Stratigraphy and Conodont Paleontology of the Salamonie Dolomite and Lee Creek Member of the Brassfield Limestone (Silurian) in Southeastern Indiana and Adjacent Kentucky

BULLETIN 40

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Stratigraphy and Conodont Paleontology of the Salamonie Dolomite and Lee Creek Member of the Brassfield Limestone (Silurian) in Southeastern Indiana and Adjacent Kentucky

By ROBERT S. NICOLL and CARL B. REXROAD

DEPARTMENT OF NATURAL RESOURCES
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Stratigraphy and Conodont Paleontology of the Salamonie Dolomite and Lee Creek Member of the Brassfield Limestone (Silurian) in Southeastern Indiana and Adjacent Kentucky

By ROBERT S. NICOLL and CARL B. REXROAD

Abstract

Zonation established by study of the conodont faunas of the Lee Creek Member (new member) of the Brassfield Limestone and of the Salamonie Dolomite, both of Silurian age, from 42 sections in southeastern Indiana and north-central Kentucky differs from the conodont zonation established by O. H. Walliser in 1964 for the lower Silurian and lower part of the middle Silurian rocks of the Carnic Alps of Europe. Three conodont assemblage zones are named. In ascending order these are the Icriodina irregularis Assemblage Zone, the Neospathognathodus celloni Assemblage Zone, and the Pterospathodus amorphognathoides-Spathognathodus ranuliformis Assemblage Zone. These zones correspond in general with the upper part of Walliser’s Bereich I and with his celloni- and amorphognathoides-Zones. The new name Lee Creek Member is applied to a thin dolomite unit at the top of the Brassfield Limestone.

Fifty-nine named species, 16 of them new, belonging to 22 genera, two of them new, were identified from about 8,900 specimens obtained in this study. The new taxa include the genera Diadelognathus and Neospathognathodus and the species Diadelognathus compressus, D. excertus, D. primus, Drepanodus aduncus, Ligonodina petila, Neospathognathodus bullatus, N. ceratoides, N. latus, Ozarkodina hanoverensis, O. neoquertneri, Spathognathodus hadros, S. polinclinus, Synprioniodina? variabilis, Trichonodella asymmetrica, T.? expansa, and T. papilio. Two species each of Diadelognathus and of Paltodus, and one each of Carniodus, Distacodus?, and Trichonodella are described but not named.

Introduction

PURPOSE AND SCOPE

Biostratigraphic study of the Lee Creek Member (new member) of the Brassfield Limestone and the Salamonie Dolomite is part of a
Figure 1. Map showing collecting localities in the Brassfield Limestone and Salamonie Dolomite. Precise locations are given in the section “Collecting Localities.” Figure 3 shows selected columnar sections on line of section.
detailed study of Silurian conodont biostratigraphy presently being conducted by the Indiana Geological Survey. Although the major emphasis of the larger study is on rocks of the Michigan Basin in northern Indiana, the correlation of these strata with the Silurian outcrop in southeastern Indiana is imperfectly understood. The present study, then, was undertaken to establish conodont zones in the upper part of the Brassfield Limestone and in the overlying Salamonie Dolomite in southeastern Indiana with the hope of tracing these zones into northern Indiana.

Material for this study was collected from 42 sections measured along the Silurian outcrop between Richmond, Ind., and Bardstown, Ky. (fig. 1). Samples were collected from many short sections to establish the relationship of the Lee Creek Member to the lower part of the Brassfield and to the overlying Osgood Member of the Salamonie Dolomite (fig. 2).

REGIONAL SETTING

Rocks of Silurian age (fig. 2) crop out along the west flank of the Cincinnati Arch from Raywick, Ky., northward to the vicinity of Richmond, Ind. The topographic expression of the Brassfield Limestone and the Osgood Member of the Salamonie Dolomite is subdued, but the Laurel Member of the Salamonie forms prominent cliffs along streams and river bluffs. The Brassfield is commonly associated with high waterfalls that drop over cliffs formed by the underlying resistant Saluda Formation (Ordovician), but normally the Brassfield forms only minor falls short distances upstream from the major falls.

The Osgood is generally poorly exposed on hill slopes, although the more resistant limestone units may project conspicuously. Fine-grained dolomitic limestone lying at the base of the Osgood is commonly associated with the Brassfield as a resistant unit. The early name of the Laurel, the Cliff Limestone, suggests its common topographic expression as ledges, cliffs, and slump blocks in areas of moderate relief. It is one of the carbonate units underlying and upholding the subdued Muscatatuck Regional Slope (Malott, 1922, p. 86).
ACKNOWLEDGMENTS
We appreciate the critical reading of the manuscript by John B. Droste and Donald E. Hattin of Indiana University and William Craig of Northeast Missouri State Teachers College. An exchange of ideas with Craig on systematic problems has been very helpful. Comparative material was loaned by R. L. Ethington from the University of Missouri collections, by Harrell L. Strimple from the University of Iowa, and by Clinton F. Kilfoyle from the New York State Museum. Comparative material also was obtained from samples collected in New York and Ontario by W. J. Kilgour. The Department of Geology,
Indiana University, made available a grant from the Cumings-Malott Memorial Fund that was used to defray part of the field expenses.

**The Conodont Fauna**

**GENERAL NATURE OF THE FAUNA**

About 8,900 specimens representing 66 species, 58 of them named, belonging in 22 genera were identified (table 1). Two new genera and 16 new species are named herein. The material came from 366 samples collected from 21 primary measured sections and 21 supplemental sections. (See fig. 1 and the list of collecting localities.) The above totals include some conodonts and samples from the lower part of the Brassfield.

Conodonts are moderately abundant in the Brassfield Limestone, including the Lee Creek Member. Abundance declines sharply in the Salamonie Dolomite. Above the lower part of the Osgood, samples average less than five conodonts per kilogram. Three distinct conodont zones are recognizable, but for the total interval studied the fauna is about equally divided between the simple cones and compound conodonts. The genus *Panderodus* dominates the fauna, and *P. unicostatus* is by far the most abundant species in the collections. *Icriodina* and *Neospathognathodus* are the most abundant compound conodonts. Other important genera include *Paltodus*, *Spathognathodus*, *Acodus*, *Hadrognathus*, *Distomodus*, *Distacodus*, and *Pterospathodus*.

**ESTABLISHMENT OF CONODONT ZONES**

A conodont zonation for the Silurian System was established by Walliser (1962, 1964) when he divided the Silurian rocks of the Carnic Alps into 11 conodont zones. Material from our study is roughly referable to the lowest three zones of Walliser, including Bereich I and the *celloni- and amorphognathoides*-Zones.

Despite general agreement of North American conodont sequences with the zones established by Walliser, our study demonstrates the need for slight redefinition of the lowest three Silurian conodont zones. Specimens identified by Walliser as *Icriodina irregularis*
Branson and Branson should be assigned to *Icriodella* Rhodes. These specimens, under the name *Icriodina*, were used by Walliser as guides to the upper part of Bereich I. Rexroad and Rickard (1965, p. 1220), however, found the youngest occurrence of *Icriodella [Scyphiodus]* in association with conodonts of the *celloni*-Zone in the Hickory Corners Limestone Member of the Reynales Limestone, and in our study *Icriodina irregularis* is found associated with *Neospathognathodus celloni* and other *celloni*-Zone species in the Lee Creek Member of the Brassfield Limestone. Thus, Bereich I and *celloni*-Zone indices are associated. It is also apparent from a study of Walliser’s (1964) plates that specimens he assigned to *Spathognathodus pennatus angulatus* (Walliser, 1964, pl. 14, figs. 20-22 only) are juvenile forms of *Pterospathodus amorphognathoides*, which is the prime indicator of the *amorphognathoides*-Zone, but *S. pennatus angulatus* was found by Walliser in the *celloni*-Zone. *P. amorphognathoides* and *Neospathognathodus celloni* were also found in association in our study. The overlap of guide species necessitates redefinition of Walliser’s conodont zones.

Faunal provincialism is a complicating factor in establishing conodont zones. For example, *Icriodella*, which is common in the Niagara Gorge section, has not been found in the Silurian of the Cincinnati Arch area except possibly for a single specimen from Ohio, and *Icriodina* appears to be absent from the Silurian sections of Europe and of the Niagara Gorge. Many species described in this report and found in the Niagara Gorge were not recorded from Walliser’s Carnic Alps section.

Following are the proposed modifications of Walliser’s zonation, the oldest zone first. For each assemblage zone limits and characteristic species are given. Some species are not limited to a single zone but are present in higher or lower zones. Figure 3 shows the relationships of the zones to the strata studied.

**Icriodina irregularis Assemblage Zone:** The lower limit is marked by the earliest occurrence of the genus *Icriodina*. The upper limit is just below the level of earliest occurrence of *Neospathognathodus* or of *Ozarkodina adiutricis*. 
Characteristic species include *Icriodina irregularis* Branson and Branson and *Spathognathodus oldhamensis* Rexroad. Common, but longer ranging, species include *Acodus curvatus*, *A. unicostatus*, *Distomodus kentuckyensis*, *Icriodina stenolophata*, *Paltodus dyscritus*, *P. debolti*, *Panderodus unicostatus*, *P. simplex*, and *Trichonodella? edentata*.

The *I. irregularis* zone does not represent the oldest Silurian conodont zone to be recognized in Europe (Walliser, 1964) or in North America. Liebe (1962) noted the absence of *Icriodina* from the Edgewood Dolomite in Illinois, and Rexroad (1967) noted a pre-*Icriodina* Silurian conodont fauna which is found in the lower part of the Belfast Member of the Brassfield Formation in Kentucky. Similar faunal relationships are found in a core from the northern peninsula of Michigan. The *I. irregularis* zone probably correlates with the upper part of Walliser’s Bereich I. The Niagara Gorge section (Rexroad and Rickard, 1965) shows that the upper limits of the ranges of *Icriodina* and *Icriodella* in their separate provinces coincide, but the relationship of their earliest occurrences has not been established. In the Niagara Gorge the Neahga Shale, then, is at the top of the *Icriodina irregularis* zone, and the Hickory Corners Limestone Member of the Reynales Limestone belongs in the next higher zone.

**NEOSPATHOGNATHODUS CELLONI ASSEMBLAGE ZONE:** The lower limit of the zone is represented by the earliest occurrence of *Neospathognathodus*, including *N. celloni*, or of *Ozarkodina adiutricis*. The upper limit is marked by the latest occurrence of the genus *Neospathognathodus*. Characteristic species include *Neospathognathodus celloni* (Walliser), *N. pennatus* (Walliser), *N. ceratoides* n. sp., *N. bullatus* n. sp., *N. latus* n. sp., and *Ozarkodina adiutricis* Walliser. *O. gaertneri* Walliser, *Hadrognathus staurognathoides* Walliser, *Icriodina irregularis* Branson and Branson, *I. stenolophata* Rexroad, and *Pterospathodus amorphognathoides* Walliser also may be present.

The *N. celloni* zone as defined here includes the larger part, if not all, of Walliser's celloni-Zone and the lower part of his *amorphognathoides*-Zone. The presence of *Icriodina* and *Pterospathodus amorphognathoides* with celloni-Zone species and the resultant
impossibility of clearly distinguishing the zones as described by Walliser have necessitated revision of zone boundaries.

PTEROSPATHTODUS AMORPHOGNATHOIDES - SPATHOGNATHODUS RANULIFORMIS ASSEMBLAGE ZONE: The lower limit is coincident with the latest occurrence of the genus Neospathognathodus. The upper limit is coincident with the earliest occurrence of Kockelella patula or other species of the patula-Zone. Characteristic species include Pterospalathodus amorphognathoides Walliser, Hadrognathus staurognathoides Walliser, Ozarkodina gaertneri Walliser, O. neogaertneri n. sp., and Spathognathodus ranuliformis Walliser. Distacodus obliquicostatus Branson and Mehl, Acodus cf. A. inornatus Ethington, and Drepanodus aduncus n. sp. are common but are rare in or absent from the zone below. The last three species range upward into much younger beds.

The lower part of this zone commonly is marked by P. amorphognathoides, and the other species listed above also may be present. S. ranuliformis generally is found higher in the section than any other of the characteristic species. Diagnostic species are lacking in the upper part of this zone, and Kockelella patula was not found during our study.

Stratigraphy

BRASSFIELD LIMESTONE

The lithology and distribution of undifferentiated Brassfield rocks in Indiana, Ohio, and Kentucky were discussed by Rexroad (1967), and so discussion here is restricted to the rocks of dolomite lithology that are found at the top of the Brassfield and that were partly excluded from the Brassfield by Rexroad (1967, p. 8) pending more extensive study.

LEE CREEK MEMBER: Foerste (1897, p. 224-226), after completing extensive fieldwork in southeastern Indiana, recognized in southeastern Clark County and in Jefferson and Ripley Counties a distinct variation in the lithology of rock that he assigned to the Clinton Limestone, now known as the Brassfield Limestone. North and west of these counties the Brassfield is characteristically a crystalline fossiliferous limestone. In the southeastern area of these counties,
Foerste noted that the limestone was replaced by red-brown and varicolored rocks which he described as being siliceous.

The lithologic variation noted by Foerste has been confirmed by our study, and the name Lee Creek Member is here proposed for the upper dolomitic part of the Brassfield Limestone in Indiana and Kentucky west of the Cincinnati Arch. The type section of the Lee Creek is near the head of a short tributary of Lee Creek in the NE¼SE¼SE¼ sec. 36, T. 3 N., R. 9 E., Jefferson County, Ind. (locality 13). Localities 12 and 14 are designated as primary reference sections.

At the type section the Lee Creek is a fine-grained dolomite. The color is variable, ranging from tan to red brown. Glauconite is common, especially near the top of the unit, and calcite-filled vugs are present throughout. Here the Lee Creek is 2.6 to 2.8 feet thick and unconformably overlies rocks belonging to the Saluda Formation of Ordovician age. The Osgood Member of the Salamonie Dolomite unconformably overlies the Lee Creek.

The Lee Creek Member is distinguished from the remainder of the Brassfield Limestone by its lithology. The lower part of the Brassfield is a crystalline limestone that commonly contains abundant fossils. The Lee Creek is a fine-grained sugary dolomite and generally lacks fossils.

Where the Lee Creek rests on Ordovician rocks, it is distinguished by lithology, color, and characteristics of bedding. The Lee Creek rests either on dolomite of the Saluda Formation or on shale and limestone tentatively assigned to the Whitewater Formation. The limestone of the Whitewater is dark brown to black and contains abundant ostracodes. The shale associated with the limestone is also dark. There is no similar lithology in the Lee Creek. The Lee Creek has thinner, less regular bedding than the more massive and even-bedded dolomitic rocks of the Saluda. In general, the Saluda appears more porous on weathered surfaces than does the Lee Creek. Disseminated fine sand to silt-size glauconite in many sections imparts a greenish hue to Saluda rocks, but the glauconite of the Lee Creek is generally in sand-size grains.
The basal unit of the Osgood immediately overlying the Lee Creek is a fine-grained tan dolomite which is as much as 3 feet thick. The even-bedded character of this unit distinguishes it from the underlying Lee Creek, which also is generally less argillaceous than the Osgood. Chemical analyses that help show the differences between the Lee Creek and the overlying and underlying units are given in table 2.

The Lee Creek is recognized in Indiana as far south as central Clark County (supplementary locality S) and is present in most sections as far north in Jefferson County as Madison (supplementary locality J). It is discontinuously present north of Madison and is recognized at localities 3 and 7 in Decatur and Switzerland Counties. In Kentucky the Lee Creek is recognized as far south as Mt. Washington (locality 21). The general relationships of the Lee Creek to the remainder of the Brassfield Limestone and to the Salamonie Dolomite are illustrated in figure 3 by selected columnar sections (localities 3, 6, 8, 14, 18, and 21). South of Mt. Washington the entire Brassfield changes lithology markedly in a short distance and becomes much thicker (Rexroad, 1967), and the Lee Creek Member is not recognized. In general, the Lee Creek tends to thin to the west and north. The maximum measured thickness of the Lee Creek is 4.3 feet at locality 12. At northern and western localities, such as localities 8 and N, the Lee Creek is less than 0.5 foot thick, and it is absent from some places.

The relationship of the Lee Creek Member to the lower part of the Brassfield Limestone in Indiana and to the Brassfield Formation as exposed at Bardstown, Ky. (supplementary locality U), is imperfectly understood. At some localities in southern Indiana (localities 7, 12, and 13) the lower part of the Lee Creek is nearly the same lithologically as the non-Lee Creek part of the Brassfield, but it is a dolomite rather than a limestone. These sections suggest that the Lee Creek is transitional with the underlying part of the Brassfield. But at most of the sections where both lithologies are found, a rather sharp lithologic break separates the Lee Creek and the underlying limestone, suggesting an unconformity. Other evidence for an unconformity is shown by material from Harts Falls (supplementary locality M), where reworked Ordovician conodonts are found in the Lee Creek but not in the
underlying Brassfield. This indicates close proximity of this area to an area of active erosion of Ordovician rocks during the time of deposition of the Lee Creek. This helps to explain the absence of all Brassfield rocks from some localities and the absence of the lower part from others. For example, the lower limestone is absent from locality 18, and the Lee Creek rests directly on Saluda rocks (fig. 3). Less than a mile away at supplementary locality S one small remnant of the lower member of the Brassfield Limestone was found in a depression in the Saluda rocks below the Lee Creek. These relationships also indicate an unconformity between the Lee Creek and the underlying part of the Brassfield.

At all localities studied in this project or by Rexroad (1967) the conodont fauna of the Brassfield, exclusive of rocks assigned to the Lee Creek, belongs in the *I. irregularis* Assemblage Zone. The fauna of the Lee Creek Member falls mostly within the *Neospathognathodus*
The number of conodont species common to both zones suggests that any interval of time not represented between the two zones was of short duration and that there is not a recognizable intervening zone in another area. Relatively few specimens of *Neospathognathodus celloni* and *N. pennatus* were found during our study, but several hundred specimens of *N. latus* were found. If our interpretation of conodont morphology and evolution is correct and *N. latus* evolved from *N. pennatus* and *N. bullatus*, then the conodont fauna of the Lee Creek at most localities lacks the species of the lowest part of the *N. celloni* zone. Thus, the existence of a sedimentational hiatus between the Lee Creek and the underlying part of the Brassfield in most of the area studied has support on both faunal and physical bases.

The problems of the age and correlation of the Brassfield Limestone, exclusive of the Lee Creek Member, were discussed by Rexroad (1967) and so are not treated here. The age relationships obtained from the conodont studies show that the Lee Creek is clearly younger than any other rocks assigned to the Brassfield in Kentucky, Ohio, or Indiana. The Lee Creek belongs mostly in the *Neospathognathodus celloni* Assemblage Zone. Rexroad (1967) found that the uppermost part of the Brassfield, exclusive of the Lee Creek, still lies within the *Icriodina irregularis* zone (Bereich I of Walliser). Rexroad noted that the Brassfield is time transgressive from the type section in Kentucky into Indiana and that the Indiana Brassfield is younger but still within the *Icriodina irregularis* zone. Examination of the Brassfield from Bardstown (supplementary locality U) shows that at this locality the top of the Brassfield is within the *I. irregularis* zone. Twenty-two miles to the north (locality 21), however, an upper bed which contains a conodont fauna belonging to the *N. celloni* zone is present, and it is here recognized as the Lee Creek (fig. 3).

The Lee Creek correlates with the Reynales Limestone of the Niagara Gorge described by Rexroad and Rickard (1965, p. 1219), who found in the Hickory Corners Limestone Member several specimens that are assigned to *Neospathognathodus* n. sp. C. The closest faunal similarity is with the Merritton Limestone Member of the Reynales as shown by specimens from material collected by W. J.
Kilgour. The Lee Creek belongs in the upper part of the Llandovery Series (Berry and Boucot, in preparation; Rexroad and Rickard, 1965, p. 1218-1219). The Lee Creek conodont fauna is comparable to the fauna described by Walliser (1964) from the celloni-Zone and perhaps part of the amorphognathoides-Zone.

SALAMONIE DOLOMITE

French (1967) extended use of the name Salamonie from northern Indiana into southern Indiana, where he equated the Salamonie with the Laurel Limestone and the Osgood Formation. The Laurel and Osgood are gradational and were reduced to the rank of members. South of Versailles, Ind., shale dominates the Osgood lithology, and as much as 50 percent of the shales are noncarbonate. In addition, chemical analyses in French’s report (1967) show that in southern Indiana carbonate rocks assigned to the Salamonie are about equally divided between limestone and dolomite. Thus, in total, no one lithology dominates the formation.

OSGOOD MEMBER: Foerste (1896, p. 191) applied the name Osgood to the lower fossiliferous phase of the Laurel for exposures north of Osgood, Ripley County, Ind. He (Foerste, 1897) later divided the Osgood into four units, which in ascending order are: the basal Niagara Limestone, the Lower Osgood Clay, the Osgood Limestone, and the Upper Osgood Clay. This four-part division is best shown in Clark, Jefferson, and Ripley Counties, Ind., and in Trimble and Oldham Counties, Ky. The Osgood ranges from 11 to 25 feet in thickness. Most of the sections examined were from 18 to 20 feet thick.

Foerste’s basal Niagara limestone is recognizable in most sections south of Decatur County, Ind., and in Trimble, Oldham, and Jefferson Counties, Ky. The unit is from 0.4 to 3.3 feet thick and is generally tan, but at some localities the color is variable. The unit is a dolomite and generally contains from 6 to 11 percent SiO₂ (table 2). At localities where the Brassfield is absent the basal bed of the Osgood rests directly on Ordovician rocks.
Above the basal bed the Osgood consists of one of three general lithologic sequences. In Decatur County, Ind., and northward, the Osgood is predominantly a limestone or dolomite with thin shale beds or shale partings. From Decatur County southward a gradual change takes place to a shale-carbonate-shale sequence that is most evident in Jefferson and Clark Counties, Ind., and in Trimble and Oldham Counties, Ky. South of Oldham County the lower part of the Osgood Formation consists of alternating red and green shales that grade to blue to gray shales in the upper part of the section. Chemical analyses from selected sections are given in table 2.

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### Table 2. Partial chemical analyses of selected samples—Continued

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At Mt. Washington, Ky., 4.7 feet of rock is exposed between the underlying Brassfield (Lee Creek Member) and the overlying red and green shales. These argillaceous dolomitic rocks may correspond to the basal dolomite of the Osgood farther north, but they are lithologically distinct. The sequence of dolomite and red and green shales most nearly resembles the Crab Orchard Group (Rexroad and others, 1965) found in eastern Kentucky and is thought to represent an environment of deposition which extended across the area of the present Cincinnati Arch. More extensive fieldwork in Nelson, Spencer, Bullitt, and Jefferson Counties, Ky., needs to be done before the relationship of the red and green shales to the more northerly shales of the Osgood is understood.

The Osgood Member of the Salamonic Dolomite lies unconformably on Silurian or Ordovician rocks in southeastern Indiana and central Kentucky (fig. 3). At most localities studied the Osgood rests on the Brassfield Limestone, including the Lee Creek Member, but in the area of the Ripley Island positive first described by Foerste (1897, p. 225-226) the Brassfield is absent and the Osgood rests directly on Ordovician rocks. The Osgood is conformably and transitionally overlain by the Laurel Member.
The conodont fauna of the Osgood at every locality studied belongs to the *P. amorphognathoides-S. ranuliformis* Assemblage Zone, the next zone above that of the Lee Creek fauna, and corresponds with part of Walliser’s (1964) *amorphognathoides*-Zone. The age of the Osgood is thus early Wenlockian in the British standard on the basis of correlation with the Niagara Gorge section (Rexroad and Rickard, 1965, p. 1218), where the same fauna is found in the Rockway Dolomite Member of the Irondequoit Limestone. The Osgood also correlates with part of the Estill Shale of east-central Kentucky (Rexroad and others, 1965) and the Joliet Dolomite of northeastern Illinois. *P. amorphognathoides* is generally found in the lowermost Osgood samples, and *S. ranuliformis* is commonly found a few feet higher in the section. Guide species and conodonts in general are less common upward in the Osgood, and in the northern part of the area studied guide fossils are found only in the basal few feet of the unit.

**Laurel Member:** The Laurel was named by Foerste (1896, p. 191) for resistant carbonate beds in the vicinity of Laurel, Ind. The Laurel Member of the Salamonie Dolomite in southeastern Indiana and the Laurel Limestone of adjacent Kentucky is a dolomitic limestone or dolomite (French, 1967). Its lithology is much less variable than is that of the Osgood Member, although chert is abundant in some exposures of the Laurel and rare in others. The maximum thickness of the Laurel is about 45 feet.

The Laurel is conformably overlain by the Waldron Shale and is gradational with the underlying Osgood Member. In the northern part of the study area the members cannot be distinguished. In Kentucky beds that probably are continuous with the middle carbonate and upper shale units of the Osgood are included in the lower part of the Laurel.

The conodonts of the Laurel, like those of the upper part of the Osgood, are few in number and are not distinctive. The fauna consists of longer ranging simple cones and a few bar and blade types of conodonts. Thus the zonal position of these beds is uncertain. Fragments of specimens belonging in the genus *Kockelella* have been found in the Mississinewa Shale Member (Wabash Formation) in
Survey drill hole 145 (locality 19) and in the quarry at Sellersburg, Ind. The conodonts of the rocks from this level down into the middle part of the Osgood represent a zone of few and nondiagnostic species. The reason for the lack of guide species may be ecologic, but this is not known.

Collecting Localities
Twenty-one sections expose relatively long sequences of the strata studied. Conodonts were collected from the total exposed part of each of these sections, and all specimens recovered were identified and counted. These are the primary sections. To supplement the information gained from these sections, critical parts of less complete sections and some excellent sections in close proximity to the primary sections were studied in the field. Conodonts from all or from selected parts of the supplementary sections were identified and counted to determine if guide species were present and to check for any anomalies.

The sample intervals of each collecting locality are given in the Appendix.

PRIMARY LOCALITIES
2. NE¼ sec. 6, T. 11 N., R. 8 E., Shelby County, Ind., Waldron Quadrangle. Section taken at southeast end of abandoned part of the Blue Ridge Quarry about a mile south of Waldron. Field Designation is Waldron Quarry.
3. SE¼ sec. 7 and NW¼NW¼ sec. 17, T. 10 N., R. 11 E., Decatur County, Ind., New Point Quadrangle. Lower part of section taken from the southeastern part and upper part (Laurel) from the western part of the New Point Stone Co. quarry. Locality 26 of Rexroad (1967, p. 20). Field designations are New Point Quarry and New Point Quarry West.
4. SE¼NE¼ sec. 30, T. 9 N., R. 10 E., Decatur County, Ind., Millhousen Quadrangle. Section along east bank of Squaw Creek. Locality 178 of Foerste (1897, p. 280) and locality 29 of Rexroad (1967, p. 20). Field designation is F-178-A.

5. NE¼SW¼SW¼ sec. 32, T. 8 N., R. 11 E., Ripley County, Ind., Osgood Quadrangle. Core and quarry section from Southeastern Materials Corp. quarry, Osgood. Field designation is Type Osgood.

6. NW¼SW¼NE¼ sec. 36, T. 7 N., R. 10 E., Ripley County, Ind., Versailles Quadrangle. Road cut along east side of Michigan Road. Locality 131 of Foerste (1897, p. 270) and locality 35 of Rexroad (1967, p. 21). Field designation is New Marion.

7. NE¼NW¼ sec. 9, T. 5 N., R. 12 E., Switzerland County, Ind., Cross Plains Quadrangle. Abandoned part of Tri-County Stone Co. quarry. Locality is stop 4 of Patton, Perry, and Wayne (1953, p. 14) and locality 37 of Rexroad (1967, p. 21). Field designation is Cross Plains.

8. NE¼ sec. 6, T. 3 N., R. 10 E., Jefferson County, Ind., Madison West Quadrangle. Road cut on north side of Indiana Highway 62. Locality 35 of Foerste (1897, p. 247), stop 1 of Esarey, Malott, and Galloway (1947, p. 5), and locality 40 of Rexroad (1967, p. 22). Field designation is Clifty Creek West.

9. NW¼NW¼ sec. 20, T. 3 N., R. 8 E., Scott County, Ind., Blocher Quadrangle. Indiana Geological Survey drill hole 144, Scott County Stone Co.

10. Carter Coordinates 20-AA-49, 11,300 feet north of south line, 1,000 feet west of east line, Trimble County, Ky., Madison West Quadrangle. Bed and bank of tributary to Gilmore Creek. Field designation is Gilmore Creek.

12. NW¼NE¼NE¼ sec. 31, T. 3 N., R. 10 E., Jefferson County, Ind., Madison West Quadrangle. Section along road and above abandoned quarry. Field designation is Harts Falls South.

13. NE¼SE¼SE¼ sec. 36, T. 3 N., R. 9 E., Jefferson County, Ind., Madison West Quadrangle. Section just below abandoned road on a short tributary of Lee Creek. Field designation is Lee Creek Indiana.


15. S¼ lot 246, Clark's Grant, Clark County, Ind., Otisco Quadrangle. Indiana Geological Survey drill hole 147, Ralph Dieterlen.

16. Center SE½ lot 59, Clark's Grant, Clark County, Ind., Owen Quadrangle. Section along county road descending Ohio River bluff. Field designation is Owen Bull Creek Osgood.

17. W½ lot 79, Clark’s Grant, Clark County, Ind., Owen Quadrangle. Indiana Geological Survey drill hole 146, Standard Materials Division, Martin-Marietta.


20. Carter Coordinates 24-W-48, 7,275 feet east of west line, 4,050 feet north of south line of W-48, Oldham County, Ky., Anchorage Quadrangle. Road cut on west side of Brownsboro Road 0.35 mile south of bridge over South Fork Harrods Creek. Stop 14 of Browne and others (1958, p. 31) and locality 47 of Rexroad (1967, p. 23). Field designation is Brownsboro Road.

SUPPLEMENTARY LOCALITIES
B. SW¼NE¼ sec. 7, T. 12 N., R. 12 E., Franklin County, Ind., Alpine Quadrangle. Section in tributary of Sains Creek. Locality 235 of Foerste (1898, p. 252), locality 1 of Mound (1961, p. 13), and locality 24 of Rexroad (1967, p. 20). Field designation is Sains Creek Tributary.
C. SW¼SW¼ sec. 20, T. 12 N., R. 12 E., Franklin County, Ind., Metamora Quadrangle. Locality 218 of Foerste (1898, p. 244). Field designation is Derbyshire Falls.
D. SW¼NE¼ sec. 5, T. 9 N., R. 9 E., Decatur County, Ind., Forest Hill Quadrangle. Section along west bank of Sand Creek. Locality 189 of Foerste (1897, p. 282) and locality 30 of Rexroad (1967, p. 21). Field designation is F-189.
E. NW¼SE¼ sec. 5, T. 8 N., R. 9 E., Decatur County, Ind., Westport Quadrangle. Section taken along east bank of Painter Creek. Locality 194 of Foerste (1897, p. 283) and locality 32 of Rexroad (1967, p. 21). Field designation is F-194.
F. NW¼NW¼ sec. 13, T. 8 N., R. 9 E., Jennings County, Ind., Millhousen Quadrangle. Section collected along tributary of Wolf Creek. Locality 182 of Foerste (1897, p. 281) and locality 31 of Rexroad (1967, p. 21). Field designation is F-182.
G. SW¼NW¼SW¼ sec. 34, T. 7 N., R. 9 E., Jennings County, Ind., Butlerville Quadrangle. Section on the north bank of South Fork
locality 18 of Foerste (1897, p. 241) and locality 42 of Rexroad (1967, p. 22). Field designation is Marble Hill Nicoll.

P. Carter Coordinates 20-Y-50, 2,700 feet west of east line, 11,850 feet north of south line of Y-50, Trimble County, Ky., Bedford Quadrangle. Bed and bank of Dog Branch near its head and about 300 yards west of Hickory Grove Church. Field designation is Morton Ridge.

Q. NW¼NW¼SE¼ sec. 3, T. 1 N., R. 9 E., Clark County, Ind., New Washington Quadrangle. Section taken at falls on short tributary to Camp Creek. Field designation is Otto Camp Creek.

R. S¼N¼ lot 80, Clark's Grant, Clark County, Ind., Owen Quadrangle. Section is in bed of Owen Creek below abandoned quarry. Field designation is Owen Creek.

S. N½W¼ lot 98, Clark's Grant, Clark County, Ind., Charlestown Quadrangle. Road cut on south side of Indiana Highway 62. Field designation is Fourteen Mile Creek West.

T. Carter Coordinates 8-T-48, 9,950 feet west of east line, 9,800 feet south of north line of T-48, Jefferson County, Ky., Jeffersontown Quadrangle. Road cut above abandoned quarry on north side of Seatonville Road on Floyds Fork about a mile west of Seatonville. Locality listed by Butts (1915, p. 72, pl. 22) and locality 48 of Rexroad (1967, p. 23). Field designation is Floyds Bluff.

U. Carter Coordinates 14-P-49, 9,000 feet east of west line, 12,600 feet south of north line of P-49, Nelson County, Ky., Bardstown Quadrangle. Section at south end of abandoned quarry on south edge of Bardstown. Stop 4 of Nosow (1959, p. 16, fig. 5) and locality 52 of Rexroad (1967, p. 23). Field designation is Old Bardstown Quarry.

Systematic Paleontology

Material used in this study is reposited in the Indiana University-Indiana Geological Survey collections. Locality and sample designation are given in parentheses following repository numbers. Under the heading “Material studied” only the specimens from the present collection are listed.
Genus **Acodus** Pander, 1856

*Type species:* *Acodus erectus* Pander, 1856.

**Acodus curvatus** Branson and Branson

Plate 7, figures 19, 20

*Acodus curvatus* Branson and Branson, 1947, Jour. Paleontology, v. 21, p. 554, pl. 81, fig. 20; Rexroad, 1967, Indiana Geol. Survey Bull. 36, p. 25, pl. 4, figs. 9-12.

*Acodus cfr. mutatus* (Branson and Mehl), Serpagli and Greco, 1964, Soc. paleont. italiana Boll., v. 3, p. 196, pl. 34, figs. 2a, b.

*Material studied:* 106 specimens.

*Repository:* 11301 (M-Z II) and 11302 (12-f) (figured specimens).

**Acodus** cf. *A. inornatus* Ethington

Plate 7, figures 8-10


*Remarks:* *Acodus inornatus* Ethington is considered by Bergström and Sweet (1966, p. 303-305) to be a junior synonym of *Acodus mutatus* (Branson and Mehl), which in turn is an apparent junior synonym of *Distacodus obliquicostatus* Branson and Mehl in Bergstrom and Sweet’s classification. This is discussed in the remarks on *D. obliquicostatus*.

*Material studied:* 53 specimens.

*Repository:* 11303 (9-177), 11304 (21-D), and 11305 (21-D) (figured specimens).

**Acodus unicostatus** Branson and Branson

Plate 7, figures 34-36

*Acodus unicostatus* Branson and Branson, 1947, Jour. Paleontology, v. 21, p. 554, pl. 82, figs. 9, 10, 41, 43; Rexroad, 1967, Indiana Geol. Survey Bull. 36, p. 26, pl. 4, figs. 13-16.
*Paltodus acostatus* **Branson** and **Branson** (part), 1947, *Jour. Paleontology*, v. 21, p. 554, pl. 82, figs. 23, 24 only.

**Material studied:** 423 specimens.

**Repository:** 11306 (M-Z II), 11307 (1-3), and 11308 (M-Z II) (figured specimens).

Genus **Apsidognathus** Walliser, 1964

**Type species:** *Apsidognathus tuberculatus* Walliser, 1964.

**Apsidognathus tuberculatus** Walliser

Plate 3, figure 8

*Apsidognathus tuberculatus* **Walliser**, 1964, *Hess. Landesamt Bodenf., Abh.*, no. 41, p. 29, pl. 5, fig. 1; pl. 12, figs. 16-22; pl. 13, figs. 1-5.

**Description:** This is a slightly arched platform species that has a raised carina running the full length of the oral surface and extending slightly beyond the anterior margin as a short blade. No distinct lateral processes are present, but the oral surface is marked by raised areas or lobes that may bear secondary carinae. The outline of the specimen is irregular. The main carina is bowed and is not symmetrically located on the platform. The oral surface is highly nodose. The aboral surface is excavated under the entire platform.

**Remarks:** Only one complete specimen and a few fragments of *A. tuberculatus* were obtained in this study. The complete specimen is comparable in all respects to specimens illustrated by Walliser (1964).

**Material studied:** 2 specimens.

**Repository:** 11455 (16-A5) (figured specimen).

Genus **Carniodus** Walliser, 1964

**Type species:** *Carniodus carnulus* Walliser, 1964.

**Carniodus carinthiacus** Walliser

Plate 5, figures 1, 2

*Carniodus carinthiacus* **Walliser**, 1964, *Hess. Landesamt Bodenf., Abh.*, no. 41, p. 31, pl. 6, fig. 8; pl. 27, figs. 20-26; text-fig. 4n.

*?Carniodus carinthiacus* **Walliser**, 1964, *Hess. Landesamt Bodenf., Abh.*, no. 41, p. 31, pl. 6, fig. 8; pl. 27, figs. 20-26; text-fig. 4n.

Description: The unit is an arched denticulate blade having a small cusp and well-developed marginal lip. The cusp is only slightly, if at all, enlarged from the size of the central denticles. All the denticles are appressed. Generally three to eight denticles are found anterior to the cusp and a similar number are found posteriorly. At the base of the denticles the blade is expanded. Below the expansion the blade narrows. The basal cavity is a shallow elongate groove along the aboral surface and is largest at midlength of the blade.

Remarks: Specimens of *Carniodus carinthiacus* from this study differ slightly from those described by Walliser in having shorter anterior and longer posterior segments of the blade. The general similarity of *C. carinthiacus* to other species of the genus, despite the reduced cusp, is the basis for removal of the questionable generic assignment of Walliser. *C. carinthiacus* differs significantly from *Ozarkodina gaertneri* in lacking the downward projection of the lateral lip.

Material studied: 15 specimens.

Repository: 11456 (21-D) and 11309 (O-14) (figured specimens).

*Carniodus carnicus* Walliser

Plate 5, figure 3

*Carniodus carnicus* **Walliser**, 1964, Hess. Landesamt Bodenf., Abh., no. 41, p. 32, pl. 6, fig. 11; pl. 28, figs. 8-11.

Remarks: Specimens of *Carniodus carnicus* from this study agree with the description for the species given by Walliser. Too few specimens were obtained in this study to describe the species adequately.

Material studied: 6 specimens.

Repository: 11310 (21-D-) (figured specimen).

*Carniodus carnulus* Walliser

Plate 5, figures 4, 5

*Carniodus carnulus* **Walliser**, 1964, Hess. Landesamt Bodenf., Abh., no. 41, p. 32, pl. 6, fig. 10; pl. 10, figs. 20, 21; pl. 27, figs. 27-38; pl. 28, fig. 1; text-fig. 4a-f.

Description: This is a short slightly arched blade with a prominent central cusp. The cusp, at the midpoint of the blade, is laterally
compressed and twice the size of the largest denticles. Denticles anterior and posterior to the cusp are appressed and shorter distally. In most specimens the blade is expanded below the denticles. Below the expansion the blade narrows abruptly. The basal cavity is a shallow groove that expands near midlength under the cusp.

Remarks: No differences were observed between specimens of *Carniodus carnulus* obtained in this study and the material described by Walliser (1964).

Material studied: 28 specimens.

Repository: 11311 (0-14) and 11312 (21-E) (figured specimens).

**Carniodus carnus** Walliser

Plate 5, figures 6-8

*Carniodus camus* Walliser, 1964, Hess. Landesamt Bodenf., Abh., no. 41, p. 34, pl. 5, fig. 3; pl. 10, fig. 13; pl. 28, figs. 2-7; text-fig. 4y-z.

Description: This is a bowed denticulate blade bearing a prominent cusp. The cusp is laterally compressed and more than twice the height of the adjoining denticles. The denticles are short and appressed and number three to eight on each limb of the blade. Both limbs of the blade are directed inward from the cusp to bow the species. The basal cavity is a narrow elongate groove that is largest under the cusp.

Remarks: Specimens from this study assigned to *Carniodus carnus* differ from the holotype designated by Walliser in the form of the cusp. The cusp in specimens from this study is erect, but the cusp of the holotype is curved posteriorly. Too few specimens were obtained to comment on variability of the species.

Material studied: 8 specimens.

Repository: 11313 (7-8), 11314 (21-G), and 11315 (18-7) (figured specimens).

**Carniodus** sp.

Plate 5, figure 9

*Carniodus* sp. Walliser, 1964, Hess. Landesamt Bodenf., Abh., no. 41, p. 35, pl. 4, fig. 12; pl. 29, figs. 1-4.
Description: Specimens have a short laterally compressed blade that supports a large centrally located cusp and two to six poorly developed denticles. Some specimens have a slight enlargement of the blade below the denticles. The basal cavity is a shallow groove along the aboral margin and is slightly deeper under the cusp.

Remarks: Only a few specimens of this species were obtained in the present study, and these were from samples of the lower part of the Brassfield. This agrees with the stratigraphic range of the species as established by Walliser.

Material studied: 12 specimens.

Repository: 11316 (S-fun.) (figured specimen).

Genus *Diadelognathus* n. gen.

Type species: *Diadelognathus excertus* n. gen., n. sp.

Derivation of name: *Diadelos*, Gk., distinctive; *gnathus*, Gk., jaw, in reference to the prominent anterior process observed in most species.

Diagnosis: Specimens assigned to *Diadelognathus* are complex denticulate forms that consist of a single prominent cusp, an outer lateral process, and an anterior or inner lateral process. The basal cavity is reduced or everted.

Description: The species assigned to *Diadelognathus* are variable in detail but are generally similar. The cusp is commonly subround and tapers sharply from the base to midheight but tapers only slightly from midheight to the tip. The cusp is directed posteriorly in all specimens without regard to the resultant orientation of the processes. The processes are variable in degree of development and orientation. In some species the outer lateral process is the larger, and in other species the anterior process is best developed. Denticles on the processes are discrete, few in number, and round to subround in cross section. The basal cavity is shallow and in some species is not apparent.

Remarks: Six species are recognized, and five of them are believed to represent a single phylogenetic sequence. *Diadelognathus primus* appears to be the most primitive species with two short processes. From *D. primus* two trends are apparent. In *D. excertus* and *D. n. sp.*
A the anterior process is the larger and there is only a short outer process. In D. n. sp. B the outer process is larger and the antero-inner lateral process is short, bearing only a single denticle. *D. compressus* is apparently a related form but does not fit into the sequence.

**Diadelognathus excertus** n. sp.

Plate 6, figures 1-4

*Derivation of name:* *Excertus*, L., projecting, in reference to the prominent anterior process.

*Diagnosis:* Specimens consist of a larger anterior process bearing the main cusp and a lateral bar with a secondary cusp. The basal cavity is very shallow.

*Description:* Specimens consist of a main posteriorly directed cusp, a secondary cusp or enlarged denticle, and two bars. The outer lateral bar is short and supports only two or three small discrete denticles. The anterior bar supports four to five large discrete denticles that are posteriorly directed. The main cusp and the enlarged denticle grow from an expanded area at the junction of the bars. The aboral view resembles that of a straight bar that has been bent back on itself with one of the ends then bent normal to the other. The basal cavity is broad and extremely shallow, but a narrow groove extends under each bar.

*Remarks:* *Diadelognathus excertus* differs from *D. primus* in the expansion of the base of the cusp, in the development of a secondary cusp, in the orientation of the processes, and in the possession of a reduced outer lateral bar.

*Material studied:* 10 specimens.

*Repository:* 11317 (12-2) (holotype); 11318 (14-A3), 11319 (14-A3), and 11320 (12-2) (paratypes).

**Diadelognathus compressus** n. sp.

Plate 6, figures 11, 12

*Derivation of name:* *Compressus*, L., compressed, in reference to the laterally compressed cusp.
**Diadelognathus compressus**

*Plate 6, figures 7, 8*

*Diagnosis:* This species has two short denticulate lateral processes and a large laterally compressed cusp posterior to the processes. The basal cavity is shallow to everted.

*Description:* This species is distinguished by its prominent laterally compressed cusp that is set posterior to the axis of the short inner and outer bars. The cusp is narrow and elongate at the base, but no complete specimen showing the tip of the cusp was found. The inner and outer bars normally support one or two and four denticles respectively. The denticles are discrete and directed slightly inwards. The aboral surface has a minor groove below the main cusp that is the only expression of a basal cavity.

*Remarks:* *Diadelognathus compressus* differs from other species of the genus in the shape of the cusp. Apparently it does not belong to the phylogenetic sequence but represents a separate line of development. *D. compressus* is most similar to *D. primus*, differing in the lateral compression of the cusp.

*Material studied:* 19 specimens.

*Repository:* 11321 (M-Z II) (holotype) and 11322 (M-Z II) (paratype).

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**Diadelognathus primus** n. sp.

*Plate 6, figures 7, 8*

*Derivation of name:* *Primus*, L., first, in reference to the primitive form of the species.

*Diagnosis:* The species has short outer and anterolateral processes and a prominent cusp with an expanded base. The basal cavity is shallow.

*Description:* The cusp is prominent and is bent sharply posteriorly and slightly outward. The base of the cusp is greatly expanded, but at midlength it is subround in cross section. The processes are short and support a maximum of two denticles each. One is directed outward and the other anterolaterally. Denticles are inclined posteriorly. The aboral surface is broadly but shallowly excavated, and the excavation extends under the processes.

*Remarks:* *Diadelognathus primus* may represent the first species of a
lineage of species to be characterized by variation of process development. Orientation of the species is a problem, but the cusp is considered to be directed posteriorly. Except for Cardiodella Branson and Mehl, which differs in having a much deeper basal cavity, no species is known that is similar to D. primus. It differs from other species of the genus by having both processes short and by being much broader at the base of the cusp.

**Material studied:** 10 specimens.
**Repository:** 11323 (M-Z II) (holotype) and 11324 (M-Z II) (paratype).

Diadelognathus n. sp. A

Plate 6, figures 9, 10

**Description:** Specimens consist of an anterior and an inner lateral process and a cusp at their intersection. The cusp is posteriorly directed, is subround at midlength, and expands posteriorly at the base. The anterior bar emerges from the inner margin of the cusp and supports three to five widely spaced denticles. The outer lateral bar is directed outward, normal to the posterior bar, and supports three to four discrete denticles. Both bars narrow toward their tips. Denticles of both bars are curved posteriorly. A shallow, but distinct, basal cavity is under the main cusp, and grooves extend from the cavity along both bars.

**Remarks:** Diadelognathus n. sp. A is similar to D. excerptus except for the larger outer lateral process of D. n. sp. A. The two are probably gradational, but no intermediate forms were found in this study.

**Material studied:** 6 specimens.
**Repository:** 11325 (M-Z II) and 11326 (12-2) (figured specimens).

Diadelognathus n. sp. B

Plate 6, figures 5, 6

**Description:** The unit consists of a posteriorly directed main cusp, a denticulate outer lateral bar, and a short inner process consisting of a single dentine. The main cusp is oval in cross section at midlength, expanding posteriorly at the base until it is twice the thickness of any
other part of the bar. The outer lateral bar supports four to six discrete denticles that are curved posteriorly. The inner process consists of a single denticle in an anterolateral position on the main cusp. The aboral surface is shallowly excavated under the cusp, and the excavation extends along the outer lateral bar.

**Remarks:** *Diadelognathus* n. sp. B has a longer outer lateral bar than *D. primus*. It differs from *D. excertus* by lacking the well-developed anterior bar.

**Material studied:** 8 specimens.

**Repository:** 11328 (14-A3) and 11329 (14-A3) (figured specimens).

**Genus Distacodus** Hinde, 1879

**Type species:** Machairodus incurvus Pander, 1856.

**Distacodus obliquicostatus** Branson and Mehl

Plate 7, figures 1-4

*Distacodus obliquicostatus* **Branson** and **Mehl**, 1933, Missouri Univ. Studies, v. 8, p. 41, pl. 3, fig. 2.


*Acontiodus procerus* (Ethington, **Serpagli** and **Greco**, 1964, Soc. paleont. italiana Boll., v. 3, p. 198, pl. 37, figs. 5, 6.

**Diagnosis:** This species is a simple conical sharply recurved unit with an anteroposteriorly elongated base and a prominent longitudinal costa near the midpoint on each side.

**Description:** Viewed laterally the unit consists of a triangular base leading into a slender cusp which is sharply recurved somewhat above midheight of the unit. The base is laterally compressed, and the anterior and posterior edges are sharp and keellike. Each lateral face bears a longitudinal posteriorly directed costa, commonly approximately along the midline. The costae continue along the distal part of the tooth, where they become asymptotic to the posterior edge of the distal part of the unit. On only a few specimens do the costae continue to the base. The basal cavity is subconical, deep, and sharp pointed. It extends upward nearly to the point of greatest curvature.
Remarks: The holotype (Missouri Univ. C152-5) is a fragment of the distal part of a specimen recovered from the Bainbridge Group (Silurian) in southeastern Missouri. A large number of well-preserved specimens were found in our topotype collection. These specimens were first compared with Branson and Mehl’s (1933) Bainbridge material by R. L. Ethington, who recognized their relationship to the fragmental holotype, a specimen we have subsequently studied. The holotype is slightly more robust than the majority of specimens, but we agree fully with Ethington’s assignment.

Specimens from the Spanish Sahara assigned by Ethington and Furnish (1962) to Distacodus procerus Ethington obviously are conspecific with the Bainbridge and present material. Whether D. procerus is a junior synonym is questionable. Because there are slight differences and because lineal continuity presently is not recognized, we prefer to recognize both species. Other workers, including Bergstrom and Sweet (1966, p. 303, 304), have considered the Ordovician and Silurian forms to be a single form species. If this is accepted or if the Bergstrom and Sweet concept of their biologic species A. mutatus is accepted, then Distacodus obliquicostatus is the correct senior synonym to be applied. Bergstrom and Sweet also believe that D. procerus Ethington and Acodus mutatus (Branson and Mehl), including A. inornatus Ethington, are conspecific. Although there is some evidence of intergradation between the form species D. obliquicostatus and A. cf. A. inornatus, we consider both to be valid taxa. The shape and the size of the base are different, a costa is present on only one face of A. cf. A. inornatus, and of fundamental importance is the difference between the shallow cavity of A. cf. A. inornatus and the very deep cavity of D. obliquicostatus.

Material studied: 187 specimens.

Repository: 11330 (9-177), 11331 (9-181, 183), 11332 (3-5), and 11333 (9-177) (figured specimens).

Distacodus n. sp.

Plate 7, figures 5-7

Description: The simple conical unit consists of a laterally compressed
base, triangular in lateral view, leading into a slender, sharply recurved cusp. The anterior margin of the base is sharp edged; the posterior margin is very narrow and is bounded by a costa on each side. The deep subconical basal cavity extends upward from the totally excavated base to a point at the posterior edge of the unit where the cusp is recurved. The posterior edge of the basal cavity parallels the posterior of the unit from which it is separated only by a thin wall.

Remarks: This species is closely similar to Distacodus obliquicostatus. Apparently the lateral costae of the latter have migrated from near the midline of the unit to a posterior position. Because of the position of the costae, the posterior margin of D. ? n. sp. is modified from sharp edged to flat or blunt. The genus Distacodus is considered to have sharp-edged anterior and posterior margins and to have lateral costae near midlength. This species does not conform to this, but because it is so obviously related to D. obliquicostatus the same generic designation is used, but with a question.

Material studied: 21 specimens.
Repository: 11334 (21-L), 11335 (18-8), and 11336 (9-177) (figured specimens).

Genus Distomodus Branson and Branson 1947

Type species: Distomodus kentuckyensis Branson and Branson, 1947.

Distomodus? egregia (Walliser)

Plate 5, figures 26-28

Ligonodina egregia Walliser, 1964, Hess. Landesamt Bodenf., Abh., no. 41, p. 40, pl. 6, fig. 5; pl. 32, figs. 3, 4.

Description: Specimens consist of a denticulate posterior bar, an anterior cusp, and a denticulate anticusp or inner lateral process. The posterior bar is straight and supports seven or more appressed denticles. The cusp is slightly recurved and subround in cross section but may bear a costa, on the inner anterior margin, that continues on to the anticusp. The anticusp is directed down and slightly to the posterior from the inner side of the cusp. The anticusp generally supports three to five appressed denticles on the inner side. On the outer side of all
specimens a rounded lip projects downward and posteriorly between the posterior bar and the anticusp. The lip is best developed on mature specimens. The basal cavity is cone shaped and under the cusp.

**Remarks:** *Distomodus? egregia* can be shown by study of gradational specimens to have evolved from *D. ? extrorsus* Rexroad with the increase in length and dentition of the anticusp and the formation of the lip on the outer side. For this reason and because the species does not seem to be closely related to associated species of *Ligonodina*, the generic assignment of Walliser (1964) has been changed.

**Material studied:** 47 specimens.

**Repository:** 11337 (21-B), 11338 (12-2), and 11339 (12-2) (figured specimens).

**Distomodus? extrorsus** (Rexroad)

Plate 5, figure 23


**Remarks:** On the basis of morphology there is some question of the generic assignment of this species to the genus *Distomodus*. Like the type species, it has a main cusp, a denticulate posterior bar, and an anticusp that may or may not bear denticles. The relationship of *D. ? extrorsus* to *D. ? egregia* is gradational, and distinction of the two species is based on the presence or absence of the liplike projection on the outer margin and the more highly developed dentition on the anticusp of *D. ? egregia*.

**Material studied:** 68 specimens.

**Repository:** 11340 (M-Z II) (figured specimen).

**Distomodus kentuckyensis**

Plate 5, figures 24, 25

*Distomodus kentuckyensis* Branson and Branson, 1947, Jour. Paleontology, v. 21, p. 553, pl. 81, figs. 21-23, 27, 29-33, 36-41; Rexroad, 1967, Indiana Geol. Survey Bull. 36, p. 28, pl. 2, figs. 11-14.

**Material studied:** 251 specimens.
Repository: 11341 (M-Z II) and 11342 (21-B) (figured specimens).

**Genus Drepanodus** Pander, 1856

**Type species:** *Drepanodus arcutus* Pander, 1856.

**Drepanodus aduncus** n. sp.

Plate 7, figures 11-15

*Derivation of name:* *Aduncus*, L. bent inward, in reference to the inward flexure of the lower anterior part of the specimens.

*Diagnosis:* Specimens are simple cones in which the cusp is bent inward throughout its length and is flexed inward in its lower part. The basal cavity is nearly round in aboral view and except for a groove to the anterior underlies only the posterior part of the specimens.

*Description:* The unit is slightly asymmetrical because the cusp is bent inward and its anticusp-like lower anterior part is flexed inward along a nearly vertical line. The outer face of the unit is smoothly convex. The moderately deep conical basal cavity underlies the posterior part of the base but has a groove extending to the anterior tip. In aboral view the cavity is broadly biconvex. Anterior to the cavity specimens are laterally compressed, but this flat area merges upward with the biconvex cusp. The flat part extends downward like the anticusp of some neoprioidids. The lower part of the posterior margin is sharp edged and costa-like.

*Remarks:* Similarities between this species and *Paltodus costulatus* suggest that *P. costulatus* is ancestral to *D. aduncus.*

**Material studied:** 56 specimens.

**Repository:** 11343 (18-8) (holotype); 11344 (21-J), 11345 (6-4), 11346 (21-L), and 11347 (9-173) (paratypes).

**Drepanodus? arrectus** Rexroad

Plate 4, figure 11

Drepanodus simplex Branson and Branson, 1947, Jour. Paleontology, v. 21, p. 522, pl. 81, figs. 24-26; pl. 82, fig. 38.

Remarks: Specimens of *Drepanodus*?arrectus from this study conform to the description given by Rexroad.

Material studied: 80 specimens.

Repository: 11348 (M-Z II) (figured specimen).

Genus Hadrognathus Walliser, 1964

*Type species*: Hadrognathus staurognathoides Walliser, 1964.

Hadrognathus staurognathoides Walliser

Plate 3, figures 12-14

*Hadrognathus staurognathoides* Walliser, 1964, Hess. Landesamt Bodenf., Abh., no. 41, p. 35, pl. 5, fig. 2; pl. 13, figs. 6-15;

Brooks and Druce, 1965, Geol. Mag., v. 102, p. 376, pl. 12, figs. 5, 6.

Description: This is a platform-type conodont with an anterior process, a slightly incurved posterior extension of the anterior process, a bifurcating outer lateral process, and an inner lateral process. All the processes are broad and result in a platform-type species. In most specimens there is a poorly developed anterior inner lateral process which may not be recognized as such in the aboral view. The anterior process has well-developed widely spaced denticles near its anterior end and in some specimens appears to be slightly twisted from the plane of the rest of the specimen. The oral surface is very irregular in outline and in surface texture. In most specimens an irregular row of nodes extends from the anterior denticles toward the posterior. The aboral surface is excavated under all the well-developed processes and has no restricted deeper basal cavity. The basal plate is commonly attached.

Remarks: Very few juvenile specimens were found in this study, and no attempt is made to relate this species to other described species or genera. There is no apparent difference between the material examined for this study and that illustrated by Walliser.

Material studied: 278 specimens.
Repository: 11349 (M-Z II), 11350 (0-14), and 11351 (21-D) (figured specimens).

Genus *Icriodina* Branson and Branson, 1947

*Type species: Icriodina irregularis* Branson and Branson, 1947.

*Icriodina irregularis* Branson and Branson

Plate 3, figures 10, 11

*Icriodina irregularis* Branson and Branson, 1947, Jour. Paleontology, v. 21, p. 551, pl. 81, figs. 3-11, 18, 19; *Rexroad*, 1967, Indiana Geol. Survey Bull. 36, p. 33, pl. 2, figs. 18-21.

*Material studied:* 617 specimens.

*Repository:* 11352 (12-d) and 11353 (15-792) (figured specimens).

*Icriodina stenolophata* Rexroad

Plate 3, figure 9


*Remarks:* Juvenile specimens show a distinct offset of the lateral processes, and the denticles of the lateral processes have a tendency to be directed towards the main axis.

*Material studied:* 140 specimens.

*Repository:* 11354 (M-Z II) (figured specimen).

Genus *Ligonodina* Bassler, 1925

Type species: Ligonodina pectinata Ulrich and Bassler, 1926.

*Ligonodina* cf. *L. kentuckyensis* Branson and Branson

Plate 5, figures 18, 19

cf. *Ligonodina kentuckyensis* Branson and Branson, 1947, Jour. Paleontology, v. 21, p. 555, pl. 82, figs. 28, 35.

*Description:* Specimens have a main cusp, posterior bar, and inner anterolateral process. The cusp is oval and directed slightly posterior. The anterolateral process is curved slightly anteriorly and downward.
The process supports four round discrete denticles and has a broad base near the cusp, which expands around the basal cavity. The posterior bar is broken in all specimens examined. The basal cavity is broad, and a groove, which narrows in a short distance, extends anteriorly under the lateral process.

Remarks: Material from this study is similar to that illustrated by Rexroad (1967, pl. 2, fig. 5) but is not closely similar to the specimen illustrated by Branson and Branson, differing in the apparent size of the posterior bar.

Material studied: 17 specimens.
Repository: 11355 (12-2) and 11356 (12-2) (figured specimens).

*Ligonodina petila* n. sp.

Plate 5, figures 20-22

*Derivation of name:* Petila, L., thin, slender, in reference to the delicate nature of the species.

*Diagnosis:* The general form is typical of *Ligonodina*, a prominent cusp, posterior bar, and inner lateral process. Denticles on the bar are large, almost equal in diameter to the bar that supports them. The inner lateral process and the posterior bar are about equal in size.

*Description:* Specimens are *Ligonodina*-form with a slightly recurved cusp, subround in cross section, and a fine denticulate inner lateral process attached to the side of the cusp and not extending anteriorly beyond the cusp. The process extends downward at an angle of 50 to 60 degrees from the posterior process when viewed from the inner side. The inner process supports four long discrete denticles that are round in cross section. The posterior bar supports four discrete denticles that are inclined slightly posteriorly. The basal cavity is small and does not expand the outline of the base of the cusp.

Remarks: *Ligonodina petila* is a delicate form with long denticles of the same diameter as the supporting processes. *L. petila* differs from *L. kentuckyensis* in the position and direction of the lateral process.

Material studied: 62 specimens.
Repository: 11357 (12-2) (holotype); 11358 (14-A3) and 11359 A3) (paratypes).

**Ligonodina? variabilis** n. sp.

Plate 4, figures 12-14

*Derivation of name:* *Variabilis*, L., variable, in reference to the variable nature of the anticusp or anterior process.

*Diagnosis:* The species has a prominent cusp, a denticulate posterior bar and a short anterolateral process bearing two to four denticles. The cusp and processes are laterally compressed. The anterolateral process is variable, and in some specimens is almost in line with the posterior bar.

*Description:* Specimens assigned to this species consist of a denticulate anterolateral process, a large recurved cusp, and a denticulate posterior bar. All are laterally compressed. The posterior bar supports numerous appressed denticles of unequal size. The anterolateral process extends from the anterior margin of the cusp and is bent inward, making an angle of 10 to 70 degrees with the axis of the posterior bar. The process supports two to five appressed denticles of unequal size. The basal cavity is under the cusp and consists of a narrow cone pointed anteriorly upward.

*Remarks:* Specimens assigned to *Ligonodina? variabilis* are variable in the degree of flexure and number of denticles on the anterolateral process. Because the process is generally found to be anteriorly directed, the generic assignment is questioned. Most specimens, however, are ligonodinid in form.

*Material studied:* 98 specimens.

*Repository:* 11360 (14-A3) (holotype); 11361 (14-A3) and 11362 (14-A3) (paratypes).
Genus **Lonchodina** Bassler, 1925

*Type species:* *Lonchodina typicalis* Ulrich and Bassler, 1926.

**Lonchodina walliseri** Ziegler

Plate 4, figures 8, 9


**Lonchodina n. sp. (b)** **Walliser**, 1957, Hess. Landesamt Bodenf., Notizbl., v. 85, p. 40, pl. 3, figs. 27, 28.

*Remarks:* Specimens found in this study are similar to those described by Walliser (1964). Rexroad (1967) found *L. walliseri* in the part of the Brassfield underlying the Lee Creek, and its occurrence in overlying beds was expected.

*Material studied:* 8 specimens.

*Repository:* 11363 (12-d) and 11364 (12-bulk) (figured specimens).

Genus **Neoprioniodus** Rhodes and Muller, 1956

*Type species:* *Prioniodus conjunctus* Gunnell, 1931.

**Neoprioniodus costatus** Walliser

Plate 5, figures 15, 16

*Neoprioniodus costatus costatus* **Walliser**, 1964, Hess. Landesamt Bodenf., Abh., no. 41, p. 48, pl. 6, fig. 14; pl. 28, figs. 36-41; text-fig. 6, 1-n; **Spassov**, 1966, “Strasimir Dimitrov” Inst. Geol. Bull., v. 15, pl. 1, fig. 5.

*Neoprioniodus costatus paucidentatus* **Walliser**, 1964, Hess. Landesamt Bodenf., Abh., no. 41, p. 48, pl. 4, fig. 23; pl. 28, figs. 31-35; text-fig. 6, 1-k.


*Remarks:* Examples of *Neoprioniodus costatus* from this study are identical to those illustrated by Walliser (1964). The subspecies recognized by Walliser were not distinguished in this study, perhaps because of the small number of specimens observed. We have some reservations on the assignment of this species to the genus *Neoprioniodus* but lack sufficient material for another assignment.
Material studied: 10 specimens.
Repository: 11365 (21-G, E, F bulk) and 11366 (7-7) (figured specimens).

**Neoprioniodus planus** Walliser

Plate 5, figures 11, 12

*Neoprioniodus planus* Walliser, 1964, Hess. Landesamt Bodenf., Abh., no. 41, p. 51, pl. 4, fig. 10; pl. 6, fig. 3; pl. 29, figs. 12, 13, 15.
Remarks: Specimens from this study assigned to *Neoprioniodus planus* agree with material described and illustrated by Walliser. *N. planus* is similar to some of the specimens of *N. multiformis* (pl. 29, figs. 17 and 21) illustrated by Walliser, but no transition was observed to forms similar to the type specimen of *N. multiformis*. The specimens referred by Rexroad (1967, p. 39) to *N. planus* possibly represent a transition between this species and specimens included by Walliser in *N. multiformis* Walliser, but the latter assignment is preferable for the specimens from that part of the Brassfield underlying the Lee Creek.
Material studied: 60 specimens.
Repository: 11367 (14-A3) and 11368 (14-A3) (figured specimens).

**Neoprioniodus subcarnus** Walliser

Plate 5, figure 10

*Neoprioniodus subcarnus* Walliser, 1964, Hess. Landesamt Bodenf., Abh., no. 41, p. 51, pl. 5, fig. 7; pl. 28, figs. 12-18.

Remarks: Specimens from this study assigned to *Neoprioniodus subcarnus* are similar to forms described by Walliser. A characteristic enlarged denticle at midlength of the posterior process is shown on more complete specimens.
Material studied: 15 specimens.
Repository: 11369 (21-I) (figured specimen).
Neoprioniodus triangularis Walliser

Plate 5, figure 17


Remarks: Our specimens are too few in number and too poorly preserved to separate readily into subspecies. Therefore, we list the material of this study at the species level, even though we consider Walliser's subdivision to be valid. Our specimens seem to fit more closely with *N. triangularis triangularis*.

Material studied: 9 specimens.
Repository: 11370 (21-C) (figured specimen).

Genus *Neospaethognathodus* n. gen.

*Type species*: *Neospaethognathodus bullatus* n. sp.

*Derivation of name*: Neo, Gk-, new; *spathognathodus*, for the genus *Spathognathodus*, in reference to the evolution of the new genus from *Spathognathodus*.

*Diagnosis*: The genus includes blade or platform types of conodonts that have one inner lateral and one or two outer lateral processes, which are generally short and nodose or in some species denticulate. Lateral processes vary from narrow to broad. Generally the aboral surface is completely excavated, but only a groove may be present on the aboral margin of the blade.

*Description*: The species representing this genus evolved from a blade type of conodont with an inner and an outer lateral process slightly posterior to the midlength to a platform type of conodont in which the processes are broad and only the anterior part of the blade is free and the posterior part is carinate. The axes of the two primary processes tend to be inclined anteriorly but may be nearly normal to the axis of the blade-carina. Typically the two processes are slightly offset from each other. In some species a second outer lateral process is posterior to the primary outer lateral process. The free blade...
bears laterally compressed denticles, which on the carina are nodelike. Surface sculpture on the processes may be smooth, denticulate, nodose, ridged, or a combination. Generally the entire aboral surface is excavated, but under the free blade only a groove is present in some forms. The base is most deeply excavated at the confluence of the processes and blade-carina.

Remarks: Walliser (1964) established two new species of Spathognathodus, S. celloni and S. pennatus. After examining material from an interval apparently not found in Walliser’s area of study, we believe that S. celloni represents the beginning of an evolutionary series that goes beyond the morphologic limits of the genus Spathognathodus. The new genus Neopathognathodus is erected for this series that includes S. celloni, S. pennatus, and three new species (fig. 4).

The following evolutionary sequence for the genus Neopathognathodus is based on observation of morphologic variation and is not yet substantiated stratigraphically. N. celloni, the most primitive species assigned to the genus, is believed to have been derived from a spathognathodid by the development of short lateral processes. Further development of the anteriorly directed inner and outer lateral processes gave rise to N. pennatus.
From the *N. pennatus* stage two directions of evolution have been observed. In one, two or more denticles of the main carina fused to form a large cusp, and the basal cavity enlarged, resulting in the expansion of the basal part of the lateral processes that still retained a single row of fused denticles. This gave rise to *N. ceratoides*. The second trend led to *N. bullatus* by the change from lateral processes, each bearing a single denticulate ridge, to processes which were broad, irregularly nodose, and platformlike. This trend to a nodose process has also been observed in the posterior process, but, as in all species, the anterior process has retained its blade form.

The continuation of the trend that led to *N. bullatus* gave rise to *N. latus*, the youngest form recognized. In *N. latus* the lateral processes are flattened and very broad. A posteriorly directed outer lateral process developed, the forerunner of which can be observed on the oral, but not the aboral, surface of some specimens of *N. bullatus*. In *N. latus* the entire aboral surface is shallowly excavated.

**Neospathognathodus bullatus** n. sp.

*Plate 1, figures 5-7*

*Derivation of name:* *Bulla*, L., knob, boss, stud, in reference to the numerous nodes on the oral surface.

*Diagnosis:* Specimens have an anterior blade and coarsely nodose inner and outer lateral processes directed outward and anteriorly. A posterior outer lateral process is also present on some specimens. The carina is bent inward near the posterior. The basal cavity underlies both processes but continues along the aboral margin of the blade as a groove.

*Description:* This species consists of a denticulate blade with inner and outer anteriorly directed lateral processes. The posterior part of the blade or carina is bent sharply inward. Some specimens have a rudimentary posterior outer lateral process at the bend of the posterior part of the blade extension. The lateral processes are slightly posterior to midlength. The outer lateral process makes an angle of 30 to 40 degrees with the anterior blade; the inner lateral process an angle of 20 to 30 degrees. The anterior part of the blade is denticulate with
denticles fused nearly to their apices. The oral surfaces of the lateral processes and the posterior part of the blade are irregularly nodose. Both processes tend to be narrow and very irregular in outline. A shallow basal cavity is present at the junction of the lateral processes, and a narrow groove extends along the aboral edge of the anterior part of the blade. The rudimentary posterior outer lateral process is not excavated.

Remarks: This species evolved from *N. pennatus* with the development of more prominent, ornamented lateral processes and of nodes on the posterior part of the blade.

Material studied: 25 specimens.

Repository: 11371 (M-Z II) (holotype); 11372 (10-3) and 11373 (M-Z II) (paratypes).

**Neospathognathodus celloni** (Walliser)

Plate 2, figures 1-4

*Spahtognathodus celloni* Walliser, 1964, Hess. Landesamt Bodenf., Abh., no. 41, p. 73, pl. 4, fig. 13; pl. 14, figs. 3-16; text-fig. lb; text-fig. 7b-f.

Description: The blade has slightly offset poorly developed lateral processes slightly posterior to midlength. Denticles on the blade are fused nearly to their apices. The lateral processes tend to be anteriorly directed. In a few specimens there are nodes on the processes. The outline of the blade as viewed laterally is very irregular, and no cusp is present. The entire aboral surface is excavated along the blade and under the lateral processes.

Remarks: *Neospathognathodus celloni* shows development of lateral processes and represents the first species of a complex evolutionary sequence. The specific spathognathodid from which *N. celloni* developed is uncertain.

Material studied: 6 specimens.

Repository: 11374 (M-Z II), 11375 (21-B), 11376 (14-A3), and 11377 (M-Z II) (figured specimens).
**Neospathognathodus ceratoïdes** n. sp.

Plate 1, figures 1-4

*Derivation of name:* *Keros*, Gk., horn; *oides*, Gk., in the form of, in reference to the prominent cusp.

*Diagnosis:* The blade is nearly straight and has a cusp posterior to the midlength. Inner and outer lateral processes are directed anteriorly, and generally each bears a row of fused denticles along the axis. The inner process is the broader. The entire under surface is excavated, most deeply at the point of union of the processes with the blade.

*Description:* This species consists of a main blade and inner and outer lateral processes. The blade is relatively straight, but the posterior part is bowed. The lateral processes are posterior to midlength of the blade and are directed anteriorly outward. The inner process is broadly expanded. The lateral processes have secondary carinae along their axes and irregularly scattered nodes. Blade denticles are fused nearly to their apices. Several denticles on the blade have fused to form a main cusp where the lateral processes join the blade. The aboral surface is deeply excavated at the junction of the lateral processes with the main blade. The anterior part of the blade is narrowly excavated.

*Remarks:* *Neospathognathodus ceratoïdes* represents an extension of the general form of *N. pennatus* by greater expansion of the lateral processes to give a platformlike appearance and by the development of the cusp. The cusp development may demonstrate the genetic link of *Neospathognathodus* to *Ozarkodina adiutricis*, which shows a similar development. The cusp distinguishes *N. ceratoïdes* from all other species of *Neospathognathodus*.

*Material studied:* 58 specimens.

*Repository:* 11378 (12-2) (holotype); 11379 (M-Z II), 11380 (M-Z II), and 11381 (12-f) (paratypes).

**Neospathognathodus latus** n. sp.

Plate 1, figures 8-11

*Derivation of name:* *Latus*, L., broad, wide, in reference to the broad processes of adult individuals.
**Diagnosis:** Specimens have an anterior blade and broad nodose or ridged inner lateral, outer lateral, and outer posterior processes. The aboral surface is shallowly excavated.

**Description:** The form consists of an anterior blade, an inner process, two outer processes, and a short posterior continuation of the blade. The lateral processes are broad in adult forms. The main axis is bowed and somewhat arched, and the posterior extension of the blade is notably bent down. The denticles of the anterior blade are fused nearly to their apices. The posterior extension of the blade is bent inward and ornamented in a variety of ways, most commonly by transverse ridges. The inner process is broad, flat, and nodose or ridged and lacks a distinct secondary carina. The posterior outer lateral process is directed slightly to the posterior and in some specimens has a median carina or a row of nodes. The anterior outer lateral process is somewhat anteriorly directed, is irregular in outline, and may have a carina, which is directed anteriorly outward. In addition to the carina, irregular nodes and short sinuous ridges are present on the oral surfaces of the lateral processes. The aboral surface is very shallowly excavated.

**Remarks:** Although material assigned to this species is fairly abundant, only two complete specimens were found and only three examples show the entire length of the main axis. A great deal of irregularity of ornamentation on the oral surface was observed. *Neospathognathodus latus* is believed to have developed from *N. bullatus* with broadening of the lateral processes and the full development of the posterior outer lateral process.

**Material studied:** 295 specimens.

**Repository:** 11382 (M-Z II) (holotype); 11383 (M-Z II), 11384 (21-B), and 11385 (13-4) (paratypes).

**Neospathognathodus pennatus** (Walliser)

Plate 2, figure 5

*Spathognathodus pennatus angulatus* **Walliser** (part), 1964, Hess. Landesamt Bodenf., Abh., no. 41, p. 79, pl. 14, fig. 19 only; text-fig. 1c.

*Spathognathodus pennatus pennatus* **Walliser**, 1964, Hess. Landesamt Bodenf., Abh., no. 41, p. 79, pl. 14, figs. 23-26; pl. 15, fig. 1; text-fig. ld.
**Spathognathodus pennatus procerus Walliser,** 1964, Hess. Landesamt Bodenf., Abh., no. 41, p. 80, pl. 15, figs. 2-8; text-fig. le.


**Description:** The blade has an inner and outer lateral process slightly posterior to midlength. The blade is straight or slightly sigmoidal and bears denticles fused nearly to their apices. The anteriorly directed lateral processes vary greatly in degree of development. The outer lateral process is the larger and is denticulate on almost all specimens. The inner lateral process may or may not bear denticles. The entire aboral surface is excavated.

**Remarks:** *Neospathognathodus pennatus* is differentiated from *N. celloni* by the more extensive development of the lateral processes. *N. pennatus* does not have a main cusp, and the lateral processes are not broadly expanded. It apparently is intermediate between *N. celloni* and *N. bullatus.*

**Material studied:** 2 specimens.

**Repository:** 11386 (M-Z II) (figured specimen).

**Genus Ozarkodina** Branson and Mehl, 1933

Type species: *Ozarkodina typica* Branson and Mehl, 1933.

**Ozarkodina adiutricis** Walliser

Plate 2, figures 6-8

*Ozarkodina adiutricis* Walliser, 1964, Hess. Landesamt Bodenf., Abh., no. 41, p. 54, pl. 4, fig. 14; pl. 27, figs. 1-10; text-fig. la; text-fig. 7h, i, k-m.

**Description:** The blade is slightly bowed and has denticles fused nearly to their apices and a prominent cusp posterior to midlength. Some specimens have an inner and (or) outer flaring lip similar to that of *Neospathognathodus celloni.* The blade is much higher anterior to the cusp; posterior to the cusp the blade is short and lower. The aboral surface is excavated along the length of the specimen, and a basal cavity is present under the cusp. The basal cavity is most prominent in specimens that possess prominent flaring lips.

**Remarks:** The lack of lateral processes and the presence of the cusp
serve to distinguish *Ozarkodina adiutricis* from *Neopathognathodus celloni*. *O. adiutricis* and *N. celloni* are believed to be closely related forms which evolved from a common ancestral form of spathognathodontid affinities (fig. 4). Some specimens illustrated by Walliser (1964, text-fig. 7g) are intermediate between the two species. We suggest then that the *O. adiutricis* lineage (*O. adiutricis* ? *O. gaertneri*? *O. neoagaertneri*) is not related to the *Ozarkodina* generic group, but we do not consider it advisable to establish a new genus at this time. Assignment of these forms to the genus *Neopathognathodus* is not acceptable morphologically. The specimens represented by figures 6 and 7, plate 2, are probably pathologic freaks and so are included only provisionally in *O. adiutricis*. 

**Material studied:** 26 specimens.

**Repository:** 11387 (21-B), 11388 (12-f), and 11389 (10-3) (figured specimens).

**Ozarkodina gaertneri** Walliser

Plate 2, figures 12-14

*Ozarkodina gaertneri* Walliser, 1964, Hess. Landesamt Bodenf., Abh., no. 41, p. 57, pl. 6, fig. 6; pl. 27, figs. 12-19; text-fig. 1g.

**Description:** The blade is slightly bowed and has a well-developed cusp near midlength and lateral ridges along the inner and outer margins of the blade. The blade narrows sharply below the lateral ridge. Mature specimens are arched. Juvenile specimens have an almost flat aboral profile and an enlarged lateral ridge below the cusp. As individuals matured, they became arched and the lateral ridge was bent downward to form an aborally projected lip on the inner side. The blade bears fused denticles distinct from the lateral ridge. Posterior to the cusp the height of the denticles is much reduced. The aboral surface is excavated along the length of the specimen and enlarged below the cusp.

**Remarks:** *Ozarkodina gaertneri* developed from *O. adiutricis* with the formation of the lateral ridges and the anticusp. Some specimens considered to be transitional from *O. adiutricis* to *O. gaertneri* were found.
Material studied: 14 specimens.
Repository: 11390 (11-0-), 11391 (18-7), and 11392 (21-D) (figured specimens).

Ozarkodina neogaertneri n. sp.

Plate 2, figures 15, 16

Derivation of name: Neo, Gk., new; gaertneri, for the species Ozarkodina gaertneri, from which this species evolved.
Diagnosis: This is an arched and slightly bowed blade with well-developed aborally projecting lips on both sides of the blade below the apical denticle. Longitudinal flanges are prominent on both sides of the blade.
Description: The blade is arched and slightly bowed and has well-developed lateral ridges and aborally projecting lips on both sides of the blade. Denticles of the blade are fused but distinct from the lateral ridge. A large cusp is above the aborally projecting lips. Posterior to the cusp the height of the denticles is much reduced. The blade narrows sharply below the lateral ridge, and the aboral surface is excavated prominently only between the lips.
Remarks: Ozarkodina neogaertneri has evolved from O. gaertneri and is differentiated by the presence of the dual aborally projecting lips. O. neogaertneri occurs stratigraphically above the major occurrence of O. gaertneri. Only a limited number of specimens have been studied, but the species seems to be reasonably constant in its morphologic character.
Material studied: 5 specimens.
Repository: 11393 (21-G, E, F) (holotype); 11394 (21-I) (paratype).

Ozarkodina hanoverensis n. sp.

Plate 2, figure 9

Derivation of name: From the town of Hanover, Ind., in and near which beds bearing the species are exposed.
Diagnosis: This is a short slightly bowed and arched blade with a prominent cusp and relatively few denticles.
Description: The apical denticle comprises a third to a fourth of the length of the specimen. There are four to six denticles on the anterior part of the blade and five to seven denticles on the posterior part of the blade. The denticles are closely appressed. The small pit below the cusp has a slight flare of the inner lip. A narrow groove extends along the aboral edge a short distance from each end of the basal cavity.

Remarks: *Ozarkodina hanoverensis* is very similar to *O. typica* in general morphology, especially in the nature of the cusp and basal cavity. *O. typica*, however, is much longer, it has more numerous denticles, and the denticles are fused rather than being closely appressed. *O. typica* could have evolved from *O. hanoverensis* by elongation of the blade and an increase in the number of denticles, but no evidence for this was found in this study.

Material studied: 127 specimens.
Repository: 11395 (14-A3) (holotype); 11453 (14-A3) and 11454 (14-A3) (unfigured paratypes).

Genus *Paltodus* Pander, 1856

*Type species:* *Paltodus subaequalis* Pander, 1856.

**Paltodus costulatus** Rexroad

Plate 7, figures 16-18


Remarks: Specimens from the Lee Creek Member and the Salamonie Dolomite are broader and more robust and have deeper basal cavities than specimens from the lower part of the Brassfield. Specimens from the Bainbridge Group at Lithium, Mo., match those from the Lee Creek and the Salamonie. Very fine vertical striations are present on a few individuals. *P. costulatus* is the most likely ancestor for *Drepanodus aduncus* n. sp.

Material studied: 186 specimens.
Repository: 11396 (4-A8), 11397 (3-5), and 11398 (21-G, E, F) (figured specimens).
Paltodus debolti Rexroad

Plate 7, figure 26

Paltodus unicostatus Branson and Mehl, Branson and Branson (part), 1947, Jour. Paleontology, v. 21, p. 554, pl. 82, figs. 20-22. 
Material studied: 199 specimens.
Repository: 11399 (18-9) (figured specimen).

Paltodus dyscritus Rexroad

Plate 7, figures 31-33

Paltodus dyscritus Rexroad, 1967, Indiana Geol. Survey Bull. 36, p. 42, pl. 4, figs. 30-34.
Paltodus unicostatus Branson and Mehl, Branson and Branson (part), 1947, Jour. Paleontology, v. 21, p. 554, pl. 82, figs. 17-19 and fig. 6?.
Material studied: 309 specimens.
Repository: 11400 (12-f), 11401 (21-B), and 11402 (9-173) (figured specimens).

Paltodus migratus Rexroad

Plate 7, figure 27

Material studied: 84 specimens.

Paltodus n. sp. A

Plate 7, figures 21, 22

Description: The asymmetrical unit is gently recurved, bowed, and uniformly tapered. The outer face is uniformly convex; the inner face is convex centrally around the basal cavity and distally but is flat along the anterior and posterior margins in the lower part. The anterior and posterior margins, therefore, are sharp edged and costalike. The basal cavity is conical and tapers to a point at or slightly below midheight.
Remarks: This species differs from *Acodus curvatus* in lacking a costa along the inner face, in being uniformly recurved, and in not having an anteriorly-posteriorly expanded base. Similarities between the two species, however, are great enough to suggest that *A. curvatus* is the ancestral form.

Material studied: 23 specimens.

Repository: 11404 (6-6) and 11405 (3-5) (figured specimens).

**Paltodus** n. sp. B

Plate 7, figures 23-25

Description: This is a slender, asymmetrical, uniformly tapered species, which is slightly bowed and recurved. The inner face is flat; the outer anterior face is convex, but distally the cusp is rounded. A small costa is present on some specimens at the anterior line of union of the two faces. Two costae are present on the posterior margin. The basal cavity is conical and is about two-thirds of the length of the specimen.

Remarks: *Paltodus debolti* is the probable ancestor of this species. The major difference between the two is that the costa on the outer anterior margin of *P. debolti* disappears and the smoothly convex face found on *P. n. sp. B* is left. Also, *P. n. sp. B* is slenderer and has a base that does not extend as far posteriorly. Immature specimens of evolutionarily advanced examples of *P. debolti* show this transition. Some specimens are closely similar to *P. n. sp. B* but have only a single costa on the posterior margin. This is the only difference in form, but the evolution does not seem to follow the same lineage. For the present this variant is not separated from *P. n. sp. B*.

Material studied: 18 specimens.

Repository: 11406 (8-10), 11407 (4-A7), and 11408 (3-5) (figured specimens).
Genus *Panderodus* Ethington, 1959

*Type species: Paltodus unicostatus* Branson and Mehl, 1933.

**Panderodus simplex** (Branson and Mehl)

Plate 7, figure 28

*Paltodus simplex* Branson and Mehl, 1933, Missouri Univ. Studies, v. 8, no. 1, p. 42, pl. 3, fig. 4.

*Panderodus simplex* (Branson and Mehl), Clark and Ethington (part?), 1966, Jour. Paleontology, v. 40, p. 682, pl. 82, fig. 10? only; Rexroad, 1967, Indiana Geol. Survey Bull. 36, p. 45, pl. 4, figs. 7, 8.

*Paltodus acostatus* Branson and Branson (part), 1957, Jour. Paleontology, v. 21, p. 554, pl. 82, figs. 15 only; Rhodes, 1953, Royal Soc. London Philos. Trans., ser. B, v. 237, no. 647, p. 296, pl. 21, figs. 111, 112; pl. 22, figs. 163, 164; pl. 23, figs. 212, 213; Bergström, 1961, Arkiv för Mineralogi och Geologi, v. 3, p. 48, pl. 1, figs. 13, 14; Philip (part), 1965, Royal Soc. Victoria Proc., v. 79, p. 108, pl. 8, fig. 23 only.


*Paltodus* cf. *P. acostatus* Branson and Branson, Walliser, 1960, Canada Geol. Survey Bull. 65, p. 31, pl. 7, fig. 10.

*Panderodus acostatus* (Branson and Branson) Serpagli and Greco, 1964, Soc. paleont. italiana Boll., v. 3, p. 204, pl. 36, figs. 4a, b; Philip, 1966, Micropaleontology, v. 12, p. 447, pl. 1, figs. 13, 18.

*Material studied:* 463 specimens.

*Repository:* 11409 (21-F) (figured specimen).

**Panderodus unicostatus unicostatus** (Branson and Mehl)

Plate 7, figures 29, 30

*Paltodus unicostatus* Branson and Mehl, 1933, Missouri Univ. Studies, v. 8, p. 42, pl. 3, fig. 3; *Branson and Branson* (part), 1947, Jour. Paleontology, v. 21, p. 554, pl. 82, figs. 14-16 only; Rhodes, 1953, Royal Soc. London Philos. Trans., ser. B, v. 237, no. 647, p. 298, pl. 21, figs. 84-88; pl. 22, figs. 155, 156; pl. 23, figs. 214-216; Walliser, 1957, Hess. Landesamt Bodenf., Notizbl., v. 85, p. 43, pl. 2, fig. 1; Philip, 1965, Royal Soc. Victoria Proc., v. 79, p. 109, pl. 8, fig. 9; Moskalenko, 1966, Paleont. zhur., no. 2, p. 82, pl. 11, figs. 1-3.


**Panderodus unicostatus** (Branson and Mehl), *Sweet* and others, 1959, Jour. Paleontology, v. 33, p. 1057, pl. 131, fig. 3; *Wolska*, 1961, Acta Palaeont. Polonica, v. 6, p. 353, pl. 4, figs. 3a, b; *Kockel* and *Stoppel*, 1962, Inst. geol. min. Espana, Notes and Commun., no. 68, p. 161, pl. 1, fig. 2; *Sweet* and *Bergström*, 1962, Jour. Paleontology, v. 36, p. 1234, text-fig. ID; *Bergström*, 1964, Lund Univ. Pub. 128, text-fig. 14; *Serpagli* and *Greco*, 1964, Soc. paleont. italiana Boll., v. 3, p. 206, pl. 36, fig. 7; pl. 37, figs. 1a, b; *Brooks* and *Druce*, 1965, Geol. Mag., v. 102, p. 376, pl. 7, fig. 8; *Merrill*, 1965, Texas Jour. Sci., v. 17, p. 390, pl. 2, fig. 8; *Winder*, 1966, Jour. Paleontology, v. 40, pl. 9, fig. 27; *Hamar*, 1966, Norsk geol. tidsskr., v. 46, p. 67, pl. 1, fig. 6; *Clark* and *Ethington*, 1966, Jour. Paleontology, v. 40, p. 683, pl. 82, figs. 17, 19; *Spassov* and *Yanev*, 1966, “Strasimir Dimitrov” Inst. Geol. Bull., v. 15, p. 55, pl. 3, figs. 13, 14; *Philip*, 1966, Micropaleontology, v. 12, p. 447, pl. 1, figs. 10-12, 19.

**Panerodus unicostatus unicostatus** (Branson and Mehl), *Rexroad*, 1967, Indiana Geol. Survey Bull. 36, p. 46, pl. 4, figs. 1, 2.

*Material studied:* 1,458 specimens.

*Repository:* 11410 (21-E) and 11411 (18-9) (figured specimens).

**Genus Plectospathodus** Branson and Mehl, 1933

*Type species:* *Plectospathodus flexuosus* Branson and Mehl, 1933.

**Plectospathodus irregularis** (Branson and Branson)

**Prioniodina irregularis** Branson and Branson, 1947, Jour. Paleontology, v. 21, p. 555, pl. 82, figs. 30, 31.

**Plectospathodus irregularis** (Branson and Branson), *Rexroad*, 1967, Indiana Geol. Survey Bull. 36, p. 48, pl. 3, fig. 15.

*Material studied:* 7 specimens.
Genus *Pterospathodus* Walliser, 1964

Type species: *Pterospathodus amorphognathoides* Walliser, 1964.

**Pterospathodus amorphognathoides** Walliser

Plate 3, figures 1-7


*Spathognathodus pennatus angulatus* **Walliser** (part), 1964, Hess. Landesamt Bodenf., Abh., no. 41, p. 79, pl. 14, figs. 20-22 only.

**Description:** This taxon consists of a nearly straight bladelike unit with a bifurcating inner lateral process slightly anterior to midlength. The part of the blade anterior to the inner lateral process is slightly incurved, and the posterior part is slightly outcurved. A prominent marginal flange is developed, especially in adult individuals, along the main blade and inner lateral process. The oral surfaces of the blade and inner process are marked by single median rows of denticles. Denticles of juvenile forms are few in number, laterally compressed, sharply pointed, and discrete. During growth the denticles increased in number and became rounded. In gerontic forms the denticles are commonly squat, rounded, and longitudinally compressed by growth pressure of adjoining denticles. The platformlike flange of mature individuals is lacking or poorly developed in juvenile forms. The branches of the bifurcating inner lateral process are generally of unequal length and in juvenile forms are small. The anterior branch is longer than the posterior branch in all observed specimens. The angle each branch makes with the main blade is quite variable but ranges from 40 to 65 degrees. In some specimens a slight irregularity is present on the outer margin opposite the inner process. This proto-process is observable both orally and aborally and in some gerontic individuals may support a few denticles. The aboral surface of the main blade and the inner process are marked by a well-developed basal groove. The basal groove is more pronounced in adult specimens.

**Remarks:** The juvenile specimens observed show the ontogenetic relationship of this species to *Spathognathodus* and possibly to *Neo-
spathognathodus. Juvenile specimens in which the inner process is broken may easily be mistaken for a spathognathodid. Pterospathodus is believed to have evolved from Neospathognathodus celloni with the development of the inner process. A few specimens which appear to be intermediate between N. celloni and P. amorphognathoides have been found in the Estill Shale of Kentucky.

Walliser’s (1964) illustrations of Spathognathodus pennatus angulatus show that specimens shown in figures 20-22 of plate 14 should be assigned to P. amorphognathoides. All three specimens appear to be juvenile forms. Figure 22 is the holotype of S. pennatus angulatus. The stratigraphic significance of this is that material assigned by Walliser to S. pennatus angulatus was found in the celloni-Zone and extends the range of P. amorphognathoides into the celloni-Zone in the Carnic Alps section. This conforms with similar findings in the Cincinnati Arch area, where adult specimens of P. amorphognathoides were associated with celloni-Zone fossils.

Material studied: 216 specimens.
Repository: 11412 (21-F), 11413 (21-D), 11414 (18-7), 11415 (14-A5), 11416 (18-6U), 11417 (14-A3), and 11418 (0-14) (figured specimens).

Genus Roundya Hass, 1953

Type species: Roundya barnettana Hass, 1953.

Roundya brevialata Walliser

Roundya brevialata Walliser, 1964, Hess. Landesamt Bodenf., Abh., no. 41, p. 69, pl. 4, fig. 16; pl. 31, figs. 8-10.
Remarks: Specimens of Roundya brevialata examined in this study are similar to those illustrated by Walliser (1964), but the lateral and posterior processes were broken on most specimens.
Material studied: 7 specimens.
Repository: 11419 (21-B) (unfigured specimens).
**Roundya caudata** Walliser


*Remarks:* *Roundya caudata* is distinguished from *R. detorta* by having symmetrical lateral processes and only a little twist to the main cusp.

*Material studied:* 104 specimens.

*Repository:* 11420 (M-Z II) and 11421 (M-Z II) (unfigured specimens).

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**Roundya detorta** Walliser

Plate 6, figures 16-18

*Roundya detorta* Walliser, 1964, Hess. Landesamt Bodenf., Abh., no. 41, p. 70, pl. 5, fig. 8; pl. 31, figs. 15-17.

*Material studied:* 53 specimens.

*Repository:* 11422 (21-D), 11423 (21-D), and 11424 (21-D) (figured specimens).

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**Genus Spathognathodus** Branson and Mehl, 1941

*Type species:* *Spathodus primus* Branson and Mehl, 1933.

Bergström and Sweet (1966, p. 317) place *Spathognathodus* Branson and Mehl in synonymy with *Bryantodina* Stauffer. Like Bergström and Sweet, we have examined Stauffer’s types of *Bryantodina typicalis* Stauffer (type species of *Bryantodina*) and the types of all other species of *Bryantodina* concurrently named by Stauffer. Several genera are represented among the species placed in *Bryantodina* by Stauffer, and so his concept of the genus is not clear. The type species, however, is the name bearer, and in gross form its holotype is similar to that of *Spathognathodus primus* (Branson and Mehl), type species of *Spathognathodus*, which we have examined along with abundant topotype material. Possibly the apparently minor differences between the two type species are of generic significance; possibly the two genera are homeomorphic, a suggestion for which some evidence has been found by Ethington (oral communication, 1966). Also, a complicating taxonomic factor is the lack of knowledge...
of other conodonts associated in the conodontifera represented by the
two type species. Until the uncertainties are settled we believe that it
is best to maintain both genera. If *Spathognathodus* subsequently is
proved to be the junior synonym of *Bryantodina*, we believe that it is
essential to petition the International Commission on Zoological
Nomenclature to use its plenary power to suppress *Bryantodina* in
favor of *Spathognathodus*.

**Spathognathodus hadros** n. sp.

Plate 2, figures 17, 18

*Derivation of name: Hadros*, Gk., well developed, stout, in reference
to the large size of adult individuals.

*Diagnosis:* Specimens have an angularly arched and unbowed blade
with a large anterior denticle. Specimens are highest over the small
basal cavity that is posterior to midlength and taper posteriorly from
the cavity.

*Description:* In lateral view the blade anterior to the basal cavity has
subparallel upper and lower margins. Behind the basal cavity the
blade tapers and is deflected downward. The denticles are fused
nearly to their apices. The anterior end of the blade is marked by a
single large denticle (rarely two denticles) that is much higher than
the rest of the denticles. Behind the large anterior denticle the
denticles are subequal to a point just posterior to the basal cavity.
From this point to the posterior margin the size of the denticles
decreases. The basal cavity is just posterior to midlength, is subround
in outline, and has a lip on the inner and outer sides; the inner lip is
the smaller. The basal cavity is very shallow to almost flat. In some
specimens a narrow groove extends anteriorly along the aboral edge;
in other specimens this groove is poorly developed or nonexistent.
There is no posterior groove.

*Remarks:* *Spathognathodus hadros* is very similar to *S. primus* but
differs because it has only a single enlarged anterior denticle and
denticles more nearly equal in size and does not have the same
general outline of the posterior part of the blade.

*Material studied:* 56 specimens.
Repository: 11425 (14A3) (holotype) and 11426 (14-A3) (paratype).

**Spathognathodus polinclinatus** n. sp.

Plate 2, figures 19, 20

*Derivation of name:* Pol, L., before; inclinatus, for the species *Spathognathodus inclinatus*, which was probably descendant from this species.

*Diagnosis:* The nearly straight blade has denticles of subequal size. The basal cavity is near the posterior and is minute.

*Description:* The denticles of the blade are fused nearly to their apices. They are subequal in size but are slightly larger near each end of the blade. Some specimens have a very minute basal cavity, but others have a shallow cavity with narrow lips. Specimens with the larger basal cavity tend to have the posterior part of the blade bent slightly inward.

*Remarks:* Specimens assigned to this species are variable, especially in the area of the basal cavity.

*Material studied:* 145 specimens.

Repository: 11427 (14A3) (holotype) and 11428 (14-A3) (paratype).

**Spathognathodus ranuliformis** Walliser

Plate 2, figures 10, 11

*Spathognathodus ranuliformis* Walliser, 1964, Hess. Landesamt Bodenf., Abh., no. 41, p. 82, pl. 6, fig. 9; pl. 22, figs. 5-7.

*Description:* The straight denticulate blade has a greatly expanded basal cavity, which extends posteriorly beyond the blade. Denticles of the blade are fused nearly to their apices. The posterior two or three denticles of the blade are slightly deflected from the axis of the blade toward the inner side. Some specimens have a single denticle on the outer side of the cup. The aboral surface has a groove under the blade which expands posteriorly into the basal cavity.

*Remarks:* Specimens of *Spathognathodus ranuliformis* from this study differ from those illustrated by Walliser (1964) only by the appearance of a denticle on the cup of a few specimens. Development of a
denticle on the cup could give rise to specimens similar to one illustrated as Spatognathodus n. sp. Walliser (1964, p1. 22, fig. 8). Material studied: 13 specimens. Repository: 11429 (14-A3) and 11430 (M-Z II) (figured specimens).

Genus Synprioniodina Bassler, 1925

Type species: Synprioniodina alternata Ulrich and Bassler, 1926.

**Synprioniodina silurica** Walliser

Plate 4, figure 10

*Synprioniodina silurica* **Walliser**, 1964, Hess. Landesamt Bodenf., Abh., no. 41, p. 88, fig. 12; pl. 8, fig. 18; pl. 29, figs. 38-41; pl. 30, figs. 1, 3.

*Description:* Specimens consist of a main cusp, a short anterior bar, and a longer posterior bar. The cusp is small and subround in cross section. The base of the cusp on the inner side has a flaring lip, which may be directed slightly posteriorly. A well-formed basal cavity is under the cusp, and a narrow groove extends partway along the posterior bar. The anterior bar bears one or two denticles. The posterior bar is sharply down curved and supports six or seven round discrete denticles.

*Remarks:* Specimens of *S. silurica* are similar to those described by Walliser (1964) except for two features. In general, specimens illustrated by Walliser, except for the holotype (pl. 30, fig. 1), show a longer anterior bar. The cross section of the cusp in material form this study is round to subround, but material illustrated by Walliser (1964) appears to have sharp edges on the cusp. Despite these differences the specimens from this study are believed to fall within the wide range of specific variability of *S. silurica* and are assigned to the species.

Material studied: 24 specimens.
Repository: 11431 (M-Z II) (figured specimen).
Genus **Trichonodella** Branson and Mehl, 1948

*Type species:* *Trichognathus prima* Branson and Mehl, 1933.

**Trichonodella asymmetrica** n. sp.

**Plate 4, figure 7**

*Derivation of name:* Asymmetrica, L., asymmetrical, in reference to the unequal processes.

*Diagnosis:* The subtriangular and slightly twisted cusp is flanked by unequal bladelike lateral processes. The basal cavity below the cusp is shallow and somewhat elongate posteriorly.

*Description:* The cusp is subtriangular, slightly twisted, and bent slightly posteriorly. The lateral blades are unequal in size and the entire form is asymmetrical. The shorter process bears four to five appressed denticles. The longer blade is broken in the specimens observed but has four to six denticles that are smaller than the denticles of the shorter blade. The basal cavity is elongate posteriorly but does not have a pronounced posterior lip.

*Remarks:* Except for the asymmetry, this species is similar to *Trichonodella papilio*. Specimens found in this study appear to grade from *T. papilio* to *T. asymmetrica* with the loss of symmetry. *T. asymmetrica* may represent the initial stage of the development of a species of *Plectospathodus* with the gradual lengthening of one of the processes. This causes some problems of orientation because in *Trichonodella* the specimens are assumed to have lateral processes on each side of a central cusp but *Plectospathodus* generally is considered to have anterior and posterior processes associated with a main cusp. *T. asymmetrica* is described so as to retain the processes in a lateral orientation.

*Material studied:* 79 specimens.

*Repository:* 11432 (14-A3) (holotype).

**Trichonodella brassfieldensis** Branson and Branson

**Plate 5, figures 13, 14**

*Trichonodella brassfieldensis Branson* and *Branson* (part), 1947, *Jour. Paleontology*, v. 21, p. 551, pl. 82, fig. 47 only (holotype); pl. 81, fig. 12 only; *Rexroad*, 1967, *Indiana Geol. Survey Bull*, 36, p. 56, pl. 3, figs. 27, 28.
Material studied: 37 specimens.  
Repository: 11433 (M-Z II) and 11434 (M-Z II) (figured specimens).

**Trichonodella? edentata** Branson and Branson

Plate 4, figures 16-18

*Trichonodella? edentata* Branson and Branson, 1947, Jour. Paleontology, v. 21, p. 552, pl. 81, fig. 28; pl. 82, figs. 40, 44, 48; Rexroad, 1967, Indiana Geol. Survey Bull. 36, p. 55, pl. 3, figs. 31-34.

*Trichonodella brassfieldensis* Branson and Branson (part), 1947, Jour. Paleontology, v. 21, p. 551, pl. 82, fig. 49 only.

Remarks: The assignment of this species to the genus *Trichonodella* is questioned, but not enough is known now about the evolutionary development of the species to assign it more accurately. Relationship with *Sagittodontus* Rhodes is probable.

Material studied: 132 specimens.  
Repository: 11435 (M-Z II), 11436 (14-A3), and 11437 (21-B) (figured specimens).

**Trichonodella excavata** (Branson and Mehl)

Plate 4, figure 2

*Trichognathus excavata* Branson and Mehl, 1933, Missouri Univ. Studies, v. 8, p. 51, pl. 3, figs. 35, 36.

*Trichonodella excavata* (Branson and Mehl), Walliser, 1957, Hess. Landesamt Bodenf., Notizbl., v. 85, p. 48, pl. 3, figs. 3, 4, 8; Bischoff and Sannemann, 1958, Hess. Landesamt Bodenf., Notizbl., v. 85, p. 109, pl. 15, figs. 16, 18; Ethington and Furnish, 1962, Jour. Paleontology, v. 36, p. 1287, pl. 173, fig. 8; Walliser, 1964, Hess. Landesamt Bodenf., Abh., no. 41, p. 89, pl. 8, fig. 2; pl. 31, figs. 26, 27.


Remarks: Specimens of *Trichonodella excavata* from this study conform to the fragments illustrated by Branson and Mehl (1933) and to topotype material from the Bainbridge Group of Missouri.  
Material studied: 29 specimens.  
Repository: 11438 (18-6) (figured specimen).
Trichonodella? expansa n. sp.

Plate 4, figures 19-22

Derivation of name: Expansa, L., spread out, in reference to the expanded base.

Diagnosis: A large, slightly twisted, triangular cusp arises from a variable three- or four-pronged platform. Development of projections from the base and of surface sculpture is variable. The aboral surface is shallowly excavated.

Description: This species consists of a prominent cusp on a small basal platform composed of three or four short coalescing processes. The cusp is triangular in cross section and directed slightly posteriorly. The edges of the cusp extend from the base as lateral processes. In some specimens several denticles are present on the processes. The processes may expand laterally and be quite broad. The longest process is directed posteriorly. The species lacks a well-developed basal cavity, but there is a shallow excavation under the cusp.

Remarks: The similarity of the cusp relates Trichonodella? expansa to specimens of the T.? edentata lineage from which it evolved by the development of the lateral processes.

Material studied: 26 specimens.

Repository: 11439 (M-Z II) (holotype); 11440 (M-Z II), 11441 (14-A3), and 11442 (M-Z II) (paratypes).

Trichonodella inconstans Walliser

Plate 4, figure 1

Trichonodella inconstans Walliser, 1957, Hess. Landesamt Bodenf., Notzibl., v. 85, p. 50, pl. 3, figs. 10-17; Walliser, 1964, Hess. Landesamt Bodenf., Abh., no. 41, p. 90, pl. 8, fig. 8; pl. 30, figs. 10-12.

Remarks: Trichonodella inconstans is a highly variable species, and material from this study seems to fall within the range of variability described by Walliser.

Material studied: 18 specimens.

Repository: 11443 (M-Z II) (figured specimen).
**Trichonodella papilio** n. sp.

Plate 4, figures 4-6

*Derivation of name:* *Papilio*, L., butterfly, in reference to high lateral processes that give the form a winglike appearance.

*Diagnosis:* On each side of the subtriangular cusp are equal to subequal, deep but short, lateral processes supporting four to seven denticles each. The basal cavity is posteriorly elongate.

*Description:* Specimens consist of a subtriangular cusp and lateral blades supporting four to seven appressed denticles. The lateral processes are symmetrical or nearly so and directed downward at an angle of 40 to 50 degrees as viewed from the posterior. The basal cavity is posteriorly elongate and generally has a strongly flared lip along the posterior margin of the cusp at its base.

*Remarks:* The lateral processes of *Trichonodella papilio* are shorter and more bladelike than those of *T. excavata*. Some specimens may be slightly asymmetrical, especially in the number of lateral denticles.

*Material studied:* 46 specimens.

*Repository:* 11444 (21-B) (holotype); 11445 (M-Z II) and 11446 (MZ II) (paratypes).

**Trichonodella** spp.

Plate 4, figures 3, 15; plate 6, figure 19

*Remarks:* A number of specimens of *Trichonodella* are not assignable to any of the named species of that genus, and their limited numbers and relatively poor preservation make separation into well-defined groups impossible. Accordingly, none of the apparent groups is named, although probably there are at least three species represented. Specimens representative of three general morphologic types are illustrated to show the type of material present.

*Material studied:* About 30 specimens.

*Repository:* 11447 (12-2), 11448 (14-A3), and 11449 (12-2) (figured specimens).
**Genus and Species Indeterminate**

Plate 6, figures 13-15

*Remarks:* Three specimens differ in morphology from any described genera, and they do not appear to be pathologic freaks of known genera. The single specimens, then, cannot be classified, but they are figured to illustrate the kind of material present in the study.

*Material studied:* 3 specimens.

*Repository:* 11450 (21-D-), 11451 (0-11), and 11452 (12-2) (figured specimens).

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Appendix: Sample Intervals for Collecting Localities

The first symbol given, generally a number, is the sample designation and is followed by the thickness of the interval sampled. “Cov.” indicates a covered interval.

PRIMARY LOCALITIES


3. Section in southeastern part of quarry, samples collected upward from top of Ordovician rocks-Brassfield Limestone: 1, 24 in.; 2, 24 in. Lee Creek Member: O-B, 0 to 4 in. Osgood Member: 3A, 20 in.; 4, 20 in.; 5, 22 in.; 6, 17 in.; 7, 18 in.; 8, 25 in.; 9, 18 in.; top of Osgood Member. Section in western part of quarry, samples collected upward from quarry ledge 20 in. below base of Laurel Member-Osgood Member: 1, 20 in. Laurel Member: 2, 16 in.; 3, 40 in.; 4, 41 in.; 5, 41 in.; 6, 39 in.; 7, 38 in.; 8, 36 in.; 9, 20 in.; top of exposure.


6. Samples collected upward from top of Ordovician rocks-Salamonie Dolomite: 2, 16 in.; 3, 4 to 6 in.; cov., 12 in.; 4, 22 in.; 5, 30 in.; 6, 36 in.; 7, 32 in.; top of exposure.
7. Samples collected upward from top of Ordovician rocks-Brassfield Lime stone: 3, 30 in.; 4, 30 in., approximate gradational base of Lee Creek Member; 5, 30 in.; 6, 21 in.; 7, 5 in. Osgood Member: 8, 14 in.; top of f exposure.

8. Samples collected upward from top of Ordovician rocks-Brassfield Lime stone: 4, 16 in. (4a, 30 in., a lateral offset from sample 4). Lee Creek Member: fun., 0 to 1 in. Osgood Member: 5, 29 in.; 6, 24 in.; 7, 30 in.; 8, 30 in.; 9, 30 in. gradational upward into Laurel Member; 10, 24 in.; 11, 36 in.; 12, 36 in.; 13, 36 in.; 14, 36 in.; 15, 36 in.; top of continuous exposure.

9. Core sampled downward from its top, 21.5 ft. below top of Salamonie Dolomite (all sample numbers prefixed by “L66”)-Salamonie Dolomite 156-1, 2.4 ft.; 156-2, 2.4 ft.; 158-1, 2.6 ft.; 158-2, 2.5 ft.; 160-1, 1.9 ft.; 160-2, 2.7 ft.; 160-3, 1.9 ft.; 162, 1.3 ft.; 163-1, 1.3 ft.; 163-2, 1.6 ft.; 165, 1.0 ft.; 167, 0.4 ft.; 169, 0.7 ft.; 171, 1.5 ft.; 173, 1.4 ft.; 175-1, 12 ft.; 175-2, 1.5 ft.; 177, 1.9 ft.; 179, 1.6 ft.; 181, 183, 2.1 ft.; 185, 1.1 ft.; 187, 189, 2.0 ft.; top of Ordovician rocks.


11. Samples collected upward from top of lower part of Brassfield Limestone Lee Creek Member: 0, 0 to 2 in. Osgood Member: 1, 5 in.; 2, 11 in. 3, 12 in.; covered above.

12. Samples collected upward from top of Ordovician rocks-Lee Creek Member? grading upward into Lee Creek Member: a, 7 in.; b, 12 in.; c, 7 in. (1, 25 in. lateral offset of samples a, b, and c); d, 6 in.; e, 7 in.; f, 5 in.; g, 5 in. (2, 24 in. lateral offset of samples d, e, f, and g). Osgood Member: 3, 12 in.

13. Samples collected upward from top of Ordovician rocks-Lee Creek Member: 1, 7 to 9 in.; 2, 11 in.; 3, 10 in.; 4, 5 in.; 5, 8 in. Osgood Member: 6,12 in.

14. Samples collected upward from top of Ordovician rocks-Brassfield Lime stone: A1, 24 in.;A2, 17 in. Lee Creek Member: A3, 11 in. Osgood Member: A4, 10 in.; A5, 15 in.; above these samples single grab samples were collected from the lower shale, middle limestone, and upper shale of the Osgood Member and from the basal part of the Laurel Member.

15. Core was sampled downward from base of Waldron Shale (all sample numbers prefixed by “L66”)-Salamonie Dolomite: 744, 746, 2.6 ft.; 748-1, 3.2 ft.;
748-2, 750, 752, 754, 2.1 ft.; 756, 758-1, 1.8 ft.; 758-2, 1.9 ft.; 760-1, 2.3 ft.; 760-2, 1.9 ft.; 760-3, 2.3 ft.; 760-4, 4.3 ft.; 762, 2.0 ft.; 764-1, 3.5 ft.; 764-2, 2.8 ft.; 766, 2.2 ft.; 768, 2.2 ft.; 770-1, 1.9 ft.; 770-2, 772, 774, 1.9 ft.; 776, 1.5 ft.; 778, 858, 780-1, 2.4 ft.; 780-2, 1.9 ft.; 780-3, 2.0 ft.; 780-4, 2.0 ft.; 780-5, 1.6 ft.; 782, 1.4 ft.; 784, 0.3 ft.; 786, 787, 0.2 ft.; 788, 0.4 ft.; 790, 0.3 ft.; 792, 1.2 ft.; 794, 1.7 ft.; 796-1, 0.3 ft.; 796-2, 798, 0.2 ft.; top of Ordovician rocks.

16. Samples collected upward from top of Ordovician rocks: Lee Creek Member: A2, 10 in.; A3, 19 in.; A4, 8 in.; A5, 12 in. Osgood Member: A6, 12 in.

17. Core was sampled downward from base of Waldron Shale (all sample numbers prefixed by “L66”)-Laurel Member: 74, 1.2 ft.; 76, 3.6 ft.; 78, 3.8 ft.; 80, 2.4 ft.; 82-1, 3.7 ft.; 82-2, 3.4 ft.; 84-1, 3.0 ft., 84-2, 3.2 ft.; 86, 1.6 ft.; 88, 89, 2.7 ft., 91, 3.3 ft.; 93, 95, 2.4 ft.; 96, 2.8 ft.; 98, 100, 1.8 ft.; 102, 103, 1.3 ft.; 104-1, 1.3 ft.; 104-2, 2.8 ft.; 106, 3.1 ft.; 108-1, 1.9 ft.; 108-2, 2.0 ft.; 110, 2.0 ft.; 112, 1.5 ft.; 114, 116, 118, 1.2 ft.; 120, 122, 0.4 ft.; 123, 124, 0.6 ft.; 126-1, 0.7 ft.; 126-2, 1.0 ft.; top of Ordovician rocks.


19. Core was sampled downward from base of Waldron Shale (all sample numbers prefixed by “L66”)-Laurel Member: 299, 1.4 ft.; 301, 0.8 ft.; 303, 2.8 ft.; 305, 2.8 ft.; 307, 4.2 ft.; 309, 3.3 ft.; 310, 1.4 ft.; 311-1, 3.1 ft.; 311-2, 2.3 ft.; 311-3, 2.4 ft.; 311-4, 2.4 ft.; 311-5, 2.3 ft. Osgood Member: 314, 1.7 ft.; 316, 1.3 ft.; 318, 1.7 ft.; 320, 1.2 ft.; 322, 1.4 ft.; 324, 326, 1.2 ft.; 328-1, 1.4 ft.; 328-2, 1.5 ft.; 330, 1.3 ft.; 332-1, 1.0 ft.; 332-2, 0.8 ft.; 334, 0.7 ft.; 336, 0.5 ft.; 338, 0.4 ft. Brassfield Limestone?: 340, 0.3 ft.; 341, 342, 343, 1.1 ft.; 345, 0.8 ft.; 347, ¼ in.; 349, 0.7 ft.; 351, 0.8 ft. Brassfield Limestone: 352, 0.1 ft.; 354, 1.5 ft.; 356-1, 1.4 ft.; 356-2, 1.5 ft.; top of Ordovician rocks.


SUPPLEMENTARY LOCALITIES

A. Section collected upward from 7-inch covered interval above Ordovician rocks-Brassfield Limestone: 3, 16 in.; 4, 24 in.; 5, 24 in.; 6, 24 in.; 7, 30 in. Salamonie Dolomite: 8, 14 in.; 9, 24 in.; 10, 20 in.; top of quarry face.

B. Section collected upward from top of Ordovician rocks-Brassfield Limestone: 1, 20 in.; 2, 20 in. Osgood Member: 3, 15 in.

C. Section collected upward from top of Brassfield Limestone-Salamonie Dolomite: 1, 26 in.; 2, 17 in.; 3, 20 in.; 4, 37 in.; 5, 23 in.; 6, 16 in.; 7, 23 in.

D. Section collected upward from top of Ordovician rocks-Brassfield Limestone: 1, 13 in.; 2, 8 in.; 3, 22 in. Salamonie Dolomite: 4, 4 in.

E. Section collected upward from top of Ordovician rocks-Osgood Member: 2, 23 in.

F. Section collected upward from top of Ordovician rocks-Brassfield Limestone: 2, 24 in.; 2a, 3 in. Salamonie Dolomite: 3, 13 in.; 4, 12 in.; 5, 22 in.; 6, 13 in.; 7, 18 in.; 8, 24 in.; 9, cov. 12 in.; 10, 24 in.; 11, 26 in.

G. Samples collected upward from top of covered interval about 20 inches thick above Ordovician rocks-Osgood Member: 1 lower, 16 in.; 1, 5 in.; 2, 7 in.; 3, 14 in.; 4, 20 in.; 5, 24 in.; 6, 24 in.; 7, 23 in.; 8, 22 in.; 9, 16 in.; 10, 11 in.; 12, 14 in.; 13, 14 in.; 14, 13 in.; base of Laurel Member.

H. Samples collected upward from top of Ordovician rocks-Brassfield Limestone: Br, 0 to 3 in. Osgood Member: 1, 6 in.; 2, 12 in.; 3, 8 in.; 4, 22 in.; top of exposure.

I. Samples collected upward from top of Ordovician rocks-Brassfield Limestone: 2, 14 in.; 3, 14 in. Osgood Member: 4, 7 in.

J. Section collected upward from top of Ordovician rocks-Brassfield Limestone: Br, 4 in. Lee Creek Member: fun., 6 in. Osgood Member: bN, 14 in.
K. Samples collected upward from top of Brassfield Limestone-Osgood Member: 1, 10 in.; 2, 12 in.; 3, 12 in.; covered above.

L. Section from Saluda Formation upward into the Laurel Limestone was examined.

M. Samples collected upward from top of Ordovician rocks-Brassfield Limestone: Br, 9 to 13 in. Lee Creek Member: Z II, 4 to 9 in.; covered above.

N. Samples collected upward from top of Ordovician rocks-Brassfield Limestone: 1, 16 in.; 2, 12 in. Lee Creek Member: fun., 4 in.

O. Samples collected upward from top of 8-inch covered interval above Ordovician rocks-Brassfield Limestone: 11, 14 in.; 12, 12 in. Lee Creek Member: 13, 14 in. Osgood Member: 14, 8 in.

P. Samples collected upward from top of Ordovician rocks-Lee Creek Member: 3, 17 in.; 4, 12 in. Osgood Formation: 5, 9 in.

Q. Samples collected upward from top of Ordovician rocks-Brassfield Limestone: 2, 5 in.; 3, 14 in. Osgood Member: 4, 12 in.

R. Samples collected upward from top of Ordovician rocks-Lee Creek Member: 1, 6 in. Osgood Member: 2, 12 in.

S. Samples Br (Brassfield Limestone) and fun. (Lee Creek Member) collected from pockets in top of Ordovician rocks; other samples collected upward from top of this surface-Osgood Member: 3, 22 in. (B, 12 in., and C, 11 in., lateral equivalents of sample 3); 4, 22 in.


U. Samples collected upward from quarry floor, which is the presumed top of Ordovician rocks-Brassfield Formation: 1, 34 in.; 2, 27 in.; 3, 30 in.; 4, 36 in.; 5, 21 in.; 6, 30 in.; 7, 37 in.; 8, 30 in.; 9, 28 in. Osgood Formation: 10, 24 in.; 11, 24 in.; 12, 24 in.; 13, 24 in.; 14, 24 in.; 15, 28 in.; top of exposure.
Plates 1-7
PLATE 1
All figures are X 40

Numbers in parentheses refer to locality and sample numbers; for example, (M-Z II) refers to locality M, sample Z II.

1-4  *Neospathognathodus ceratooides* n. sp. (p. 46).
   1. Lateral view of paratype 11379 (M-Z 11).
   2, 3. Oral views of paratypes 11380 (M-Z II) and 11381 (12-f).
   4. Aboral view of holotype 11378 (12-2).

5-7  *Neospathognathodus bullatus* n. sp. (p. 44).
   5. Oral view of holotype 11371 (M-Z II).
   6. Oral view of paratype 11372 (10-3).
   7. Aboral view of paratype 11373 (M-Z 11).

8-11 *Neospathognathodus latus* n. sp. (p. 46).
   8-10. Oral views of paratypes 11383 (M-Z II), 11384 (21-B), and 11385 (13-4).
CONODONTS FROM THE BRASSFIELD LIMESTONE AND SALAMONIE DOLOMITE
Numbers in parentheses refer to locality and sample numbers; for example, (M-Z II) refers to locality M, sample Z II).

1-4  *Neospathognathodus celloni* (Walliser) (p. 45).
    Lateral view of 11374 (M-Z II), oral views of 11375 (21-B) and 11376 (14A3), and lateral view of 11377 (M-Z II).

5  *Neospathognathodus pennatus* (Walliser) (p. 47).
    Oral view of 11386 (M-Z II).

6, 7  *Ozarkodina adiutricis* Walliser? (p. 48).
    Lateral views of 11388 (12-f) and 11389 (10-3).

8  *Ozarkodina adiutricis* Walliser (p. 48). Lateral view of 11387(21-B).

9  *Ozarkodina hanoverensis* n. sp. (p. 50).
    Inner lateral view of holotype 11395 (14-A3).

10,11  *Spathognathodus ranuliformis* Walliser (p. 60).
    Inner lateral view of 11429 (14-A3) and oral view of 11430 (M-Z II).

12-14  *Ozarkodina gaertneri* Walliser (p. 49).
    Lateral views of 11390 (11-0), 11391 (18-7), and 11392 (21-D).

15, 16  *Ozarkodina neogaertneri* n. sp. (p. 50).
    15, Lateral view of holotype 11393 (21-G, E, F).
    16, Lateral view of paratype 11394 (21-I).

17,18  *Spathognathodus hadros* n. sp. (p. 59).
    17, Lateral view of paratype 11426 (14-A3).
    18, Lateral view of holotype 11425 (14-A3).

19,20  *Spathognathodus polinclinatus* n. sp. (p. 60).
    19, Lateral view of holotype 11427 (14A3).
    20, Lateral view of paratype 11428 (14-A3).
Numbers in parentheses refer to locality and sample numbers; for example, (21-F) refers to locality 21, sample F.

1-7 *Pterospathodus amorphognathoides* Walliser (p. 56).
   Lateral view of 11412 (21-F), lateral view of 11413 (21-D), oral
   view of 11414 (18-7), aboral view of 11415 (14A5), oral view of
   11416 (18-6U), oral view of 11417 (14A3), and cross-sectional
   view of 11418 (O-14).

8 *Apsidognathus tuberculatus* Walliser (p. 24).
   Oral view of 11455 (16-A5).

9 *Icriodina stenolophata* Rexroad (p. 37).
   Oral view of 11354 (M-Z II).

10,11 *Icriodina irregularis* Branson and Branson (p. 37).
   Oral views of 11352 (12-d) and 11353 (15-792).

12-14 *Hadrognathus staurognathoides* Walliser (p. 36).
   Oral view of 11349 (M-Z II), aboral view of 11350 (O-14), and oral
   view of 11351 (21-D).
CONODONTS FROM THE BRASSFIELD LIMESTONE AND SALAMONIE DOLOMITE
Numbers in parentheses refer to locality and sample numbers; for example, (M-Z II) refers to locality M, sample Z II.

1. *Trichonodella inconstans* Walliser (p. 64).
   Posterior view of 11443 (M-Z II).

2. *Trichonodella excavata* (Branson and Mehl) (p. 63).
   Posterior view of 11438 (18-6).

3. *Trichonodella* sp. (p. 65).
   Posterior view of 11447 (12-2).

4-6. *Trichonodella papilio* n. sp. (p. 65).
   4, 5. Posterior views of paratypes 11445 (M-Z II) and 11446 (M-Z II).

7. *Trichonodella asymmetrica* n. sp. (p. 62).
   Posterior view of holotype 11432 (14-A3).

   Inner lateral views of 11363 (12-d) and 11364 (12-bulk).

    Inner lateral view of 11431 (M-Z II).

    Lateral view of 11348 (M-Z II).

   12. Outer lateral view of paratype 11361 (14-A3).
   13. Inner lateral view of holotype 11360 (14-A3).

15. *Trichonodella* sp. (p. 65).
    Oblique posterior view of 11448 (14A3).

    Lateral view of 11435 (M-Z II), lateral view of 11436 (14-A3), and posterior view of 11437 (21-B).

   19. Oblique oral view of paratype 11440 (M-Z II).
   20. Lateral view of holotype 11439 (M-Z II).
   22. Oblique aboral view of paratype 11442 (M-Z II).
CONODONTS FROM THE BRASSFIELD LIMESTONE AND SALAMONIE DOLOMITE
Numbers in parentheses refer to locality and sample numbers; for example, (21-D) refers to locality 21, sample D.

1, 2  *Carniodus carinthiacus* Walliser (p. 24).
     Lateral views of 11456 (21-D) and 11309 (O-14).
3  *Carniodus carnulus* Walliser (p. 25).
     Lateral view of 11310 (21-D-).
4, 5  *Carniodus carnulus* Walliser (p. 25).
     Lateral views of 11311 (0-14) and 11312 (21-E).
6-8  *Carniodus carnulus* Walliser (p. 26).
     Lateral views of 11313 (7-8), 11314 (21-G), and 11315 (18-7).
9  *Carniodus* sp. (p. 26).
     Lateral view of 11316 (S-fun.).
10  *Neoprioniodus subcarnus* Walliser (p. 41).
     Lateral view of 11369 (21-I).
11, 12  *Neoprioniodus planus* Walliser (p. 41).
     Lateral views of 11367 (14-A3) and 11368 (14-A3).
13, 14  *Trichonodella brassfieldensis* Branson and Branson (p. 62).
     Lateral view of 11433 (M-Z II) and posterior view of 11434 (M-Z II).
15, 16  *Neoprioniodus costatus* Walliser (p. 40).
     Lateral views of 11365 (21-G, E, F bulk) and 11366 (7-7).
17  *Neoprioniodus triangularis* Walliser (p. 42).
     Lateral view of 11370 (21-C).
18, 19  *Ligonodina* cf. *L. kentuckyensis* Branson and Branson (p. 37).
     Inner lateral view of 11355 (12-2) and posterior view of 11356 (12-2).
20-22  *Ligonodina petila* n. sp. (p. 38).
     20, Inner lateral view of paratype 11358 (14-A3).
     21, Outer lateral view of paratype 11359 (14-A3).
     22, Inner lateral view of holotype 11357 (12-2).
23  *Distomodus? extrorsus* Rexroad (p. 34).
     Outer lateral view of 11340 (M-Z II).
24, 25  *Distomodus kentuckyensis* Branson and Branson (p. 34).
     Inner lateral views of 11341 (M-Z II) and 11342 (21-B).
     Outer lateral views of 11337 (21-B) and 11338 (12-2) and inner lateral view of 11339 (12-2).
Numbers in parentheses refer to locality and sample numbers; for example, (12-2) refers to locality 12, sample 2.

1-4 *Diadelognathus excertus* n. sp. (p. 28).
   1a, 1b, Oblique anterior and aboral views of holotype 11317 (12-2).
   2a, 2b, Oblique anterior and aboral views of paratype 11318 (14A3).
   3, 4, Oblique anterior views of paratypes 11319 (14-A3) and 11320 (12-2).

5, 6 *Diadelognathus* n. sp. B (p. 30).
   Posterior and oral views of 11328 (14-A3) and 11329 (14-A3).

7, 8 *Diadelognathus primus* n. sp. (p. 29).
   7, Aboral view of paratype 11324 (M-Z II).
   8a, 8b, Oblique posterior and oblique anterior views of holotype 11323 (M-Z II).

9, 10 *Diadelognathus* n. sp. A (p. 30).
   9a, 9b, Anterior and aboral views of 11325 (M-Z II).
   10a, 10b, Anterior and posterior views of 11326 (12-2).

11, 12 *Diadelognathus compressus* n. sp. (p. 28).
   11a, 11b, Lateral and aboral views of paratype 11322 (M-Z II).
   12, Oblique aboral view of holotype 11321 (M-Z II).

13-15 Genus and species indeterminate (p. 66).
   Oral view of 11450 (21-D-), lateral view of 11451 (0-11), and oral view of 11452 (12-2).

16-18 *Roundya detorta* Walliser (p. 58).
   Lateral views of 11422 (21-D), 11423 (21-D), and 11424 (21-D).

19 *Trichonodella* sp. (p. 65).
   Posterior view of 11449 (12-2).
CONODONTS FROM THE BRASSFIELD LIMESTONE AND SALAMONIE DOLOMITE
1-4  *Distacodus obliquicostatus* Branson and Mehl (p. 31).
   Lateral views of 11330 (9-177), 11331 (9-181, 183), 11332 (3-5), and 11333 (9-177).

5-7  *Distacodus*? n. sp. (p. 32).
   Lateral views of 11334 (21-L), 11335 (18-8), and 11336 (9-177).

8-10  *Acordus* cf. *A. inornatus* Ethington (p. 23).
   Lateral views of 11303 (9-177), 11304 (21-D), and 11305 (21-D).

11-15  *Drepanodus aduncus* n. sp. (p. 35).
   11, Aboral view of paratype 11344 (21-J).
   12, 13, Lateral views of paratypes 11345 (6-4) and 11346 (21-L).
   14, Lateral view of holotype 11343 (18-8).
   15, Lateral view of paratype 11347 (9-173).

16-18  *Paltodus costulatus* Rexroad (p. 51).
   Lateral views of 11396 (4-A8), 11397 (3-5), and 11398 (21-G, E, F).

19, 20  *Acorus curvatus* Branson and Branson (p. 23).
   Inner lateral view of 11301 (M-Z II) and outer lateral view of 11302 (12-f).

21, 22  *Paltodus* n. sp. A (p. 52).
   Inner lateral view of 11404 (6-6) and outer lateral view of 11405 (3-5).

23-25  *Paltodus* n. sp. B (p. 53).
   Posterior view of 11406 (8-10), outer lateral view of 11407 (4A7), and inner lateral view of 11408 (3-5).

26  *Paltodus debolti* Rexroad (p. 52).
   Outer lateral view of 11399 (18-9).

27  *Paltodus migratus* Rexroad (p. 52).
   Lateral view of 11403 (17-108-1).

28  *Panderodus simplex* (Branson and Mehl) (p. 54).
   Lateral view of 11409(21-F).

29,30  *Panderodus unicostatus* (Branson and Mehl) (p. 54).
   Lateral views of 11410 (21-E) and 11411 (18-9).

31-33  *Paltodus dyscritus* Rexroad (p. 52).
   Lateral views of 11400 (12-f) and 11401 (21-B) and anterior view of 11402 (9-173).

34-36  *Acorus unicostatus* Branson and Branson (p. 23).
   Inner lateral view of 11306 (M-Z II) and outer lateral views of 11307 (1-3) and 11308 (M-Z II).
CONODONTS FROM THE BRASSFIELD LIMESTONE AND SALAMONIE DOLOMITE
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