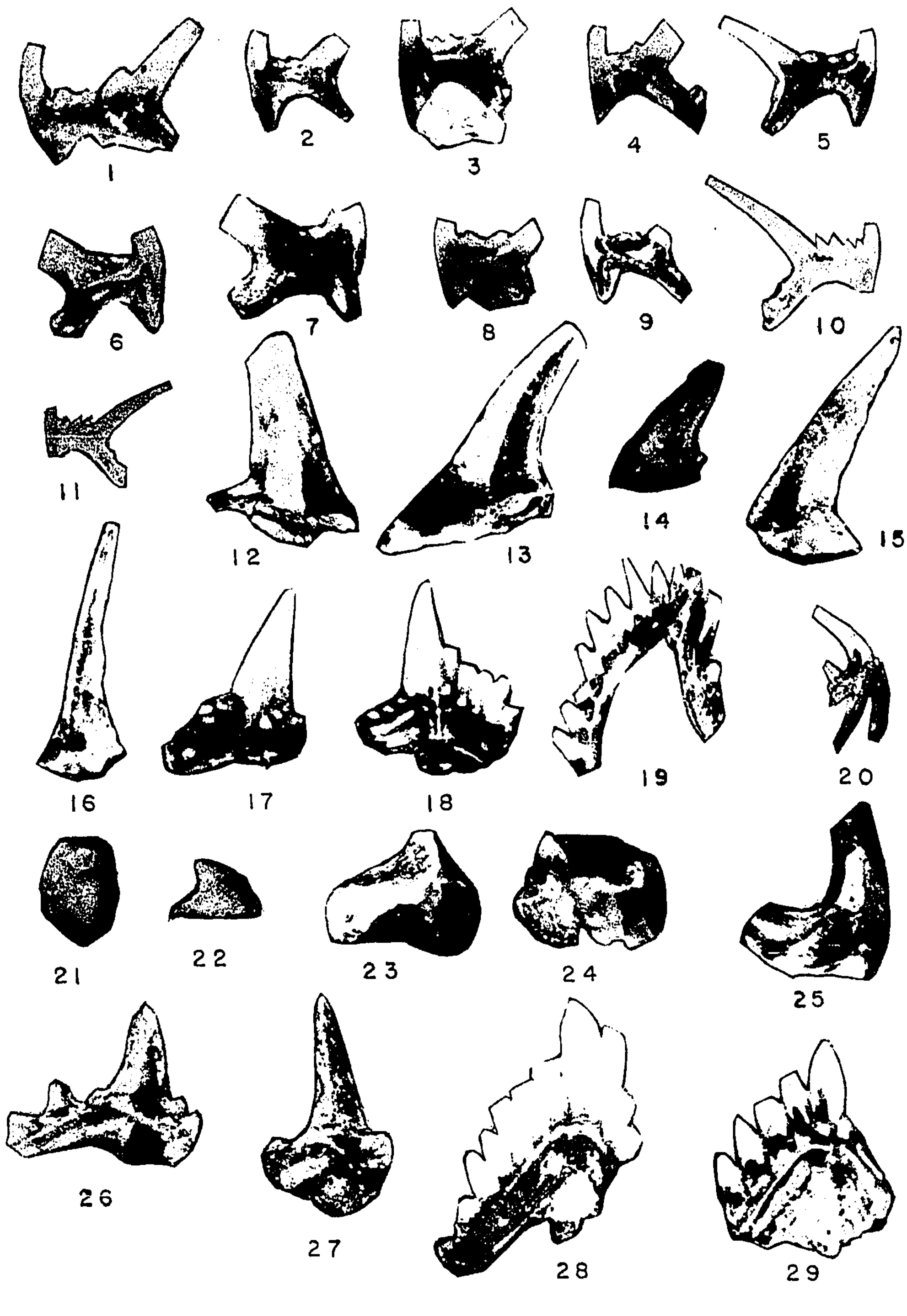

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6	magnification 48X, Highway 18 section, sample Z	
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8	magnification 48X, Mayberry section, sample B	
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16	<u>Oistodus</u> <u>abundans</u> (Branson and Mehl)	125
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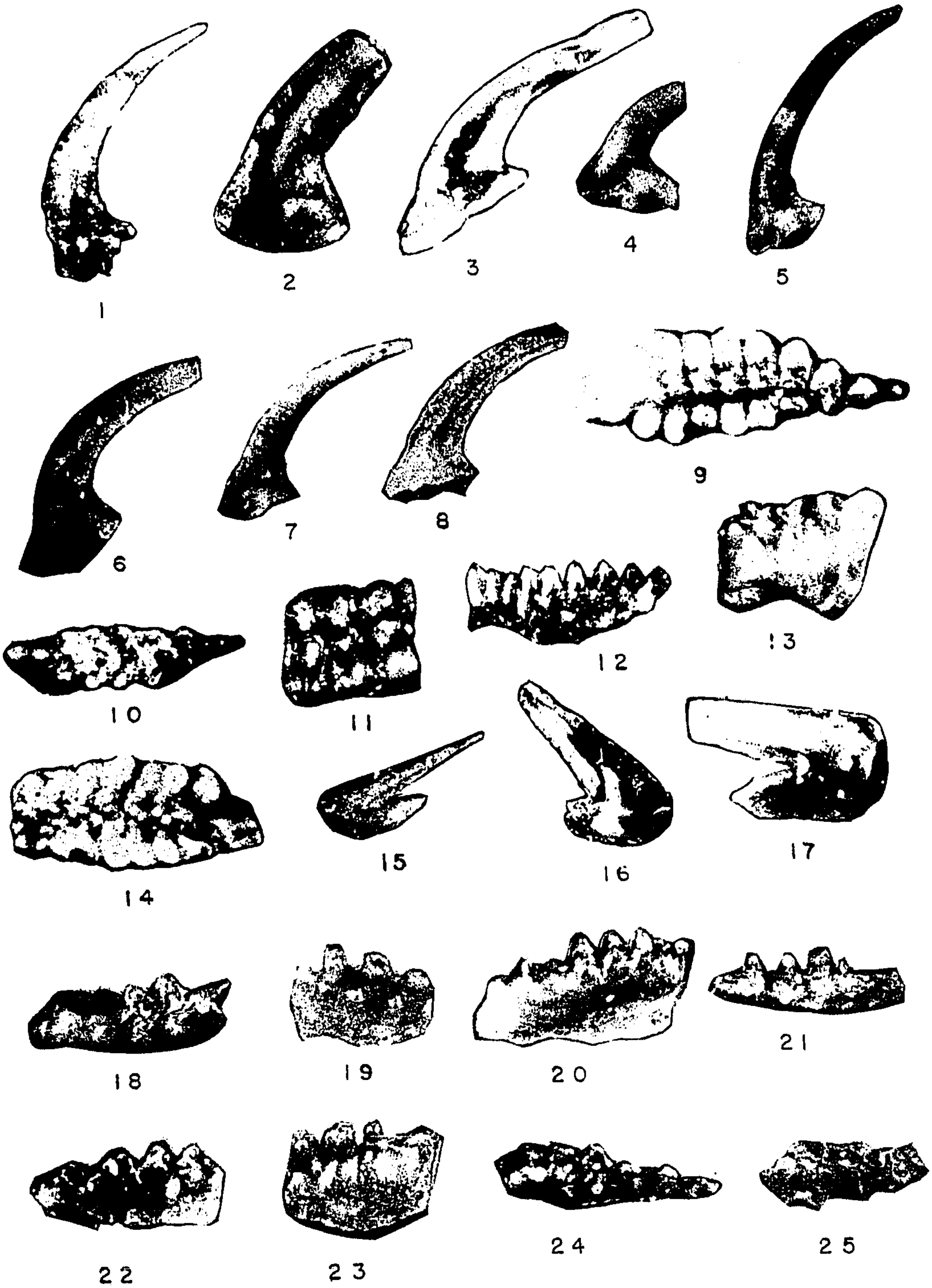
PLATE 5



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15	<u>Trichonodella</u> sp. B	173
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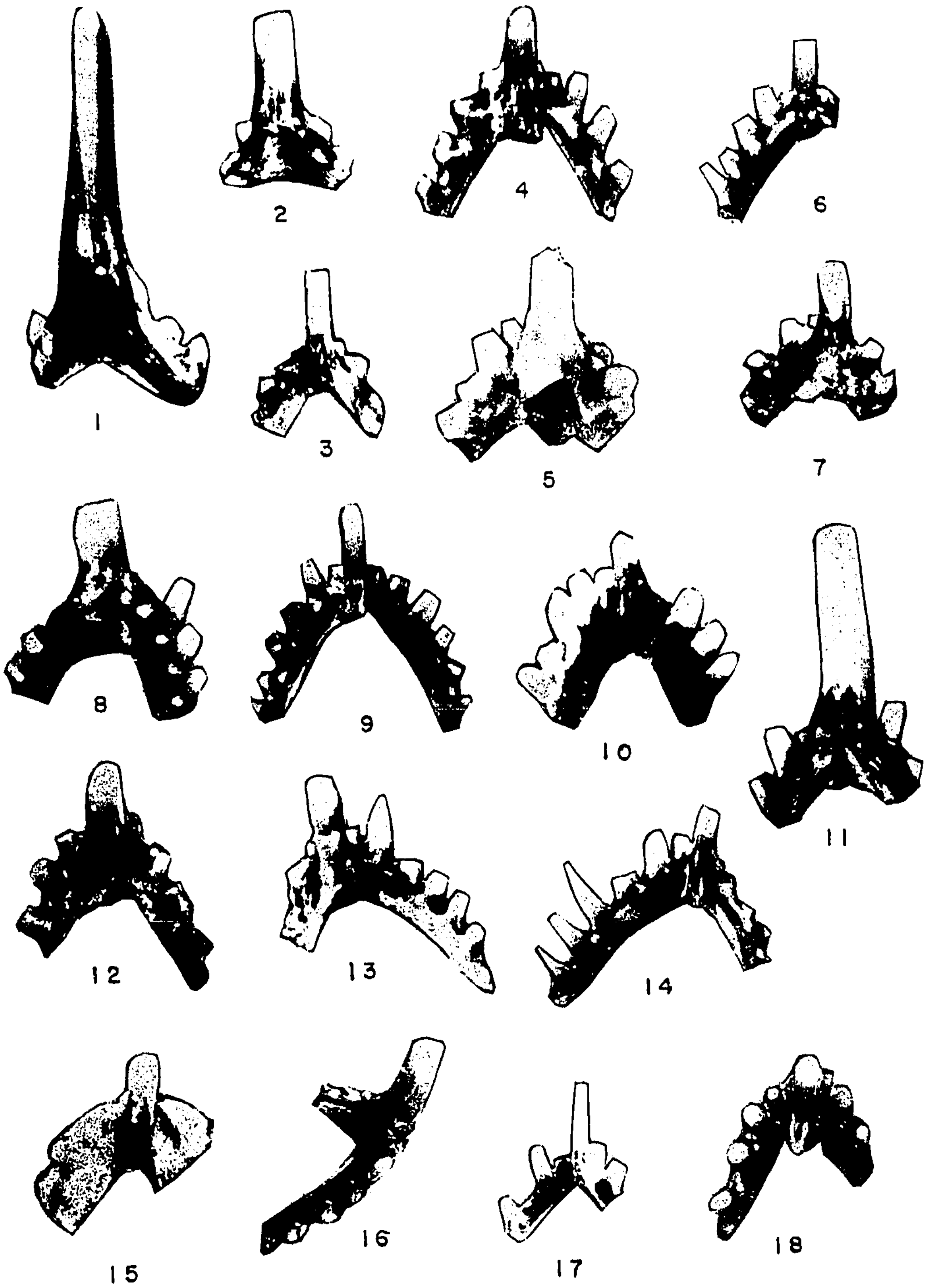
PLATE 6



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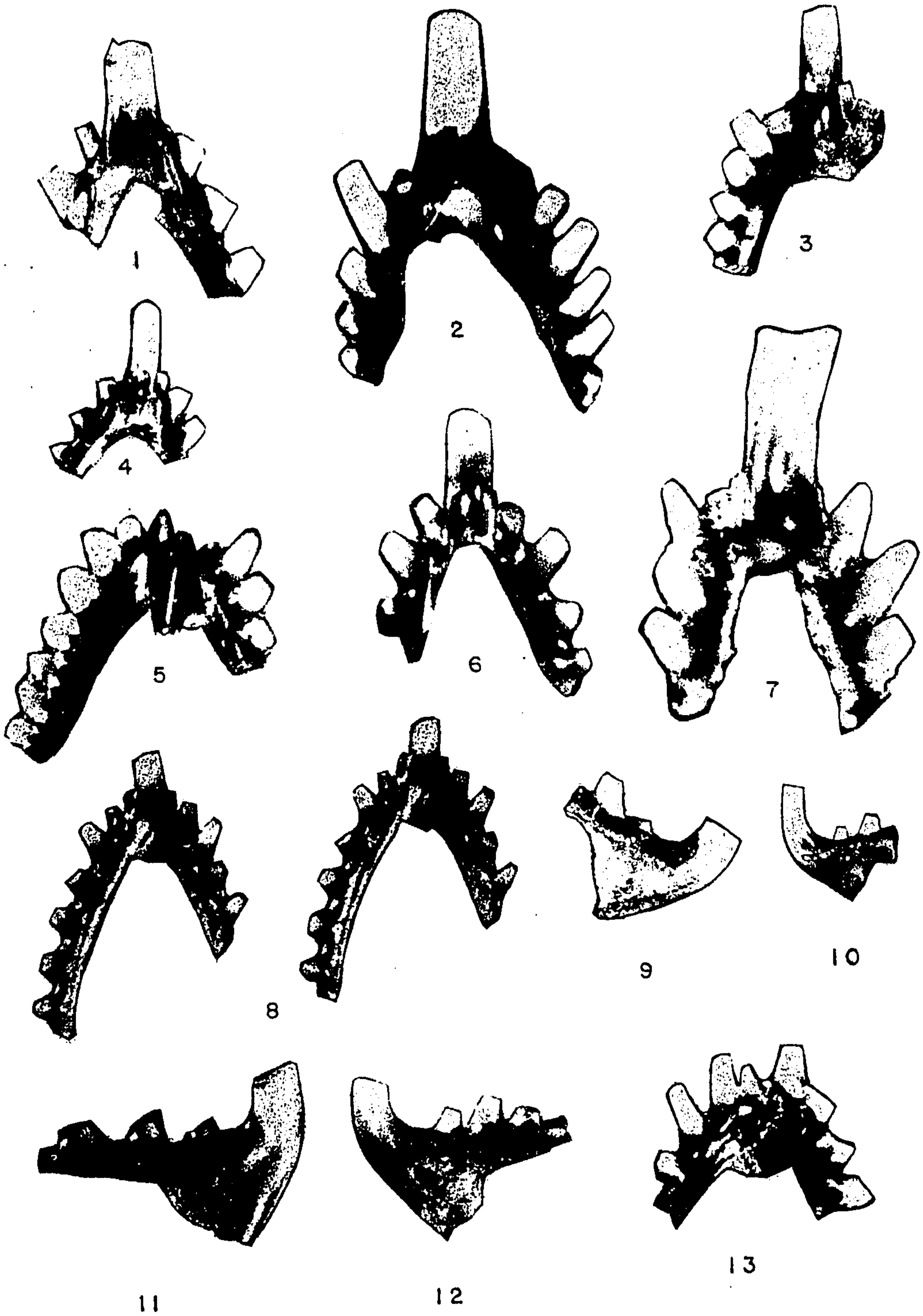

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12	magnification 48X, Franklin section, sample M	

PLATE 8.


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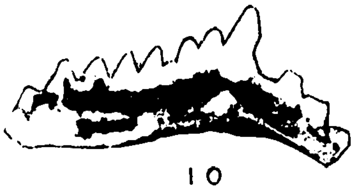
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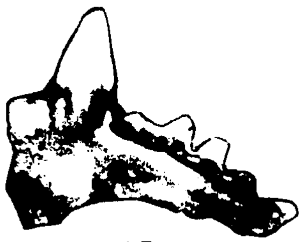
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PLATE 9

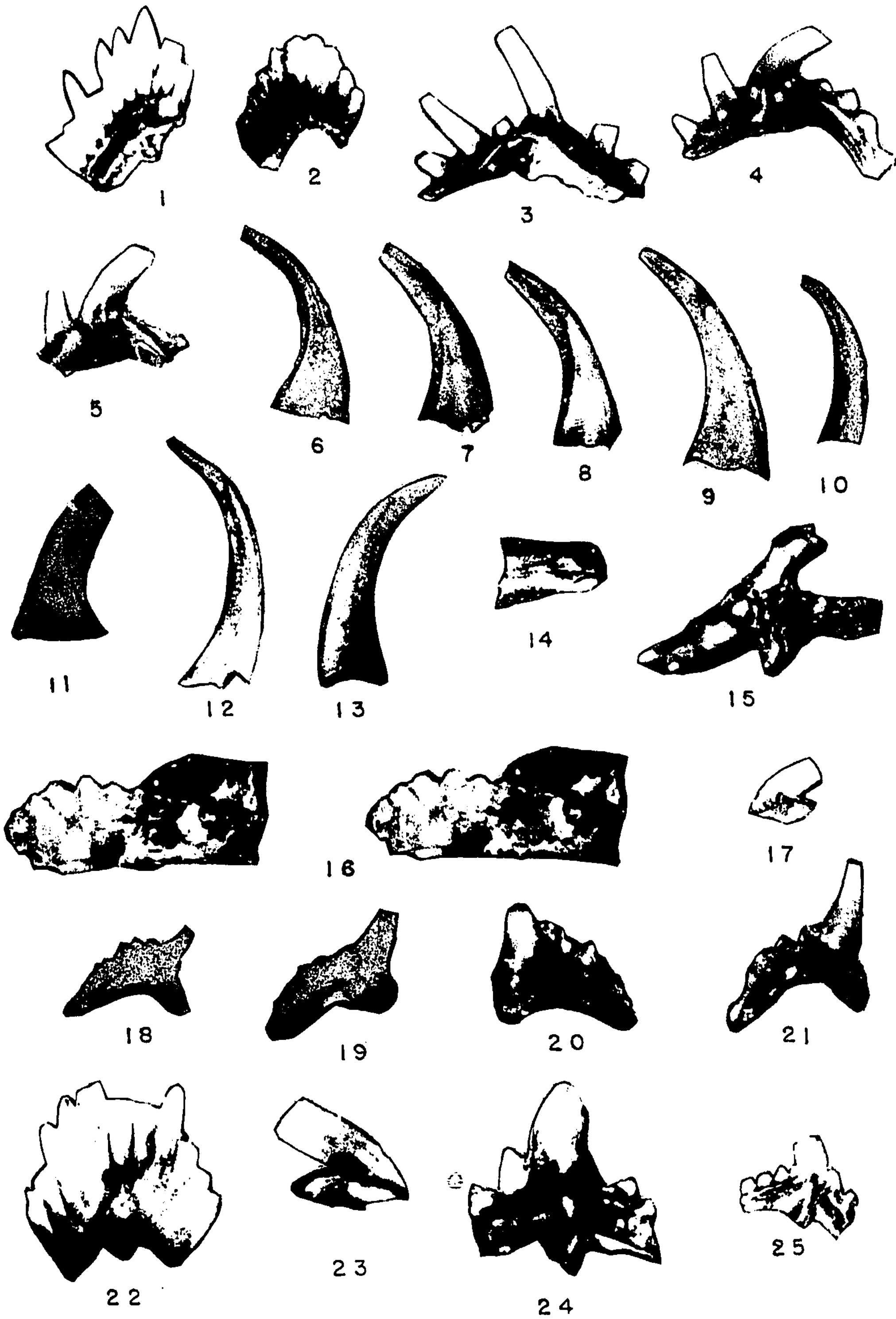

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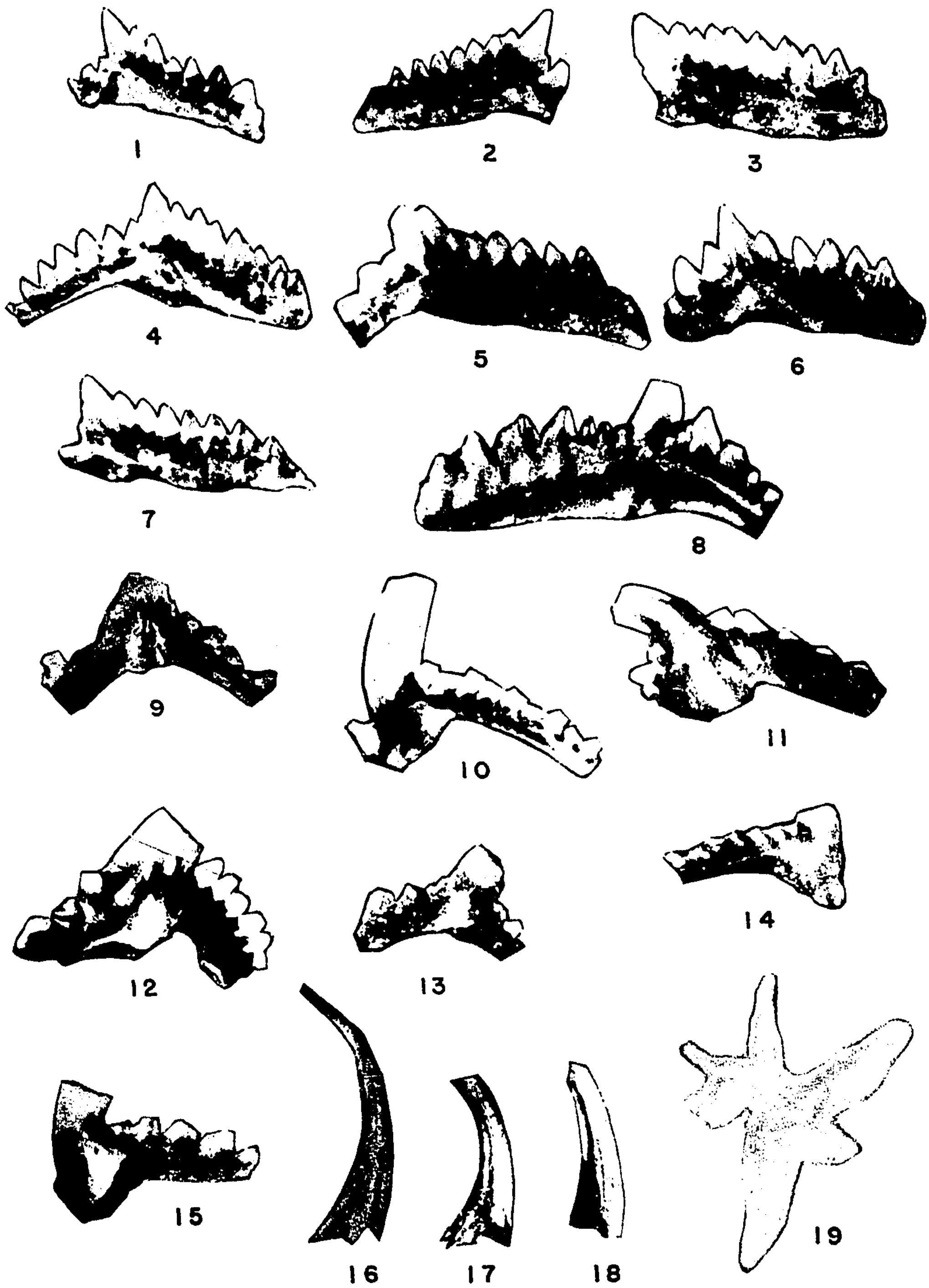
PLATE 10



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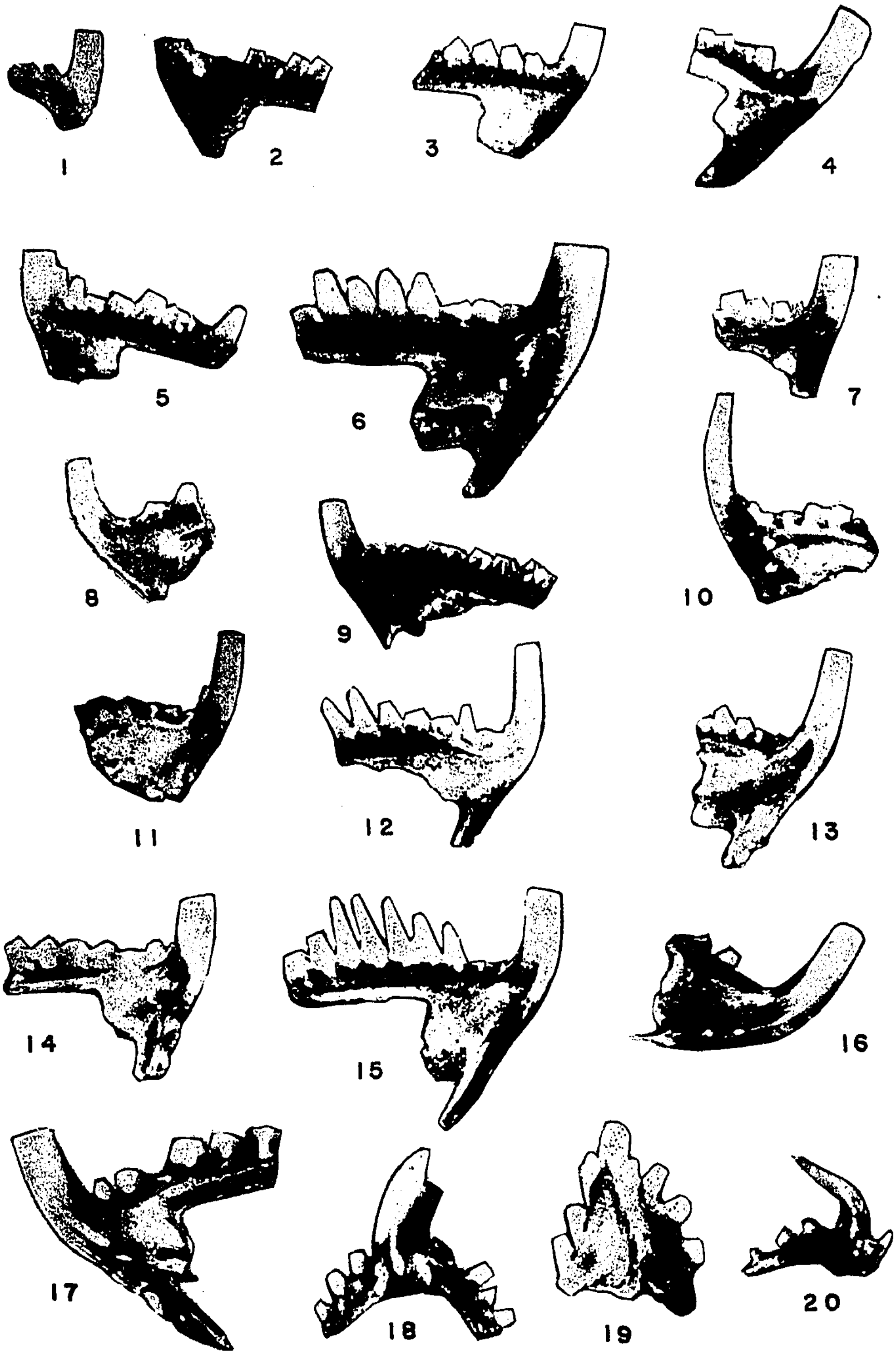

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10	<u>Oistodus</u> <u>abundans</u> Branson and Mehl	125
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11-13	<u>Aphelognathus</u> <u>grandis</u> Branson, Mehl, and Branson	74
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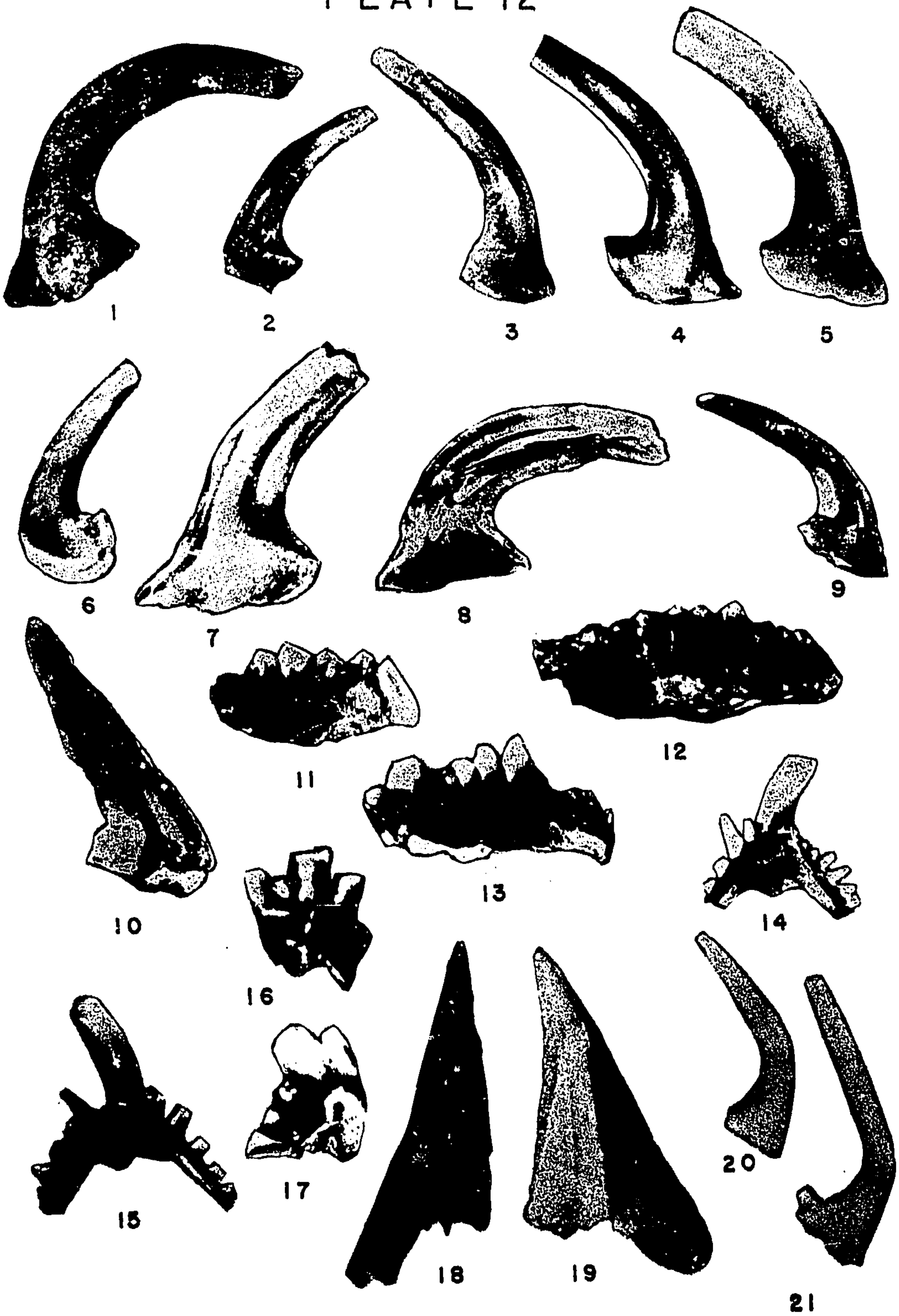
20	Scandodus sp. magnification 90X, Mayberry section, sample A	163
21	Multioistodus sp. cf. M. lateralis Cullison magnification 90X, Mayberry section, sample A	123

PLATE 12



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20	magnification 48X, Franklin section, sample I	
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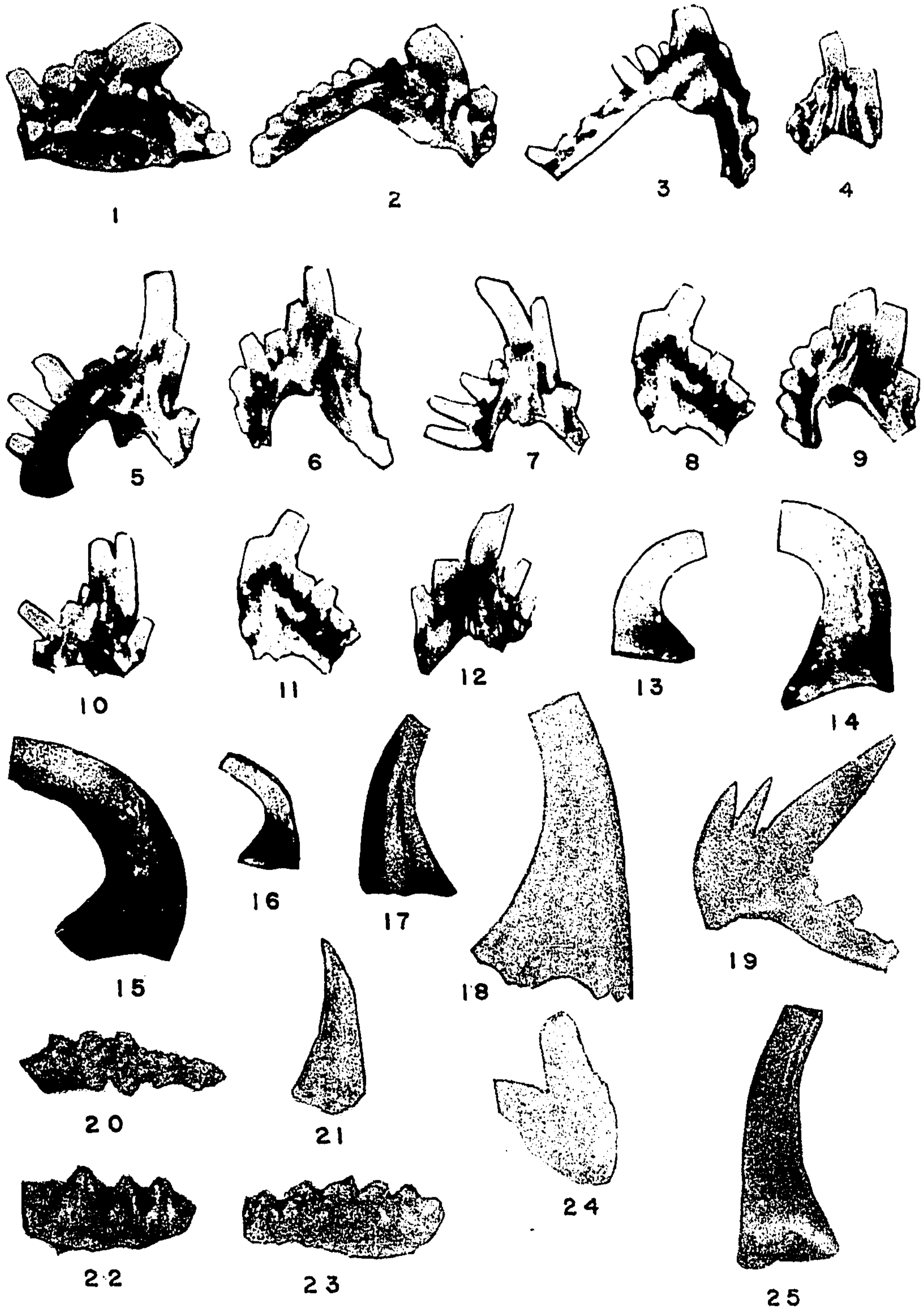
PLATE 13



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11	Drepanodus homocurvatus Lindström	96
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12-17	Prioniodina oregonia Branson, Mehl, and Branson var.	156
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23, 25	*Sagittodontus robusta* Rhodes	161
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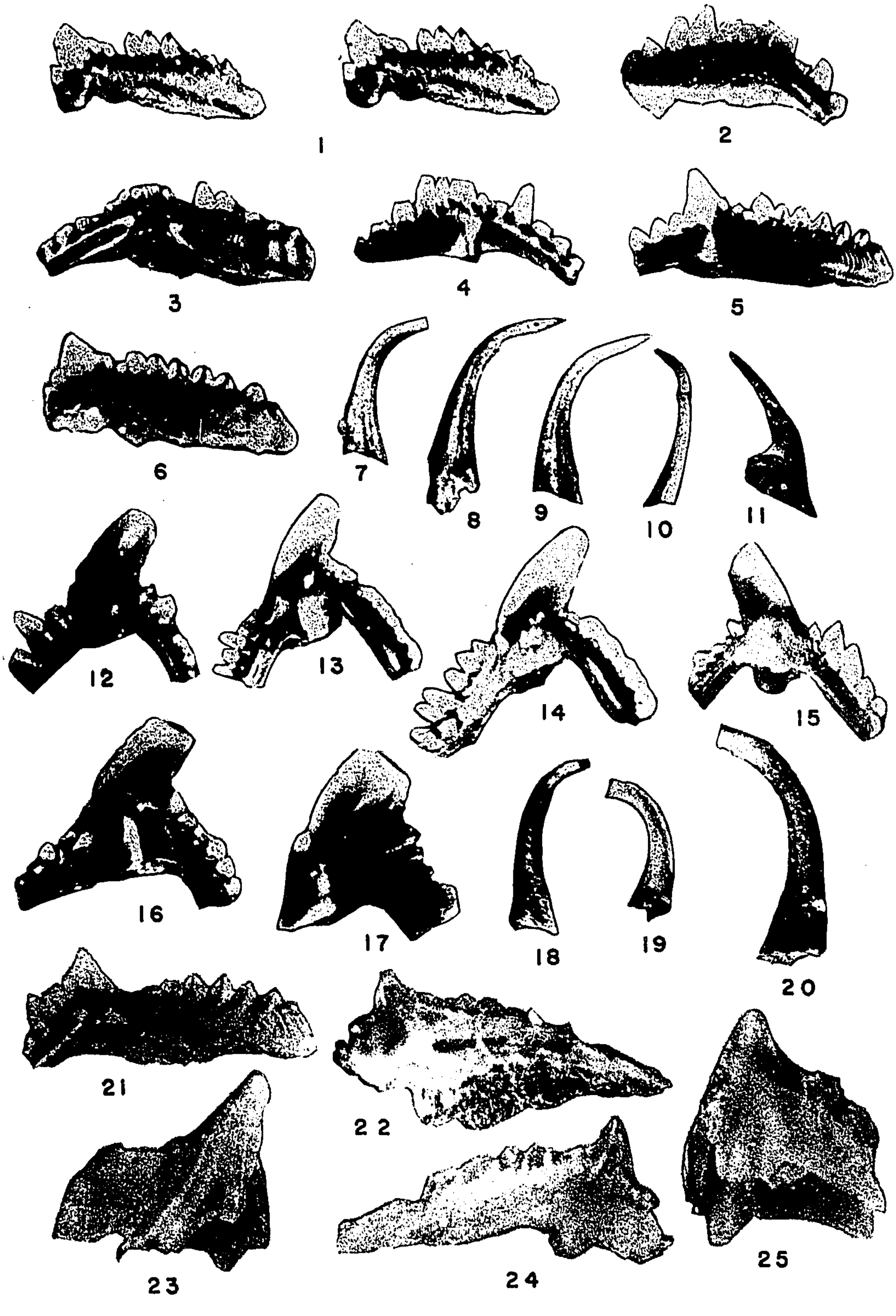

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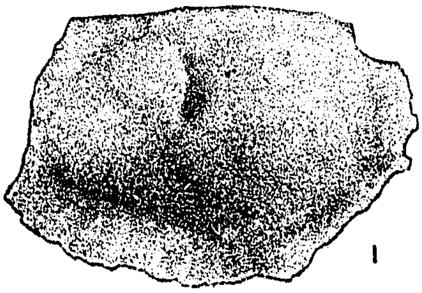

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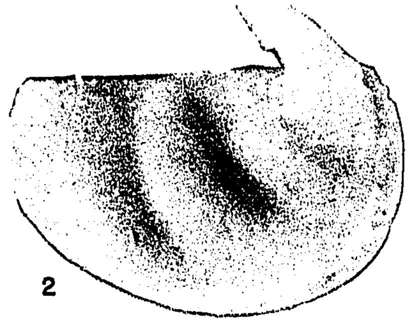

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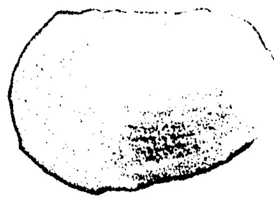

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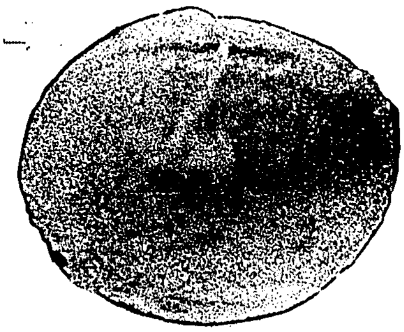

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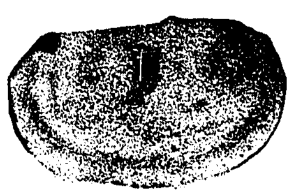

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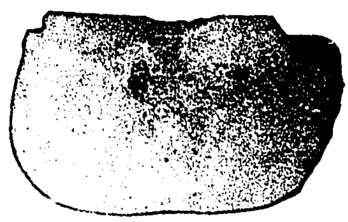

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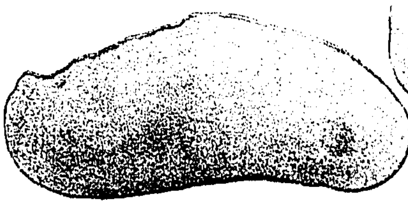

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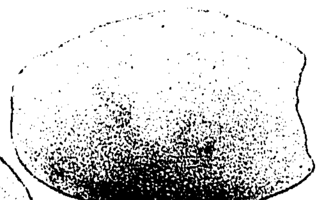

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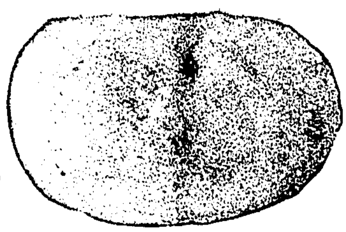

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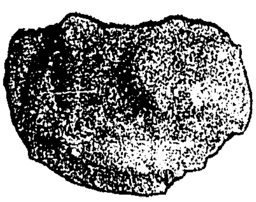

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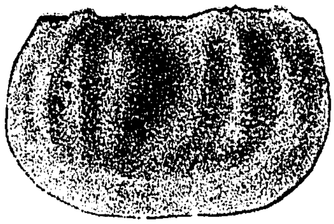

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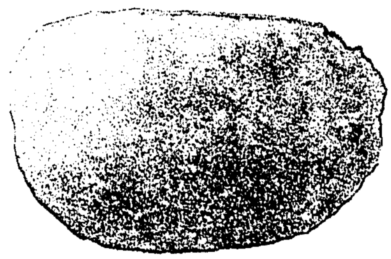

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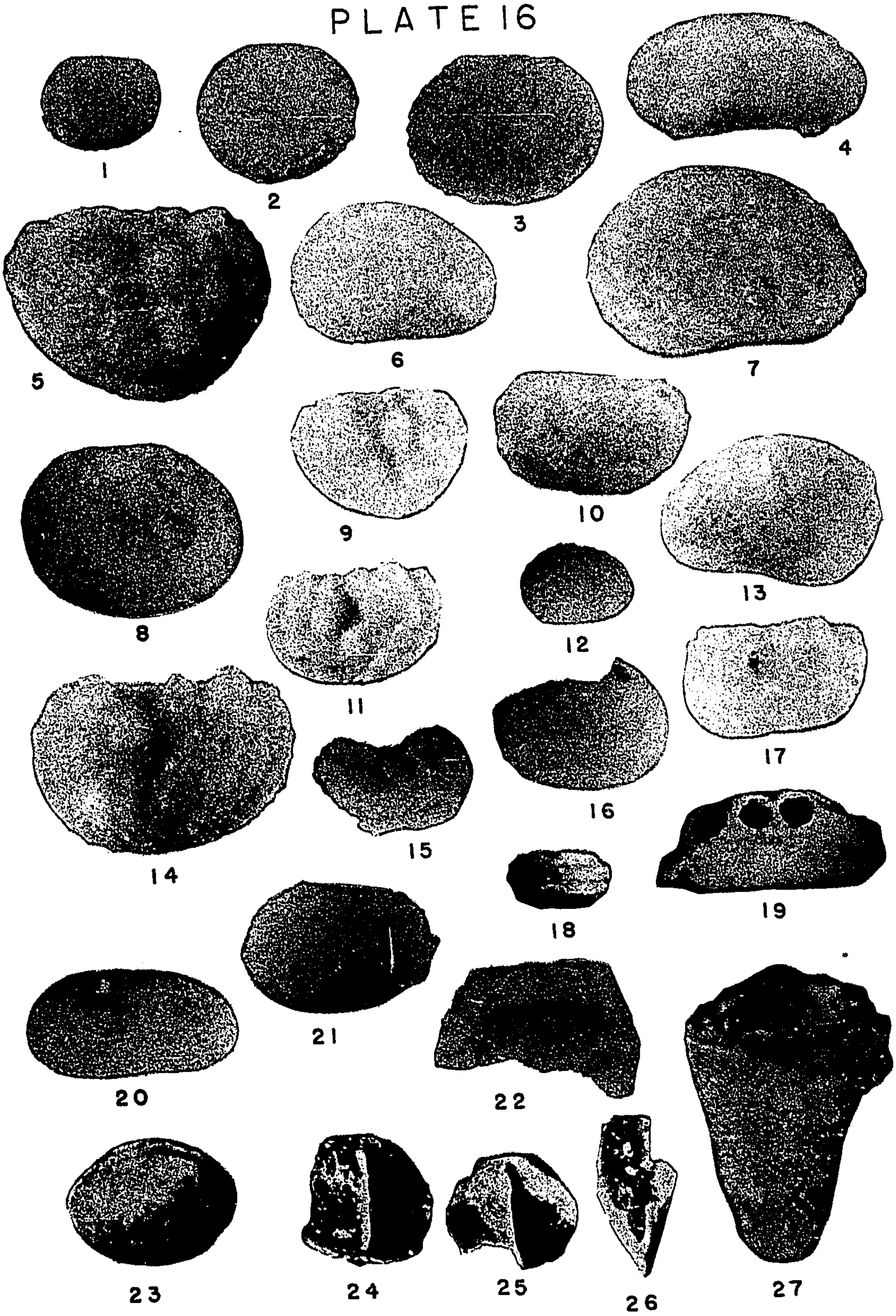
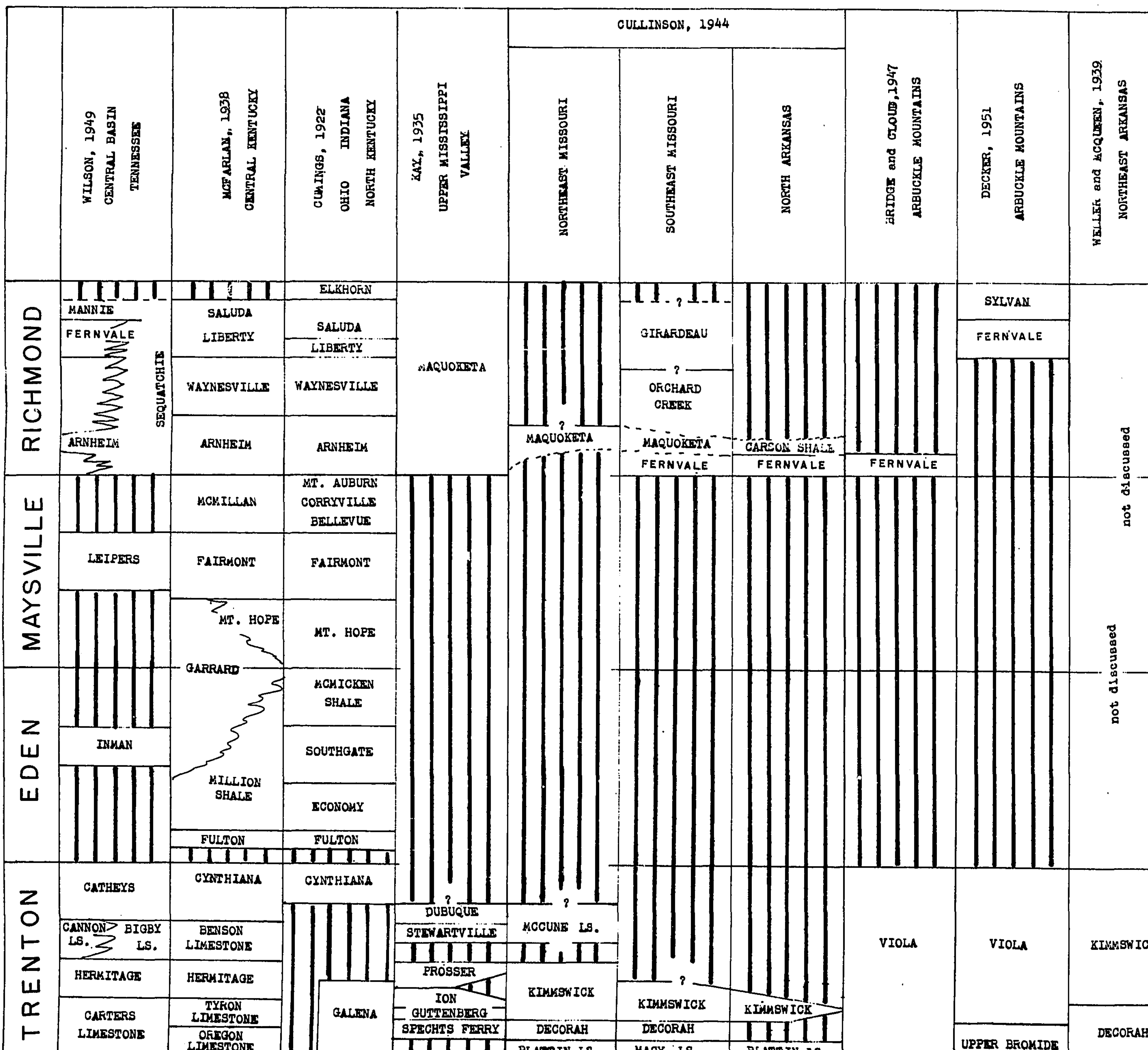
PLATE 16



CORRELATION CHART OF UPPER ORDOVICIAN STRATA

BY K.V. BORDEAU



	VIOLA			FERNVALE		BRIDGE and CLOUD, 1947 ARBUCKLE MOUNTAINS	
UPPER BROMIDE	VIOLA			FERNVALE	SYLVAN	DECKER, 1951 ARBUCKLE MOUNTAINS	
DECORAH	KIMMSWICK	not discussed	not discussed			WELLER and MCQUEEN, 1939 NORTHEAST ARKANSAS SOUTHEAST MISSOURI	
DECORAH	KIMMSWICK	not discussed	not discussed			MCQUEEN and GREENE, 1938 IOWA WISCONSIN	
	VIOLA	not discussed	not discussed			DAPPLES, 1955 OKLAHOMA	
	VIOLA	not discussed	not discussed			SOUTH OKLAHOMA	CRONENWET, 1955
	VIOLA	not discussed	not discussed			CENTRAL OKLAHOMA	CRONENWET, 1955
	FITE	not discussed	not discussed			NORTHEAST OKLAHOMA	CRONENWET, 1955
FITE				FERNVALE	SYLVAN	NORTHEAST OKLAHOMA	HARRIS, 1957
CORBIN RANCH	VIOLA			FERNVALE	SYLVAN	ARBUCKLE MOUNTAINS	HARRIS, 1957

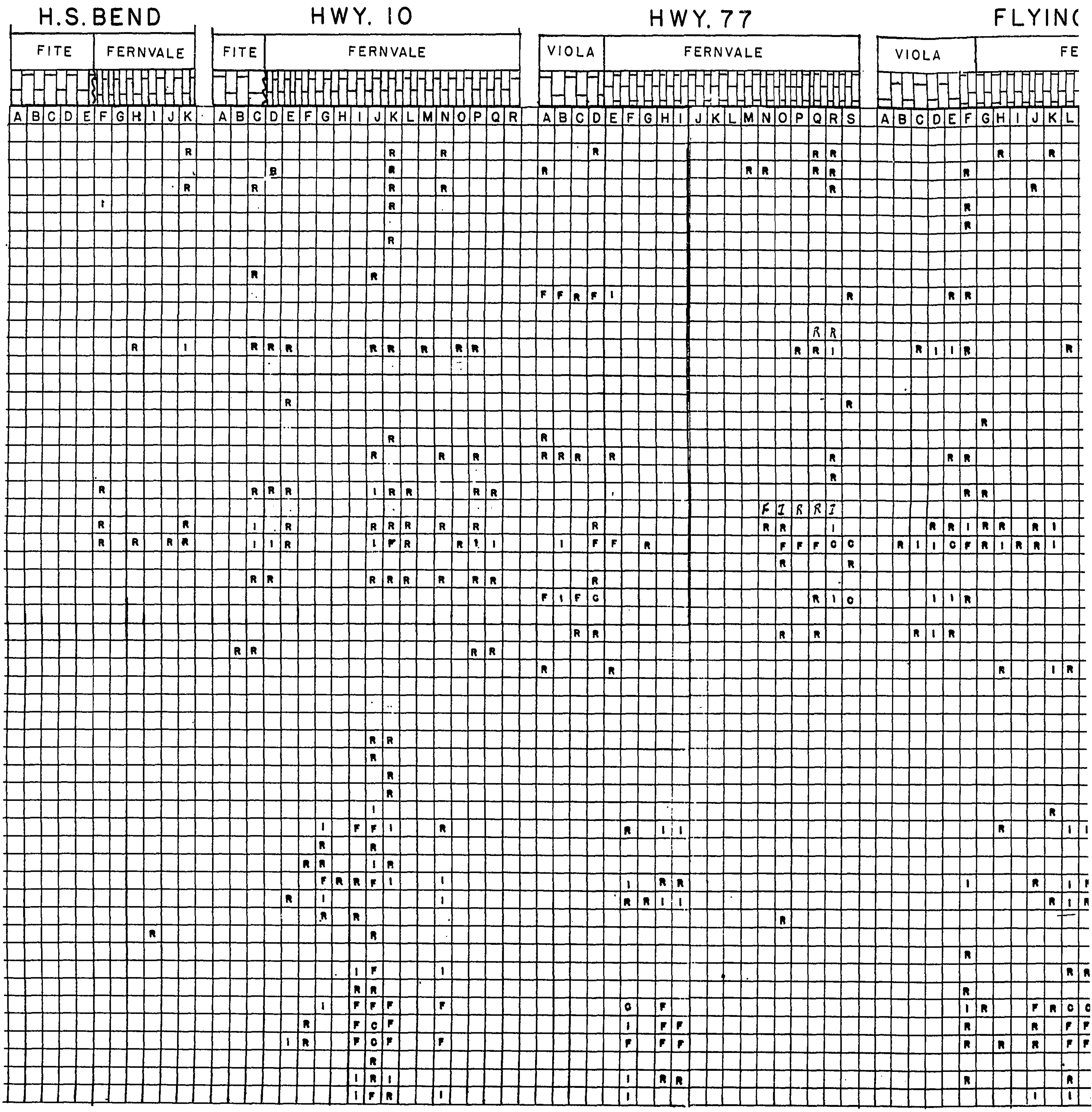
Reference	Area					
HARRIS, 1957	NORTHEAST OKLAHOMA	SYLVAN	FERNVALE			FITE
HARRIS, 1957	ARBUCKLE MOUNTAINS	SYLVAN	FERNVALE			VIOLA / CORBIN RANCH
HUFFMAN, 1958	NORTHEAST OKLAHOMA	SYLVAN	FERNVALE			FITE
SCHRAMM, 1964	ARBUCKLE MOUNTAINS			not discussed	not discussed	VIOLA / CORBIN RANCH
SCHRAMM, 1964	NORTHEAST OKLAHOMA			not discussed	not discussed	FITE / UPPER TYNER
IRELAND, 1965	ARBUCKLE MOUNTAINS			not discussed	not discussed	VIOLA
IRELAND, 1965	NORTHEAST OKLAHOMA			not discussed	not discussed	VIOLA (FITE)
IRELAND, 1965	KANSAS			not discussed	not discussed	VIOLA or KIMMSWICK
IRELAND, 1965	WEST TEXAS			not discussed	not discussed	MONTOYA
						V

VIOLA (FITE)		not discussed	not discussed	NORTHEAST OKLAHOMA	IRELAND, 1965
VIOLA or KIMMSWICK		not discussed	not discussed	KANSAS	
MONTOYA		not discussed	not discussed	WEST TEXAS	
VIOLA ?		not discussed	not discussed	ARBUCKLE MOUNTAINS	STADTLER, 1965
FITE ?		not discussed	not discussed	NORTHEAST OKLAHOMA	
not discussed		not discussed	not discussed FERNVALE	TENNESSEE	THIS PAPER
CORBIN RANCH VIOLA	FERNVALE ?		SYLVAN ?	ARBUCKLE MOUNTAINS	
FITE	FERNVALE ?		SYLVAN ?	NORTHEAST OKLAHOMA	

RANGE CHART 2

BY
K.V. BORDEAU

R = RARE 1-5
I = INFREQUENT 6-15
F = FREQUENT 16-30
C = COMMON 30+



FLYING L

HWY. 18

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	1	2	3	4	S	T	U	V	W	X	Y	Z	A	B	C	
VIOLA						FERNVALE																VIOLA																						FERNVALE							VIO			
							R			R						R						R												R														R	R	R			R	
					R									R	R			R	R			C							R	C			C		C									R					R					
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			R	R	1	R	R		R	1						R		R	R	1		R	1							1					F												R		1			R	1	1
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OKLAHOMA

SECTION | FORMATION | LITHOLOGY | SAMPLE NO.

HWY. 18

SAMPLE NO.	K	L	M	N	O	P	Q	1	2	3	4	S	T	U	V	W	X	Y	Z
FORMATION	OLA												FERNVALE						
ACONTIODUS sp.																			
AMBALODUS TRIANGULARIS			R														R	R	R
AMORPHOGNATHUS ORDOVICICA		C		C									R					R	
BELODINA COMPRESSA													R					R	
BELODINA DIMINUTIVA																			
BELODINA INCLINATA																			
BELODINA ORNATA																			
CORDYLODUS DELICATUS																			
CYRTONIODUS FLEXUOSUS																			
DICHOGNATHUS EXTENSA																			I
DREPANODUS CAVUS													R						
DREPANODUS CONCAVUS							R							R					R
DREPANODUS HOMOCURVATUS						F													F
DREPANODUS sp.																			
FALODUS PRODENTATUS																			
KEISLOGNATHUS GRACILIS				R															
LEPODUS sp. A																			
LEPODUS sp. B																			
OISTODUS ABUNDANS																			
OISTODUS FORCEPS		R																	
OZARKODINA CONCINNA																			
PANDERODUS ACOSTATUS																R			
PANDERODUS COMPRESSUS				F												R		I	
PANDERODUS GRACILIS		I		F		F							R		I			I	C
PANDERODUS PANDERI						R													
PANDERODUS UNICOSTATUS																			
PHRAGMODUS UNDATUS																			F
PLECTOSPATHODUS sp.																			
PTILONCODUS sp.																			
SCOLOPODUS INSCULPTUS																			
SCOLOPODUS cf. QUADRAPLICATUS													R						
TRICHONODELLA sp. B																			
EOHOLLINA DEPRESSA																			
EURYCHILINA sp.																			
THOMASATIA sp. A																			
THOMASATIA sp. B																			
? EUPRIMITIA LABIOSA																			
CERATOPSIS CHAMBERSI																			
TALLINELLA sp.																			
TETRADELLA SEPTINODA																			
TETRADELLA ULRICHI																R			
APARCHITES cf. FIMBRIATA																			
APARCHITES SUBORBICULARIS																			
APARCHITES sp.																			
APARCHITES MACRUS																			
CRYPTOPHYLLUS sp.																			
PRIMITIELLA sp.																			
SCHMIDTELLA cf. AFFINIS															I	I			
"BYTHOCYPRIS" cf. CYLINDRICA															R	R			
"BYTHOCYPRIS" ? cf. CYLINDRICA															I	I			
"BYTHOCYPRIS" cf. FURNISHI																			
MACROCYPROIDES TRENTONENSIS																			
PUNCTAPARCHITES cf. RUGOSA																I			

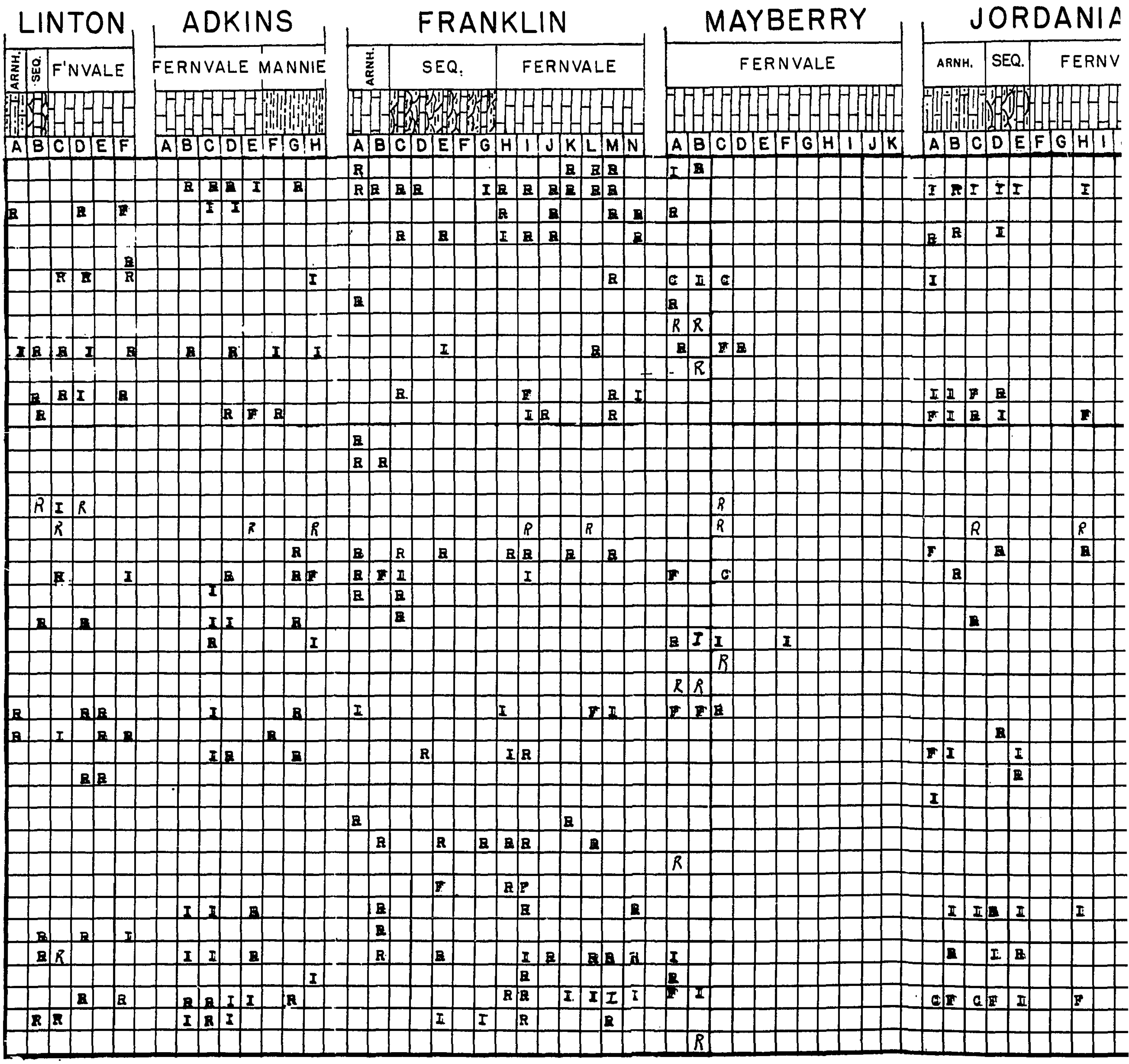
ROB. RANCH

SAMPLE NO.	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
FORMATION	VIOLA						FERNVALE													
ACONTIODUS sp.							R													
AMBALODUS TRIANGULARIS			R																	
AMORPHOGNATHUS ORDOVICICA																				
BELODINA COMPRESSA	R		R	R			I	R	R											
BELODINA DIMINUTIVA				R					R			R								
BELODINA INCLINATA	R						R													
BELODINA ORNATA																				
CORDYLODUS DELICATUS	R	R		C	I		R	R	R											
CYRTONIODUS FLEXUOSUS	R	R		F	F		F	R												
DICHOGNATHUS EXTENSA																				
DREPANODUS CAVUS																				
DREPANODUS CONCAVUS																				
DREPANODUS HOMOCURVATUS	F		I	I	I		F	R			R	R								
DREPANODUS sp.																				
FALODUS PRODENTATUS	R																			
KEISLOGNATHUS GRACILIS																				
LEPODUS sp. A			R	R																
LEPODUS sp. B				R																
OISTODUS ABUNDANS	R	R																		
OISTODUS FORCEPS	R																			
OZARKODINA CONCINNA	F	I	I	C	C		F	I	F		R	I								
PANDERODUS ACOSTATUS							R		R											
PANDERODUS COMPRESSUS		R	I	I	R		F		R		R	R								
PANDERODUS GRACILIS	R	I	F	C	C		F	R	I		I	I								
PANDERODUS PANDERI			R	R																
PANDERODUS UNICOSTATUS																				
PHRAGMODUS UNDATUS																				
PLECTOSPATHODUS sp.	R																			
PTILONCODUS sp.																				
SCOLOPODUS INSCULPTUS		R																		
SCOLOPODUS cf. QUADRAPLICATUS																				
TRICHONODELLA sp. B	R			I																
EOHOLLINA DEPRESSA																				
EURYCHILINA sp.																				
THOMASATIA sp. A																				
THOMASATIA sp. B																				
? EUPRIMITIA LABIOSA																				
CERATOPSIS CHAMBERSI																				
TALLINELLA sp.																				
TETRADELLA SEPTINODA																				
TETRADELLA ULRICHI																				
APARCHITES cf. FIMBRIATA																				
APARCHITES SUBORBICULARIS																				
APARCHITES sp.																				
APARCHITES MACRUS																				
CRYPTOPHYLLUS sp.																				
PRIMITIELLA sp.																				
SCHMIDTELLA cf. AFFINIS																				
"BYTHOCYPRIS" cf. CYLINDRICA																				
"BYTHOCYPRIS" ? cf. CYLINDRICA																				
"BYTHOCYPRIS" cf. FURNISHI																				
MACROCYPROIDES TRENTONENSIS																				
PUNCTAPARCHITES cf. RUGOSA																				

RANGE CHART 1

R = RARE 1-5
I = INFREQUENT 6-15
F = FREQUENT 16-30
C = COMMON 30+

BY
K.V. BORDEAU



RE 1-5
FREQUENT 6-15
EQUENT 16-30
MMON 30+

MAYBERRY										JORDANIA												SOUTHALL														TENNESSEE SECTION
FERNVALE										ARNH.			SEQ.		FERNVALE							ARNH.			FERNVALE							MANNIE				FORMATION
																																				LITHOLOGY
B	C	D	E	F	G	H	I	J	K	A	B	C	D	E	F	G	H	I	J	K	L	A	B	C	D	E	F	G	H	I	J	K	L	M	N	SAMPLE NO.
R																															R				R	AMORPHOGNATHUS ORDOVICICA
										I	R	I	I	I			I					R	I	F	F	I		I		F	I		R			APHELOGNATHUS GRANDIS
																							R		I	R			I		R				R	CORDYLODUS DELICATUS
										R	R		I										I		F	I		I		I	R					CORDYLODUS PLATTINENSIS
																																				CORDYLODUS sp.
I	C									I																		R							R	CYRTONIODUS FLEXUOSUS
																																				DICHOGNATHUS EXTENSA
R																																				DREPANODUS CONCAVUS
	F	R																						I						R	R				R	DREPANODUS HOMOCURVATUS
R																																				DREPANODUS sp.
										I	I	F	R										I	I		F		I	F							EOLIGONODINA RICHMONDENSIS
										F	I	R	I				F						R	F		I		F	I	C	I					EOLIGONODINA ROBUSTA
																																				FALODUS ? sp.
																																				ICRIODINA SUPERBA ACUTA
																								R												LIGONODINA cf. FAIRMONTENSIS
	R																																			OISTODUS ABUNDANS
	R											R					R								R											OISTODUS FORCEPS
										F			R				R						R	I	I	R		R			R					OULODUS MEDIOCRIS
	C										R												R			R		R	R		R	R				OZARKODINA CONCINNA
																							I	I	R				R	R					R	OZARKODINA ROBUSTA
												R													R	R			R				R			OZARKODINA TENUIS
I	I			I																																PANDERODUS GRACILIS
	R																													R						PANDERODUS PANDERI
R																																				PANDERODUS UNICOSTATUS
F	R																						R					R							R	PHRAGMODUS UNDATUS
													R													R	R					R	R		I	PRIONIODINA DELECTA
										F	I			I									R	F		I		I		I				R		PRIONIODINA OREGONIA
														R															R							PRIONIODINA OREGONIA var.
										I														R					R		R					RHIPIDOGNATHUS SYMMETRICA
																								I					I							RHIPIDOGNATHUS PAUCIDENTATA
																																				SAGITTODONTUS ROBUSTUS
																																				SCANDODUS sp.
																																				SCYPHIODUS cf. PRIMUS
											I	I	R	I			I						I	R	I	R		R	I	F	I	R			R	TRICHONODELLA RECURVA
																																				TRICHONODELLA cf. RECURVA
											R		I	R										R	I	R			R	F					I	TRICHONODELLA UNDULATA
																																				TRICHONODELLA sp. A
I										C	F	C	F	I			F						I	I	C	I		I	F	F	I			R	R	ZYGOGNATHUS DEFORMIS
																						R	I			I		R		F					R	ZYGOGNATHUS PYRAMIDALIS
R																																				ZYGOGNATHUS sp.