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in
BIOLOGY
and
GEOLOGY

Number 87

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Milwaukee Public Museum Contributions in Biology and Geology

Rodney Watkins, Editor

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ISBN 0-89326-172-6

ABSTRACT

The Silurian Brandon Bridge Formation is a transgressive unit of argillaceous dolostone. At Voree Quarry in Walworth County, Wisconsin, the Brandon Bridge is of Late Llandovery age (*Pterospathodus celloni* zone) and about 7.6 m thick. It consists of bioturbated skeletal mudstone and wackestone with thin, laminated interbeds and packstone lags formed as storm deposits; these sediments represent a shelf environment below fair-weather wave base. The brachiopod fauna includes *Dolerorthis, Resserella, Dicoelosia, Leangella, Eoplectodonta, Jonesea, Leptaena, Coolinia, Eospirifer,* an atrypid and a clorinidid, and it represents Benthic Assemblage 4 of Boucot (1975). Other groups include foraminifers, sponge spicules, tabulates, rugosans, bryozoans, gastropods, cephalopods, ostracods, trilobites, crinozoan ossicles, and dendroid graptolites. The large trilobite *Stenopareia imperiator* (Hall) is the most conspicuous member of the fauna, but crinozoans dominate preserved skeletal material. Collections from Voree Quarry represent the most diverse skeletal fauna reported to date from the Brandon Bridge Formation. This fauna is comparable in guild structure and tiering to BA4-5 communities in the Wenlock Waukesha and Racine formations. Conodonts in the Brandon Bridge Formation at Voree Quarry occur in greater abundance and diversity than in other Silurian formations of southeastern Wiscosnin, and they include 10 genera and 16 species.

INTRODUCTION

The Brandon Bridge Formation is a Lower Silurian (Upper Llandovery to earliest Wenlock) unit of argillaceous dolostone that occurs in northeastern Illinois and southeastern Wisconsin. Averaging about 8 m thick, the Brandon Bridge is a transgressive deposit that overlies a regional unconformity at the top of the Plaines Member of the Kankakee Formation, as recognized by Kluessendorf and Mikulic (1992). Previous studies of the Brandon Bridge Formation have focused on lithostratigraphy (Willman, 1973; Mikulic, 1977, 1979; Mikulic et al., 1985a; Rovey, 1990), sedimentology (Kluessendorf 1990), conodont zonation (Liebe and Rexroad, 1977; Kleffner et al., 1994) and a soft-bodied fauna preserved at one locality (Mikulic et al., 1985b).

This paper is the first comprehensive account of the skeletal macrofauna of the Brandon Bridge Formation, based on collections from Voree Quarry in Walworth County, Wisconsin (Fig. 1). We present a sedimentologic description of this locality, a systematic description and paleoecologic analysis of the skeletal macrofauna, and a discussion of the conodont fauna and other microfossils. All macrofossils and non-conodont microfossils are housed in the Milwaukee Public Museum (MPM). Conodonts have been deposited in the Geology Museum of the University of Wisconsin, Madison (UW).

THE BRANDON BRIDGE FORMATION IN WALWORTH COUNTY

The Brandon Bridge Formation in Walworth County is exposed at a locality known as Voree Quarry. Voree Quarry is located on the east bank of the White River in the NE¼ NE¼ section 36, T3N R18E, Spring Prairie Township, USGS Burlington 7½ minute quadrangle (Fig. 1). This quarry takes its name from the early Mormon town of Voree. It was first opened in the mid-1800's and was flooded and abandonded by the early 1960's (Mikulic, 1979). In 1993, about 1.5 m of strata were exposed above water level at the south end of the quarry (Pl. 1, fig. 2). Voree Quarry is located two miles west of Burlington, Racine County, and Burlington has often been incorrectly used as the name of this locality. Another flooded quarry located opposite Voree Quarry on the west bank of the White River ("J.W. Peters Co. Quarry No. 2" of Mikulic, 1979) is not considered in this report.

Brief discussions of exposures at Voree Quarry were given by Percival (1856), Chamberlin (1877), Buckley (1898), and Alden (1918). When R.R. Shrock visited the quarry in 1931, a section 25 ft (7.6 m) in thickness was exposed (Mikulic, 1979). Ball (1940) published a stratigraphic description of Voree Quarry which is summarized here as Figure 2. Burpee (1932) and Gutschick (1941) briefly discussed microfossils recovered from Voree Quarry samples.

The Brandon Bridge Formation in southeastern Wisconsin is underlain by strata of the Byron Formation which are equivalent to the Plaines Member of the Kankakee Formation. The Brandon Bridge is overlain by the Waukesha Formation. Observations by Shrock (as summarized by Mikulic, 1979) and Ball (1940) indicate that neither the lower or upper contact of the Brandon Bridge Formation was exposed at Voree Quarry.

Age significance of the conodont fauna

In northeastern Illinois, the Brandon Bridge Formation includes, in ascending order, the *Distomodus kentuckyensis* (formerly *Icriodina irregularis*), *Pterospathodus celloni*, and *Pterospathodus amorphognathoides* zones (Liebe and Rexroad, 1977). All samples from Voree Quarry except 30234 contain either Pa or Pb elements of *Pterospathodus celloni*, indicating the presence of the *P. celloni* zone (Late Llandovery, C5). Sample 30230, made from the upper 1.2 m of the quarry, contains *P. celloni* Pa elements, and 30235, from a bed 8 cm below the top of the quarry, contains a Pb element. At the Vulcan Materials quarry in Franklin, 32 km northeast of Voree Quarry, *P. celloni* Pa elements occur 0.8 m above the base of the Brandon Bridge Formation, and *Aulacognathus bullatus, Ozarkodina polinclinata* and *Pterospathodus* sp. (Pb elements only) occur 0.2 m above the contact with the underlying Franklin Member of the Waukesha Formation (Kuglitsch, personal observation, 1992). *Aulacognathus bullatus* ranges from slightly below the *celloni* zone to the top of the zone. *Ozarkodina polinclinata* ranges from the base of the *celloni* zone into the overlying *Pterospathodus amorphognathoides* zone. This suggests that at Franklin, and probably at Voree Quarry, the base of the Brandon Bridge falls within the *celloni* zone.

A lateral process distinguishes *Pterospathodus pennatus* and *P. angulatus* from *P. celloni*. Männik and Aldridge (1989) considered all three taxa to be conspecific, but they noted an upsection increase of pennate and angulate forms and a greater development of the lateral process in an Estonian borehole spanning the *celloni* and *amorphognathoides* zones. All Pa elements recovered at Voree Quarry are of the *celloni* form, as are all those from Franklin except for a single poorly-developed angulate specimen. Assuming that the upsection change in morphology seen in the Estonian core is not facies dependent, the dominance of *celloni* forms at Voree Quarry suggests that the section falls in the lower part of the *celloni* zone (Männik and Aldridge, 1989: fig. 2).

MPM SAMPLES FROM VOREE QUARRY

Macrofossils were collected from Voree Quarry for the Milwaukee Public Museum by a number of individuals between 1926 and 1954. Specimens range from single fossils to fossiliferous slabs up to 37 cm in size.

□30229 includes specimens collected in 1930 and 1935 by I. Edwards, in 1930, 1936 and 1945 by R.A. Fritzke, in 1961 by J.O. Montague, in 1954 by E.R. Nelson, in 1936 by G.O. Raasch, in 1936 by K.E. Vaillancourt, and at an unknown date by J. Vukovich. No data were recorded as to location of specimens within the quarry, and this sample was potentially derived from the entire 7.6 m thick section. The material was selectively collected and is dominated by large specimens of the trilobite *Stenopareia imperiator*.

□30230 includes specimens recorded from "Beds 1 and 2, top 4 ft of quarry." Collectors include Montague, W.C. Miller, Nelson, and Raasch, and material was collected in 1941 and 1946. The material was selectively collected and includes most of the cephalopods obtained from the quarry.

□30231 includes specimens recorded from "Bed 4, *Orthis* layer." This bed was sampled in 1941 and 1946 by Montague, Nelson and Raasch. The specimens represent a bulk sample from a 5 cm thick bed of green shaly dolostone. The "*Orthis*" of MPM records is in fact *Coolinia applanata*, which dominates the fauna. This sample was made stratigraphically below 30230, but no records have survived to indicate its precise position in the section. Sample 30231 is probably equivalent to either "unit 6" or "unit 8" of Ball (1940; Fig. 2).

□30232 consists of seven specimens recorded from "Bed 5, below *Orthis* layer," but no further data are preserved. This sample was made by Nelson and Raasch in 1941.

□30233 includes specimens collected in 1931 by R.R. Shrock. No data on stratigraphic location have been preserved, and this sample was potentially derived from the entire 7.6 m section. It was selectively collected and is dominated by specimens of *Stenopareia imperiator*.

□30234 includes lithologic specimens and trace fossils collected by Nelson in 1949. This material appears to be derived from a single horizon within the quarry, but no stratigraphic data were recorded. Prominent red banding in these specimens suggests derivation from the lower part of the section, based on the stratigraphic description of Ball (1940; Fig. 2).

□30235 was collected in 1993 by the present authors. This sample was made from a 5 cm stratigraphic interval located 8 cm below the top of the exposed section, and its location is shown in Figure 3.

Macrofauna

Most of the MPM macrofossils from Voree Quarry consist of internal and less common external molds. Surface detail of the molds is generally good, but very fine features, such as pustulation in calymenid trilobites, are not preserved. Well-preserved, silicified corals, bryozoans and brachiopods were recovered in portions of samples digested in acetic acid. These specimens generally show finer morphologic detail than do the dolomitic molds.

Microfauna

Portions of samples 30229 to 30234 were trimmed by rock saw. This material, along with sample 30235, was crushed and digested in 10% acetic acid. Sample weights are given in Table 1. Every ten days, samples were rinsed through a pair of U.S. standard mesh 20 and 120 size sieves. The coarse fraction was returned to the acid solution and the fine fraction retained for heavy liquid separation in tetrabromoethene. Both heavy and light fractions were picked, yielding conodonts, fish plate fragments, and silicified foraminifers, sponge spicules, and ostracods.

SEDIMENTOLOGY

The only published section of Voree Quarry is that of Ball (1940, table 1), which is summarized here as Figure 2. Ball's data indicate massive to laminated dolostone and shaly dolostone beds from about 1 to 33 cm thick. Color banding is locally prominent, and shades of yellow, grey, green and red are present in the lower part of the section, while shades of yellow, grey, green, purple and pink occur in the upper part of the section (Fig. 2). Red coloration of the dolostone is diagenetic in origin and cross-cuts bedding.

Lithology of MPM specimens

Polished slabs and thin sections cut from MPM specimens represent several sedimentologic varieties of dolostone:

1. *Massive mudstone* consists of dolomite crystals 0.2 mm and smaller and shows a mottled coloring of yellow, grey-green, pink and red. Pyrite and limonite after pyrite are locally present. Bioclasts form less than 8% of sediment volume and are scattered, matrix-supported, and mainly less than 2 mm in size. Crinozoan ossicles, ostracods, and ramose bryozoan fragments predominate. Sclerites of the large trilobite *Stenopareia* are oriented subparallel to bedding in both convex-up and convex-down positions. Trace fossils include *Chondrites* and *Planolites*. This sediment type represents a highly bioturbated mud that formed in a low-energy environment below fair-weather wave base. It is present in samples 30229, 30230, 30232 and 30233.

2. *Argillaceous mudstone* consists of dolomite crystals 0.1 mm and smaller and is mainly grey-green in color. Slightly wavy, darker green stringers 1 mm or less thick consist of dolomite crystals in an argillaceous matrix. Rare grains of rounded detrital quartz reach 0.8 mm in size. Matrix-supported bioclasts are 10 mm or smaller and consist of crinozoan ossicles and fragments of ramose bryozoans and brachiopods. Trace fossils include *Chondrites* and *Planolites*. This sediment type also represents a low-energy environment below fair-weather wave base, and it forms sample 30231 and also occurs in 30230.

3. *Laminated mudstone* is dull grey to grey-green and contains parallel to small ripple lamination. Laminae range from less than 0.1 to 1.5 mm thick and are defined by differences in argillaceous content and differences in grain size of dolomite crystals 0.2 mm and smaller. *Chondrites* is present. The laminated dolostone occurs in samples 30230 and 30233, where it forms beds 16 to 25 mm thick. In one polished section, the laminated dolostone bed has a sharp, irregular base and overlies massive dolomite mudstone. In two sections, the laminated bed contains an interconnecting network of subvertical to subhorizontal burrows, 1 to 7 mm in diameter, which are filled with matrix derived from overlying massive dolomite mudstone (Pl. 1, fig. 1). In another section, the laminated

dolostone contains no bioturbation. This sediment type represents distal storm deposits.

4. *Color-banded mudstone* with prominent red layers forms sample 30234. Brick-red mudstone forms two beds 19 and 32 mm thick and is composed of dolomite crystals 0.1 mm and smaller in a red argillaceous matrix. Tunnel systems of *Chondrites*, which are darker red and more argillaceous than the surrounding sediment, are abundant in this lithology (Pl. 1, fig. 4), and *Planolites* is less commonly present. Crinozoan ossicles and ostracods to 1 mm in size form less than 1% of sediment volume. Also present is a 20 mm thick bed of dull yellow-green mudstone with grey-green argillaceous stringers less than 1 mm thick. This bed contains less than 1% ostracods, crinozoan ossicles and ramose bryozoan fragments. A fourth bed is 41 mm thick and consists of ripple-laminated mudstone; laminae are defined by alternations of dolomite and argillaceous dolomite, and crystal sizes are less than 0.2 mm. Sparse cross-sections of red *Chondrites* are present, and crinoid ossicles and brachiopods to 4 mm in size form less than 1% of sediment volume. The base of the bed is loaded into underlying red mudstone. This bed has a mottled coloring of purple, dull yellow, and grey-green, and color boundaries cross-cut the ripple lamination.

5. *Skeletal wackestone* is present in samples 30229 and 30230 (Pl. 1, fig. 3). It is mottled yellow and grey-green and includes thin argillaceous stringers. Evenly-disseminated, matrix-supported bioclasts form 10 to 15% of sediment volume and consist of crinozoan ossicles and ramose bryozoan fragments smaller than 2 mm. *Planolites* is also present. The wackestone represents highly bioturbated mud that formed in a low-energy environment below fair-weather wave base.

6. *Laminated skeletal wackestone* forms beds 2 to 3 cm thick in the measured section shown in Figure 3. Beds contain either parallel or small ripple lamination. Crinozoan ossicles less than 2 mm in size form up to 45% of sediment volume, and *Chondrites* is locally present. One bed includes an erosional base. This sediment type represents storm deposits.

7. *Trilobite packstone* forms one specimen from sample 30229. This specimen, representing a small lens at least 2 cm thick, consists of 30 to 40% self-supporting *Stenopareia* in a fine-grained, grey-green dolomite matrix. The trilobites consist of articulated pygidia and thoracic segments reaching 4 cm in size, and they also include isolated sclerites and fragments. Larger bioclasts are oriented subparallel to bedding and have convex surfaces mainly oriented in one direction. Small crinozoan ossicles are present. This sediment type may be either a storm deposit or a concentration of molted sclerites related to life activities of *Stenopareia*.

Depositional environment

The Brandon Bridge Formation at Voree Quarry was deposited in a shelf environment below fair-weather wave base and within the reach of storm deposition; the fauna of all observed sediment types is fully marine. During fair-weather periods, highly bioturbated carbonate mud accumulated. Storm events are represented by thin beds with erosional bases, lamination and skeletal concentrations. A small section measured at the top of the quarry shows the close stratigraphic alternation of fair-weather and storm-deposited sediments (Fig. 3).

Boucot (1975) established a benthic assemblage classification for Silurian macrofaunas that has become widely established in the literature. Based on the original bathymetric interpretation of Silurian communities by Ziegler (1965), this classification begins with

Benthic Assemblage 1 (intertidal) and extends through Benthic Assemblage 6 (slope and basin). Silurian marine communities were not controlled by water depth, but Boucot's benthic assemblages are a useful way of relating faunas to a general position along a shoreline to basin gradient.

The brachiopod assemblage in the Brandon Bridge Formation at Voree Quarry represents Benthic Assemblage 4 of Boucot (1975), as indicated by the co-occurrence of *Resserella, Dicoelosia, Leangella, Eoplectodonta, Jonesea, Leptaena, Coolinia, Eospirifer,* and an unidentified genus of clorindid. The corals, bryozoans, and trilobites associated with these brachiopods are also consistent with such an assignment. Benthic Assemblage 4 consists of faunas that lived at mid-shelf depths below fair-weather wave base but within the reach of storm deposition. The absolute depth represented by Benthic Assemblage 4 was probably no more than about 50 m (Brett et al., 1993). The interpretation by Kluessendorf and Mikulic (1994) that the Brandon Bridge Formation contains a "peritidal biota" is not substanciated by data from Voree Quarry.

MACROFAUNAL PALEOECOLOGY

Relative abundance of taxa

The four selectively-collected macrofaunal samples (30229, 30230, 30232, 30233) contain the following numbers of specimens (counted here, unlike Table 2, as the sum of all whole and partial specimens of a taxon): 12 corals, 60 brachiopods, 14 cephalopods, 130 trilobites, 4 crinoids, and 1 graptolite. A total of 120, or 54%, of these specimens consist of the trilobite *Stenopareia imperiator* (Hall), a very distinctive fossil that reaches 14 cm in size. This abundance is probably an artifact of the collecting bias toward trilobites and larger fossils which is present in other MPM Silurian samples that were made by selective collection (Watkins, 1991; 1993).

In polished slabs from the selective collections, crinozoans are consistently the most abundant taxon. Bryozoan fragments are also abundant in sample 30231. Trilobites and brachiopods comprise less than 10% of preserved skeletal material, and other macrofaunal taxa are relatively rare. In point counts of samples made from the measured section in Figure 3, crinozoans comprise 97.1%, brachiopods 1.4%, ostracods 1.4%, and bryozoans <1.4% of total skeletal material.

Taphonomy

Skeletal remains in laminated mudstone and laminated skeletal wackestone represent transported assemblages that were deposited during storms. Bioturbated mudstones and wackestone that formed under fair-weather conditions contain skeletal remains which have been disarticulated and dispersed by bioturbation and other organic processes, but which are preserved in the sedimentary facies in which they lived. The selectively-collected samples represent mixtures of both types of taphonomic assemblage. Sample 30231, collected in bulk from a single bed, represents a non-transported assemblage.

Paleoecologic associations

Data for samples 30229, 30230, 30232, and 30233 (Table 2) indicate the presence of one general macrofaunal association throughout the Brandon Bridge Formation at this locality. The most common species in this association, based on frequency of occurrence in samples, include solitary rugosan sp. 1, solitary rugosan sp. 2, *Dolerorthis* sp., *Resserella* sp., *Leptaena* sp., clorindid, atrypid, *Eospirifer* sp., *Geisonocerina wortheni*, and *Stenopareia imperiator*. Small concentrations of clorindids and *Stenopareia* indicate variable patterns of dominance among species. Crinozoans were the most abundant taxa in the association, based on point count data summarized above. A reconstruction of this association is shown in Figure 4.

Sample 30231 represents a second association dominated by bryozoans and the free-lying brachiopod *Coolinia applanata*. All other species in this sample are also present in the general macrofaunal association discussed above, and the abundance of *C. applanata* can be considered as an "opportunistic species" phenomenon. This association appears to be confined to a single 5 cm thick bed, and it is reconstructed in Figure 5.

Guild structure, diversity and tiering

Watkins (1991, 1993) established a classification of guilds for skeletal macrofauna of the Wisconsin Silurian. Based upon this classification, the Brandon Bridge fauna from Voree Quarry contains 5 guilds of corals, 5 guilds of brachiopods, 3 guilds of bryozoans, 2 guilds of trilobites, and 1 guild each of sponges, gastropods, cephalopods and dendroid graptolite. A minimum of 2 crinozoan guilds are probably represented by variably-sized column fragments and ossicles. This represents a total of about 21 guilds. The Wenlock interreef community of the Racine Formation, which occurs in bioturbated dolomite mudstone, contains a very similar content of 27 guilds that are also dominated by corals, bryozoans, brachiopods, trilobites and crinozoans (Watkins, 1991). Diversity of species and guilds within the Brandon Bridge Formation at Voree Quarry is compared to that of Racine faunas in Figure 6.

Tiering relationships among sessile suspension feeders in the fauna are shown in Figures 4 and 5. A lower tier, extending to 2 cm above the bottom, was occupied by corals, ramose bryozoans, brachiopods and dendroid graptolites. Another tier extending from 2 to 15 cm above the bottom was occupied by small crinozoans and fenestrate bryozoans. Robust column fragments of crinozoans, which reach 18 cm in length, indicate the presence of a still higher tier which may have reached about 25 cm above the bottom. This pattern of tiering is also very similar to that shown by the Wenlock interreef community of the Racine Formation (Watkins, 1991).

CONODONT PALEOECOLOGY

Composition of the conodont fauna

The conodont fauna from Voree Quarry is dominated by *Panderodus* sp., which forms no less than 54% of elements in any sample and reaches a maximum abundance of nearly 81%. *Ozarkodina polinclinata* is the next most abundant species, typically comprising 9 to 21% of elements. *Dapsilodus obliquicostatus* is present in all but one sample, its abundance ranging from 0.7 to 4.2%. A checklist of conodont species is given in Table 1.

Abundance and diversity

Conodont abundance in the Voree Quarry section of the Brandon Bridge Formation is the highest in the Silurian of southeastern Wisconsin. Number of elements ranges from a low of 15.7 to a high of 82.2 per 1 kg of digested sample. In the overlying Waukesha Formation, number of elements ranges from 0.2 to 15.8 per 1 kg, and in the Racine Formation, number of elements ranges from 1.8 to 9.1 per 1 kg (Kuglitsch, personal observations).

Conodont species diversity is also the highest in the Silurian of southeastern Wisconsin. Samples from Voree Quarry have yielded 16 species belonging to 10 genera. In the Sussex and Lannon areas, the Racine Formation has yielded 8 species and 7 genera, and the Waukesha Formation has yielded 12 species and 11 genera (Kuglitsch, personal observations). The abundance in the Waukesha is deceptively high, as it represents a cumulative total from four lithologically distinct members. In contrast, sample 30235 from Voree Quarry, which represents a stratigraphic thickness of 5 cm, contains 14 species belonging to 10 genera. Rarefaction curves comparing conodont diversity in Brandon Bridge sample 30235 with selected high-diversity subunits of the Waukesha and Racine formations are shown in Fig. 7.

Paleoenvironmental implications

Abundance and diversity of conodonts from Voree Quarry are in accord with deposition of the Brandon Bridge Formation in an open marine, offshore shelf environment. In the *celloni* zone of the Welsh Basin, Aldridge and Mabillard (1981) found *P. celloni* primarily in offshore sediments. Small numbers of *Dapsilodus obliquicostatus*, dominance of *Panderodus*, and absence of *Icriodella* are other apsects of the conodont fauna from Voree Quarry which suggest an offshore shelf environment (Aldridge, 1976; Aldridge and Mabillard, 1981: fig. 1.4; Aldridge and Jeppsson, 1984). This interpretation is also corroborated by the common occurrence of *Ozarkodina polinclinata* at Voree Quarry. Kleffner (1987) showed that *O. polinclinata* declined in abundance stratigraphically upward in a shallowing upwards sequence in the Upper Llandovery to Lower Wenlock Estill Shale of Ohio, and he concluded that the species was adversely affected by a change from a deep, quiet subtidal environment to a shallow, agitated environment.

Associated microfauna

Conodonts are associated with smaller numbers of foraminifers, sponge spicules, ostracods and fish plate fragments listed in Table 3.

SYSTEMATIC PALEONTOLOGY

Phylum PROTISTA
Class RHIZOPODEA von Siebold 1845
Order FORAMINIFERIDA Eichwald 1830
Family ASTRORHIZIDAE Brady 1881

Astrorhizid, indeterminate

Fig. 8A-C

Material. - 30231, 24; 30233, 6; 30234, 19; all are silicified fragments.

Family SACCAMMINIDAE Brady 1884
Genus *Lagenammina* Rhumbler 1911

Lagenammina sp.

Fig. 8I-J

Material. - 30231, 1, silicified.

Genus *Thurammina* Brady 1879
Thurammina polygona Ireland 1939

Fig. 8G-H

Thurammina polygona Ireland, 1939, figs. B1, B2; p. 197.

Material. - 30231, 2, both silicified.

Family AMMODISCIDAE Reuss 1862
Genus *Glomospirella* Plummer 1945

Glomospirella exserta (Moreman 1930)

Fig. 8D-F

Lituotuba exserta Moreman, 1930, pl. 7, figs. 5, 6; p. 59.
Lituotuba exserta Moreman, Dunn, 1942, pl. 44, fig. 37, p. 339.

Material. - 30229, 1; 30231, 2; 30233, 2; 30234; 5; all silicified.
Discussion. - Ireland (1966, p. 229) recommended that Silurian species traditionally assigned to *Lituotuba* be placed in *Glomospirella*.

Phylum PORIFERA

Discussion. - Sponges are represented only in sample 30235, where 5 silicified, hexactine spicules (Fig. 8K-M) were obtained from insoluble redidue. The spicules range from 0.5 to 1.1 mm in size.

Phylum COELENTERATA
Class ANTHOZOA Ehrenberg 1834
Subclass TABULATA Milne-Edwards & Haime 1850
Order FAVOSITIDA Wedekind 1937
Family FAVOSITIDAE Dana 1846

Favositid, indeterminate

Pl. 2, fig. 2

Material. - 30229, 1 nearly complete colony; 30231, 1 fragment.

Description. - Corallum cerioid, low domical to sheet-like, maximum height 13 mm, partial length 130 mm. Corallites prismatic; mean diameter of 20 corallites = 2.9 mm (range = 2.0 to 3.7 mm); tabulae complete, numerous. Details of wall structure not preserved.

Family MICHELINIIDAE Waagen & Wentzel 1886

Micheliniid, indeterminate

Pl. 2, figs. 6-7

Material. - 30229, 2 silicified fragments.

Description. - Corallum cerioid, cylindrical, maximum diameter 3.9 mm, length of largest fragment 37 mm. Corallites prismatic, 1.7 to 2.3 mm in diameter; septal ridges present, mural pores common, tabulae absent.

Order AULOPORIDA Sokolov 1947
Family AULOPORIDAE Milne-Edwards & Haime 1851

Auloporid, indeterminate

Material. - 30230, 6 silicified fragments. This species, with an average corallite diameter of about 0.5 mm, occurs as fragments 2 mm and smaller.

Subclass RUGOSA Milne-Edwards & Haime 1850

Unidentified solitary rugosans

Discussion. - Solitary rugosan sp. 1 (Pl. 2, fig. 3) is a small trochoid form that reaches 5 mm in diameter and 10 mm in length; it is preserved as both molds and silicified specimens. Solitary rugosan sp. 2 is a larger trochoid form that is preserved as molds up to 16 mm in diameter and about 7 mm in length. Sample occurrences and numbers of specimens for both species are given in Table 2.

Order CYSTIPHYLLIDA Nicholson 1889
Family PALAEOCYCLIDAE Dybowski 1873

Palaeocyclid, indeterminate

Pl. 2, figs. 6-7

Material. - 30229, 1 silicified specimen. This specimen is trochoid, 2.3 mm in height, and 7.4 mm in diameter. It is attached to a micheliniid fragment.

Order STAURIIDA Verrill 1865
Family ARACHNOPHYLLIDAE Dybowski 1873

Arachnophyllid, indeterminate

Material. - 30233, 1 fragment.
Description. - Corallum cerioid, probably of a sheet-like form, partial length 207 mm; height unknown. Mean diameter of 20 corallites = 5.8 mm (range = 4.9 to 7.3 mm).

Phylum BRYOZOA

Fenestrate bryozoan sp. 1

Pl. 2, fig. 4

Material. - 30231, 2 nearly complete colonies, 1 silicified fragment.
Description. - These are poorly-preserved, compacted specimens with fenestrae less than 2 mm in size. Colonies are cone-shaped and reach about 220 mm in diameter. Maximum height of colonies was probably about 150 mm.

Fenestrate bryozoan sp. 2

Pl. 2, fig. 1

Material. - 30230, 1 colony; 30231, 2 questionably assigned silicified fragments; 30233, 1 questionably assigned silicified fragment.

Description. - This colony is fan shaped and is characterized by suboval fenestrae 2 to 4 mm in size. It is 40 mm in maximum breadth; preserved height is 42 mm.

Other bryozoans

Discussion. - Six additional species of bryozoans are illustrated in Figure 9 and listed by sample number in Table 2. These species are recognized from silicified internal molds that occur as colony fragments 2 mm or less in size, and no attempt has been made to assign them to formal taxa. They include one encrusting bryozoan and four species of ramose bryozoans.

Phylum BRACHIOPODA
Class ARTICULATA Huxley 1869
Order ORTHIDA Schuchert & Cooper 1932
Suborder ORTHIDINA Schuchert & Cooper 1932
Family DOLERORTHIDAE Öpik 1934
Genus *Dolerorthis* Schuchert & Cooper 1931

Dolerorthis sp.

Pl. 3, figs. 1-3

Material. - 30229, 1 silicified pedicle valve, 2 brachial valves (1 silicified); 30233, 2 pedicle valves, 2 brachial valves, 1 articulated specimen. Maximum valve width is 24.8 mm, although most specimens are smaller than 18 mm.

Family DALMANELLIDAE Schuchert 1913
Genus *Resserella* Bancroft 1928

Resserella sp.

Pl. 3, fig. 5

Material. - 30229, 1 silicified pedicle valve; 30230, 1 silicified pedicle valve; 30231, 4 pedicle valves; 30232, 1 pedicle valve; 30233, 1 pedicle valve.

Discussion. - These small pedicle valves have the general form of *Resserella canalis* (Sowerby). They range from 2.1 to 4.7 mm in width.

Family DICOELOSIDAE Cloud 1948
Genus *Dicoelosia* King 1850

Dicoelosia sp.

Pl. 3, fig. 4

Material. - 30230, 1 articulated, silicified specimen.

Discussion. - This specimen is 4.5 mm in length and resembles *Dicoelosia biloba* (Linnaeus) and *Dicoelosia osloensis* Wright.

Order STROPHOMENIDA Öpik 1934
Suborder STROPHOMENIDINA Öpik 1934
Family LEPTESTIIDAE Öpik 1933
Genus *Leangella* Öpik 1933

Leangella sp.

Material. - 30230, 1 articulated, silicified specimen.

Discussion. - This specimen is 4.3 mm in width and is comparable to *Leangella segmentum* (Lindström) from Gotland and the Welsh Borderland.

Family SOWERBYELLIDAE Öpik 1930
Genus Eoplectodonta Kozlowski 1929

Eoplectodonta sp.

Material. - 30229, 1 silicified brachial valve; 30231, 2 pedicle valves (1 silicified). Width of these specimens, which are possibly juvenile individuals, ranges from 5.5 to 5.9 mm.

Genus *Jonesea* Cocks and Rong 1989

Jonesea sp.

Material. - 30230, 2 silicified pedicles valves; 30231, 1 silicified internal mold of articulated specimen, 3 silicified pedicle valves, 3 silicified brachial valves; all fragmentary.

Discussion. - These specimens range from 1.0 to 1.6 mm in length. They are closely comparable to *Jonesea grayi* (Davidson) from the Welsh Borderland, as illustrated by Bassett (1974) and Cocks and Rong (1989). *J. grayi* is the type species for both *Jonesea* and its junior synonym *Dionaegiria* Havlíček (in Havlíček and Štorch, 1990).

Family LEPTAENIDAE Hall & Clark 1894
Genus *Leptaena* Dalman 1828

Leptaena sp.

Pl. 3, fig. 6

Material. - 30229, 1 brachial valve; 30230, 1 brachial valve.

Discussion. - Maximum width of these specimens, both of which are external molds, is 10.5 mm. Ornament is of the general form of *L. depressa* (Sowerby).

Family MEEKELLIDAE Stehli 1954
Genus *Coolinia* Bancroft 1949

Coolinia applanata (Salter 1846)

Pl. 3, figs. 7, 10-11

Orthis(?) applanata Salter *in* McCoy, 1846, pl. 5, figs. 1a-e, p. 72.
Coolinia applanata Salter, Bassett, 1974, pl. 23, figs. 1-7.

Material. - 30231, 69 pedicle valves, 62 brachial valves, 3 articulated specimens.

Discussion. - This is a small species of *Coolinia* that reaches 18.2 mm in maximum width. Material from Voree Quarry compares closely with *Coolinia applanata* (Salter) from the Welsh Borderland, as described by Bassett (1974).

Order PENTAMERIDA Schuchert & Cooper 1931
Suborder PENTAMERIDINA Schuchert & Cooper 1931
Family CLORINDIDAE Rzhonsnitskaya 1956

Clorindid, indeterminate

Pl. 3, fig. 8

Material. - 30229, 3 pedicle valves; 30230, 20 pedicle valves (including one silicified specimen), 3 brachial valves; 30232, 4 pedicle valves; 30233, 1 pedicle valve.

Discussion. - These are smooth, strongly biconvex shells that reach a maximum width of 13.4 mm. The anterior commissure is uniplicate, and the fold and sulcus are very weakly developed to absent. In these features, the material resembles *Indaclor* Havlíček 1990 (in Havlíček and Štorch, 1990). The pedicle valve interior has a short median septum and small spondylium; interior of the brachial valve has not been observed.

Order SPIRIFERIDA Waagen 1883
Suborder ATRYPIDINA Moore 1952
Family ATRYPIDAE Gill 1871
Subfamily ATRYPINAE

Atrypid, indeterminate

Pl. 3, fig. 9

Material. - 30229, 2 brachial valves (1 silicified); 30230, 1 articulated specimen; 30231, 1 pedicle valve, 1 brachial valve; 30233, 1 brachial valve.

Discussion. - These finely-ribbed specimens reach 11 mm in width. They resemble *Reticulatrypa* but are too poorly preserved to be identified beyond subfamily.

Suborder SPIRIFERIDINA Waagen 1883
Family CYRTIIDAE Fredericks 1919
Genus *Eospirifer* Schuchert 1913

Eospirifer sp.

Material. - 30229, 1 silicified pedicle valve; 30230, 7 pedicle valves.

Phylum MOLLUSCA
Class GASTROPODA Cuvier 1797
Order ARCHAEOGASTROPODA Thiele 1925
Family PLATYCERATIDAE Hall 1859

Platyceratid, indeterminate

Material. - 30231, 5 specimens.

Discussion. - These fragmentary specimens reach a maximum size of 9 mm; they are irregularly capuliform and ornament consists of faint growth lines.

Class CEPHALOPODA Cuvier 1797
Subclass NAUTILOIDEA Agassiz 1847
Order ORTHOCERIDA Kuhn 1940
Family GEISONOCERATIDAE Zhuravleva 1959
Genus *Geisonocerina* Foerste 1935

Geisonocerina wortheni (Foerste 1928)

Pl. 2, fig. 5

Geisonoceras wortheni Foerste, 1928, pl. 66, fig. 2; p. 253-254.

Material. - 30229, 3 partial phragmocones; 30230, 8 partial phragmocones, 2 partial body chambers; 30233, 1 partial phragmocone.

Description. - Shell orthoconic, cross-section subcircular. Longest partial phragmocone is 594 mm in length, expanding from diameter of 16 mm to 43 mm from distal to proximal end. Maximum diameter of partial phragmocones is 48 mm. Two phragmocones show poorly-preserved, centrally located siphuncles 7 mm in diameter; one phragmocone with poorly-preserved septa spaced 13 to 14 mm apart. Largest partial body chamber is 324 mm in length, expanding from diameter of 58 mm to 66 mm from distal to proximal end; aperature not observed. Shell exterior with 10 to 12 transverse lirae per 10 mm of shell length.

Discussion. - Foerste (1928) described *G. wortheni* from the "Joliet member of the Niagaran" at Joliet, Illinois. MPM specimens from Voree Quarry were identified as *G. wortheni* by R.A. Hewitt.

Phylum ARTHROPODA
Class OSTRACODA Latreille 1806

Discussion. - Numbers of ostracods obtained in insoluble residues are given in Table 3. Ostracods in these samples consist of poorly preserved, silicified internal molds of articulated individuals and silicified valves and valve fragments. Gutschick (1941) discussed ostracods from Voree Quarry and stated that "there is quite a diversity of forms represented by approximately 15 species which includes 9 or 10 genera." Identifications furnished by Gutschick (1941) include the genera *Kloedenella, Tubulibairdia, Leperditia* and *Bairdia*.

Class TRILOBITA Walch 1771
Order PTYCHOPARIIDA Swinnerton 1915
Family ILLAENIDAE Hawle & Corda 1847
Genus *Stenopareia* Holm 1886

Stenopareia imperiator (Hall 1861)

Pl. 4, figs. 1-4; Pl. 5, figs. 2-4

Illænus imperiator Hall, 1861, p. 49.
Illænus imperiator Hall. Hall, 1867, pl. 22, figs. 15-17; pl. 23, figs. 2, 3; p. 420.
Illaenus imperiator Hall. Weller, 1907, pl. 16, figs. 13-16; p. 225-226.

Material. - 30229, 2 cranidia, 1 free cheek, 16 pygidia, 5 pygidia with attached thoracic segments; 30230, 4 cranidia, 5 pygidia; 30231, 9 cranidia, 1 pygidium; 30232, 1 cranidium, 1 pygidium; 30233, 37 cranidia, 6 free cheeks, 22 pygidia. Nearly all material consists of internal molds.

Description. - Cranidium with moderate to strong convexity. Axial furrows broad, directed mildly inward for most of length, and becoming subparallel to slightly divergent anteriorly. Glabella 36% to 48% of basal width. Length of cranidium ranges from 57% to 86% of width, with average of 75% (Fig. 10). Anterior branch of facial suture curving slightly outward forward from eye. Palpebral lobes 26% to 36% length of cranidium. Internal molds of cranidia smooth; a few poorly preserved external molds are also apparently smooth. Largest cranidium is 130 mm in width.

Pygidium moderately convex; length 33% to 71% of width with average of 58% (Fig. 10). Axial furrows broad and shallow, axis poorly defined. Largest pygidium is 141 mm in width. Internal molds are smooth; a few poorly preserved external molds are also apparently smooth. The most complete specimens of *S. imperiator* contain 9 thoracic segments anterior to the pygidium.

Discussion. - *S. imperiator* shows a relatively wide range of variation, with an overlap of characters shown by *S? julli* Norford and *S. illtyd* Ludvigsen and Tripp from the Silurian of Canada. *S. imperiator* differs from both species in attainment of large size. Based on photos in Norford (1981) and Ludvigsen and Tripp (1990), *S? julli* reaches 16 mm in maximum width and *S. illtyd* reaches 17 mm in maximum width.

Order PHACOPIDA Salter 1864
Family ENCRINURIDAE Angelin 1854
Genus *Distyrax* Lane 1988

Distyrax sp.

Material. - 30231, 1 pygidial pleural fragment, 1 free cheek; 30233, 1 glabella.

Discussion. - K.C. Gass (written communication, 1994) states that "on the basis of the free cheek, this material has been identified as *Distyrax*, owing to the characteristic outer row of anterior border tubercles which overhang the librigenal margin. The presence of only one additional row of anterior border tubercles adaxially to this is consistent with *Distyrax* n. sp. of Gass et al. (1992), but the fragmentary nature of the material at hand does not allow conclusive specific determination." *Distyrax* n. sp. of Gass et al. (1992) occurs in the Brandon Bridge Formation at Romeoville, Illinois.

Family CALYMENIDAE Burmeister 1843
Genus *Sthenarocalymene* Siveter 1976

?Sthenarocalymene sp.

Pl. 5, fig. 1

Material. - 30230, 6 partial individuals, 1 cephalon, 1 pygidium. The largest individual is 22.8 in total length.

Family PHACOPIDAE Hawle & Corda 1847
Genus *Acernaspis* Campbell 1967

Acernaspis sp.

Material. - 30230, 1 cephalon; 30231, 1 fragmentary pygidium. Width of cephalon is 13.2 mm.

Phylum ECHINODERMATA
Subphylum CRINOZOA Matsumoto 1929

Discussion. - Crinozoans are present in all samples as disarticulated ossicles and less common fragments of columns. The largest column fragments reach 13 mm in diameter and 180 mm in length and represent a robust species of camerate or inadunate crinoid. An unknown number of other crinozoan species are represented by smaller ossicles observed in polished slabs.

Phylum HEMICHORDATA
Class GRAPTOLITHINA Bronn 1846
Order DENDROIDEA Nicholson 1872
Family DENDROGRAPTIDAE Roemer 1897

Dendrograptid, indeterminate

Material. - 30233, 1 colony fragment of bush-like form, 28.5 mm in breadth and 17.4 mm in partial height.

Phylum VERTEBRATA

Fish plates

Material. - 30230, 7; 30234, 7; 30235, 2.

Discussion. - This material consists of fragments of dermal plates less than 1 mm in size. Possible teeth and other phosphatic fragments, which are still under study, may represent additional fish material.

Class CONODONTA Eichenberg 1930

Discussion. - Conodonts are illustrated in Plates 6 through 14. All elements are referred to existing multimembrate or unimembrate conodont species except for informal groupings of *Aspelundia* and *Oulodus*. Locational notation follows Sweet (1981) for non-coniform species and Barrick (1977) for coniform species. The following taxonomic treatment references the multielement species schemes used in this study. Where multielement references do not contain descriptions of all of the individual species elements, additional references containing the pertinent descriptions are given.

Subclass CAVIDONTI Sweet 1988
Order BELODELIIDA Sweet 1988
Family BELODELLIDAE Khodalevich & Tschernich 1973
Genus *Walliserodus* Serpagli 1967

Walliserodus curvatus (Branson & Branson 1947)

Pl. 8, fig. 4; Pl. 9, fig. 5

Multielement:
Waliserodus curvatus (Branson & Branson). Cooper, 1975, pl. 1, figs. 10-11, 16-21; p. 995-996.

M element:
Acodus unicostatus Branson & Branson. Aldridge, 1972, pl. 9, figs. 2-3; p. 162.

Sa element:
Paltodus dyscritus Rexroad, 1967, pl.4, figs. 30-34; p. 42-44.
Sb element:
Paltodus debolti Rexroad, 1967, pl. 4, figs. 22-25; p. 41-42.
Sc element:
Acodus curvatus Branson & Branson. Aldridge, 1972, pl. 9, fig. 1; p. 162.
Sd element:
Paltodus migratus Rexroad, 1967, pl. 4, figs. 17-21; p. 44-45.

Material. - 30229, 1 M, 1 Sa, 1 Sb; 30230, 1 Sa, 1 Sc; 30233, 1 Sa, 1 Sc; 30235, 4 M, 2 Sa.

Discussion. - *Walliserodus curvatus* is a quinquimembrate coniform species including M and Sa through Sd elements. The presence of one to three costae on the inner lateral face of the Sc element of *W. curvatus* distinguishes it from *W. sancticlairi*, which generally has a non-costate or weakly costate Sc element (Cooper, 1976; Barrick, 1977) and the non-costate Sc elements of *W. blackstonensis* McCracken 1991 and *W. bicostatus* Armstrong 1990 (see McCracken, 1991, p. 81 regarding the issue of conspecificity of the latter two species). The two *Walliserodus* Sc elements recovered in this study are costate; consequently all *Walliserodus* elements recovered have been assigned to *W. curvatus*. Sc elements recovered from the Brandon Bridge Formation at the Vulcan Materials quarry, Franklin, are also costate. The small number of Sc elements recovered in this study warrants caution in accepting the specific assignment, as does the existence of rare, weakly costate Sc elements found in some collections of *W. sancticlairi* (Barrick, 1977). The absence of Sd elements among the *W. curvatus* material (13 total elements) is not surprising in light of Barrick's (1977) calculated *Walliserodus* element ratio of 3.5:2:2:1.5:1 (M:Sa:Sb:Sc:Sd).

Family DAPSILODONTIDAE Sweet 1988
Genus *Dapsilodus* Cooper 1976

Dapsilodus obliquicostatus (Branson & Mehl 1933)

Pl. 9, figs. 1-2

Multielement:
Dapsilodus obliquicostatus (Branson & Mehl). Cooper, 1976, Pl. 2, figs. 10-13, 18-20; p. 212.
M element:
Acodus-like elements of *Acontiodus obliquicostatus* (Branson & Mehl). Serpagli, 1967, pl. 23, figs. 6-10; p. 82-83.

Material. - 30229, 8 M, 3S; 30230, 1 M; 30231, 1 M, 1 S; 30233, 2 M, 1 S; 30235, 2 M.

Discussion. - *Dapsilodus obliquicostatus* is a quadrimembrate coniform species including M and Sa through Sc members (Barrick, 1977). The S elements form a symmetry transition series from the symmetrical Sa through the most asymmetrical Sc, and they are difficult to distinguish from one another, although the symmetry of the Sa tends to make it conspicuous (Barrick, 1977). S elements in this study are not subdivided.

Subclass CONODONTI Branson 1938
Order PROTOPANDERODONTIDA Sweet 1988
Family PROTOPANDERODONTIDAE Lindström 1970
Genus *Pseudooneotodus* Drygant 1974

Pseudooneotodus beckmanni (Bischoff & Sannemann 1958)

Unimembrate:
Pseudooneotodus beckmanni (Bischoff & Sannemann), Cooper, 1977, pl. 2, figs. 14, 17; p. 1068-1069.

Material. - 30229, 1; 30230, 1; 30235, 1.

Discussion. - Bischoff (1986) criticized Cooper (1977) for grouping all squat single tipped cones as *P. beckmanni*, ignoring potentially useful taxonomic traits like the basal outline of the element, nature of the basal band, and length/width ratios. Only three elements were recovered in this study, one of which may be a basal filling from a large element (sample 30235). Preservation of elements from samples 30229 and 30230 is marginal; however, they appear to possess the subtriangular basal margin outline which Bischoff (1986) noted as characteristic of *P. beckmanni* from his type area collections.

Pseudooneotodus tricornis Drygant 1974

Pl. 14, fig. 4

Unimembrate:
Pseudooneotodus tricornis Drygant. Bischoff, 1986, pl. 27, figs. 20, 28-37; p. 238-240.

Material. - 30229, 4; 30233, 4; 30235, 2.

Discussion. - Barrick (1977) reconstructed *P. tricornis* as a trimembrate apparatus that included squat and slender single-tipped cones as well as the nominate three-tipped form. Evidence against this reconstruction was provided by Bischoff (1986) who recovered no single-tipped cones in unsieved samples containing *P. tricornis.*

Order PANDERODONTIDA Sweet 1988
Family PANDERODONTIDAE Lindström 1970
Genus *Panderodus* Ethington 1959

Panderodus recurvatus (Rhodes 1953)

Pl. 14, fig. 5

Multielement:
Panderodus recurvatus (Rhodes). Barrick, 1977, pl. 3, figs. 3, 4, 7-12; p. 54-55.

Material. - 30230, 1 S.

Panderodus unicostatus (Branson & Mehl 1933)

Pl. 9, figs. 3-4; Pl. 12, figs. 3-5

Multielement:
Panderodus unicostatus (Branson & Mehl). Barrick, 1977, pl. 3, figs. 1, 2, 5, 6; p. 56-57.

Material. - 30229, 52 M, 105 S; 30230, 31 M, 52 S; 30231, 7 M, 35 S; 30233, 42 M, 84 S; 30234, 32 M, 50 S; 30235, 45 M, 115 S.

Discussion. - Barrick (1977) first applied the locational notation of Sweet and Schönlaub (1975) to simple cones and distinguished M, Sa, Sb and Sc positions for *P. unicostatus*. In this study all robust symmetrical or nearly symmetrical cones are grouped as M elements and all others as S elements. Material of *P. unicostatus* includes three fused clusters from sample 30234.

Order PRIONIODONTIDA Dzik 1976
Family DISTOMODONTIDAE Klapper 1981
Genus *Distomodus* Branson & Branson 1947

Distomodus staurognathoides (Walliser 1964)

Pl. 7, fig. 6; Pl. 10, fig. 5; Pl. 11, figs. 1-5; Pl. 12, fig. 1

Multielement:
Distomodus staurognathoides (Walliser). Barrick & Klapper, 1976, pl. 1, figs. 20-28; p. 71-72.
Pa element:
Hadrognathus staurognathoides Walliser. Aldridge, 1972, pl. 2, figs. 8, 10, 11; p. 180-181.
Pb element:
Exochognathus expansus (Nicoll & Rexroad). Rexroad & Nicoll, 1972, pl. 2, figs. 24, 25; p. 67.
M element:
Distomodus kentuckyensis Branson & Branson. Aldridge, 1972, pl. 6, figs. 7, 11; p. 173.
Sa element:
Exochognathus brassfieldensis (Branson & Branson). Aldridge, 1972, pl. 7, fig. 4; p. 176-177.
Sb element:
Exochognathus caudatus (Walliser). Aldridge, 1972, pl. 7, fig. 13; p. 177-178.
Exochognathus detorus (Walliser). Aldridge, 1972, pl. 7, figs. 7, 12; p. 178.
Sc element:
Distomodus? egregius (Walliser). Aldridge, 1972, pl. 6, figs. 4, 9; p. 172.

Material. - 30229, 1 Pa, 4 PB, 1 M, 1 Sa, 4 Sb, 2 Sc; 30230, 1 M, 1 Sa, 1 Sc, 2 "*J.hud.*"; 30233, 1 Pa, 2 M, 1 Sa, 2 Sb, 2 Sc; 30234, 2 Pa, 2 Sa, 2 Sc, 2 "*J.hud.*"; 30235, 3 Pa, 3 M, 5 Sa; 2 Sb, 1 Sc, 2 "*J.hud.*"

Discussion. - *Johnognathus huddlei* Mashkova 1977, tabulated here as a separate element, represents broken fragments of *D. staurognathoides* Pa and Sa elements (see Over and Chatterton, 1987, pl. 2, figs. 13-16, 21-25).

Order PRIONIODINIDA Sweet 1988
Family PRIONIODINIDAE Bassler 1925
Genus *Oulodus* Branson & Mehl 1933

Discussion. - Three informal groups of *Oulodus* are recognized based on similarity of color, basal cavity, element robustness and denticle morphology.

Oulodus sp. 1

Material. - 30229, 1 Sb?; 30235, 1 Sb?

Discussion. - The two recovered Sb? elements of *Oulodus* sp. 1 are more robust than the other *Oulodus* Sb elements recovered in this study. Pa elements and additional Sb? elements of this species were recovered from the Brandon Bridge Formation at Vulcan Materials quarry, Franklin.

Oulodus sp. 2

Pl. 8, figs. 2-3; Pl. 12, fig. 2

Material. - 30229, 1 Sb; 30230, 2 Sa, 3 Sc; 30233, 1 Sa, 4 Sc; 30235, 5 Sa, 11 Sc.

Discussion. - *Oulodus* sp. 2 elements are distiguished from *Oulodus* sp. 1 and sp. 3 elements by their large, excavated basal cavities and typical oulodontiform denticles, which are round in cross-section, peg-like, and separated by U-shaped spaces.

Oulodus sp. 3

Pl. 13, figs. 4-5; Pl. 14, fig. 3

Material. - 30229, 1 Sa, 1 Sb; 30230, 1 Sc; 30233, 1 Pa?; 30234, 2 Sc; 30235, 1 Pb?, 3 Sb, 7 Sc.

Discussion. - *Oulodus* sp. 3 is distinguished from *Oulodus* sp. 1 and sp. 2 by the delicate nature of the elements, slightly compressed denticles and unexpanded, shallow basal cavities. The two latter features might make placement in the genus *Aspelundia* more appropriate.

Order OZARKODINIDA Dzik 1976
Family SPATHOGNATHODONTIDAE Hass 1959
Genus *Ozarkodina* Branson & Mehl 1933

Ozarkodina hadra (Nicoll & Rexroad 1968)

Pl. 8, fig. 1

Pa element:
Spathognathodus hadros Nicoll & Rexroad, 1968, pl. 2, figs. 17-18; p. 59.

Material. - 30229, 3 Pb?; 30233, 1 Pa; 30235, 3 Pa, 4Pb?, 2 M?.

Discussion. - The Pa element of *O. hadra* is very similar to the delta morphotype of *O. confluens* (Branson & Branson) of Klapper and Murphy (1975). The basal cavity of the *O. hadra* Pa is more symmetrical and located in a more posterior position than that of the *O. confluens* delta morphotype (Klapper and Murphy, 1975). Nicoll and Rexroad (1968) noted that the oral and aboral margins of the portion of the blade anterior to the basal cavity are subparallel while the posterior margins converge and are deflected downward. They also noted the presence of a large anteriormost denticle on the blade. This enlarged denticle is not present on the Pa elements recovered in this study or in those examined by Klapper and Murphy (1975) and Barrick and Klapper (1976). One of the Pa elements recovered from 30235 appears to be a juvenile with seven disproportionately large denticles spanning the entire oral margin of the element (versus sixteen on the adult pictured in Pl. 8, fig. 1).

Elements are tentatively assigned to the M and Pb positions based solely upon the lack of an appropriate alternative species Pa element for assignment and the similarity of the elements to analogous elements of *O. confluens*, particularly with regard to the distribution of white matter which, as noted by Jeppsson (1969), extends from the dentical tips far into the element processes, leaving only a narrow strip along the aboral margin free of white matter. These elements may represent another species, since others, such as Armstrong (1990), have reconstructed *O. hadra* with different Pb and M elements.

Ozarkodina polinclinata (Nicoll & Rexroad 1968)

Pl. 7, figs. 1-5

Multielement:
Ozarkodina polinclinata (Nicoll & Rexroad). Cooper, 1977, pl. 1, figs. 11, 13-15, 17-18; p. 1058, 1061-1062.
Pa element:
Spathognathodus polinclinata Nicoll & Rexroad, 1968, pl. 2, figs. 19-20; p. 60.
Pb element:
Ozarkodina hanoverensis Nicoll & Rexroad, 1968, pl. 2, fig. 9; p. 50-51.
M element:
Neoprioniodus planus Walliser. Nicoll & Rexroad, 1968, pl. 5, figs. 11-12; p. 41.
Sa element:
Trichonodella papilio Nicoll & Rexroad, 1968, pl. 4, figs. 4-6; p. 65.
Sb element:
Trichondella asymmetrica Nicoll & Rexroad, 1968, pl. 4, fig. 7; p. 62.

Material. - 30229, 10 Pa, 6 Pb, 6 M, 6 Sa, 4 Sb, 14 Sc; 30230, 9 Pa, 2 M, 1 Sa, 9 Sc; 30231, 2 Pa, 1 Pb, 1 Sa, 2 Sc; 30233, 11 Pa, 5 Pb, 6 M, 5 Sa, 3 Sb, 12 Sc; 30234, 18 Pa, 1 Pb, 1 M, 5 Sc; 30235, 12 Pa, 3 Pb, 1 M, 4 Sb 7 Sc.

Discussion. - A small number of M and Sc elements are fragmentary and may be improperly referred to *O. polinclinata.* Cooper (1977) noted the Sc element of *O. polinclinata* to be morphologically variable and Armstrong (1990) noted the identity of the

M elements of *Ozarkodina pirata* Uyeno and Barnes and *Aspelundia fluegeli* Walliser and their similarity to the M element of *O. polinclinata*. The Pa, Pb, Sa and Sb elements of *O. polinclinata* are, in contrast, distinctive (Cooper, 1977).

The distribution of white matter in *O. polinclinata* Pa elements collected in this study is invarient. In all cases the white matter extends from the dentical tips toward the aboral margin of the element, terminating along a diagonal line lowest at the posterior end of the element and highest at the anterior end. White matter distribution in the Pa element may be a species diagnostic characteristic if the same pattern is present in *O. polinclinata* Pa elements from other localities. Jeppsson (1969) noted the utility of white matter distribution in identifying elements of *O. confluens*.

Family PTEROSPATHODONTIDAE Cooper 1977
Genus *Aulacognathus* Mostler 1967

Discussion. - The multielement reconstruction of *Aulacognathus* remains questionable. Cooper (1977) recognized a bimembrate apparatus consisting of a Pa element (platform) and a Pb element (blade). Bischoff (1986) followed the same plan for several new species of *Aulacognathus* from New South Wales, while Armstrong (1990) reconstructed a seximembrate apparatus based on collections from Greenland and Austria. Only Pa and Pb elements were recovered in this study.

Aulacognathus bullatus (Nicoll & Rexroad 1968)

Pl. 6, figs. 4-5

Multielement:
Aulacognathus bullatus (Nicoll & Rexroad). Armstrong, 1990, pl. 6, figs. 1, 2, 4-7; p. 62, 64-65.
Pa element:
Neospathognathodus bullatus Nicoll & Rexroad 1968, pl. 1, figs. 5-7; p. 44-45.
Pb element:
Neospathognathodus ceratoides Nicoll & Rexroad 1968, pl. 1, figs. 1-4; p. 46.

Material. - 30235, 5 Pa, 1 Pb.

Discussion. - It is difficult to distinguish Pb elements of *Aulacognathus bullatus* from those of *Aulacognathus latus* (Aldridge, 1979; Cooper, 1977; Armstrong, 1990). In material collected in this study, *A. bullatus* and *A. latus* Pa elements do not occur together in any samples and Pb elements are assigned to the species represented by the Pa elements with which they co-occur. Many Pa and Pb elements of both *A. bullatus* and *A. latus* are broken. Fragmentary elements were counted as whole specimens only where they clearly represent individuals not previously counted.

Aulacognathus latus (Nicoll & Rexroad 1968)

Pl. 6, figs. 1-3, 6; Pl. 14, fig. 2

Multielement:
Aulacognathus latus (Nicoll & Rexroad), Cooper, 1977, pl. 2, figs. 1, 2, 5, 10; p. 1063.
Pa element:
Neospathognathodus latus Nicoll & Rexroad 1968, pl. 1, figs. 8-11; p. 46-47.
Pb element:
Neospathognathodus ceratoides Nicoll & Rexroad 1968, pl. 1, figs. 1-4; p. 46.

Material. - 30229, 3 Pa, 10 Pb; 30230, 6 Pa, 3 Pb; 30233, 8 Pa, 7 Pb.

Discussion. - The ontogeny of the Pa element of *A. latus* from a delicate juvenile form to a large, robust mature form is shown in Pl. 6, figs. 1-3. A questionable *Aulacognathus* Pb element (Pl. 14, fig. 1) recovered from 30229 bears a close resemblance to the Pa element of the Ordovician genus *Aphelognathus* (see, for example, McCracken and Barnes, 1981, pl. 3, figs. 51-53).

Genus *Pterospathodus* Walliser 1964

Pterospathodus celloni (Walliser 1964)

Pl. 10, figs. 1-4

Multielement:
Pterospathodus celloni (Walliser). Barrick & Klapper, 1976, pl. 1, figs. 3, 5; p. 82-83.
Pa element:
Neospathognathodus celloni (Walliser). Nicoll & Rexroad, 1968, pl. 2, figs. 1-4; p. 45.
Pb element:
Ozarkodina adiutricis Walliser. Nicoll & Rexroad, 1968, pl. 2, figs, 6-8; p. 48-49.
S element:
Neoprioniodus costatus paucidentatus Walliser. Aldridge, 1972, pl. 5, figs. 20-21; p. 193-194.

Material. - 30229, 4 Pb; 30230, 4 Pa, 2 Pb, 1 S?; 30231, 1 Pa, 1 Pb; 30233, 8 Pa, 12 Pb, 1 S?; 30235, 1 Pb.

Discussion. - Barrick and Klapper (1976) proposed a quadrimembrate apparatus for *P. celloni*, including M and S elements in addition to the Pa and Pb elements included in earlier bimembrate reconstructions (for example, Walliser, 1964).

Order Unassigned
Genus *Aspelundia* Savage 1985

Aspelundia sp.

Pl. 13, figs. 1-3

Material. - 30229, 2 Sb; 30230, 4 Sa, 2 Sb; 30233, 1 Pb, 2 Sa, 3 Sb; 30234, 1 Pb; 30235, 5 Pb, 10 M, 4 Sa, 9 Sb.

Discussion. - Savage (1985) created the genus *Aspelundia* to accomodate *Oulodus*-like elements lacking expanded basal cavities and having compressed denticles. Based primarily on similarity in color, element shape and denticle compression, an informal

Aspelundia group is recognized in this study. Compressed denticles, shallow basal cavities and light color distinguish *Aspelundia* sp. elements from *Oulodus* species recovered in this study. Except for compression of the denticles, the M, Sa and Sb elements of *Aspelundia* sp. appear identical to the analogous elements in Savage's (1985) reconstruction of *Oulodus fluegeli* (Walliser). The Sc element is bipennate. No Pa elements have been recovered.

ACKNOWLEDGMENTS

J. Peterson developed and printed macrofaunal photographs. Reviewers for this paper were A.J. Boucot and P.M. Sheehan.

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Sample number	30229	30230	30231	30233	30434	30235
Weight digested (g)	5573	7502	1099	4538	1435	18251
Total conodonts	262	142	52	234	118	286
Conodonts/kg	47.0	18.9	47.3	51.6	82.2	15.7
Aspelundia sp. Pb	-	-	-	1	1	5
Aspelundia sp. M	-	-	-	-	-	10
Aspelundia sp. Sa	-	4	-	2	-	4
Aspelundia sp. Sb	2	2	-	3	-	9
Aulacognathus bullatus Pa	-	-	-	-	-	5
Aulacognathus bullatus Pb	-	-	-	-	-	1
Aulacognathus latus Pa	3	6	-	8	-	-
Aulacognathus latus Pb	10	3	-	7	-	-
Dapsilodus obliquicostatus M	8	1	1	2	-	2
Dapsilodus obliquicostatus S	3	-	1	1	-	-
Distomodus staurognathoides Pa	1	-	-	1	2	3
Distomodus staurognathoides Pb	4	-	-	-	-	-
Distomodus staurognathoides M	1	1	-	2	-	3
Distomodus staurognathoides Sa	1	1	-	1	2	5
Distomodus staurognathoides Sb	4	-	-	2	-	2
Distomodus staurognathoides Sc	2	1	-	2	2	1
Distomodus staurognathoides (*J.hud.*)	-	2	-	-	2	2
Oulodus sp. 1 Sb	1	-	-	-	-	1
Oulodus sp. 2 Sa	-	2	-	1	-	5
Oulodus sp. 2 Sb	1	-	-	-	-	-
Oulodus sp. 2 Sc	-	3	-	4	-	11
Oulodus sp. 3 Pa	-	-	-	1	-	-
Oulodus sp. 3 Pb?	-	-	-	-	-	1
Oulodus sp. 3 Sa	1	-	-	-	-	-
Oulodus sp. 3 Sb	1	-	-	-	-	3
Oulodus sp. 3 Sc	-	1	-	-	2	7
Ozarkodina hadra Pa	-	-	-	3	-	3
Ozarkodina hadra Pb?	3	-	-	-	-	4
Ozarkodina hadra M?	-	-	-	-	-	2
Ozarkodina polinclinata Pa	10	9	2	11	18	12
Ozarkodina polinclinata Pb	6	-	1	5	1	3
Ozarkodina polinclinata M	6	2	-	6	1	1
Ozarkodina polinclinata Sa	6	1	1	5	-	-
Ozarkodina polinclinata Sb	4	-	-	3	-	4
Ozarkodina polinclinata Sc	14	9	2	12	5	7

Table 1. Checklist of conodont species from the Brandon Bridge Formation at Voree Quarry.

Sample number	30229	30230	30231	30233	30434	30235
Panderodus recurvatus S	-	1	-	-	-	-
Panderodus unicostatus M	52	31	7	42	32	45
Panderodus unicostatus S	105	52	35	84	50	115
Pseudooneotodus beckmanni	1	1	-	-	-	1
Pseudooneotodus tricornis	4	-	-	4	-	2
Pterospathodus celloni Pa	-	4	1	8	-	-
Pterospathodus celloni Pb	4	2	1	12	-	1
Pterospathodus celloni S?	-	1	-	1	-	-
Walliserodus curvatus M	1	-	-	-	-	4
Walliserodus curvatus Sa	1	1	-	1	-	2
Walliserodus curvatus Sb	1	-	-	-	-	-
Walliserodus curvatus Sc	-	1	-	1	-	-

Table 1. (Continued) Checklist of conodont species from the Brandon Bridge Formation at Voree Quarry.

Sample number	30229	30230	30231	30232	30233	30234
TABULATA:						
favositid	1	-	1	-	-	-
micheliniid	2	-	-	-	-	-
auloporid	-	6	-	-	-	-
RUGOSA:						
arachnophyllid	-	-	-	-	1	-
palaeocyclid	1	-	-	-	-	-
solitary rugosan sp. 1	2	1	5	-	1	-
solitary rugosan sp. 2	1	-	-	-	2	-
BRYOZOA:						
fenestrate bryozoan sp. 1	-	-	2	-	-	-
fenestrate bryozoan sp. 2	-	1	2	-	1	-
encrusting bryozoan	-	-	-	-	-	1
ramose bryozoan sp. 1	-	-	6	-	1	-
ramose bryozoan sp. 2	-	-	2	-	-	2
ramose bryozoan sp. 3	-	-	3	-	-	-
ramose bryozoan sp. 4	-	-	1	-	-	1
BRACHIOPODA:						
Dolerorthis sp.	2	-	-	-	3	-
Resserella sp.	1	1	4	1	1	-
Dicoelosia sp.	-	1	-	-	-	-
Leangella sp.	-	1	-	-	-	-
Eoplectodonta sp.	1	-	2	-	-	-
Jonesea sp.	-	2	4	-	-	-
Leptaena sp.	1	1	-	-	-	-
Coolinia applanata (Salter)	-	-	72	-	-	-
clorindid	3	20	-	4	1	-
atrypid	2	1	1	-	1	-
Eospirifer sp.	1	7	-	-	-	-
GASTROPODA:						
platyceratid	-	-	5	-	-	-
CEPHALOPODA:						
Geisonocerina wortheni (Foerste)	3	10	-	-	1	-
TRILOBITA:						
Stenopareia imperiator (Hall)	22	5	9	1	37	-
Distyrax sp.	-	-	1	-	1	-
?*Sthenarocalymene* sp.	-	7	-	-	-	-
Acernaspis sp.	-	1	1	-	-	-
GRAPTOLITHINA:						
dendrograptid	-	-	-	-	1	-

Table 2. Checklist of macrofaunal species from the Brandon Bridge Formation at Voree Quarry. Colonies and individuals were counted with methods of Watkins (1991).

Sample number Weight digested (g)	30229 5573	30230 7502	30231 1099	30233 4538	30434 1435	30235 18251
FORAMINIFERIDA:						
astrorhizid fragments	-	-	24	6	19	-
Lagenammina sp.	-	-	1	-	-	-
Thurammina polygona Ireland	-	-	2	-	-	-
Glomospirella exserta (Moreman)	1	-	2	2	5	-
PORIFERA:						
hexactine spicules	-	-	-	-	-	5
OSTRACODA:						
unidentified ostracods	1	-	8	3	3	-
VERTEBRATA:						
fish plate fragments	-	7	-	-	7	2

Table 3. Checklist of non-conodont microfauna from the Brandon Bridge Formation at Voree Quarry.

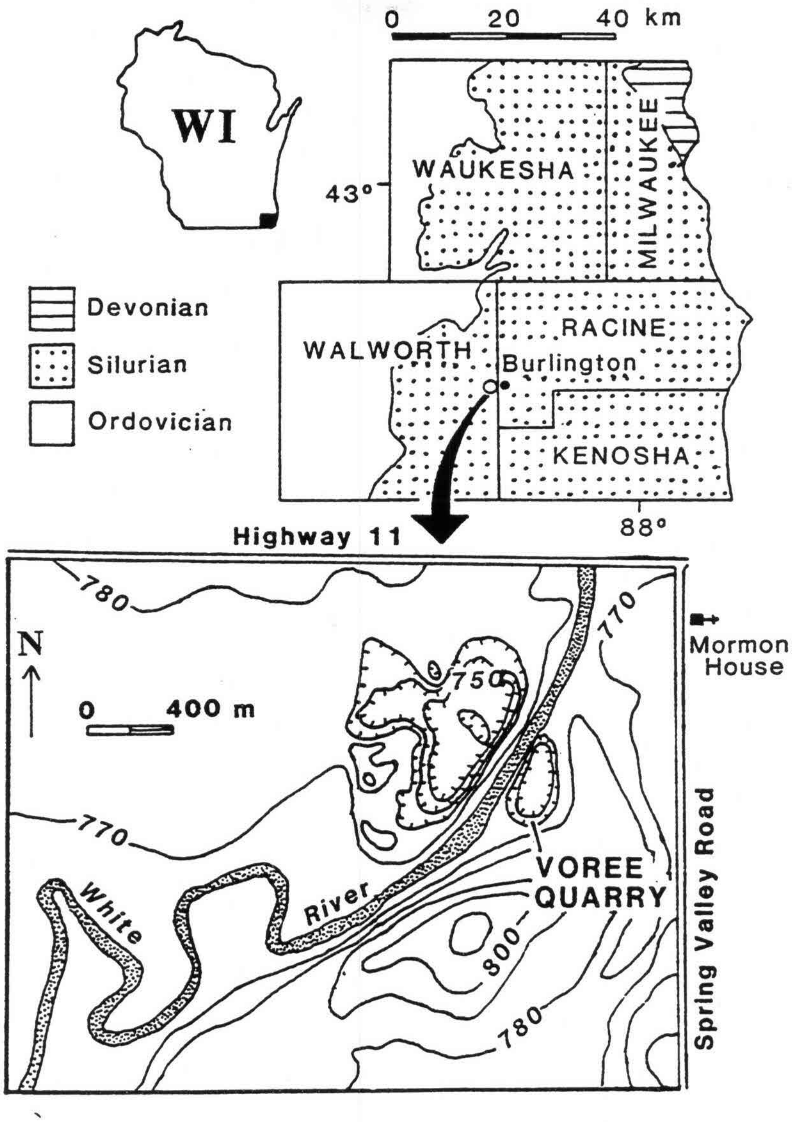


Fig. 1. Location maps for Voree Quarry. Topographic base for lower map from U.S.G.S. Burlington 7.5' quadrangle; contours in feet.

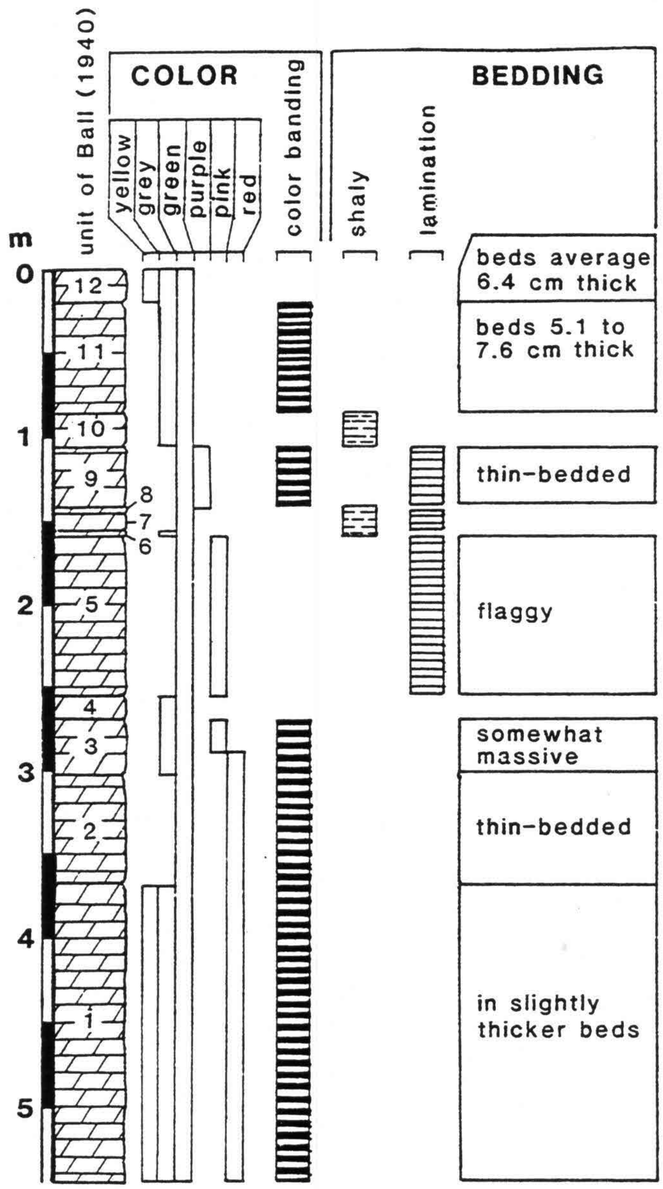


Fig. 2. Generalized section of the Brandon Bridge Formation at Voree Quarry, based on stratigraphic section described by Ball (1940).

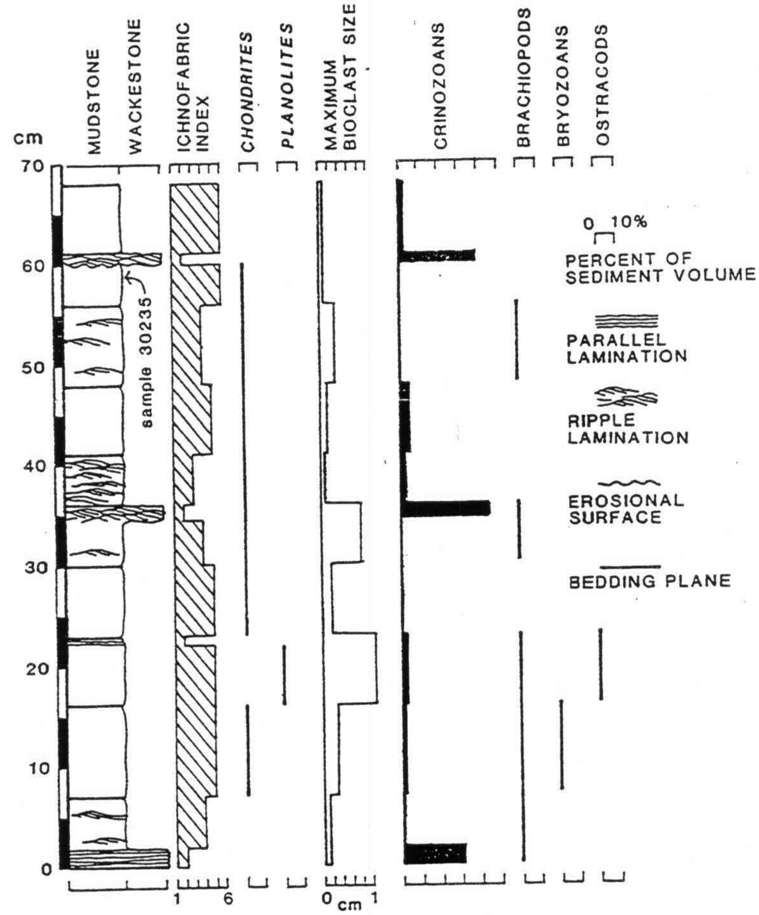


Fig. 3. Detailed section of the stratigraphically highest beds preserved at the south end of Voree Quarry. Ichnofabric indices from 1 through 6 are those of Droser and Bottjer (1986).

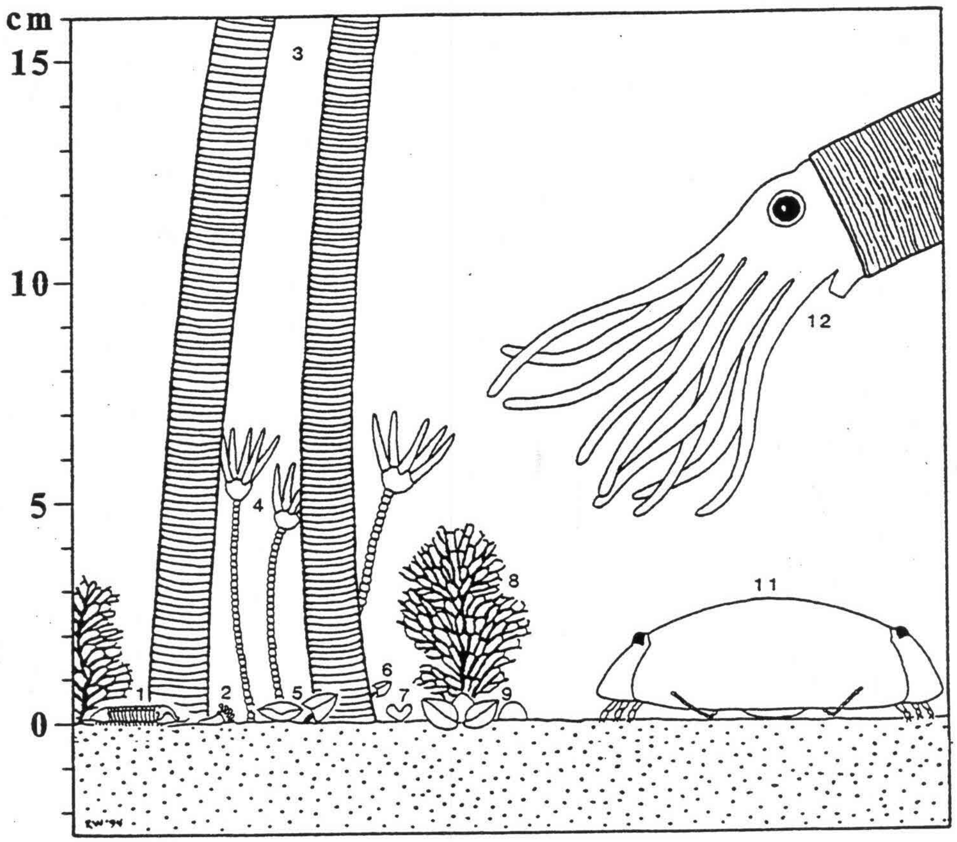


Fig. 4. Reconstruction of the general macrofaunal association preserved in the Brandon Bridge Formation at Voree Quarry, based mainly on sample 30230. 1 - *?Sthenarocalymene* sp.; 2 - rugosan sp. 1; 3 - larger crinoids; 4 - smaller crinoids (arbitrarily shown as inadunates); 5 - *Eospirifer* sp.; 6 - *Resserella* sp.; 7 - *Dicoelosia* sp.; 8 fenestrate bryozoan sp. 2; 9 - clorindid; 11 - *Stenopareia imperiator*; 12 - small individual of *Geisonocerina wortheni*. Density of organisms shown is probably greater than in life.

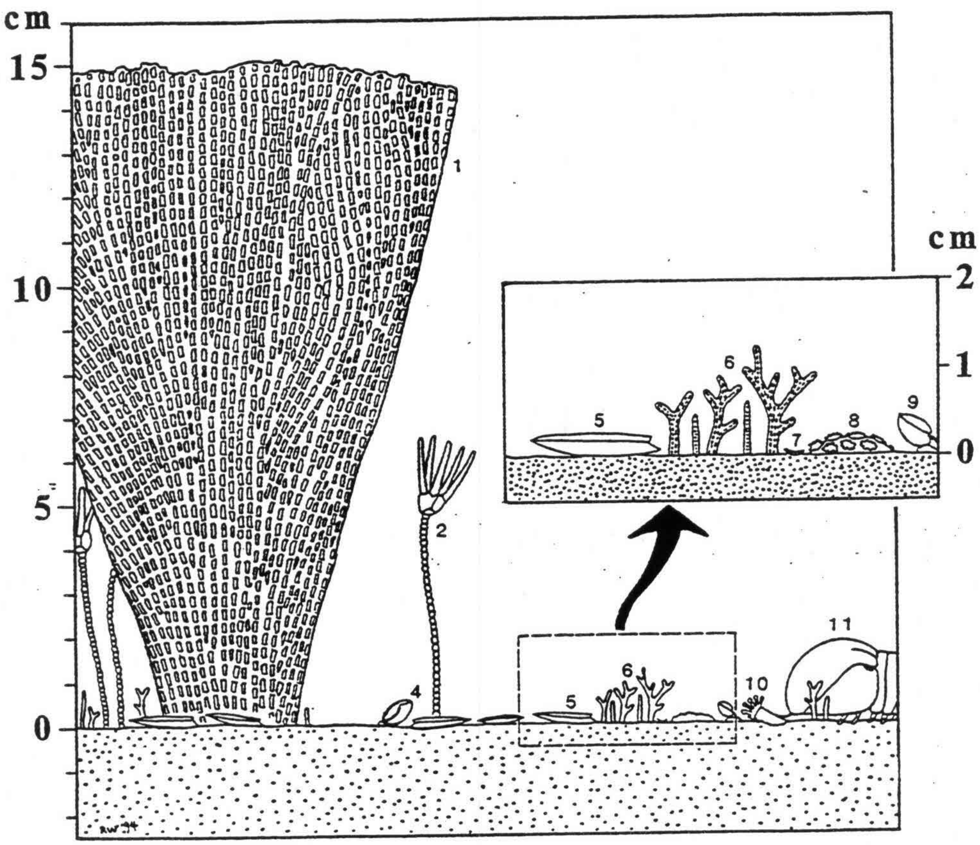


Fig. 5. Reconstruction of *Coolinia*-dominated association, based on sample 30231. 1 - fenestrate bryozoan sp. 1; 2 - crinoid (arbitrarily shown as an inadunate); 4 - atrypid; 5 - *Coolinia applanata*; 6 - ramose bryozoans; 7 - *Jonesea* sp.; 8 - favositid; 9 - *Resserella* sp.; 10 - solitary rugosan sp. 1; 11 - *Stenopareia imperiator*. Density of organisms shown is probably greater than in life.

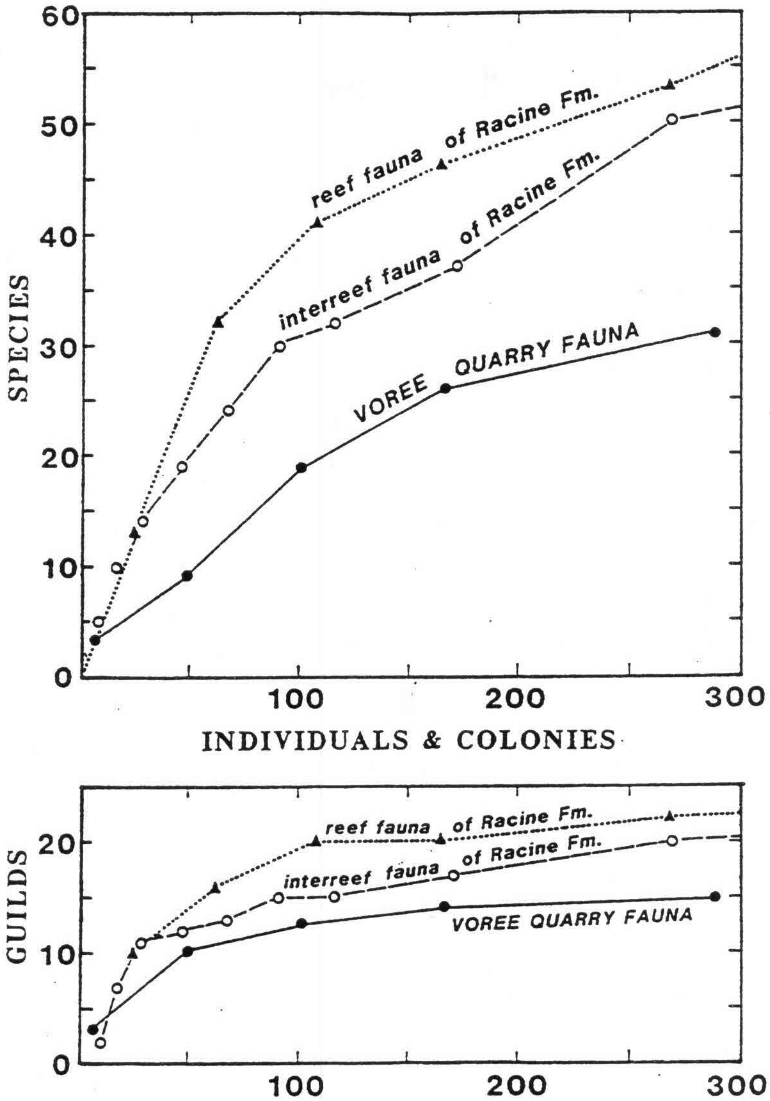


Fig. 6. Plots of species and guild diversity based on cumulative addition of sets of samples. Curve for "reef fauna of Racine Fm." is based on data for Ives Quarry, Racine County (Watkins, 1993). Curve for "interreef fauna of Racine Fm." is based on data from Wauwatosa, Milwaukee County (Watkins, 1991). Curve for Voree Quarry fauna from Brandon Bridge Formation is based on data in Table 2.

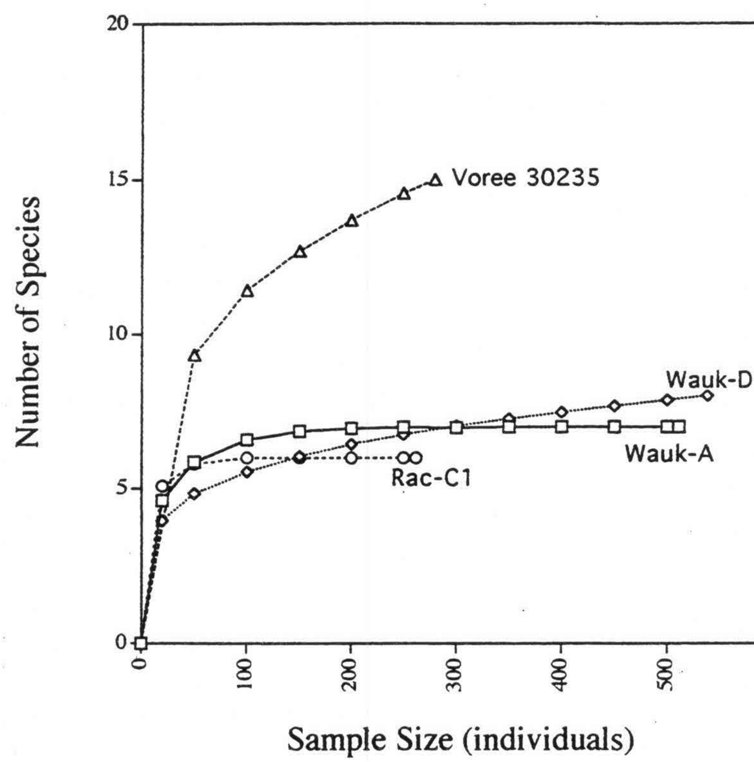


Fig. 7. Rarefaction curves for conodont diversity in the Brandon Bridge Formation at Voree Quarry and in the Waukesha (Wauk-A & Wauk-D) and Racine Formations (Rac-C1). Number of individuals represent total number of recovered conodont elements.

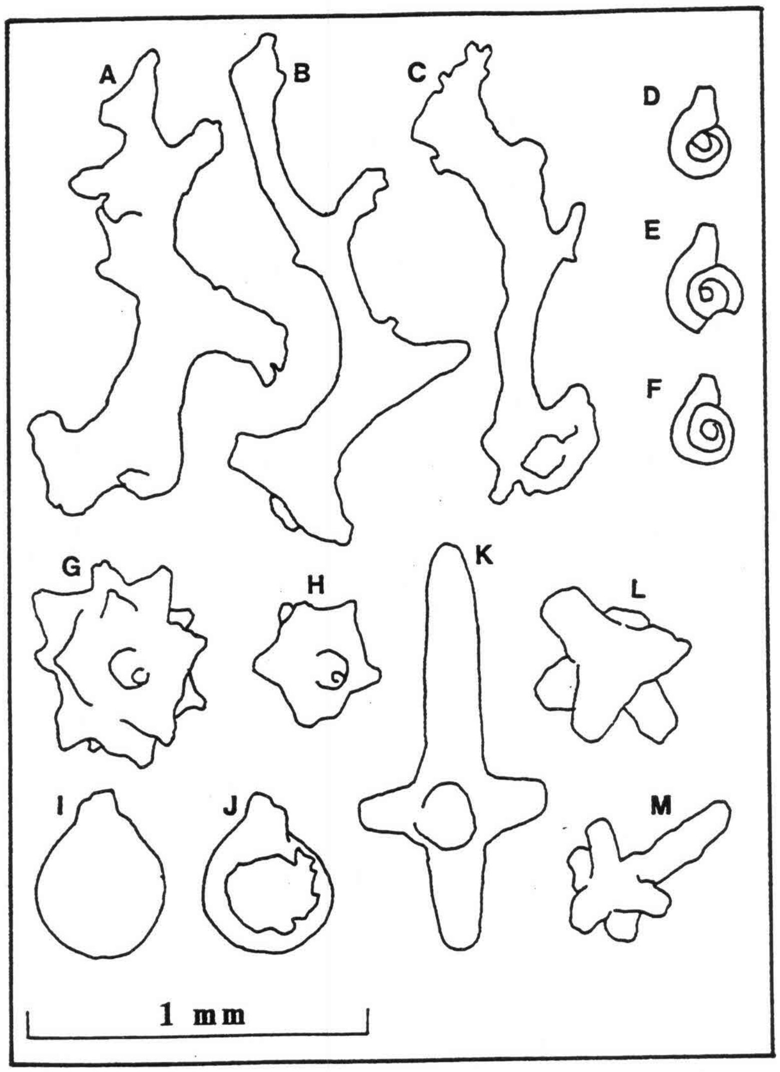


Fig. 8. Camera lucida drawings of foraminifers and sponge spicules. A, B, C - astrorhizid, 30234; D, E, F - *Glomospirella exserta* (Moreman), D 30231, E & F 30234; G, H - *Thurammina polygona* Ireland, 30231; I, J - *Lagenammina* sp., two views of same specimen, 30231; K, L, M - hexactine sponge spicules, 30235.

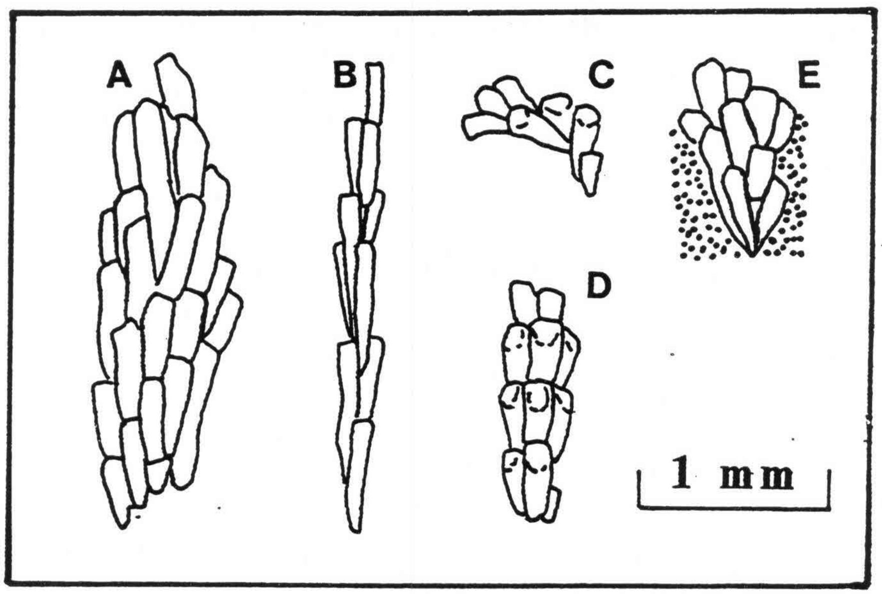
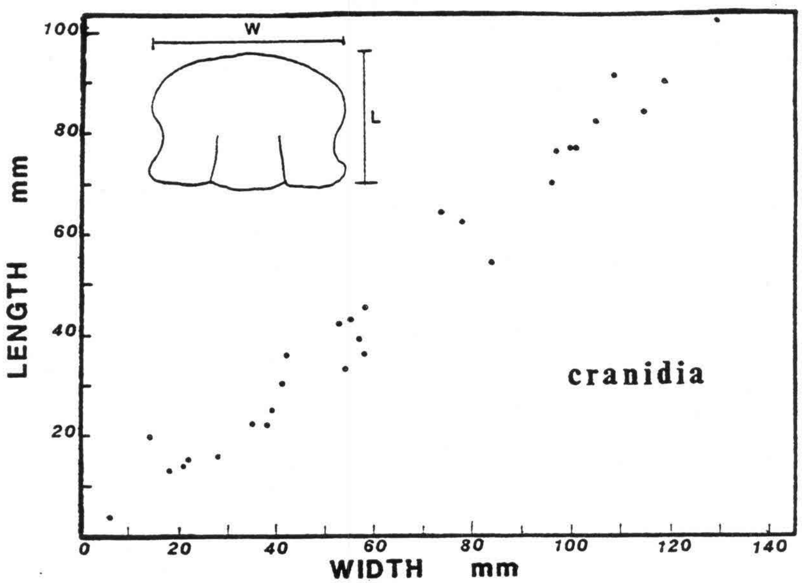


Fig. 9. Sketches of silicified bryozoans preserved as internal molds. A - ramose bryozoan sp. 1; B - ramose bryozoan sp. 2; C - ramose bryozoan sp. 3; D - ramose bryozoan sp. 4; E - encrusting bryozoan.



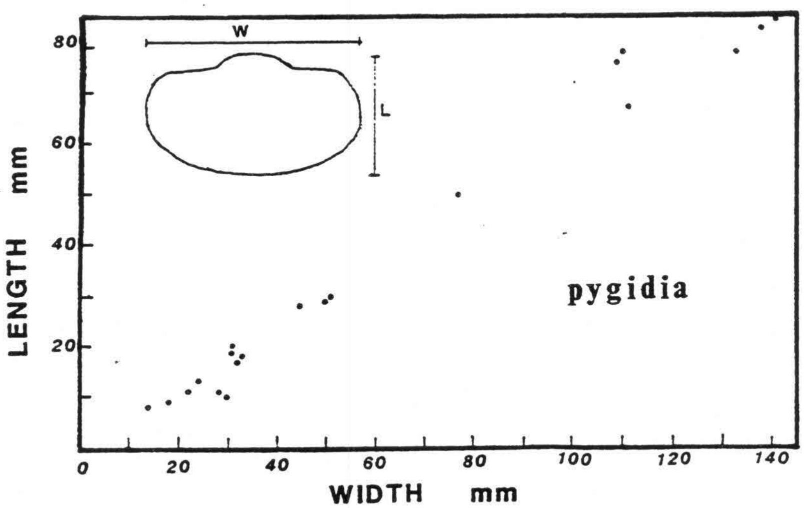


Fig. 10. Scatter diagrams of length versus width for cranidia and pygidia of *Stenopareia imperiator* (Hall).

PLATE 1

Fig. 1. Storm deposit with cross lamination disrupted by burrows; scale bar is 5 mm.

Fig. 2. Dolostone outcrop at south end of Voree Quarry; stratigraphic thickness is about 1.5 m.

Fig. 3. Bioturbated skeletal wackestone; scale bar is 5 mm.

Fig. 4. Mudstone with *Chondrites* and *Planolites*; scale bar is 5 mm.

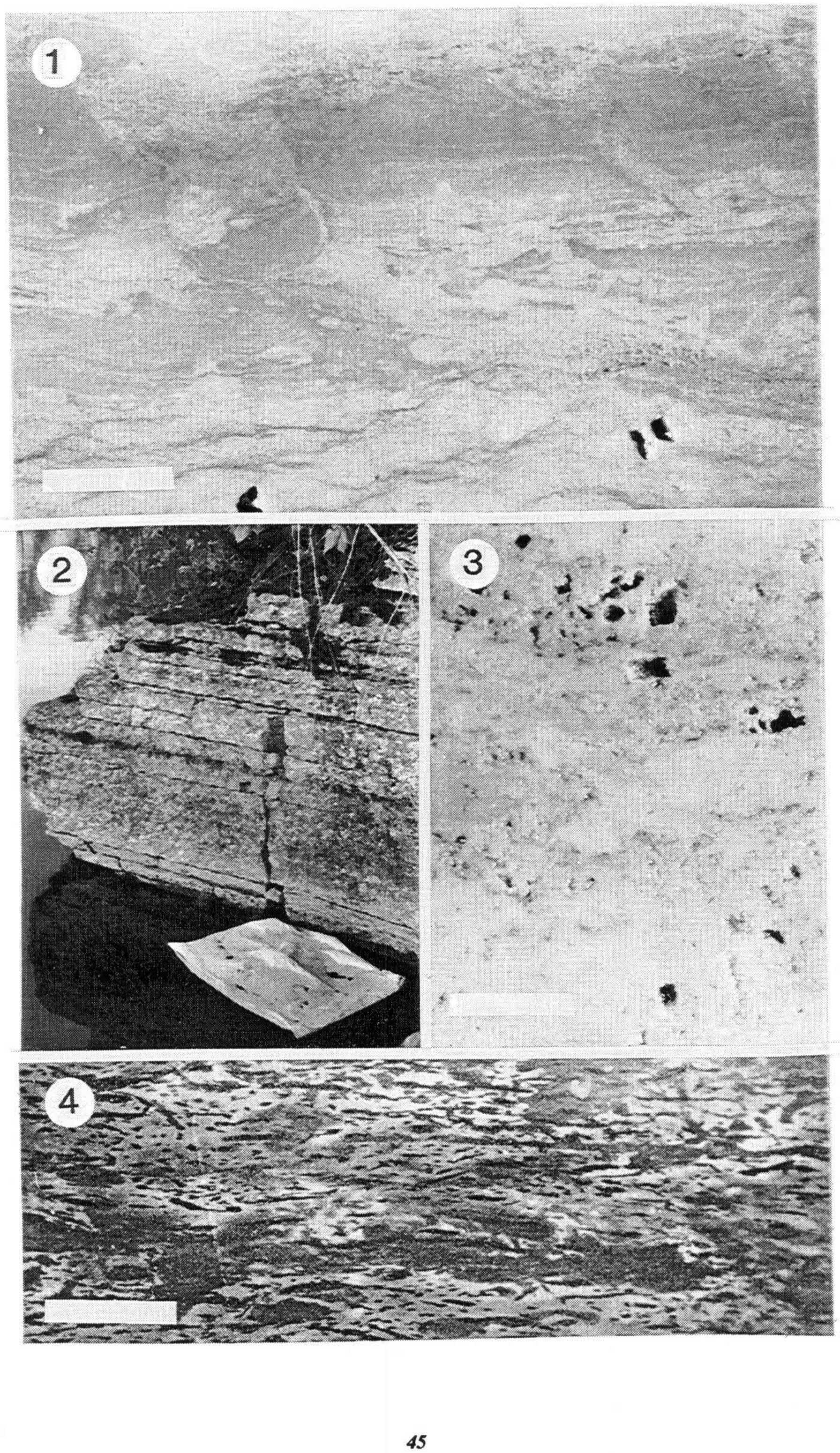

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PLATE 2

Fig. 1. fenestrate bryozoan sp. 2, MPM28421, external mold, X 1.8.

Fig. 2. favositid, MPM28424, internal mold, X 0.7.

Fig. 3. solitary rugosan sp. 1, MPM28422, silicified specimen, X 4.4.

Fig. 4. fenestrate bryozoan sp. 1, MPM28419, external mold, X 0.6.

Fig. 5. *Geisonocerina wortheni* Foerste, MPM21003, X 0.6.

Fig. 6. micheliniid, MPM28429, with attached palaeocyclid, MPM28430, silicified, X 2.8.

Fig. 7. micheliniid with attached palaeocyclid, same specimens as Fig. 6, X. 2.8.

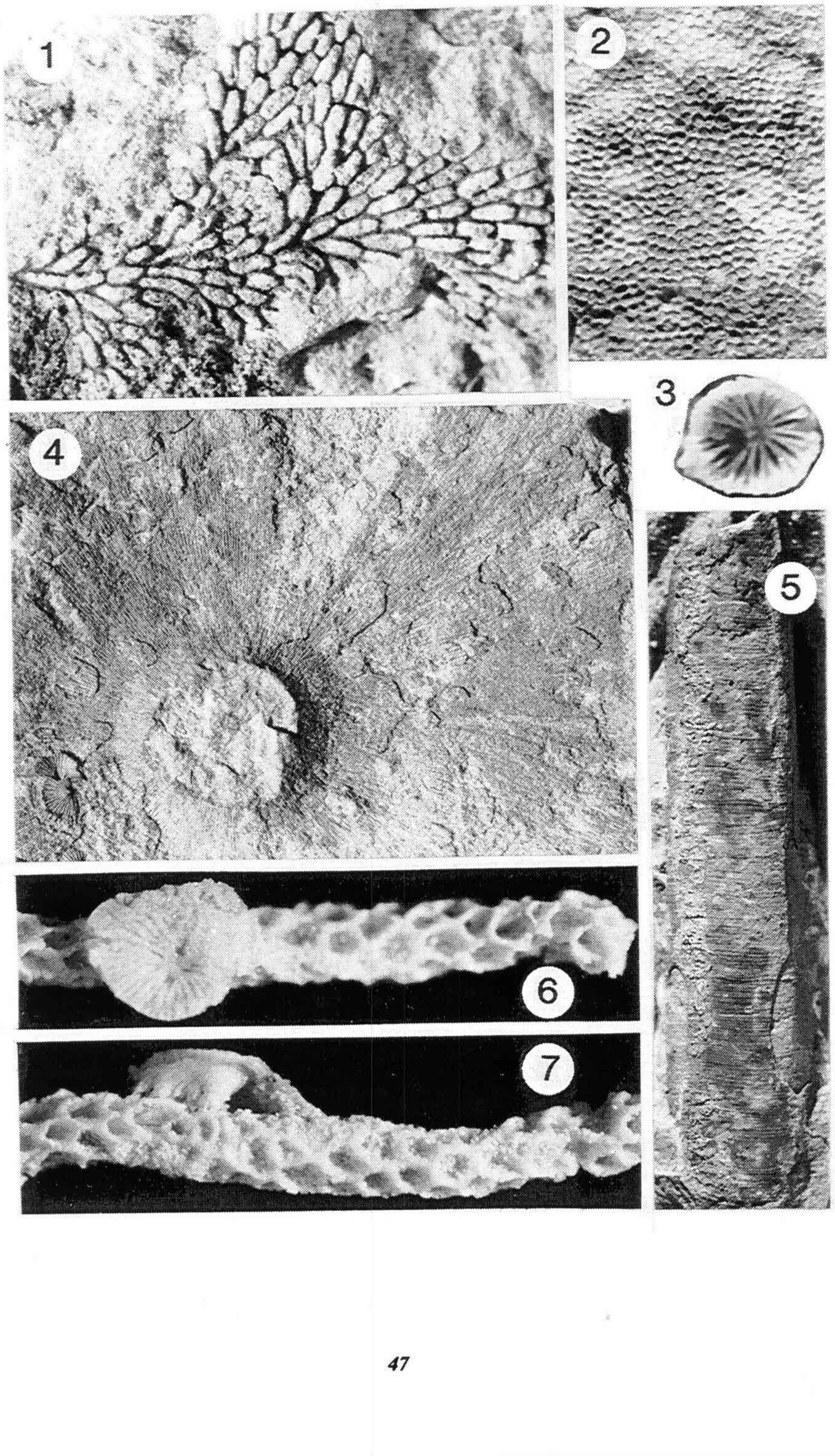
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PLATE 3

Fig. 1. *Dolerorthis* sp., MPM28413, internal mold of brachial valve, X 3.

Fig. 2. *Dolerorthis* sp., MPM28414, interior of silicified pedicle valve, X 4.6.

Fig. 3. *Dolerorthis* sp., MPM28412 exterior of silicified brachial valve, X 3.

Fig. 4. *Dicoelosia* sp., MPM28415, exterior of silicified pedicle valve, X 4.6.

Fig. 5. *Resserella* sp., MPM28416, interior of silicified pedicle valve, X 4.6.

Fig. 6. *Leptaena* sp., MPM20485, external mold of brachial valve, X 3.3.

Fig. 7. *Coolinia applanata* (Salter), MPM28409, internal mold of pedicle valve, X 3.

Fig. 8. clorindid, MPM28417, internal mold of pedicle valve, X 3.

Fig. 9. atrypid, MPM28418, exterior of silicified brachial valve, X4.6.

Fig. 10. *Coolinia applanata* (Salter), MPM28411, external mold of pedicle valve, X5.

Fig. 11. *Coolinia applanata* (Salter), MPM28408, internal mold of brachial valve, X5.

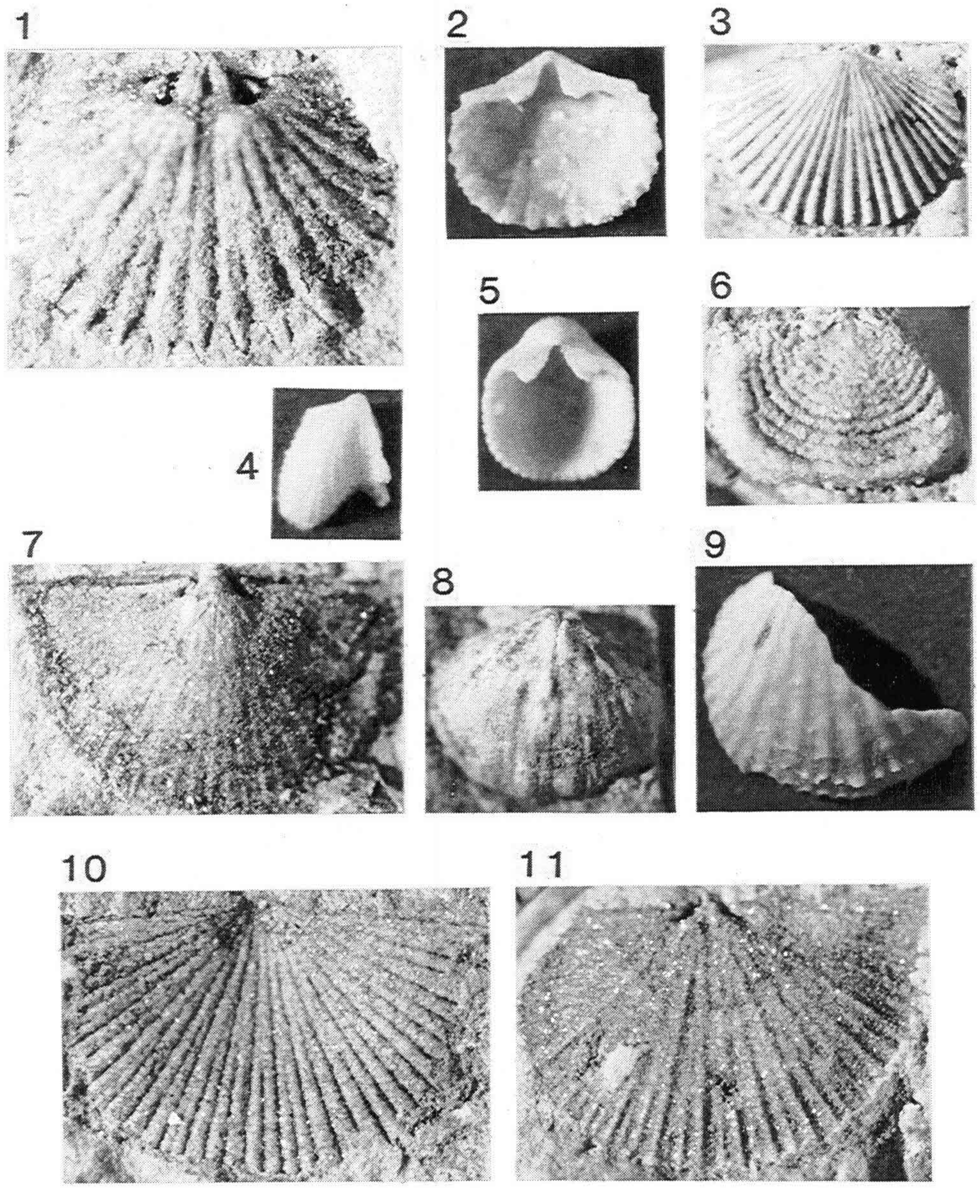
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PLATE 4

Stenopareia imperiator (Hall)

Fig. 1. internal mold of cranidium, MPM225549,, X 0.6.

Fig. 2. internal mold of cranidium, MPM28420, X 0.6.

Fig. 3. internal mold of cranidium, MPM20482, X 1.1.

Fig. 4. internal mold of pygidium, MPM28403, X 0.6.

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PLATE 5

Fig. 1. *?Sthenarocalymene* sp., MPM28427, internal mold of cranidium, X 3.6.

Fig. 2. *Stenopareia imperiator* (Hall), MPM20484, internal mold of cranidium, X 0.9.

Fig. 3. *Stenopareia imperiator* (Hall), MPM28402, internal mold of pygidium, X 0.6.

Fig. 4. *Stenopareia imperiator* (Hall), MPM28405, internal mold of pygidium, X 0.6.

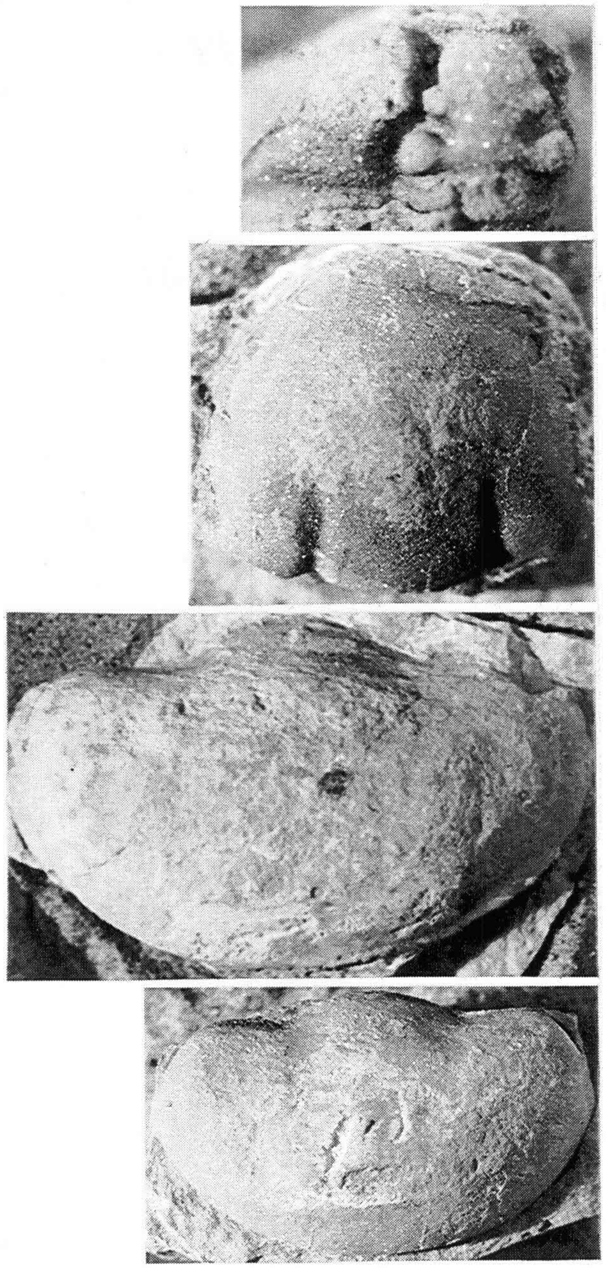

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PLATE 6

Fig. 1. *Aulacognathus latus* (Nicoll and Rexroad), UW4201/37, Pa element, upper side, X 45.

Fig. 2. *Aulacognathus latus* (Nicoll and Rexroad), UW4201/38, Pa element, upper side, X 45.

Fig. 3. *Aulacognathus latus* (Nicoll and Rexroad), UW4201/39, Pa element, upper side, X 45; for figs. 1-3, note increased element robustness with increased size.

Fig. 4. *Aulacognathus bullatus* (Nicoll and Rexroad), UW4201/40, Pa element, upper side, X 58.

Fig. 5. *Aulacognathus bullatus* (Nicoll and Rexroad), UW4201/41, Pa element, upper side, X 58.

Fig. 6. *Aulacognathus latus* (Nicoll and Rexroad), UW4201/42, Pb element, upper side, X 120.

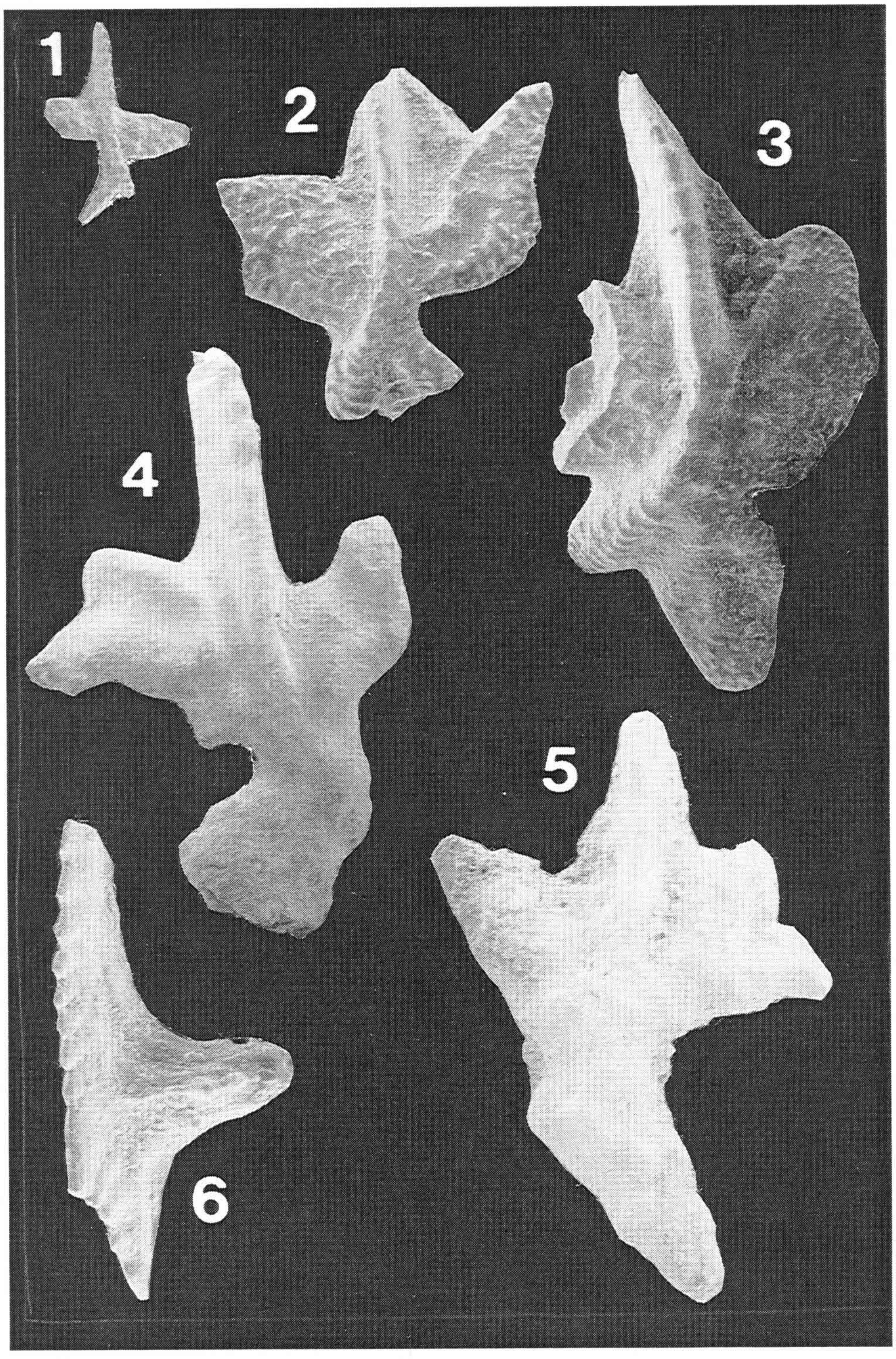
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PLATE 7

Fig. 1. *Ozarkodina polinclinata* (Nicoll and Rexroad), UW4201/43, Pa element, lateral view, X 86.

Fig. 2. *Ozarkodina polinclinata* (Nicoll and Rexroad), UW4201/44, M element, inner lateral view, X 120.

Fig. 3. *Ozarkodina polinclinata* (Nicoll and Rexroad), UW4201/45, Sc element, inner lateral view, X 120.

Fig. 4. *Ozarkodina polinclinata* (Nicoll and Rexroad), UW4201/46, Pb element, inner lateral view, X 143.

Fig. 5. *Ozarkodina polinclinata* (Nicoll and Rexroad), UW4201/47, Sa element, posterior view, X 150.

Fig. 6. *Distomodus staurognathoides (Johnognathus huddlei* Mashkova), x 44; specimen from sample 30230 lost after being photographed.

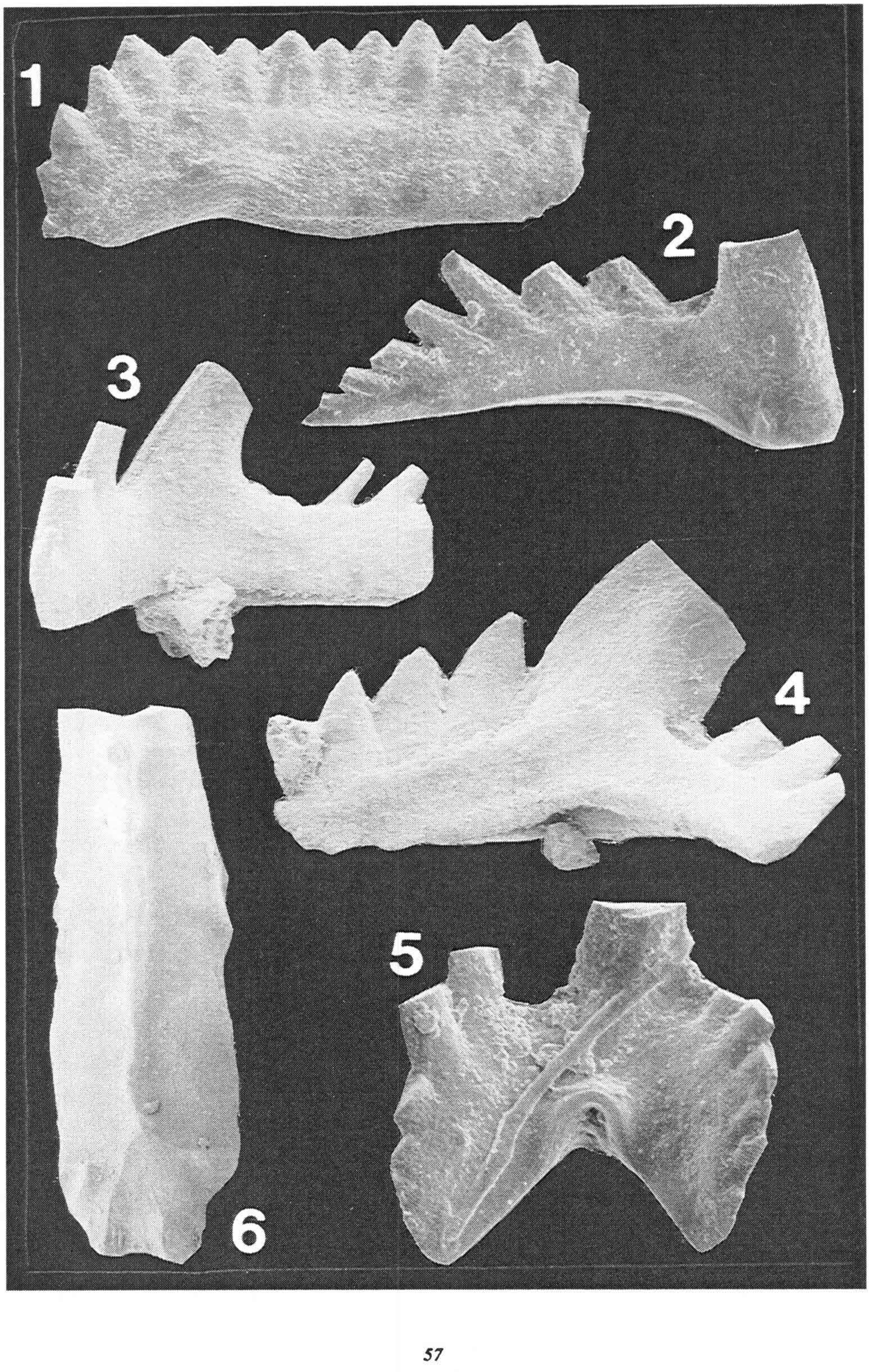
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PLATE 8

Fig. 1. *Ozarkodina hadra* (Nicholl and Rexroad), UW4201/48, Pa element, lateral view, X 45.

Fig. 2. *Oulodus* sp. 2, UW4201/49, Sc element, lateral view, X 72.

Fig. 3. *Oulodus* sp. 2, UW4201/50, Sa element, oblique posterior view, X 85.

Fig. 4. *Walliserodus curvatus* (Branson and Branson), UW4201/51, Sa element, lateral view, X 142.

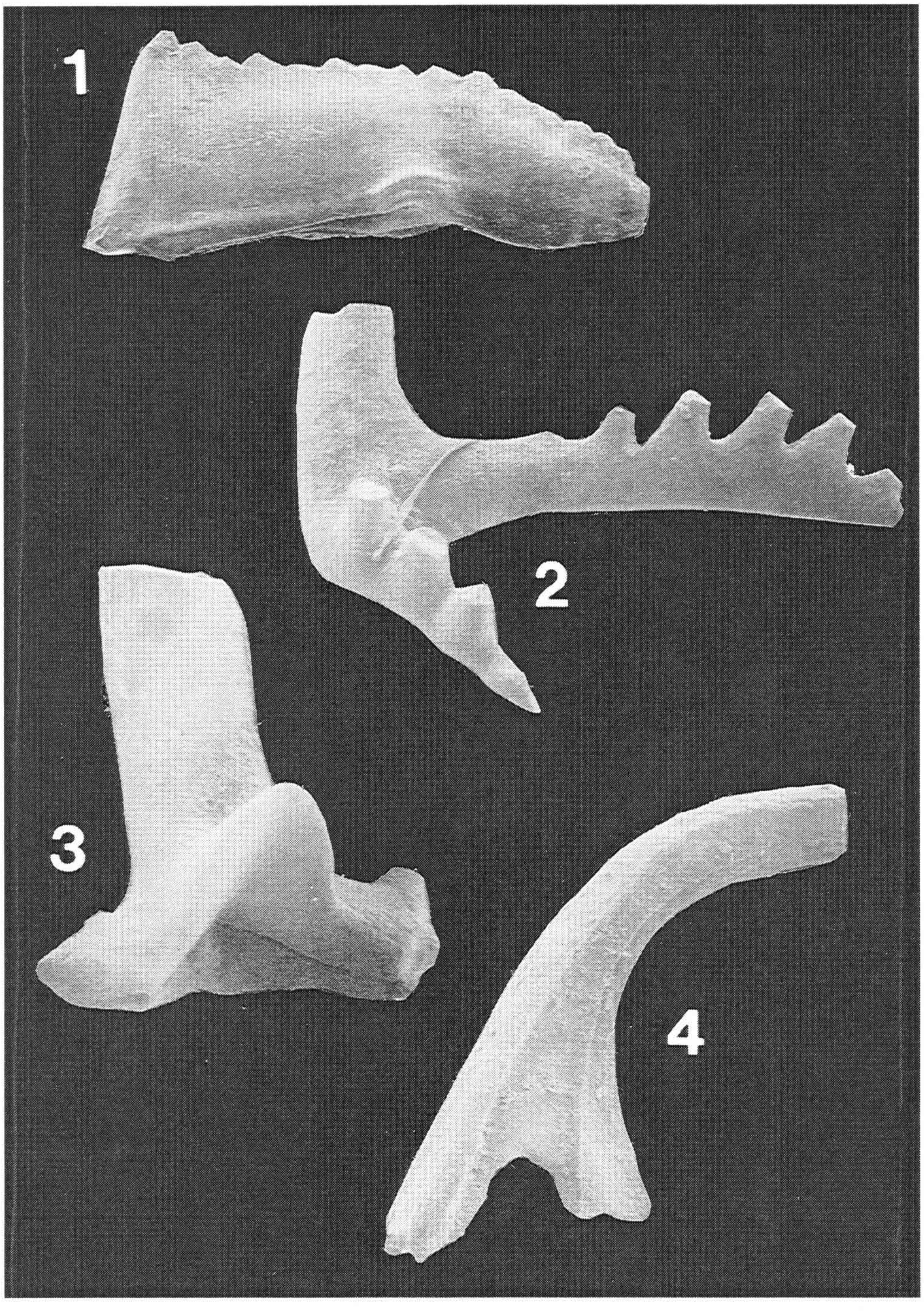

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PLATE 9

Fig. 1. *Dapsilodus obliquicostatus* (Branson and Mehl), UW4201/52, M element, lateral view, X 170.

Fig. 2. *Dapsilodus obliquicostatus* (Branson and Mehl), UW4201/53, S element, lateral view, X 200.

Fig. 3. *Panderodus unicostatus*, UW4201/54, S element, lateral view, X 84.

Fig. 4. *Panderodus unicostatus*, UW4201/55, M element, lateral view, X 82.

Fig. 5. *Walliserodus curvatus* (Branson and Branson), UW4201/56, Sa element, elevated anterior view, X 152.

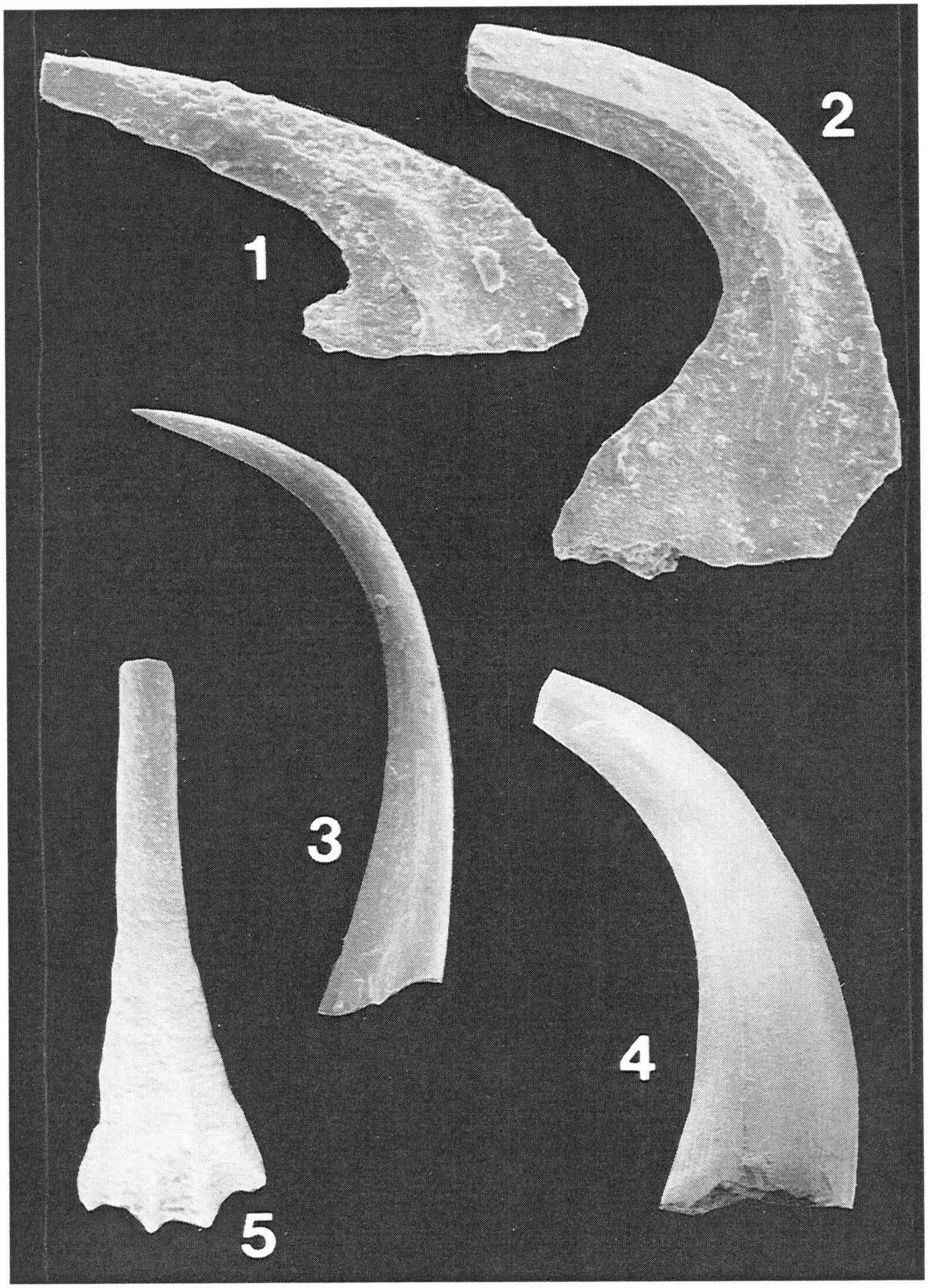
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PLATE 10

Fig. 1. *Pterospathodus celloni* (Walliser), UW4201/57, Pb element, lateral view, X 157.

Fig. 2. *Pterospathodus celloni* (Walliser), UW4201/58, Pa element, lateral view, X 150.

Fig. 3. *Pterospathodus celloni* (Walliser), UW4201/59, Pa element, upper side, X 153.

Fig. 4. *Pterospathodus celloni* (Walliser), UW4201/60, Pa element, lower side, X 201.

Fig. 5. *Distomodus staurognathoides* (Walliser), UW4201/61, M element, lateral view, X 90.

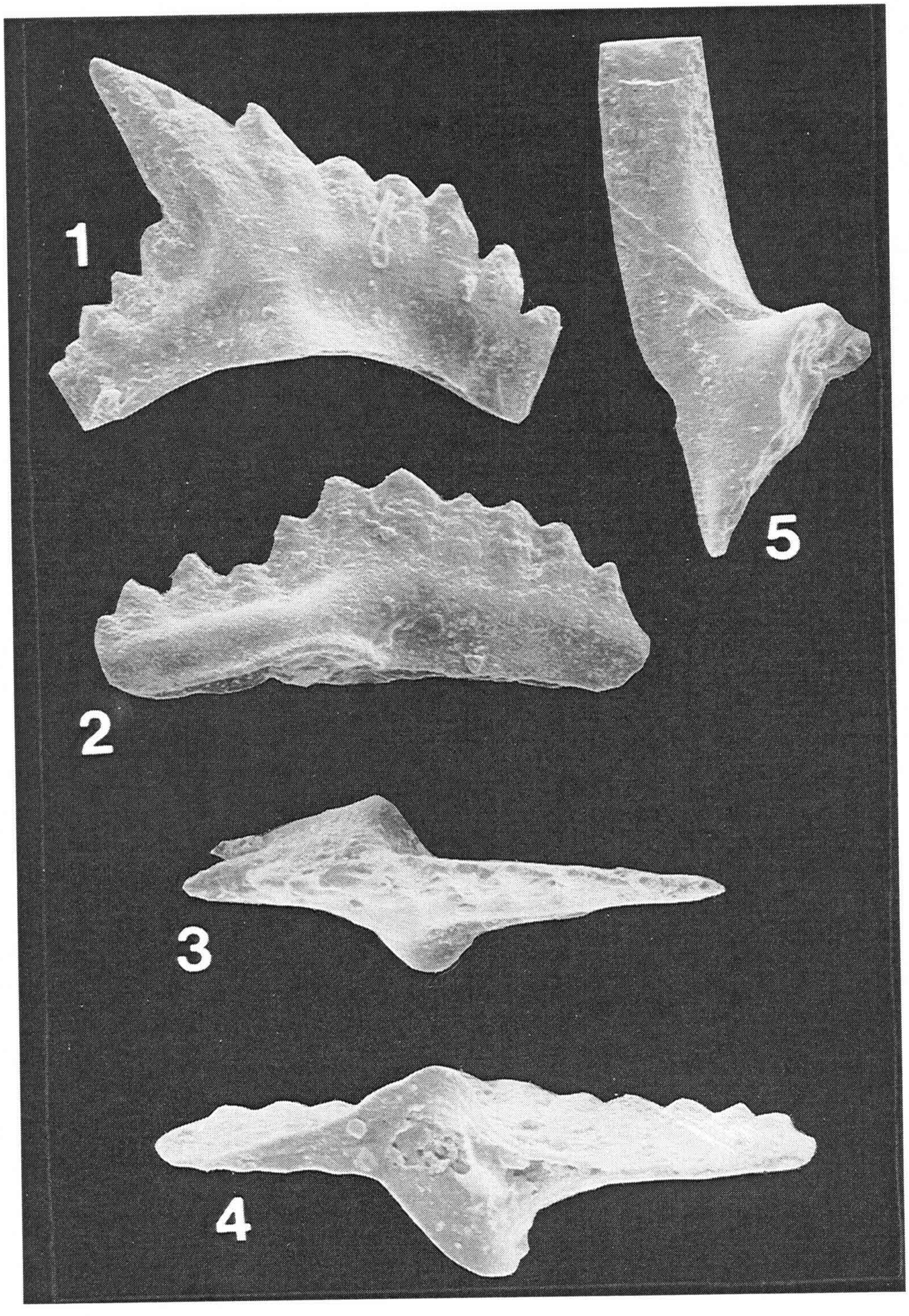
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PLATE 11

Distomodus staurognathoides (Walliser)

Fig. 1. UW4201/62, Pa element, upper side, X 47.

Fig. 2. UW4201/63, Pa element, upper side, X 60.

Fig. 3. Sb element, oblique posterior view, X 67; specimen from sample 30235 lost after being photographed.

Fig. 4. UW4201/64, M element, lateral view, X 127.

Fig. 5. UW4201/65, Sc element, lateral view, X 103.

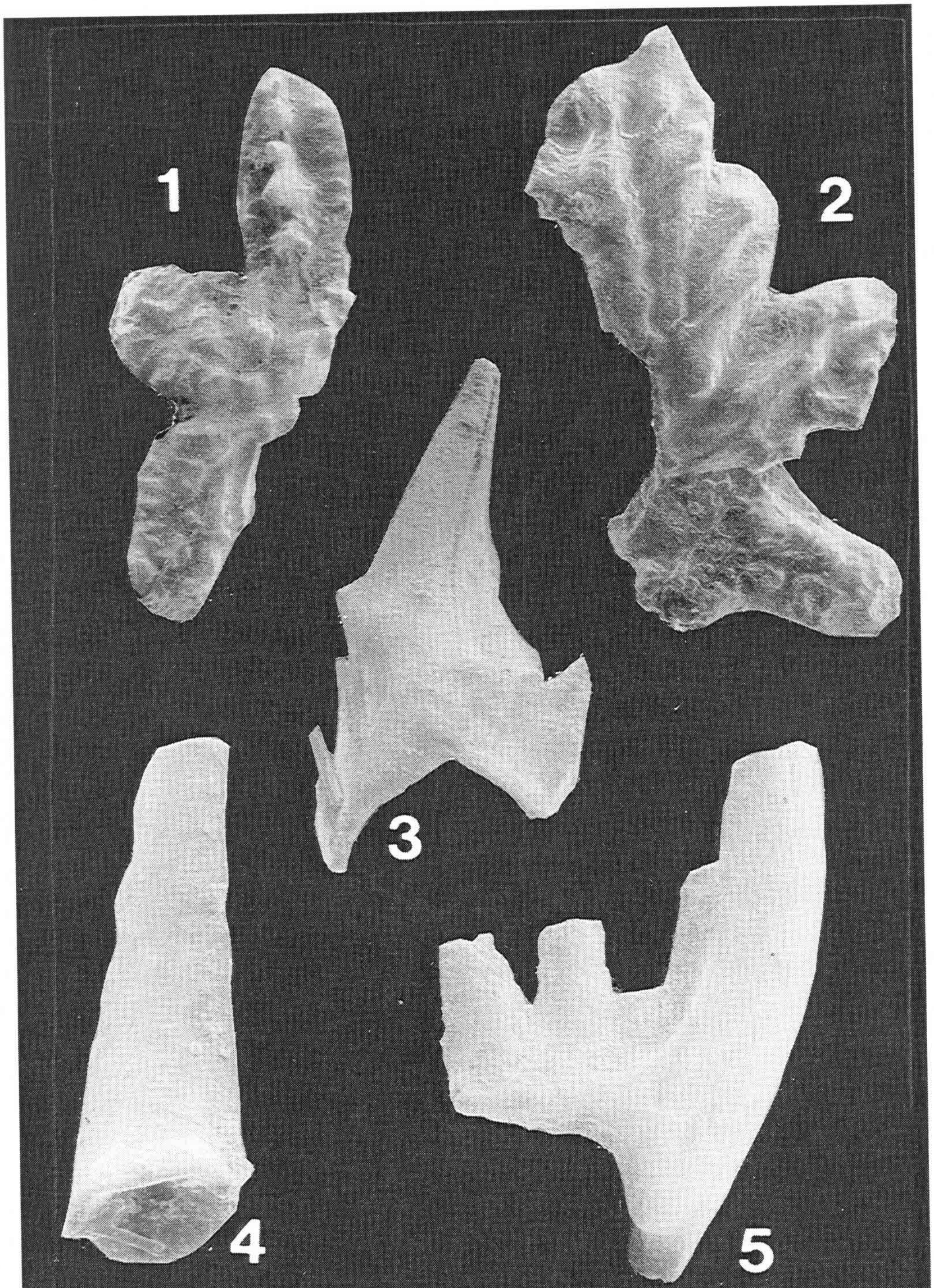
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PLATE 12

Fig. 1. *Distomodus staurognathoides* (Walliser), UW4201/66, Sa element, anterior view, X 85.

Fig. 2. *Oulodus* sp. 2, UW4201/67, Sa element, lateral view, X 146.

Fig. 3. *Panderodus unicostatus*, UW4201/68, fused cluster, X 85.

Fig. 4. *Panderodus unicostatus*, UW4201/69, fused cluster, X 160.

Fig. 5. *Panderodus unicostatus*, UW4201/70, fused cluster, X 165.

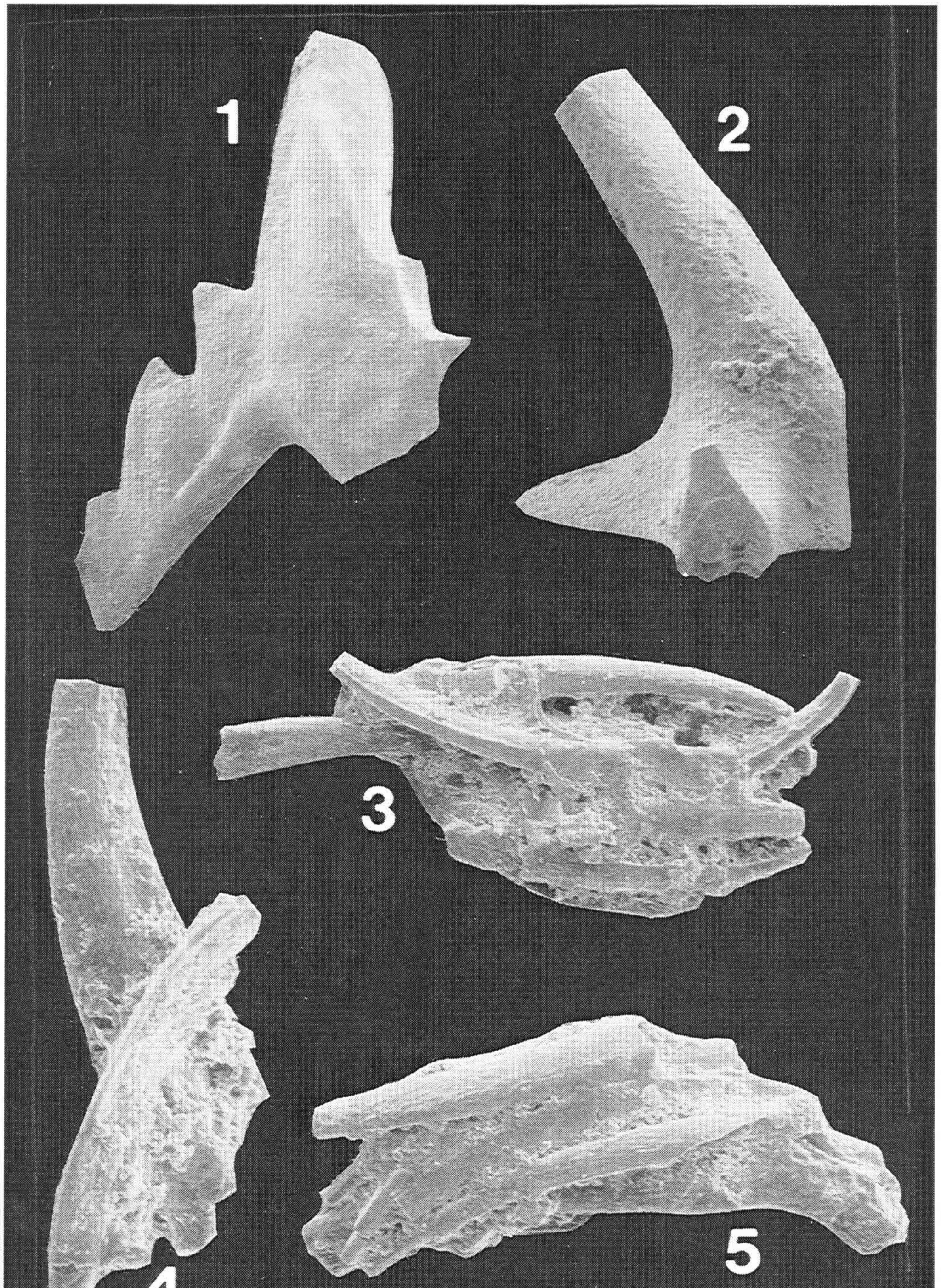
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PLATE 13

Fig. 1. *Aspelundia* sp., UW4201/71, posterior view, X 123; note partially intact basal filling.

Fig. 2. *Aspelundia* sp., UW4201/72, M element, posterior view, X 90.

Fig. 3. *Aspelundia* sp., UW4201/73, Sb element, oblique posterior view, X 71.

Fig. 4. *Oulodus* sp. 3, UW4201/74, Sb element, anterior view, X 89.

Fig. 5. *Oulodus* sp. 3, UW4201/75, Sb element, posterior view, X 76.

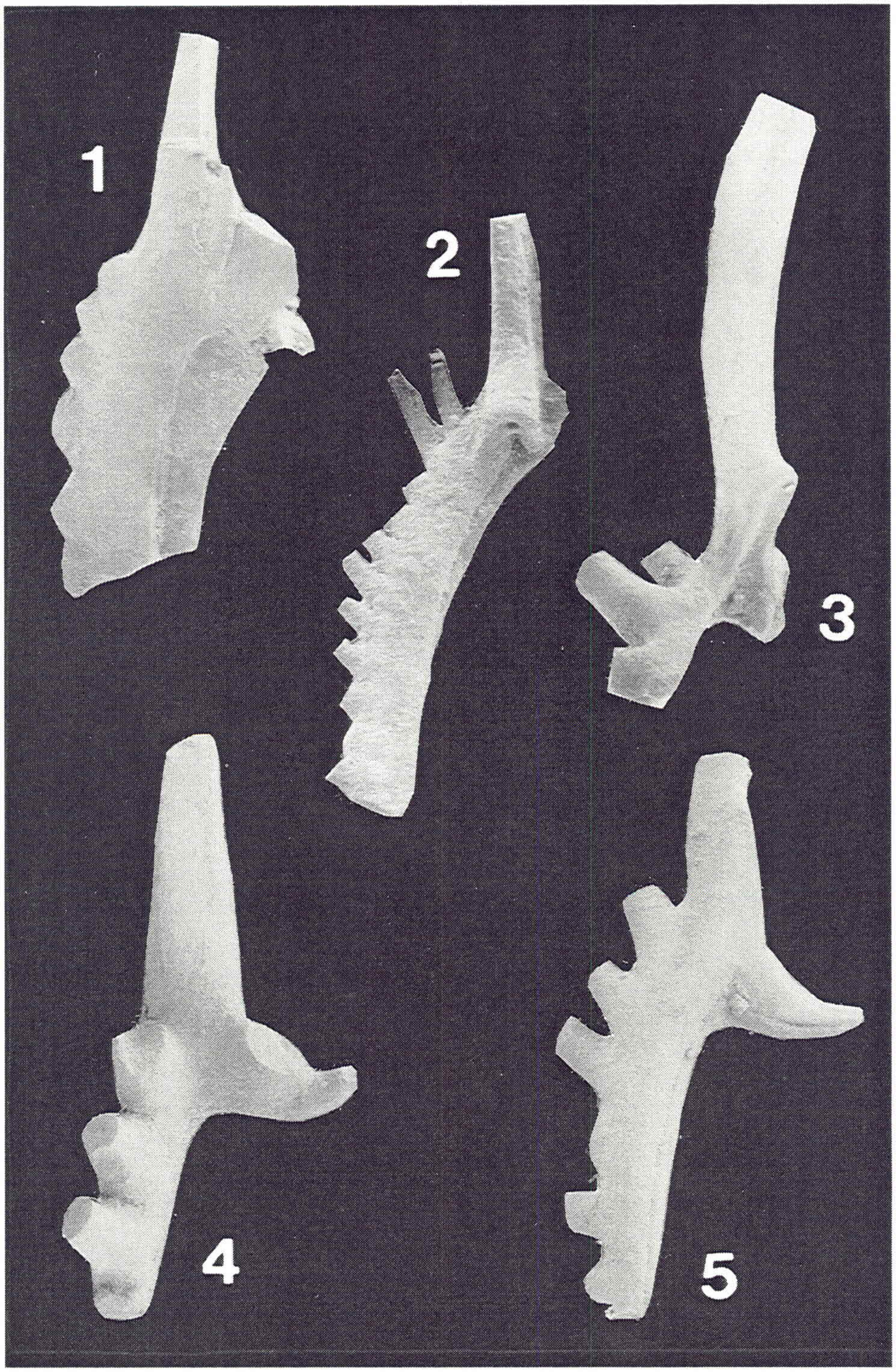
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PLATE 14

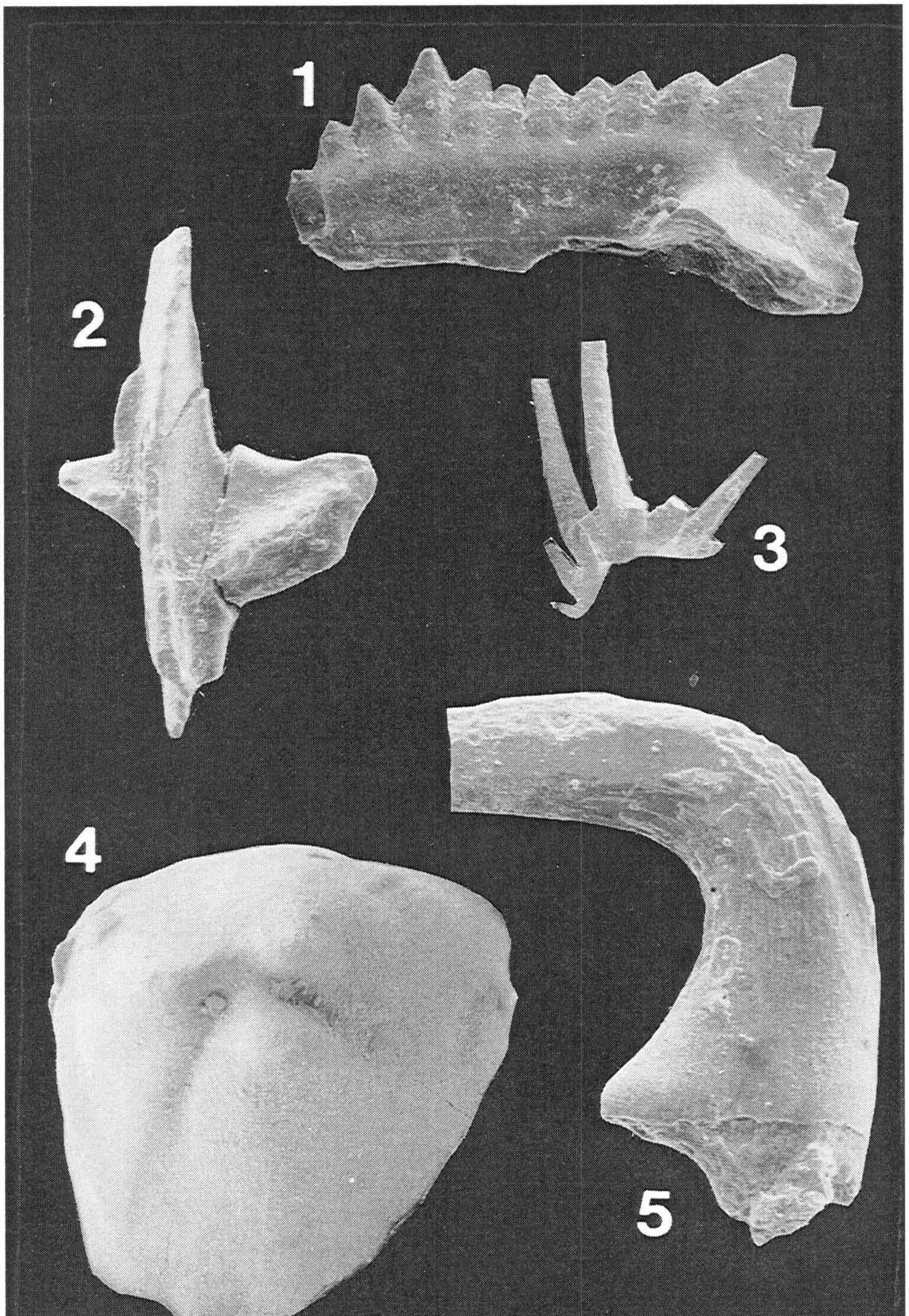
Fig. 1. *Aulacognathus?* sp., UW4201/76, Pb element, lateral view, X 120.

Fig. 2. *Aulacognathus latus* (Nicoll and Rexroad), UW4201/77, Pb element, upper side, X 69.

Fig. 3. *Oulodus* sp. 3, UW4201/78, Pa? element, anterior view, X 45.

Fig. 4. *Pseudooneotodus tricornis* Drygant, UW4201/79, upper side, X 165.

Fig. 5. *Panderodus recurvatus*, UW4201/80, S element, X 155.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