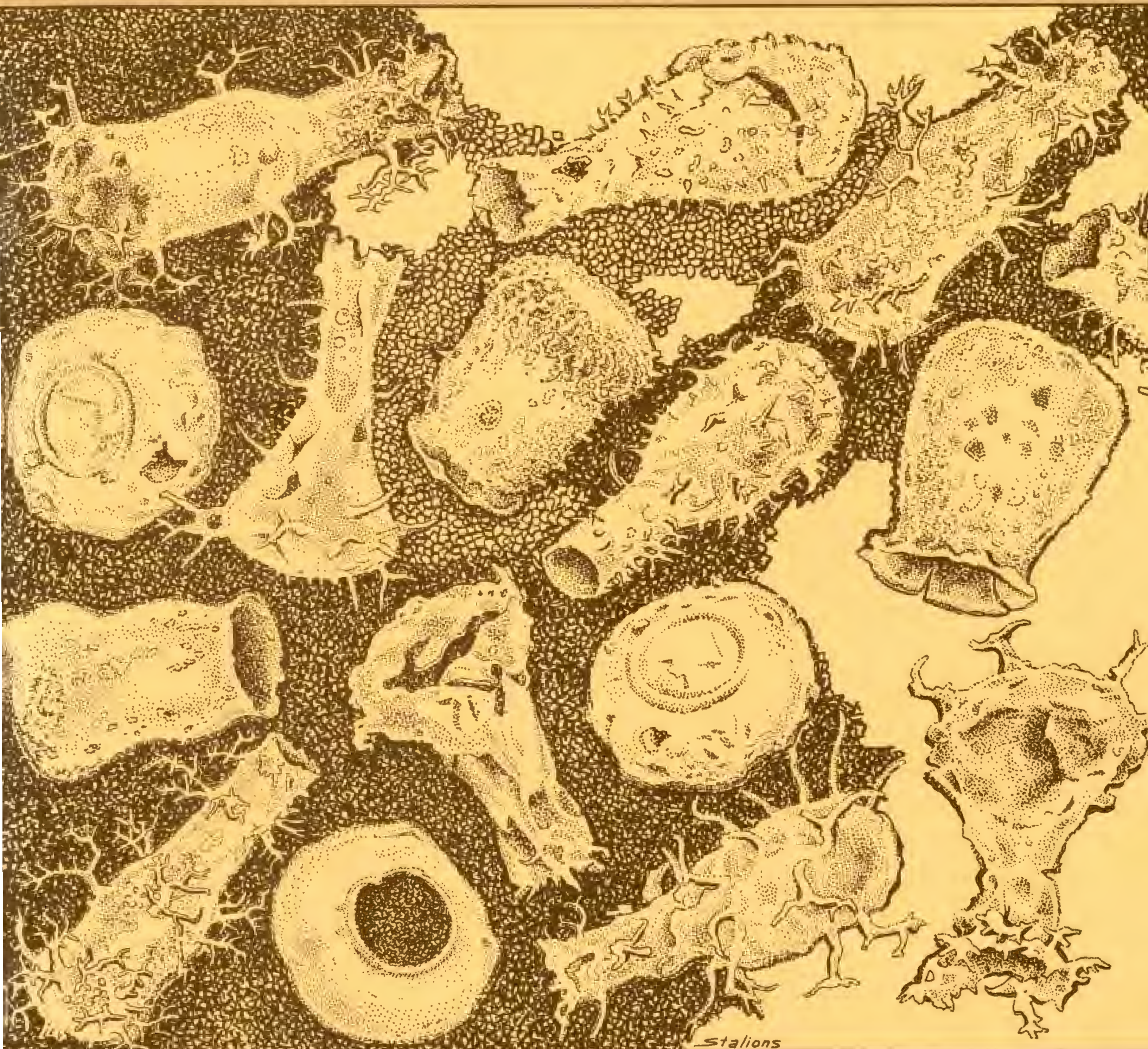
MIDDLE DEVONIAN CHITINOZOA OF INDIANA

Special Report 18



State of Indiana
Department of Natural Resources
GEOLOGICAL SURVEY

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Middle Devonian Chitinozoa of Indiana

By ROBERT P. WRIGHT

DEPARTMENT OF NATURAL RESOURCES
GEOLOGICAL SURVEY SPECIAL REPORT 18

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Contents

Illustrations

Table

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By ROBERT P. WRIGHT

Abstract

Middle Devonian chitinozoans from the Muscatatuck Group of Indiana belong to eight species of the genera *Alpenachitina*, *Ancyrochitina*, *Angochitina*, *Eisenackitina*, and *Hoegisphaera*. The Chitinozoa are most abundant in the carbonate rocks that represent well-circulated open-water conditions and are low in diversity or are absent from lithographic and laminated dolomite representing the shallower, more restricted environments. The local range zones of the chitinozoans from the Muscatatuck Group, when compared with the occurrence of similar taxa from correlative strata in the midwestern United States, are quite parallel to the established conodont zones. The lowest occurrence of *Alpenachitina eisenacki*, *Angochitina callawayensis*, and *Eisenackitina inflata* in the lowermost rocks of the Muscatatuck Group is in the *Icriodus latericrescens robustus* Zone, which is early Eifelian in age. *Ancyrochitina hamiltonensis* in association with *A.* cf. *A. spinosa* and *Hoegisphaera glabra* characterizes the upper part of the Muscatatuck rocks, and the occurrence of those chitinozoans ranges from the upper part of the late Eifelian *I. angustus* Zone into the early Givetian *I. latericrescens latericrescens* Zone.

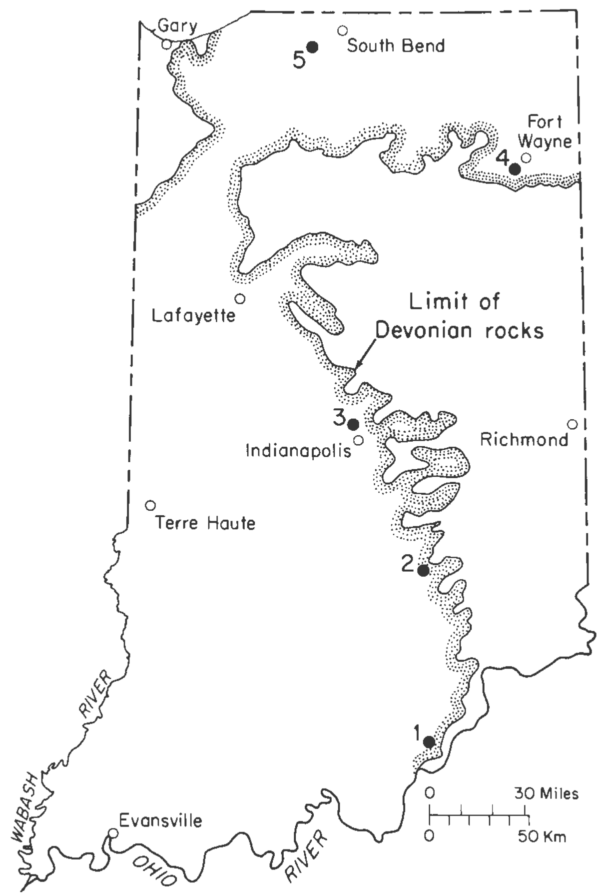

Figure 1. Map showing location of collecting sites in Indiana.

Introduction

PURPOSE OF THE STUDY

This study of chitinozoans from the Muscatatuck Group of Indiana is part of a larger effort that is being made by members of the Chitinozoa Working Group of the International Commission of Paleozoic Microflora to improve the use of these fossils in biostratigraphy and paleoecology. The Muscatatuck Group was selected for study because the precise ages (Orr, 1971) and the various depositional environments of the rocks have been fairly well established (Droste and Shaver, 1975). This was an opportunity to compare the stratigraphic distribution of the Muscatatuck Chitinozoa with established conodont zones and to see if the occurrence of the Chitinozoa was in some way controlled by normal-marine conditions.

To satisfy these objectives, rocks from three outcrops and two cores in Indiana were sampled (fig. 1). The rocks belonged to the Jeffersonville and North Vernon Limestones in central and southern Indiana and to the Detroit River and Traverse Formations in northern Indiana. Most lithofacies were sampled so that no lithologic type would be ignored. Although not all the samples contained chitinozoans, well-preserved specimens were found. Because the Chitinozoa were not compacted in the carbonate rocks, they were easily compared with taxa of other assemblages from correlative strata in Illinois, Iowa, Ohio, and Ontario.

The Chitinozoa still remain a problematical group because of the uncertainty of their biologic affinity. First discovered in 1929 by the German scientist Eisenack from glacial erratics of Silurian rocks in the Baltic region of Europe, chitinozoans are now known indisputably to occur in marine rocks ranging in age from the Tremadocian (earliest Ordovician) through latest Devonian. Because the chemical nature of the body wall makes them resistant to treatment by concentrated acidic solutions, their tests are easily extracted from sedimentary rocks with a minimum of careful effort by using HCl, HF, and HNO_3 without fear of losing the fossils.

More recently the quality of published illustrations has improved with the use of the scanning electron microscope. With this tool, chitinozoan morphology and its variability are more readily determined, which results in better comparisons among taxa. In addition, recent publications have contained detailed information about chitinozoan geographic and stratigraphic locations. Such trends have led to increased application of chitinozoans to problems of general biostratigraphy (Laufeld, 1975; Laufeld and others, 1975; Cramer and Diéz de Cramer, 1972; Achab, 1977; and many others), even to dating autochthonous sedimentary sequences (Neville, 1974) and low-grade metamorphic rocks (Priewalder and Schumacher, 1976).

Finally, the Chitinozoa have been shown to be useful shoreline indicators (Williams and Sarjeant, 1967; Gray and others, 1974; Laufeld, 1975; Wright and Felt, 1977; Wright, 1978). This means that a representative picture of the depositional framework of a sequence of strata may be better defined when particular attention is paid to the contained chitinozoans.

ACKNOWLEDGMENTS

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Information in this report has been discussed with Robert H. Shaver, Department of Geology, Indiana University; Sven Laufeld, Geological Survey of Sweden; and Steven R. Jacobson, Chevron Oil Co. F. H. Cramer, Institute of Palynological Investigations, Leon, Spain, Sven Laufeld, and Robert H. Shaver read the manuscript and offered valuable assistance for its improvement. Special thanks are due to J. Franklin, SEM technician; Robert Wilkinson, photographer; and Karen Tyler, draftsman, all of the Department of Geology and Mineralogy, The Ohio State University, for preparation of the illustrations. Marjorie Fields, The Ohio State University, Marion Campus, typed several drafts of the manuscript.

Stratigraphic Summary

The Middle Devonian carbonate rocks of the cratonic Kaskaskia Sequence in Indiana make up the Muscatatuck Group (Shaver, 1974). This group includes the Jeffersonville and North Vernon Limestones in the subsurface and outcrop belt in central and southern Indiana and the Detroit River and Traverse Formations in northern Indiana. Rocks of the Jeffersonville and Detroit River were the initial sediments deposited primarily over exposed and eroded Silurian rocks during late Emsian and Eifelian transgression of the Kaskaskia Sea. The North Vernon Limestone and the Traverse Formation, mainly Givetian in age, were the end of carbonate deposition across Indiana before the dark overlying New Albany Shale and Antrim Shale were deposited.

The present outcrop pattern of the Muscatatuck Group is broadly restricted to south-central and north-central Indiana. The

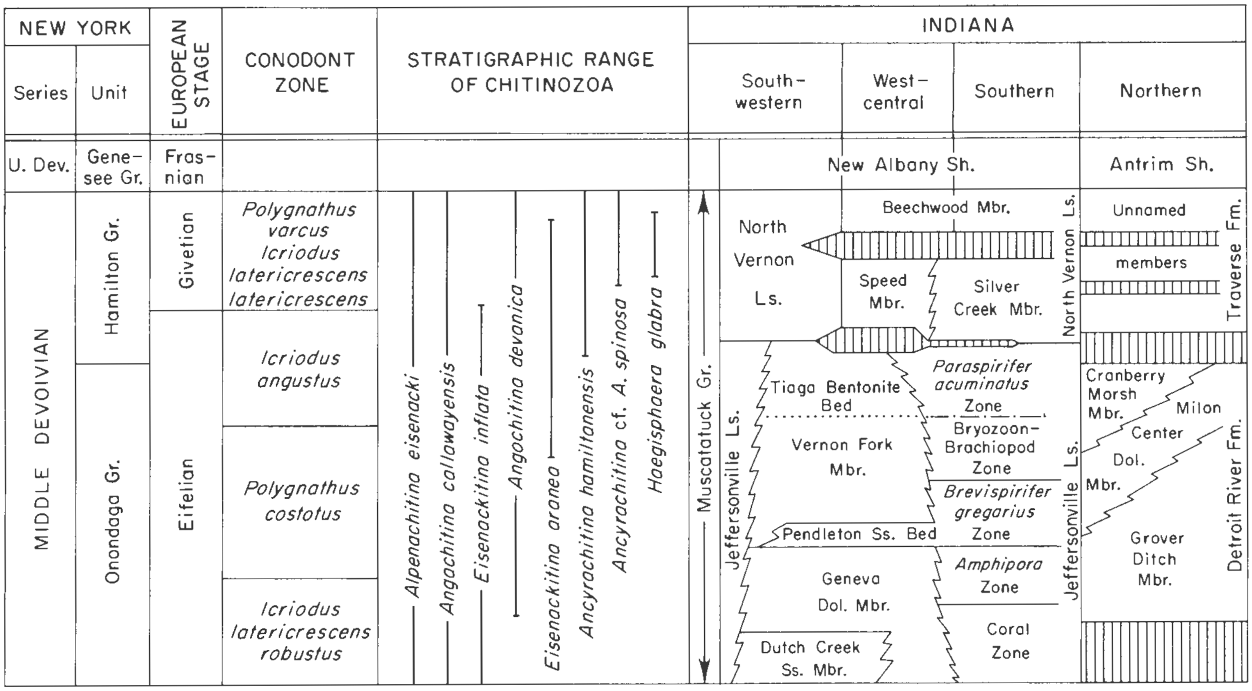

Figure 2. Chart showing correlation of Middle Devonian formations in Indiana and ranges of Chitinozoa.

rocks in those areas thicken toward the Illinois Basin to the southwest and toward the Michigan Basin to the north. The present geometry of these deposits is a result of postdepositional erosion that took place over the Kankakee and Cincinnati Arches. The original depositional framework was a broad carbonate shelf called the Wabash Platform (Droste, Shaver, and Lazor, 1975) that existed throughout much of Indiana and extended into northern Illinois and western Ohio. The platform served to separate the Michigan, Illinois, and Appalachian Basins and affected the sedimentation in Indiana during Middle Devonian time. Thus the distribution of the Muscatatuck lithofacies was controlled by the changing depositional conditions across the platform during Eifelian and Givetian time.

JEFFERSONVILLE LIMESTONE

The Jeffersonville Limestone is subdivided into a southern facies and a west-central facies. The better known southern facies includes the invertebrate faunal zones (fig. 2) on which the formation has been subdivided. But the west-central facies cannot be subdivided into the same biozones because there are few invertebrates. Instead, the Jeffersonville in this area is subdivided into distinct bodies of rock called the Geneva Dolomite Member and the Vernon Fork Member.

In general, the base of the Jeffersonville Limestone is recognized where brownish limestones unconformably overlie the lighter colored Silurian or Lower Devonian carbonate rocks. In southwestern Indiana sands of the Dutch Creek Sandstone Member form the base of the Jeffersonville. The top of the formation in southern Indiana is chosen where fossiliferous light-brown carbonate rocks of the Jeffersonville change upward into the gray fine-grained limestone of the Silver Creek Member or the gray fossiliferous Speed Member of the North Vernon Limestone. In central Indiana, the contact between the Jeffersonville and the North Vernon is where fine-grained dolomite (Vernon Fork) is overlain by coarse-grained biofragmental and fossiliferous beds (North Vernon).

The lithofacies are clearly shown at three localities of this report (appendix and pl. 1). In southeastern Indiana, grain-supported biomicrites and biosparites dominate and represent continuous deposition under normal-marine conditions. But in south-central Indiana, as in Bartholomew and Marion Counties, the rocks are dolomites. The Geneva Dolomite Member is primarily brown crystalline vuggy dolomite in which the vugs are calcite filled and record in detail the skeletal structures of corals, brachiopods, and bivalves as fossil ghosts. The overlying Vernon Fork Member is characterized by lithographic and laminated dolomite which is brecciated in many places and contains bird's-eye structures. Detailed petrographic examination by Perkins (1963) and Droste and Shaver (1975) has indicated that the dolomite includes a middle unit that is pelletoidal and granular.

NORTH VERNON LIMESTONE

The carbonate rocks of the North Vernon Limestone are mostly undolomitized, fossiliferous, and in places coarsely biofragmental. They are grain supported and have sparry calcite and carbonate mud for matrix.

The formation is mainly Givetian in age and has three members that in ascending order are the Speed, Silver Creek, and Beechwood Members. The fossiliferous medium-gray carbonate rocks of the Speed Member are readily distinguished from the overlying fine-grained conchoidally fractured Silver Creek Member. The Silver Creek thins to the north and west away from southeastern Indiana, and its stratigraphic position is taken by the thickening Speed Member. Separate members were not recognized at locality 3 in Marion County, but the fossiliferous carbonate rocks overlying the Jeffersonville at that locality probably belong to the Speed Member.

The North Vernon Limestone, unlike the underlying Jeffersonville Limestone, records normal-marine conditions over the Wabash Platform that existed when deepening water by Givetian time brought an end to the restricted water environments that are reflected by the Geneva Dolomite and Vernon Fork Members of the Jeffersonville.

DETROIT RIVER FORMATION

The petrography and stratigraphy of the Detroit River Formation have been studied in detail most recently by Doheny, Droste, and Shaver (1975). The formation has been divided into three members that in ascending order are the Grover Ditch, Milan Center Dolomite, and Cranberry Marsh Members.

The Grover Ditch Member is characterized by laminated dolomite mudstone that is sandy at its base; an example is at locality 5 in LaPorte County. The basal sandy dolomite, which overlies the Salina Formation (Silurian), grades upward into laminated and brecciated dolomite. These beds record tidal-flat conditions. In LaPorte County the Grover Ditch Member is relatively thin. It thickens northeastward and the two higher members thin, as seen at locality 4 in Allen County, where the entire Devonian section below the Traverse Formation may belong to the Grover Ditch. Where the Milan Center Dolomite Member is present, its base is recognized where the laminated dolomites of the Grover Ditch change upward to the tan porous dolomites of the Milan Center.

The lithofacies of the Milan Center Dolomite Member is primarily dolomite that has replaced oolitic, pelletoidal, and fossiliferous limestone. The resulting grainstones, packstones, and wackestones record deepening water conditions over shoals and banks. In sharp contrast to these dolomites are the gypsum and anhydrite of the next higher Cranberry Marsh Member in northernmost Indiana. The evaporites, with associated brecciated limestone and dolomite, may be thick and readily apparent as in LaPorte County, but they are not present in much of the southern extent of the member where the brecciated carbonate rocks are typical. Above the evaporites are chocolate-brown laminated lithographic limestone that along with the underlying evaporites records intertidal to sulfate-bay conditions.

The upper contact of the Detroit River Formation with the overlying Traverse Formation varies from one locality to another because of erosion which resulted in updip truncation of the Detroit River rocks. Where the Traverse lies directly on the Cranberry

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Marsh Member, the contact is between lithographic limestone below and biofragmental limestone above. Where the Traverse overlies the Grover Ditch Member, the contact is between dolomite below and coarsely biofragmental limestone above. Elsewhere in northern Indiana, where shaly and micritic rocks form the lower part of the Traverse, placing the contact becomes more difficult.

TRAVERSE FORMATION

The Traverse Formation consists primarily of limestone and dolomite and minor amounts of shale. The limestones are fossiliferous and biofragmental. The dolomite may be petroliferously stained and thinly laminated. The Traverse, like the correlative North Vernon Limestone, is Givetian in age and records open-water, normal-marine environments and the beginning of the end of carbonate deposition within the Kaskaskia Sea across the Wabash Platform. Traverse carbonate rocks are overlain by dark Antrim shale.

Chitinozoa Fauna

STRATIGRAPHIC DISTRIBUTION

Standard biostratigraphic zonations for the Middle Devonian are now fairly well established with some degree of precision. This means that the biochronology of the Chitinozoa is becoming precisely defined as their stratigraphic ranges are compared with existing biochronologic units whenever possible.

The assemblage of chitinozoans from the Muscatatuck Group of Indiana contains taxa recorded elsewhere as characteristic of the Lower and Middle Devonian. *Angochitina devonica* occurs throughout the entire section of Muscatatuck rocks. This taxon has been reported from the Lower Devonian in France (Paris, 1976), North Africa (Magliore, 1967; Taugourdeau and Jekhowsky, 1960; Taugourdeau, 1962), and Rumania (Beju, 1967) and from the Middle Devonian in North America (Boneham, 1967; Legault, 1973; Wright, 1976; Collinson and Scott, 1958; Urban, 1972) and Germany (Eisenack, 1955a and b; Pichler, 1971). *A. devonica* therefore existed from at least Siegenian through Givetian time. Its association with the first occurrence of *A. callawayensis* and *Alpenachitina eisenacki* in the midcontinent of North America is a reliable indicator of lower Eifelian rocks. *A. callawayensis* first appears in the lower part of the Jeffersonville Limestone in southeastern Indiana, which lies within the *Icriodus latericrescens robustus* Zone (Orr, 1971). *A. callawayensis* ranges upward into the Givetian as recorded from the Cedar City Formation in Missouri (Urban and Kline, 1970). Most recently, Paris (1976) reported the association of *A. devonica* and *A.* cf. *A. callawayensis* from the very upper part of the Saint-Cenere Formation in France and remarked that this may signal the beginning there of late Emsian time.

Alpenachitina eisenacki, one of the more characteristic chitinozoans in Middle Devonian strata in the midwestern United States, was first reported from the Alpena Limestone of Michigan (Dunn and Miller, 1964). It is a distinctive part of assemblages from the Cedar Valley Formation in Iowa (Urban, 1972), the Dundee Limestone in Ontario (Hill, 1975), and the middle part of the Columbus Limestone in Ohio just above the *Icriodus latericrescens huddlei* Zone (latest Emsian) and ranging up through the Delaware Limestone (Wright, 1978). Although *A. eisenacki* occurs throughout the entire Muscatatuck Group, only a few specimens occur above the Jeffersonville Limestone.

Completing the association of chitinozoans in the lower part of the Muscatatuck Group is *Eisenackitina inflata*. It first occurs near the bottom of the Jeffersonville Limestone in southeastern Indiana and in the Milan Center Dolomite Member of the Detroit River Formation in northwestern Indiana. In Ohio, this taxon is also abundant from the middle part of the Columbus Limestone (early Eifelian) through that part of the Delaware Limestone containing the youngest part of the Eifelian *Icriotus angustus* Zone (Ramsey, 1969; Wright, 1976). Wood (1974) reported it from the Silica Formation in Ohio.

The upper part of the Muscatatuck Group is characterized by *Eisenackitina aranea*, *Ancyrochitina hamiltonensis*, *A.* cf. *A. spinosa*, and *Hoegisphaera glabra*. *A. hamiltonensis* is one of the more abundant taxa within the North Vernon Limestone and the Traverse Formation; it also occurs within the Silica

Formation (Wood, 1974) and the Hamilton Formation (Legault, 1973), thereby indicating its age to be late Eifelian (*Icriodus angustus* Zone) into Givetian. *A. hamiltonensis* is associated with *A.* cf. *A. spinosa*, which first occurs in the middle part of the North Vernon Limestone. *A.* cf. *A. spinosa* is considered to represent the earliest Givetian time. A Givetian age for *A.* cf. *A. spinosa* is further supported by its presence in the Cedar City Formation of Missouri (Urban and Kline, 1970) and in the Cedar Valley Formation of Iowa (Urban, 1972).

Eisenackitina aranea occurs in large numbers in just a few samples in the Detroit River Formation and the North Vernon Limestone. It is also found from the middle part of the Columbus Limestone into the overlying Delaware Limestone in Ohio (Wright, 1978), as well as in the Silica Formation in Ohio (Wood, 1974), and in the Cedar Valley Formation in Iowa (Urban, 1972). Its range is middle Eifelian (*Polygnathus costatus* Zone) to Givetian. *Hoegisphaera glabra* in the upper part of the North Vernon Limestone as reported here, the Dundee Limestone of Ontario (Hill, 1975), the Silica Formation of Ohio (Wood, 1974), the Hamilton Formation of Ontario (Legault, 1973), the Davenport Member of the Wapsipinicon Formation of Iowa (Urban and Newport, 1973), the Cedar Valley Formation of Iowa (Urban, 1972), and the Delaware Limestone of Ohio (Wright, 1978) indicates that its range is from youngest Eifelian into Givetian rocks in the midcontinent of North America.

On the basis of material obtained during this study and information from correlative strata elsewhere in the midcontinent of North America, the stratigraphic distribution of selected chitinozoans compares quite closely with well-known conodont zones. The stratigraphic occurrence and ranges of the Chitinozoa now remain to be established within the standard North American Devonian sequence of New York.

BIOGEOGRAPHY

The broad, shallow Kaskaskia Sea covered the midwestern part of the North American craton during the Middle and Late Devonian Epochs. The distribution of the facies of the Muscatatuck Group reflects the changing nature of the depositional sites in Indiana during this time. In early Eifelian time, the Illinois Basin was set off from the Michigan and Appalachian Basins by a shallow-water carbonate platform, in part emergent, that influenced the pattern of sedimentation by establishing mud-flat and embayment areas in the Indiana region of the sea (Droste, Shaver, and Lazor, 1975). By late Eifelian time the water deepened across the platform as transgression occurred southward from the Michigan Basin (Gardner, 1974) and eastward from the Illinois Basin (Droste and Shaver, 1975). Transgression eliminated the existing mud-flat and embayment depositional sites. Open-water circulation then prevailed and normal-marine sedimentation took place on and across the preexisting Wabash Platform. The zoogeography of the Chitinozoa reflects the changing nature of the depositional conditions.

Abundant remains of ancyrochitinid, alpenachitinid, angochitinid, and eisenackitinid chitinozoans occur in the Detroit River, Traverse, Jeffersonville, and North Vernon formations in Indiana. The stratigraphic distribution of the Chitinozoa (pl. 1) is closely related to specific lithofacies, which suggests an ecologic control on their original occurrence within the Devonian sea. The exposure of Jeffersonville and North Vernon rocks at locality 1 in southeastern Indiana records a sequence of normal-marine open-water carbonates that were deposited slightly off of and away from the main area of the restrictive conditions on the Wabash Platform that existed farther north. The census shows that there was little change in either the number of different kinds or the relative abundance of chitinozoans from the bottom of the section to the top. From locality 1 to localities 2 and 3, in the direction toward the shallow lagoon to carbonate-flat environments, there is a drastic decrease in chitinozoan diversity and abundance within the Jeffersonville Limestone. The Geneva Dolomite Member and the Vernon Fork Member, which record shallow embayment and carbonate-flat conditions respectively (Droste and Shaver, 1975), record their general absence. The few chitinozoans in the

Jeffersonville at locality 2 probably reflect the transitional nature of the Geneva Dolomite and Vernon Fork Members in that area. As shallowing occurred during late Geneva deposition, this area would not have been influenced initially by the very harsh conditions of restricted water farther north on the platform. There, the depth of the water was apparently not great enough to maintain a normal-marine situation, the presence of which was apparently an ecologic requirement for the Chitinozoa.

A similar pattern of restrictive occurrence of chitinozoans exists within the Detroit River Formation in northern Indiana. At locality 5, as evidenced by specimens of eisenackitinids and angochitinids within the Milan Center Dolomite Member, free circulation must have existed even though the area was close to the sulfate-bay region, site of accumulation of the Cranberry Marsh Member. The absence of Chitinozoa from the same rock types at locality 4 in northeastern Indiana indicates that the extensive intertidal and supratidal flats in northeastern Indiana during middle and late Eifelian time (Doheny, Droste, and Shaver, 1975) were far removed from the more normal saline-water bays in northeastern Indiana. Doheny, Droste, and Shaver (1975) have shown that the least alternating environments existed in the northwestern and north-central counties of Indiana at this time and that the shallow carbonate environments alternated more rapidly in the northeastern counties. The absence of chitinozoans from the Detroit River Formation at locality 4 in northeastern Indiana would support that conclusion.

Submergence of the carbonate platform by middle Givetian time established normal-marine conditions throughout Indiana. This shift to equitable conditions is reflected in the reoccurrence of chitinozoans in the North Vernon Limestone in central and southern Indiana and in the Traverse Formation in northern Indiana. That the Wabash Platform was submerged by Givetian time and ceased to act as a marine barrier is reflected in the cosmopolitan nature of the Middle Devonian Chitinozoa assemblages of the midcontinent (Urban and Kline, 1970; Urban, 1972; Legault, 1973; Wood, 1974; Wright, 1976).

In conclusion, the nearly total restriction of chitinozoans to holomarine facies of the Muscatatuck Group implies that salinity may have been an important factor controlling their distribution. The partial restriction of chitinozoans to holomarine environments has now been established for the Silurian (Laufeld, 1975) and the Devonian (Wright, 1978). Chitinozoa can now be considered as good paleontologic indices to well-circulated water in the early and middle Paleozoic seas.

Systematic Paleontology

The figured specimens that are described and illustrated here have been deposited in the Orton Museum at The Ohio State University in Columbus, Ohio, and designated with OSU numbers. The specimens are on scanning electron microscope stubs and, as designated in the plate descriptions, are coded for example: 1-2-6, 1 = stub number, 2 = stratigraphic section locality number, 6 = sample number.

Chitinozoa, Eisenack, 1931

Genus *Alpenachitina* Dunn and Miller, 1964

Type species by original designation, *Alpenachitina eisenacki* Dunn and Miller, 1964.

Alpenachitina eisenacki
Dunn and Miller, 1964

Plate 2, figures 1-6

Description: This species has nearly straight body-chamber walls that break inward to form a distinct shoulder area. One to three rows of multibranched spines encircle the body chamber at both the basal edge and at the shoulder. Similar spines occur about the neck in the upper part of the neck near the oral end of the vesicle. The base has short branching spines.

Remarks: This species is easily recognized by the separate rows of body-chamber spines arranged horizontally around the body chamber at the shoulder and basal edge areas. In poorly preserved specimens where spines have been broken off, their original presence is indicated by attachment scars or short stubs. The type material (from the Alpena Limestone of Michigan), as well as specimens of this species from the Columbus Limestone of Ohio (Wright, 1976) and the Cedar Valley Formation of Iowa (Urban, 1972), do not have more than a single row of spines about both the base and the shoulder. The specimens illustrated here have from one to three rows of shoulder spines, which reflect the greater variability of this species than previously thought. In addition, many well-preserved specimens have small multibranched spines that cover the base of the body chamber. These spines were not mentioned in the original description of the type material.

Material: 1,973 specimens were recorded. Most are well preserved with complete vesicles and occur widely within the southern Indiana facies of the Jeffersonville Limestone, the southern and west-central facies of the North Vernon Limestone, and the Traverse Formation of northern Indiana. The dimensions (in microns) of the specimens on plate 2 are: length 153, width 54 (fig. 1); length 135, width 65 (fig. 2); length 180, width 54 (fig. 3); length 128, width 58 (fig. 4); length 180, width 45 (fig. 5); length 180, width 54 (fig. 6). Other individuals of this species have dimensions similar to the figured specimens.

Figured specimens: OSU 33661 (fig. 1), OSU 33662 (fig. 2), OSU 33663 (fig. 3), OSU 33664 (fig. 4), OSU 33665 (fig. 5), OSU 33666 (fig. 6).

Genus *Ancyrochitina* Eisenack, 1955

Type species by original designation, *Conochitina ancyrea* Eisenack, 1931.

Ancyrochitina hamiltonensis Legault, 1973

Plate 2, figures 7-9

Description: The vesicle is cylindro-conical, and the base is flat to slightly convex. The vesicle sides are straight to slightly concave. The neck is cylindrical and flares slightly in an oral direction. The basal edge is ornamented with up to eight spines that are simple or branched. The oral edge has closely spaced spines that are multibranched.

Remarks: The specimens figured here are like those described by Legault (1973) from the Hamilton Formation of southwestern Ontario and illustrated by Wood (1974) from the Silica Formation of Ohio. In both reports, the characteristic antlerlike, branching spines are around the oral flange. Most of the basal spines are broken off, but their original positions are easily seen because of attachment scars.

Material: 16,249 specimens were counted and represent one of the more abundant chitinozoans from the Devonian strata of Indiana. They occur within the Traverse Formation in northeastern Indiana, the upper part of the Jeffersonville Limestone and the North Vernon Limestone in southeastern Indiana, and the North Vernon Limestone in central Indiana. The dimensions (in microns) of the specimens on plate 2 are: length 135, width 72 (fig. 7); length 117, width 80 (fig. 8); length 120, width 63 (fig. 9). Most other individuals of this species are of a similar size.

Figured specimens: OSU 33667 (fig. 7), OSU 33668 (fig. 8), OSU 33669 (fig. 9).

Ancyrochitina cf. *A. spinosa* (Eisenack, 1932)

Plate 3, figures 1-6

Conochitina spinosa Eisenack, 1932, p. 270, pl. 12, figs. 11-13.

Ancyrochitina spinosa (Eisenack, 1932), Eisenack, 1959, p. 18, pl. 2, figs. 1, 2.

Description: The vesicle is cylindro-conical. The neck broadens slightly from the shoulder in an oral direction to the aperture. Spines cover the vesicle surface and are simple to multibranched. Short spines may be present on the slightly convex base in well-preserved specimens. The vesicle spines near the base of the chamber may be broadly based and antlerlike in shape as described by Eisenack.

Remarks: The specimens figured here are similar to those described from the Cedar City

Formation of Missouri by Urban and Kline (1970) and the Cedar Valley Formation of Iowa by Dunn (1959). Unlike the Cedar City and Cedar Valley specimens, those illustrated here show a slightly granulose surface.

Material: 880 specimens were recorded. Most of them have complete vesicles and are fairly well preserved. Specimens were found only in the North Vernon Limestone in central Indiana and in the lower part of the Antrim Shale in northwestern Indiana. The dimensions (in microns) of the specimens on plate 3 are: length 81, width 45 (fig. 1); length 144, width 64 (fig. 2); length 145, width 63 (fig. 3); length 144, width 63 (fig. 4); length 153, width 72 (fig. 5); length 149, width 72 (fig. 6).

Figured specimens: OSU 33670 (fig. 1), OSU 33671 (fig. 2), OSU 33672 (fig. 3), OSU 33673 (fig. 4), OSU 33674 (fig. 5), OSU 33675 (fig. 6).

Genus *Angochitina* Eisenack, 1931

Type species by original designation, *Angochitina echinata* Eisenack, 1931.

Angochitina callawayensis
Urban and Kline, 1970

Plate 3, figures 7-9

Description: The vesicle is cylindro-ovoid and has an indistinct flexure. The spines are simple to multibranched and are flattened in an oral-aboral plane. Spines are arranged in slightly sinuous oral-aboral rows extending from the oral end to the base of the body chamber.

Remarks: The body-chamber spines in the figured specimens of the Indiana material are not arranged in as well-defined oral-aboral rows as in the type material from the Cedar City Formation described by Urban and Kline (1970). But the shape of the vesicle and the relative proportionate length of the body chamber to neck length agree well with the type material. The overall size and shape of specimens assigned to this species are similar to those of *A. devonica* Eisenack, but the spines of *A. devonica* are more massive (pl. 4, figs. 1-3).

Material: 20 well-preserved specimens were studied. Next to *Hoegisphaera glabra* Staplin, this is the least abundant of the Chitinozoa from Devonian strata of Indiana, but they do occur in Jeffersonville, North Vernon, and Antrim rocks. The dimensions (in microns) of the specimens on plate 3 are: length 171, width 72 (fig. 7); length 153, width 63 (fig. 8); length 162, width 63 (fig. 9).

Figured specimens: OSU 33676 (fig. 7), OSU 33677 (fig. 8), OSU 33678 (fig. 9).

Angochitina devonica Eisenack, 1955

Plate 4, figures 1-3

Angochitina devonica Eisenack, 1955b, p. 318, pl. 1, figs. 10-12.
Angochitina milanensis Collinson and Scott, 1958, p. 11, 13, pl. 1, figs. 1-5, 7, 8, 19, 26.
Angochitina globosa Collinson and Scott, 1958, p. 15, pl. 1, figs. 11, 13, 22, 23, 25.
Angochitina milanensis Collinson and Scott, Dunn, 1959, p. 1011, pl. 125, figs. 17, 18, 20, 21.
Angochitina globosa Collinson and Scott, Dunn, 1959, p. 1011, pl. 125; p. 1011, 1012, pl. 126, figs. 22-25.
Angochitina cf. *A. devonica* Eisenack, Staplin, 1961, p. 419, pl. 51, figs. 1-7.

Description: The vesicle is cylindo-conical, the chamber is spherical to subspherical, and the neck is cylindrical and expands slightly in an oral direction. Ornamentation consists of thick spines that may be simple or multibranched at their tips. The spines are arranged randomly on the vesicle and are generally thinner and shorter on the neck.

Remarks: The Indiana specimens are between 171 and 207 microns long and therefore agree closely in size with those described from the Cedar Valley Formation by Collinson and Scott in 1958. *A. devonica* of the Hamilton Formation (Legault, 1973) is broader based and more varied in the thickness of the spines. The spines of *A. devonica* are larger than those of *A. callawayensis* and are not in vertical rows. *A. devonica* should not be confused with *A. implicationis* Urban of the Cedar Valley Formation of Iowa, which has small spines like *A. callawayensis* but spines that are interconnected at their bases.

Material: 2,956 specimens were recorded. Members of this species are the most ubiquitous of all the Indiana chitinozoans. Specimens occur in the Geneva Dolomite Member of the Jeffersonville Limestone, the North Vernon Limestone, the Grover Ditch and Milan Center Dolomite Members of the Detroit River Formation, and the Antrim Shale. The dimensions (in microns) of the specimens shown on plate 4 are: length 180, width 64 (fig. 1); length 207, width 81 (fig. 2); length 171, width 65 (fig. 3).

Figured specimens: OSU 33679 (fig. 1), OSU 33680 (fig. 2), OSU 33681 (fig. 3).

Genus *Hoegisphaera* Staplin, 1961, emend. Urban, 1972

Type species by original designation, *Hoegisphaera glabra* Staplin, 1961.

Hoegisphaera glabra Staplin, 1961

Plate 4, figures 7, 8

Hoegisphaera cf. *H. glabra* Staplin, 1961, Legault, 1973, p. 91, pl. 8, figs. 4-6, 8, 10.

Description: The vesicle is subspherical and wider than high, and the circular oral opening is bordered by a low rim or annulus. The aboral end of the chamber has a carina. The surface of the body chamber may be smooth or slightly spinose. The operculum is external.

Remarks: The Indiana specimens attributed to *H. glabra* are not compacted, and one is preserved with the operculum. Because the Hamilton specimens described by Legault (1973) are similar in size to the type material of Staplin (1961) and have the same type of smooth surface as those of the Cedar Valley Formation (Urban, 1972), the Wapsipinicon Formation (Urban and Newport, 1973), and the figured specimens shown here, they are considered conspecific to the rest. A slightly spinose ornamentation in some specimens should not be interpreted to be of enough specific value in the taxonomy of this species to warrant the erection of a new species at this time.

Material: The two figured specimens are the only representatives of this species that were found. They were extracted from the same sample of the North Vernon Limestone at locality 3. The dimensions (in microns) of the figured specimens on plate 4 are: diameter 90 (fig. 7); diameter 98 (fig. 8).

Figured specimens: OSU 33684 (fig. 7), OSU 33685 (fig. 8).

Genus *Eisenackitina* Jansonius, 1964

Type species by original designation, *Eisenackitina castor* Jansonius, 1964.

Eisenackitina aranea (Urban, 1972)

Plate 4, figures 4-6

Desmochitina aranea Urban, 1972, p. 20, 21, pl. 6, figs. 10-12; pl. 7, figs. 1-12; pl. 8, figs. 1-3, 8, 9.

Desmochitina aranea Urban, 1972, Wood, 1974, p. 136, pl. 9, figs. 1-3; pl. 12, fig. 1.

Eisenackitina ruthi Wood, 1974, p. 136-137, pl. 12, figs. 2-3.

Desmochitina spinosa Wood, 1974, p. 136, pl. 20, figs. 1, 2.

Desmochitina aranea Urban, 1972, Wright, 1976, p. 222, fig. 3, nos. 1-5.

Description: The vesicle is ovoid to cylindrical and has a gently convex base. The body shape may vary from relatively straight sides to convex sides whose greatest diameter is near the midway part of the chamber. The oral end has a circular aperture bordered by a short collar that may vary from being parallel to the longitudinal axis of the vesicle or flared outward. A basal callus is present and varies in prominence. The vesicle ornamentation consists of small loops, many of which are interconnected and on degradation look like short verrucae or broadly based spines. The basal callus lacks ornamentation.

Remarks: The Indiana specimens agree in vesicle shape and ornamentation with the type material from the Cedar Valley Formation of Iowa (Urban, 1972). The conical sculptural units, whose broad bases stand on multiple feet, are distinct in well-preserved specimens. *Eisenackitina ruthi* Wood and *Desmochitina spinosa* Wood are considered here to be junior synonyms of *E. aranea.* Urban (1972) has shown that degradation of the periderm would result in variations in the degree and type of ornamentation. In *D. parkerae* a complete morphologic series exists. The form of the periderm ranges from a spongy, porous structure to rugae, loops, low stubs, and a smooth vesicle wall. Variations in the degree of ornamentation of *E. aranea* also exist, as the well-preserved loops may be corroded to form short, thick spinose stubs, both occurring on the same specimen. Illustrations of *D. spinosa* (Wood, 1974, pl. 10, fig. 1b) and *E. ruthi* (Wood, 1974, pl. 12, fig. 2b) show the similarity in ornamentation to the type material of the species (Urban, 1972).

The species is reassigned to the genus *Eisenackitina.* In *Desmochitina* the vesicle shape is a variation of a sphere or an ovoid with an obvious convexity. In *E. aranea* the long length of the longitudinal axis results in the sides of the vesicle being only slightly convex to nearly straight. Also, the collar in the desmochitinids sits directly on the vesicle rather than being the extension of a neck as in *E. aranea* and *E. inflata.*

Material: 11,190 specimens were recorded. The representatives of this species are common to the North Vernon Limestone in southern and central Indiana and to the Milan Center Dolomite and Cranberry Marsh Members of the Detroit River Formation and the Traverse Formation in northwestern Indiana. Most of the specimens are well preserved and not compacted. The dimensions (in microns) of the figured specimens on plate 3 are: length 117, width 80 (fig. 5); length 135, width 81 (fig. 6).

Figured specimens: OSU 33682 (fig. 6), OSU 33683 (fig. 5).

Eisenackitina inflata (Wood, 1974)

Plate 5, figures 1-6

Conochitina inflata Wood, 1974, p. 137, pl. 15, figs. 2, 3; pl. 16, figs. 1-4.

Eisenackitina sylvaniensis Wood, 1974, p. 136, pl. 10, figs. 3, 4; pl. 11, figs. 1-3.

Conochitina inflata Wood, 1974, Wright, 1976, p. 222, fig. 5, nos. 1, 2.

Eisenackitina robusta Wright, 1976, p. 222, 223, fig. 5, nos. 3-9.

Description: The vesicle is subconical to subcylindrical and has a distinct flexure defining the shoulder. A short neck is rimmed with a narrow collar. The circular aperture has an external smooth operculum. A basal callus is present. The aboral part of the chamber expands at the basal edge. The base is slightly convex. The surface ornamentation varies from verrucate to smooth. The swollen basal edge is more heavily verrucate than the remaining chamber wall.

Remarks: Examination of 3,690 specimens of this species from Indiana and 4,768 from the Columbus and Delaware Limestones in Ohio indicates that the shape of the vesicle may vary from subconical and little expansion at the basal edge to subcylindrical and a distinct basal bulge. Most of the specimens are similar in shape to those figured on plate 5. There is also a complete transition from heavily verrucate ornamentation to smooth chamber walls. Many single specimens have both extremes (pl. 5, fig. 3). Thus individuals of this species may vary widely in vesicle shape and amount of surface sculpturing. That the verrucae, when they are present, are in patches and ridges, not the degree or intensity of their ornamentation, is what is important. *E. sylvaniensis* Wood and *E. robusta* Wright fall within the range of shape and degree of ornamentation variation of *E. inflata* (Wood, 1974) and are considered to be junior synonyms. This species is placed within the genus *Eisenackitina* because of an external operculum, because of the internal operculum of *Conochitina* (Jansonius, 1964), and because of the shoulder and short neck, which are absent from *Conochitina.*

Material: 3,690 specimens of this species were examined. Most are well preserved and not compacted. They occur in the Jeffersonville and North Vernon Limestones in southeastern Indiana and in the Grover Ditch and Milan Center Dolomite Members of the Detroit River Formation in northwestern Indiana. The dimensions (in microns) of the figured specimens on plate 5 are: length 126, width 90 (fig. 1); length 135, width 92 (fig. 3); length 153, width 108 (fig. 4); length 126, width 108 (fig. 5); length 117, width 81 (fig. 6).

Figured specimens: OSU 33686 (figs. 1, 2), OSU 33687 (fig. 3), OSU 33688 (fig. 4), OSU 33689 (fig. 5), OSU 33690 (fig. 6).

Literature Cited

Achab, Aicha
1977 - Les chitinozoaires de la zone à *Climacograptus prominens elongatus* de la Formation de Vauréal (Ordovicien superieur), Ile d'Anticosti, Quebec: Canadian Jour. Earth Sci., v. 14, p. 2193-2212.

Beju, Dan
1967 - Quelques spores, acritarches, et chitinozoaires d'âge Dévonien inférieur de la Plate-forme Moésienne (Roumanie): Rev. Palaeobotany and Palynology, v. 5, p. 39-49.

Boneham, R. F.
1967 - Hamilton (Middle Devonian) Chitinozoa from Rock Glen, Arkona, Ontario: Am. Midland Naturalist, v. 78, p. 121-125.

Collinson, Charles, and Scott, A. J.
1958 - Chitinozoa fauna of the Cedar Valley Formation: Illinois Geol. Survey Circ. 247, p. 1-34.

Cramer, F. H., and Diéz de Cramer, M. d. C. R.
1972 - Subsurface section from Portuguese Guinea dated by palynomorphs as Middle Silurian: Am. Assoc. Petroleum Geologists Bull., v. 56, p. 2271-2272.

Doheny, E. J., Droste, J. B., and Shaver, R. H.
1975 - Stratigraphy of the Detroit River Formation (Middle Devonian) of northern Indiana: Indiana Geol. Survey Bull. 53, 86 p.

Droste, J. B., and Shaver, R. H.
1975 - The Jeffersonville Limestone (Middle Devonian) of Indiana: Stratigraphy, sedimentation, and relationship to Silurian reef-bearing rocks: Am. Assoc. Petroleum Geologists Bull., v. 59, p. 393-412.

Droste, J. B., Shaver, R. H., and Lazor, J. D.
1975 - Middle Devonian paleogeography of the Wabash Platform, Indiana, Illinois, and Ohio: Geology, v. 3, p. 269-272.

Dunn, D. L.
1959 - Devonian chitinozoans from the Cedar Valley Formation in Iowa: Jour. Paleontology, v. 33, p. 1001-1017.

Dunn, D. L., and Miller, T. H.
1964 - A distinctive chitinozoan from the Alpena Limestone (Middle Devonian) of Michigan: Jour. Paleontology, v. 38, p. 725-728.

Eisenack, Alfred
1931 - Neue Mikrofossilien des baltischen Silurs. I: Palaeontology, v. 13, p. 74-118.
1932 - Neue Mikrofossilien des baltischen Silurs. II: Palaeontology, v. 14, p. 257-277.
1955a - Chitinozoen, Hystrichosphären und andere Mikrofossilien aus dem Beyrichia-Kalk: Senckenbergiana Lethaea, v. 36, p. 157-188.
1955b - Neue Chitinozoen aus dem Silur des Baltikums und dem Devon der Eifel: Senckenbergiana Lethaea, v. 36, p. 311-319.
1959 - Neotypen baltischer Silur-Chitinozoen und neur Arten: Neues Jahrb. Geologie u. Paläontologie Abh., v. 108, p. 1-20.

Gardner, W. C.
1974 - Middle Devonian stratigraphy and depositional environments in the Michigan Basin: Mich. Basin Geol. Soc. Spec. Paper 1, 138 p.

Gray, Jane, and others
1974 - Silurian trilete spores and spore tetrades from Gotland: their implication for land plant evolution: Science, v. 185, p. 260-263.

Hill, Jean
1975 - Some Chitinozoa of the Dundee Limestone, St. Marys, Ontario [unpub. B.S. thesis]: Waterloo, Western Ontario Univ.

Jansonius, Jan
1964 - Morphology and classification of some Chitinozoa: Bull. Canadian Petroleum Geology, v. 12, p. 901-918.

Legault, J. A.
1973 - Chitinozoa and Acritarcha of the Hamilton Formation (Middle Devonian), southwestern Ontario: Canada Geol. Survey Bull., v. 221, 101 p.

Laufeld, Sven
1974 - Silurian Chitinozoa from Gotland: Fossils and Strata, v. 5, p. 1-130.
1975 - Paleoecology of Silurian polychaetes and chitinozoans in a reef controlled sedimentary regime [abs.]: Geol. Soc. America Abs. with Programs, v. 7, p. 804-805.

Laufeld, Sven, and others
1975 - The boundary between the Silurian *Cyrtograptus* and *Colonus* Shales in Skane, southern Sweden: Geol. Fören. Stockholm Förh., v. 97, p. 207-222.

Magloire, Lily
1967 - Étude stratigraphique, par la palynologie, des dépôts argilo-gréseux du Silurien et du Dévonien inférieur dans la région du Grand Erg occidental (Sahara algerien): Internat. Symposium on the Devonian System, v. 2, p. 473-491.

Neville, R. S. W.
1974 - Ordovician Chitinozoa from western Newfoundland: Rev. Palaeobotany and Palynology, v. 18, p. 187-221.

Orr, R. W.
1971 - Conodonts from Middle Devonian strata of the Michigan Basin: Indiana Geol. Survey Bull. 45, 110 p.

Paris, Florentin
1976 - Les schistes et calcaires Eodévonien de Saint-Cénère (Massif Armoricain, France): Soc. Géol. et Minéral. Bretagne Mem. 19, p. 93-113.

Perkins, R. D.
1963 - Petrology of the Jeffersonville Limestone (Middle Devonian) of southeastern Indiana: Geol. Soc. America Bull., v. 74, p. 1335-1354.

Pichler, R.
1971 - Mikrofossilien aus dem Devon der südlichen Eifeler Kalkmulden: Senckenbergiana Lethaea, v. 52, p. 315-357.

Priewalder, Helga, and Schumacher, R.
1976 - Petrographisch-tektonische Untersuchungen in den Ennstaler Phylliten (Niedere Tauern, Steiermark) und deren Einstufung in das Silur durch Chitinozoen: Verh. Geol. B.-A., no. 2, p. 95-113.

Ramsey, N. J.
1969 - Conodonts from the Columbus and Delaware Limestones (Middle Devonian) of central Ohio [abs.]: Geol. Soc. America Abs. with Programs, v. 6, p. 39.

Shaver, R. H.
1974 - The Muscatatuck Group (new Middle Devonian name) in Indiana: Indiana Geol. Survey Occasional Paper 3, 7 p.

Staplin, F. L.
1961 - Reef controlled distribution of Devonian microplankton in Alberta: Palaeontology, v. 4, p. 392-424.

Taugourdeau, Philippe
1962 - Associations de chitinozoaires dans quelques sondages de la région d'Edjélé (Sahara): Rev. Micropaléontologie, v. 4, p. 229-236.

Taugourdeau, Philippe, and Jekhowsky, B.
1960 - Repartition et description des chitinozoaires Siluro-Dévoniens de quelques sondages de la C.R.E.P.S., de la C.F.P.A. et de la S.N. Répal au Sahara: Inst. Francais Pétrole Rev., v. 15, p. 1199-1260.

Urban, J. B.
1972 - A reexamination of Chitinozoa from the Cedar Valley Formation of Iowa with observations on their morphology and distribution: Bulls. Am. Paleontology, v. 63, p. 1-44.

Urban, J. B., and Kline, J. K.
1970 - Chitinozoa of the Cedar City Formation, Middle Devonian of Missouri: Jour. Paleontology, v. 44, p. 69-76.

Urban, J. B., and Newport, R. L.
1973 - Chitinozoa of the Wapsipinicon Formation (Middle Devonian) of Iowa: Micropaleontology, v. 19, p. 239-246.

Williams, D. B., and Sarjeant, W. A. S.
1967 - Organic-walled microfossils as depth and shoreline indicators: Marine Geology, v. 5, p. 389-412.

Wood, G. D.
1974 - Chitinozoa of the Silica Formation (Middle Devonian), Ohio, vesicle ornamentation and paleoecology: Michigan State Univ. Mus., Paleont. Ser., v. 1, p. 127-162.

Wright, R. P.
1976 - Occurrence, stratigraphic distribution, and abundance of Chitinozoa from the Middle Devonian Columbus Limestone of Ohio: Ohio Jour. Sci., v. 76, p. 214-224.

Wright, R. P.
1978 - Biogeography of Middle Devonian Chitinozoa of the Midwestern United States: Palinologia, Número extraordinario 1, p. 501-505.

Wright, R. P., and Felt, E. W.
1977 - Chitinozoa from the Middle Devonian Muscatatuck Group of Indiana [abs.]: Geol. Soc. America Abs. with Programs, v. 9, p. 668.

Appendix

This appendix consists of field-type lithologic descriptions of well cores and outcrop exposures. Sample numbers and the species of the Chitinozoa extracted from those samples are given.

Five stratigraphic localities were sampled. They were selected to ensure that all lithofacies of the Jeffersonville Limestone, the North Vernon Limestone, the Detroit River Formation, and the Traverse Formation were included. About 200 grams of fresh rock were taken from each collecting horizon. In all, 209 samples from five localities were treated by using standard palynologic procedures and a sieving technique described by Laufeld (1974). Fifty-gram samples were used, and the number of species and the number of specimens per 50 grams of rock were tabulated (table 1).

Table 1. Abundance of Chitinozoa in samples from localities 1, 2, 3, 4, and 5

[Figures in italics indicate locality numbers; figures in roman indicate number of specimens per 50 grams]

Sample No.	Species							
	Alpenachitina eisenacki	*Ancyrochitina* cf. *A. spinosa*	*Ancyrochitina hamiltonensis*	*Angochitina callawayensis*	*Angochitina devonica*	*Eisenackitina aranea*	*Eisenackitina inflata*	*Hoegisphaera glabra*
1	*1*-2		*1*-1		*5*-20			
2		*3*-4, *5*-21			*3*-7, *5*-37			
3		*5*-2	*3*-15	*5*-2	*3*-150, *5*-44			
4	*1*-1, *4*-1	*5*-12	*1*-5,983, *3*-18, *4*-1		*1*-253, *5*-37	*3*-156		
5	*3*-8	*3*-8	*1*-252, *4*-114		*1*-64, *3*-13	*1*-989, *3*-265		
6			*1*-2,232, *4*-1		*1*-85	*1*-1,891, *3*-1		
7		*3*-300	*1*-1,392		*3*-48	*1*-122, *3*-360		*3*-2
8	*1*-1, *3*-2	*3*-36	*1*-3,874, *3*-12	*3*-8	*1*-781, *3*-40	*1*-31, *3*-252		
9		*3*-1	*1*-864, *3*-12		*1*-220	*1*-48, *3*-44		
10			*1*-1,050		*1*-490	*3*-1		
11						*1*-192	*1*-556	
12			*1*-114				*1*-90	
13	*1*-450		*1*-36			*5*-1	*1*-24	
14	*5*-2						*1*-18	
15		*3*-441	*3*-81	*3*-78	*1*-30, *3*-15			
16	*1*-6						*1*-6	
17	*1*-6		*3*-17				*1*-132	
18	*1*-60							
19	*1*-450			*1*-250			*2*-1	
20	*1*-234		*3*-24			*3*-48	*1*-90	
21	*1*-84						*1*-300	
22	*1*-66			*1*-48			*1*-301	
23	*1*-600						*1*-138	
24				*1*-78			*1*-12	

Table 1. Abundance of Chitinozoa in samples from localities 1, 2, 3, 4, and 5—Continued

Sample No.	Species							
	Alpenachitina eisenacki	*Ancyrochitina* cf. *A. spinosa*	*Ancyrochitina hamiltonensis*	*Angochitina callawayensis*	*Angochitina devonica*	*Eisenackitina aranea*	*Eisenackitina inflata*	*Hoegisphaera glabra*
26				*1*-6				
27				*1*-1	*2*-6			
29					*2*-4			
31					*2*-26			
32					*2*-9	*5*-1		
33					*2*-9			
34					*2*-120			
35	*2*-1				*2*-27			
42					*5*-24	*5*-3,624	*5*-2,076	
43						*5*-322	*5*-3	
44					*5*-309			
45					*5*-139		*5*-1	
47					*5*-1			
48					*5*-3			
49					*5*-3		*5*-6	
50					*5*-10		*5*-18	
51					*5*-18			
52					*5*-5			
57					*5*-2			

Locality 1. Exposure in an abandoned quarry of the Sellersburg Stone Co., Sellersburg, Clark County, Ind. (SE¼W¼ Grant 20, Clark Military Survey).

Devonian System:	Sample No.	Sample footage	Unit thickness (ft)
New Albany Shale, 5.0 ft, not sampled:			
1. Shale, black, fissile, carbonaceous.			
North Vernon Limestone, 22.0 ft measured:			
2. Limestone, gray, crystalline, fossiliferous (Beechwood Member).	1	6.0	5.0 - 8.8
Chitinozoa: 3 specimens per 50 g in sample 1; sample 2 barren. *Ancyrochitina hamiltonensis*, *Alpenachitina eisenacki*.	2	8.0	
3. Limestone, gray, crystalline, fossiliferous, phosphate nodules (Silver Creek facies?); no Chitinozoa.	3	9.0	8.8 - 9.0
4. Limestone, gray, argillaceous, dolomitic, fossiliferous; conchoidal fracture (Silver Creek facies).	4 5	11.0 14.0	9.0 - 14.5
Chitinozoa: 6,237 specimens per 50 g in sample 4 and 1,306 in sample 5. *Alpenachitina eisenacki*, *Angochitina devonica*, *Ancyrochitina hamiltonensis*, *Eisenackitina aranea*.	6	15.5	14.5 - 15.5
5. Limestone, gray, crystalline, dolomitic, fossiliferous; weathers to thin chips (Speed facies?).			
Chitinozoa: 4,208 specimens per 50 g. *Angochitina devonica*, *Ancyrochitina hamiltonensis*, *Eisenackitina aranea*.			
6. Limestone, gray, argillaceous, dolomitic, fossiliferous; weathers conchoidally (Silver Creek facies).	7 8 9	16.0 18.0 21.0	15.5 - 24.6
Chitinozoa: 1,514 specimens per 50 g in sample 7; 4,686 in sample 8; 1,132 in sample 9; 1,540 in sample 10. *Ancyrochitina hamiltonensis*, *Eisenackitina aranea*, *Angochitina devonica*, *Alpenachitina eisenacki*.			
7. Limestone, gray, crystalline, argillaceous, laminated; weathers to thin chips (Speed facies).	11	25.0	24.6 - 27.0
Chitinozoa: 778 specimens per 50 g in sample 11; 214 in sample 12. *Eisenackitina inflata*, *E. aranea*, *Angochitina devonica*, *Ancyrochitina hamiltonensis*.	12	27.0	
Jeffersonville Limestone, 31.6 ft measured:	13	28.0	27.0 - 32.6
8. Limestone, tan, crystalline, massive, fossiliferous.	14 15	30.0 32.0	
Chitinozoa: 510 specimens per 50 g in sample 13; 18 in sample 14; 30 in sample 15. *Alpenachitina eisenacki*, *Angochitina devonica*, *Ancyrochitina hamiltonensis*, *Eisenackitina inflata*.			
9. Limestone, same lithology as above.	16	34.0	32.6 - 38.2
Chitinozoa: 12 specimens per 50 g in sample 16; 138 in sample 17. *Alpenachitina eisenacki*, *Eisenackitina inflata*.	17	35.5	
10. Limestone, tannish-gray, dense, fossiliferous.	18	38.2	38.2 - 40.5

	Sample No.	Sample footage	Unit thickness (ft)
Devonian System—Continued			
Jeffersonville Limestone—Continued			
Chitinozoa: 60 specimens per 50 g. *Alpenachitina eisenacki.*			
11. Limestone, medium-brown, coarsely crystalline, fossiliferous.	19	40.0	40.5 - 41.1
Chitinozoa: 700 specimens per 50 g. *Alpenachitina eisenacki, Angochitina callawayensis.*			
12. Limestone, bluish-gray to tan.	20	42.0	41.1 - 43.9
Chitinozoa: 224 specimens per 50 g. *Alpenachitina eisenacki, Eisenackitina inflata.*			
13. Limestone, brown to gray, dense to crystalline.	21	45.0	43.9 - 48.6
Chitinozoa: 384 specimens per 50 g in sample 21; 415 in sample 22. *Alpenachitina eisenacki, Eisenackitina inflata, Angochitina callawayensis.*	22	47.0	
14. Limestone, dark-brown, coral zone.	23	49.0	48.6 - 58.6
Chitinozoa: 738 specimens per 50 g in sample 23; 90 in sample 24; 6 in sample 26, 1 in sample 27. *Alpenachitina eisenacki, Eisenackitina inflata, Angochitina callawayensis.*	24 25 26 27	51.0 52.0 53.0 56.0	

Locality 2. Exposure in the Meshberger Stone, Inc., quarry, Elizabethtown, Bartholomew County, Ind. (SE¼NE¼ sec. 6, T. 8 N., R. 7 E.).

	Sample No.	Sample footage	Unit thickness (ft)
Devonian System:			
North Vernon Limestone, 2.6 ft measured:			
1. Limestone; upper 1.1 ft dark gray, dense, fossiliferous; lower 1.5 ft gray to tan, coarsely crystalline, fossiliferous (Beechwood Member). No Chitinozoa.	1 2	1.0 2.5	0 - 2.6
Jeffersonville Limestone, 75.7 ft measured:			
Vernon Fork Member:			
2. Limestone; upper 3.0 ft tan, crystalline, medium bedded, fossiliferous; lower 4.4 ft tan, fine grained, mottled; contains fossil detritus. Lenticular chert 1.0 ft from base. No Chitinozoa.	3	6.0	2.6 - 10.0
3. Limestone, tan, fine-grained, dolomitic; black shale partings occur at base and top. No Chitinozoa.	4	10.5	10.0 - 11.3
4. Limestone, gray, dense, dolomitic. No Chitinozoa.	5	12.5	11.3 - 14.9
5. Limestone, tan, dense, chalky, dolomitic. No Chitinozoa.	6	15.5	14.9 - 15.9
6. Limestone, brown, dense, crystalline; laminated in upper part. No Chitinozoa.	7	15.9	15.9 - 17.7
7. Limestone, tan, granular, porous, dolomitic; shows calcite faces; upper part brecciated. No Chitinozoa.	8	18.1	17.7 - 18.8
8. Limestone, tan, dense, dolomitic; laminated in upper part.	9	18.8	18.8 - 22.3

Devonian System—Continued Jeffersonville Limestone—Continued Vernon Fork Member—Continued	Sample No.	Sample footage	Unit thickness (ft)
Chitinozoa: 1 specimen per 50 g. *Eisenackitina inflata.*			
9. Dolomite, light-tan, nearly white when dry, chalky, soft, slightly laminated; scattered calcite crystals. No Chitinozoa.	10	23.0	22.3 - 28.7
10. Dolomite, brown, chalky, laminated. No Chitinozoa.	11	29.0	28.7 - 30.0
11. Limestone, tan, dense, laminated, dolomitic; calcite-filled vugs. No Chitinozoa.	12	31.0	30.0 - 32.2
12. Dolomite, gray, chalky, argillaceous, laminated. No Chitinozoa.	13	33.0	32.2 - 33.5
13. Limestone; upper 1.0 ft gray, finely granular, chalky; calcite crystals; lower 1.7 ft brown, dolomitic, granular; banded; calcite crystals. No Chitinozoa.	14	33.5	33.5 - 36.2
	15	34.0	
	16	36.0	
14. Limestone, light-gray, granular, dolomitic, soft, fossiliferous, fragmented. No Chitinozoa.	17	36.2	36.2 - 45.1
	18	40.0	
	19	44.0	
15. Limestone, grayish-brown, fine-grained, dolomitic, fossiliferous. No Chitinozoa.	20	47.0	45.1 - 48.4
Geneva Dolomite Member:			
16. Dolomite, brownish-gray to chocolate-brown, finely granular to saccharoidal, massive; calcite present. No Chitinozoa.	21	49.0	48.4 - 52.2
	22	52.0	
17. Dolomite, brown, granular, massive; coarsely crystalline calcite present; carbonaceous partings; fossils dolomitized.	23	52.0	52.2 - 78.3
	24	54.0	
Chitinozoa: 6 specimens per 50 g in sample 27; 4 in sample 29; 26 in sample 31; 9 in sample 32; 9 in sample 33; 120 in sample 34; 28 in sample 35. *Angochitina devonica* in samples 27, 29, 31-35; *Alpenachitina eisenacki* in sample 35.	25	56.0	
	26	58.0	
	27	60.0	
	28	62.0	
	29	64.0	
	30	66.0	
	31	68.0	
	32	70.0	
	33	72.0	
	34	74.0	
	35	77.0	

Locality 3. Log of core from Shell Oil Co. Pipeline Terminal No. 4 well, Marion County, Ind. (SW¼NE¼, 1,250 ft from south line and 575 ft from west line, sec. 13, T. 17 N., R. 2 E.).

Devonian System:	Sample No.	Sample footage	Unit thickness (ft)
North Vernon Limestone, 56 ft measured:			
1. Limestone, light-gray and grayish-tan, dense to fine-grained, earthy, argillaceous; interbeds of black to blackish-brown carbonaceous shale containing limestone pebbles; fossiliferous.	1	213	213 - 229
	2	215	
	3	217	

Devonian System—Continued North Vernon Limestone—Continued	Sample No.	Sample footage	Unit thickness (ft)
Chitinozoa: 11 specimens per 50 g in sample 2; 165 in sample 3; 174 in sample 4; 294 in sample 5; 1 in sample 6; 710 in sample 7; 350 in sample 8; 56 in sample 9. *Angochitina devonica*, *Ancyrochitina* cf. *A. spinosa*, *Eisenackitina aranea*, *Alpenachitina eisenacki*, *Hoegisphaera glabra*, *Ancyrochitina hamiltonensis*, *Angochitina callawayensis*.	4 5 6 7 8 9	219 221 223 225 227 229	
2. Limestone, bluish- to tannish-gray, fine-grained; a few carbonaceous partings.	10	231	229 - 231
Chitinozoa: 1 specimen per 50 g. *Eisenackitina aranea*.			
3. Limestone, light-tan, fine-grained to coarse-grained, fossil-fragmental, cherty; a few carbonaceous partings. No Chitinozoa.	11 12 13 14	232 233 235 237	231 - 237
4. Limestone, gray and grayish-tan, dense to coarse-grained, fossil-fragmental; dark shaly partings.	15	239	237 - 241
Chitinozoa: 615 specimens per 50 g. *Ancyrochitina* cf. *A. spinosa*, *Angochitina devonica*, *Ancyrochitina hamiltonensis*, *Angochitina callawayensis*.			
5. Limestone, light-tan; zones of fine-grained and coarse-grained material; fossil-fragmental; some zones of petroleum stains.	16 17	242 244	241 - 249
Chitinozoa: 5 specimens per 50 g in sample 17. *Ancyrochitina hamiltonensis*.	18 19	246 248	
6. Limestone, brownish-gray, dense to earthy, fine-grained; argillaceous, fossiliferous, laminated.	20 21	250 252	249 - 256
Chitinozoa: 72 specimens per 50 g in sample 20. *Eisenackitina aranea*, *Ancyrochitina hamiltonensis*.	22 23	254 256	
7. Limestone, grayish-tan and tan; tending to grade downward from fine grained to very coarse grained, the lower few feet being mostly a coarse-grained fossiliferous breccia; fossiliferous. No Chitinozoa.	24 25 26 27 28 29 30	258 260 262 264 266 268 269	256 - 269
Jeffersonville Limestone, 59 ft measured:			
Vernon Fork Member:			
8. Dolomite, light-tannish-gray, dense, earthy, argillaceous, stylolitic, brecciated. No Chitinozoa.	31 32 33	270 271 273	269 - 273
9. Dolomite, light-gray, dense, earthy, argillaceous. No Chitinozoa.	34 35 36 37	275 277 279 281	273 - 281

Devonian System—Continued Jeffersonville Limestone—Continued Vernon Fork Member—Continued	Sample No.	Sample footage	Unit thickness (ft)
10. Dolomite; shades of gray to tan; banded, laminated, brecciated zones; finely rounded quartz sand at base. No Chitinozoa.	38	283	281 - 299
	39	285	
	40	287	
	41	289	
	42	291	
	43	295	
	44	297	
	45	299	
Geneva Dolomite Member:			
11. Dolomite, tan to brown, mottled gray, fine-grained, saccharoidal, vuggy; brecciated in upper part; vugs used to delineate unit from unit below. No Chitinozoa.	46	301	299 - 309
	47	303	
	48	305	
	49	307	
	50	309	
12. Dolomite, mostly tan, fine-grained, saccharoidal; has few relict structures, including casts of brachiopod interiors. No Chitinozoa.	51	311	309 - 328
	52	313	
	53	315	
	54	317	
	55	319	
	56	321	
	57	324	
	58	326	

Locality 4. Exposure in the active May Stone & Sand, Inc., quarry, Fort Wayne, Allen County, Ind. (N½ sec. 29, T. 30 N., R. 12 E.).

Devonian System:	Sample No.	Sample footage	Unit thickness (ft)
Traverse Formation, 12.5 ft measured:			
1. Limestone, thin-bedded and flaggy, gray-tan, fine-grained, fossil-fragmental; has many black carbonaceous partings throughout; separated from the underlying Detroit River Formation by erosion surface.	1	1	0 - 12.5
	2	2	
	3	3	
	4	4	
Chitinozoa: 2 specimens per 50 g in sample 4; 114 in sample 5; 1 in sample 6. *Alpenachitina eisenacki*, *Ancyrochitina hamiltonensis*.	5	5	
	6	6	
	7	7	
	8	8	
	9	9	
	10	10	
	11	11	
Detroit River Formation, 35.0 ft measured:			
2. Dolomite, light-gray-tan, fine-grained, argillaceous, slightly sandy. No Chitinozoa.	12	13	12.5 - 17.0
	13	15	

Devonian System—Continued Detroit River Formation—Continued	Sample No.	Sample footage	Unit thickness (ft)
3. Dolomite, thinly laminated, light-tan and brown; laminae are contorted. No Chitinozoa.	14	17	17.0 - 18.6
4. Dolomite, slightly sandy, mottled light- and dark-gray and tan, fine-grained; irregular shale partings. No Chitinozoa.	15	20.5	18.6 - 22.1
5. Dolomite, thinly laminated, brown, fine-grained. No Chitinozoa.	16 17 18 19	23.0 24.0 25.0 26.0	22.1 - 26.6
6. Dolomite, sandy, gray and tan, argillaceous; irregular shale partings; undulatory bedding planes. No Chitinozoa.	20	27.0	26.6 - 27.7
7. Dolomite; in five alternating units of thinly laminated and sandy rocks like unit 6. No Chitinozoa.	21 22 23	29.0 34.0 38.0	27.7 - 39.0
8. Dolomite, sandy, nodular; interbedded with fissile shale. No Chitinozoa.	24	39.5	39.0 - 39.8
9. Dolomite, thinly laminated, brown, fine-grained. No Chitinozoa.	25 26	41.0 45.0	39.8 - 46.6
10. Dolomite, very sandy, very fine-grained; dark-gray shale partings; basal contact with underlying Silurian rocks is disconformable. No Chitinozoa.	27	47.0	46.6 - 47.5

Locality 5. Log of core from the Northern Indiana Public Service Co. Wes Worthington No. 1 well near Mill Creek, LaPorte County, Ind. (NE¼NW¼SW¼ sec. 8, T. 36 N., R. 1 W.).

Devonian System:	Sample No.	Sample footage	Unit thickness (ft)
Antrim Shale, 13.3 ft examined:			
1. Shale, mostly brownish black, carbonaceous, fossiliferous; contains brachiopod *Lingulella;* has some gray laminae and pyrite nodules.	1	327.0	325.1 - 330.4
Chitinozoa: 20 specimens per 50 g. *Angochitina devonica.*			
2. Shale, gray; becomes vermiform mottled in bottom few feet; calcareous or dolomitic.	2 3	331.0 334.0	330.4 - 338.4
Chitinozoa: 58 specimens per 50 g in sample 2; 48 in sample 3; 49 in sample 4. *Ancyrochitina* cf. *A. spinosa*, *Angochitina devonica*, *A. callawayensis.*	4	337.0	
Traverse Formation, 69.9 ft examined:			
3. Dolomite, brown and gray, argillaceous, fine-grained, but most is fine to coarse grained and vuggy and contains much sparry calcite, some in euhedral dolomite and calcite crystals; fossiliferous and bioclastic. No Chitinozoa.	5	339.0	338.4 - 340.4

Devonian System—Continued Traverse Formation—Continued	Sample No.	Sample footage	Unit thickness (ft)
4. Dolomite; as the purer part of unit 3, contains more silicified fossils and more obviously bioclastic. No Chitinozoa.	6	342.0	340.4 - 342.8
5. Dolomite, mostly medium- to coarse-grained, vuggy; distorted bedding, veins of white calcite, and petroliferous residue; shaly and finely sandy to coarsely bioclastic in lower 4 in.; sand is carbonate debris. No Chitinozoa.	7	344.0	342.8 - 344.1
6. Limestone, off-white; consists of light-gray very coarse carbonate debris in cream-colored chalk-textured calcite matrix composed of fossil material (bryozoan mats in part); has some petroliferous residue and few stylolites; fine grained near base. No Chitinozoa.	8	347.0	344.1 - 358.8
	9	350.0	
	10	353.0	
	11	357.0	
7. Limestone, white; mostly chalky material as that of unit 6, containing very little coarse matter; has 5-in. zone of unit 6 lithology. No Chitinozoa.	12	360.0	358.8 - 362.2
8. Limestone and some dolomitic limestone, greenish, gray, and brown, mostly granular, somewhat argillaceous, bioclastic, fine- to coarse-grained; has many shaly laminae that are irregular and also wrapped around other fossils (tetracorals and other debris); some is pure and fine grained; some (388 to 392 ft) is slightly glauconitic and phosphatic.	13	364.0	362.2 - 394.7
	14	368.0	
	15	372.0	
	16	376.0	
	17	380.0	
	18	384.0	
Chitinozoa: 2 specimens per 50 g in sample 14. *Eisenackitina aranea* and *Alpenachitina eisenacki.*	19	388.0	
	20	391.0	
	21	394.0	
9. Limestone, brown, medium-grained, pure; also limestone as in unit 6, gray-tan, finely bioclastic in chalkly matrix, bearing irregular coarse-grained bioclastic brown zones containing corals, brachiopods, and other fossil debris. No Chitinozoa.	22	397.0	394.7 - 408.3
	23	400.0	
	24	404.0	
	25	408.0	
Detroit River Formation, 115.5 ft examined:			
Cranberry Marsh Member:			
10. Limestone, tan and gray, lithographic and sublithographic; has black shaly irregular laminae and some fine-grained bioclastic zones, especially in bottom few feet. No Chitinozoa.	26	409.0	408.3 - 425.8
	27	413.0	
	28	417.0	
	29	421.0	
	30	425.0	
11. Limestone, gray, tan, and brown; mostly lithographic as above but contains 1- to 2-in. zones of dark shale and shaly carbonate that has irregular or inclined bedding.	31	428.0	425.8 - 432.1
	32	431.0	
Chitinozoa: 1 specimen per 50 g in sample 32. *Eisenackitina aranea.*			
12. Limestone, gypsum, and anhydrite; limestone as unit 11 but mostly as breccia and concentrated in bottom and top 2 ft and also in a shaly sulfate zone near top that has sulfate veins and other sulfate fillings; most sulfate is probably gypsum; middle few feet is coarsely crystalline gypsum. No Chitinozoa.	33	433.0	432.1 - 439.4
	34	436.0	
	35	439.0	

Devonian System—Continued Detroit River Formation—Continued Cranberry Marsh Member—Continued	Sample No.	Sample footage	Unit thickness (ft)
13. Anhydrite, blue-white, finely crystalline; bearing large crystals of gypsum and containing irregular intercalations of laminated fine-grained and lithographic limestone. No Chitinozoa.	36 37 38 39	443.0 448.0 451.0 454.0	439.4 - 454.0
14. Gypsum; much as unit 12 but having nearly pure coarsely crystalline gypsum at top and breccia and laminae of fine-grained earthy dolomite in bottom 1 ft. No Chitinozoa.	40	456.0	454.0 - 458.2
Milan Center Dolomite Member:			
15. Dolomite, tan, very fine-grained, earthy, sparsely stylolitic; has small white chalk-textured chert nodules near middle and some lamination near top.	41 42 43	459.0 464.0 468.0	458.2 - 469.1
Chitinozoa: 5,724 specimens per 50 g in sample 42; 325 in sample 43. *Angochitina devonica, Eisenackitina aranea, E. inflata.*			
16. Dolomite, brown, very fine-grained, saccharoidal, fairly pure, finely vuggy, uniform; sparse irregular black shale laminae.	44 45	472.0 476.0	469.1 - 484.3
Chitinozoa: 309 specimens per 50 g in sample 44; 140 in sample 45; 1 in sample 47. *Angochitina devonica, Eisenackitina inflata.*	46 47	480.0 484.0	
Grover Ditch Member:			
17. Dolomite, tan and brown, gray-mottled and irregularly banded, very fine-grained and earthy to saccharoidal; has common irregular shaly to stylolitic partings and some disseminated gypsum crystals and veins; has more shale and inclined bedding in bottom 2 ft.	48 49 50 51 52	486.0 490.0 493.0 497.0 500.0	484.3 - 504.6
Chitinozoa: 3 specimens per 50 g in sample 48; 9 in sample 49; 28 in sample 50; 18 in sample 51; 5 in sample 52. *Angochitina devonica, Eisenackitina inflata.*			
18. Highly clastic zone; irregular color banded and mottled; breccia that consists of cream-colored fine-grained earthy dolomite; this dolomite in irregular thin beds; gray lithographic dolomite; dark shaly carbonate in irregular partings and beds, partly around brecciated fragments; has veins and irregular pockets of gypsum. No Chitinozoa.	53 54 55 56	510.0 514.0 517.0 520.0	504.6 - 520.3
19. Dolomite, brown to gray, fine-grained to sublithographic, earthy; bottom 1 ft has fine-grained subrounded disseminated quartz grains.	57	522.0	520.3 - 523.8
Chitinozoa: 2 specimens per 50 g. *Angochitina devonica.*			

Plates 2-5

PLATE 2

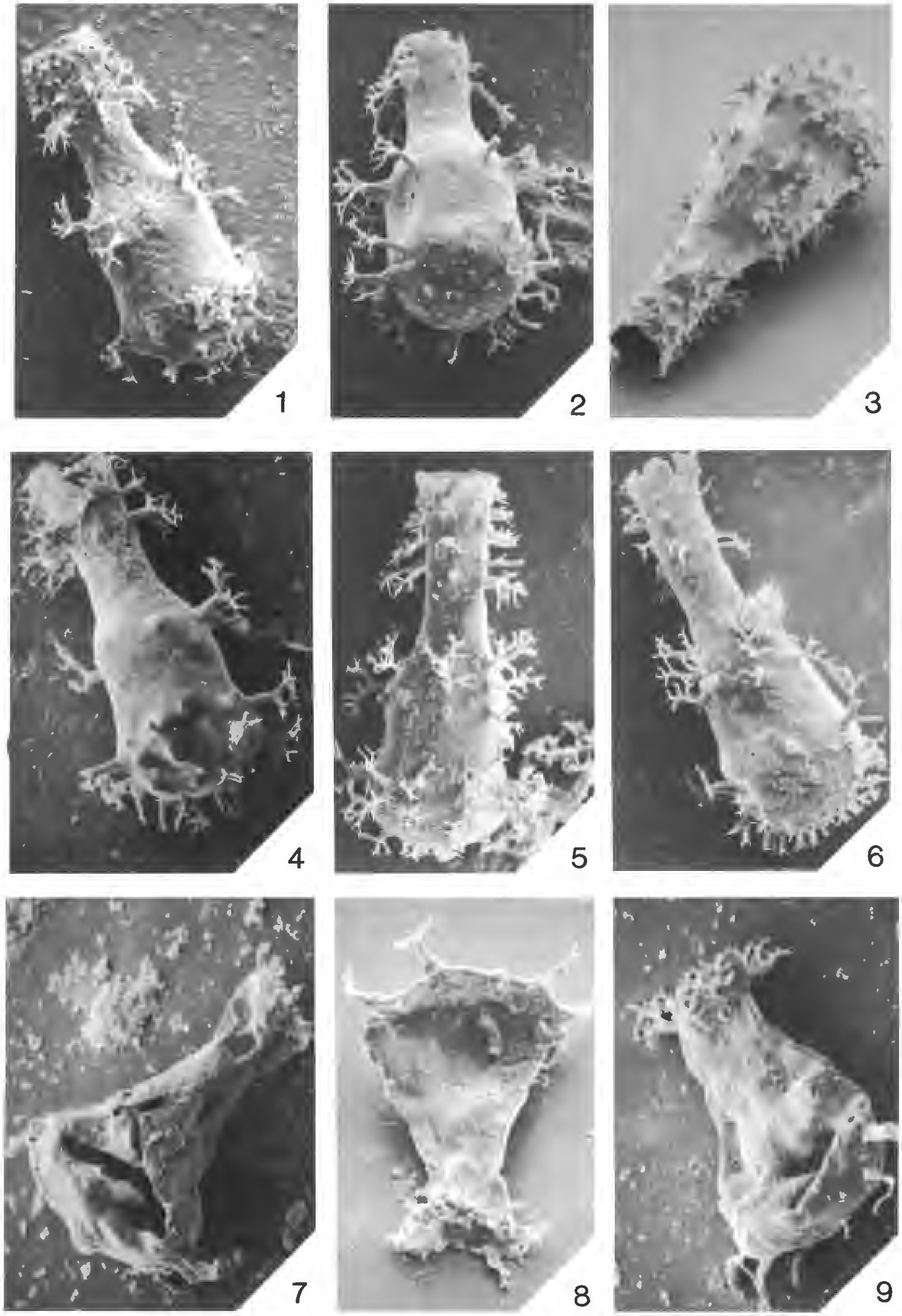
[All figures are scanning electron micrographs]

1-6 *Alpenachitina eisenacki* Dunn and Miller, 1964

1. Side view showing typical body profile, OSU 33661, × 330, 1-1-19.
2. Aboral view, OSU 33662, × 340, 1-1-19.
3. Slightly oral view showing circular aperture, OSU 33663, × 340, 2-1-19.
4. Side view showing well-developed basal spines, OSU 33664, × 340, 1-1-19.
5. Side view with well-developed neck spines, OSU 33665, × 340, 1-1-19.
6. Side view with a possible acritarch on the shoulder, OSU 33666, × 340, 1-1-19.

7-9 *Ancyrochitina hamiltonensis* Legault, 1973

7. Side view, OSU 33667, × 410, 3-1-8.
8. Side view with fairly well-preserved basal spines, OSU 33668, × 350, 3-1-8.
9. Side view showing well-preserved short spines about the oral end, OSU 33669, × 370, 3-1-8.



DEVONIAN CHITINOZOA FROM THE MUSCATATUCK GROUP

PLATE 3

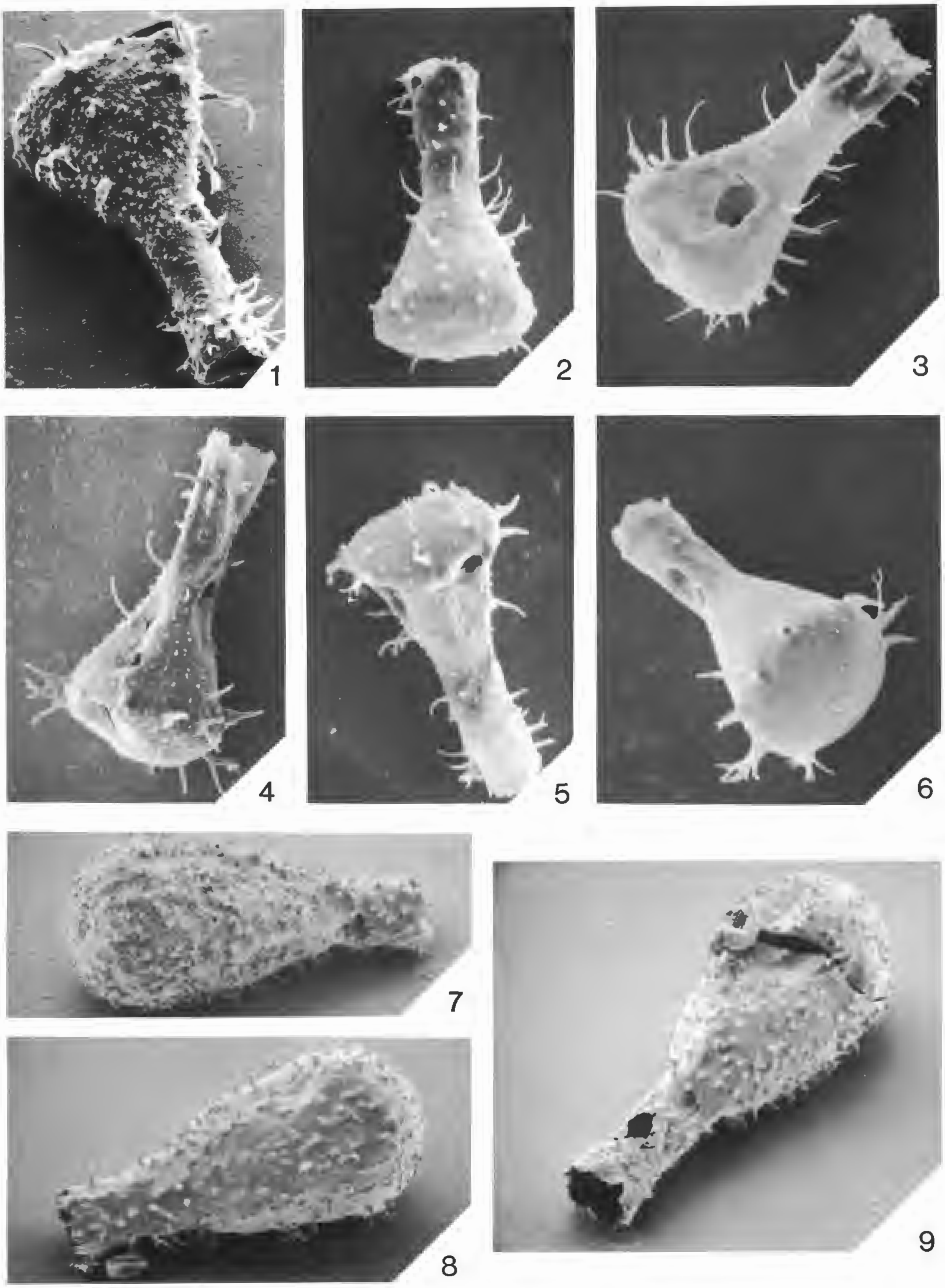
[All figures are scanning electron micrographs]

1-6 *Ancyrochitina* cf. *A. spinosa* (Eisenack, 1932)

1. Side view showing the almost granulose texture of the surface ornamentation, OSU 33670, × 330, 5-3-15.
2. Side view, OSU 33671, × 370, 4-3-15.
3. Side view. Note granulose surface texture. OSU 33672, × 370, 4-3-15.
4. Side view. Note the broadly based spines at the base of the body chamber. OSU 33673, × 320, 5-3-15.
5. Slightly aboral view showing the spines on the aboral surface, OSU 33674, × 350, 4-3-15.
6. Slightly aboral view showing the two spine stubs reflecting that the spines are hollow, OSU 33675, × 350, 4-3-15.

7-9 *Angochitina callawayensis* Urban and Kline, 1970

7. Side view showing the oral-aborally arranged surface ornamentation, OSU 33676, × 475, 2-1-19.
8. Side view showing the short vesicle spines that are simple to multibranched, OSU 33677, × 440, 2-1-19.
9. Slightly oral view. Note the oral-aboral arrangement of spines. OSU 33678, × 440, 2-1-19.



DEVONIAN CHITINOZOA FROM THE MUSCATATUCK GROUP

PLATE 4

[All figures are scanning electron micrographs]

1-3 *Angochitina devonica* Eisenack, 1955

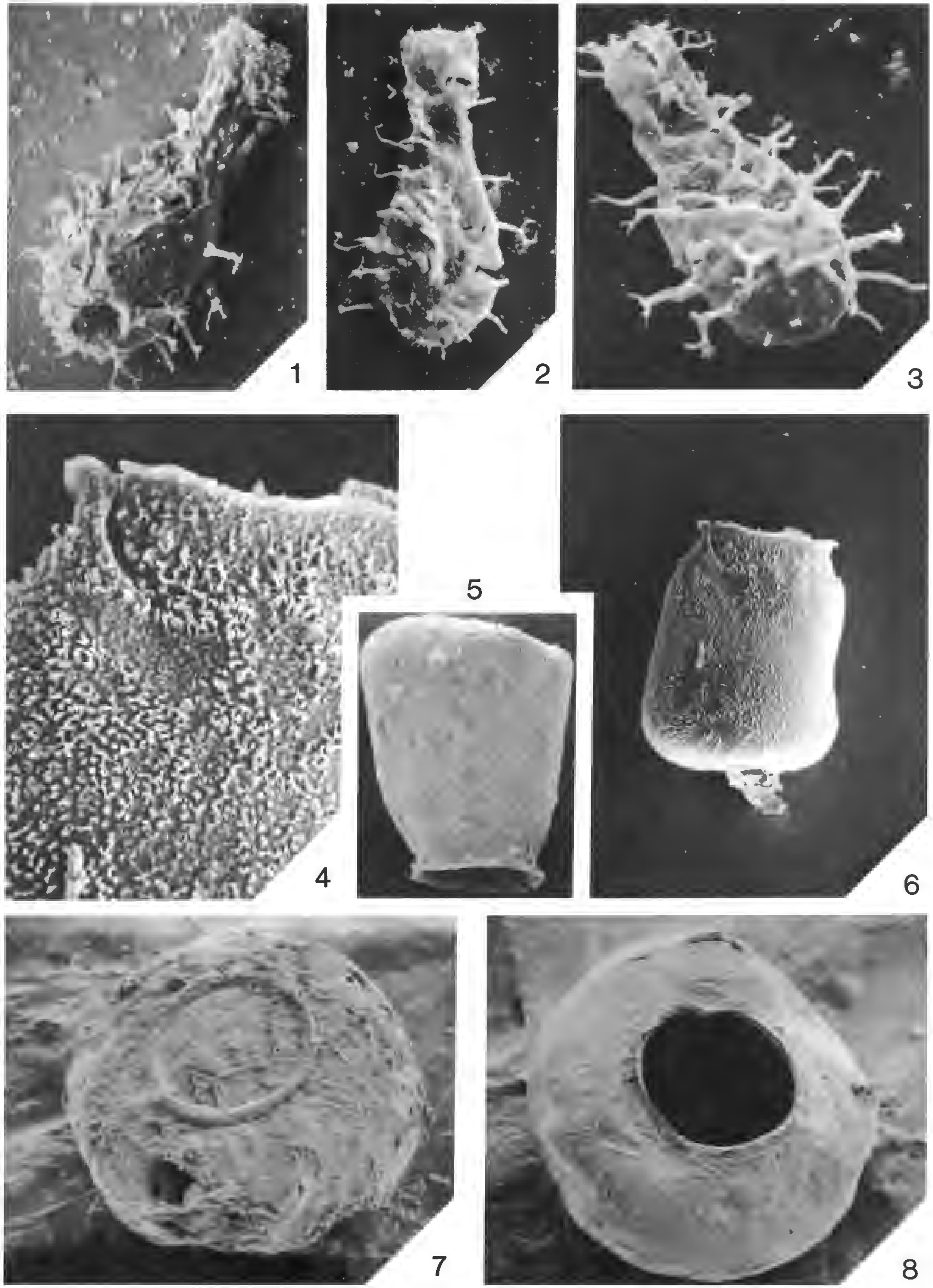
1. Note how the thick vesicle spines are randomly arranged. OSU 33679, × 300, 6-1-10.
2. Side view, OSU 33680, × 225, 6-1-10.
3. Side view showing the degree to which the vesicle spines are multibranched, OSU 33681, × 350, 6-1-10.

4-6 *Eisenackitina aranea* (Urban, 1972)

4. Closeup of specimen 6 showing the surface ornamentation arranged in patches of loops and spines having broad bases, OSU 33682, × 990, 7-3-5.
5. Note the well-developed outwardly flaring collar around the circular aperture. OSU 33683, × 370, 7-3-5.
6. Side view showing the subcylindrical shape of the vesicle, OSU 33682, × 350, 7-3-5.

7, 8 *Hoegisphaera glabra* Staplin, 1961

7. Oral view with the operculum in place, OSU 33684, × 580, 4-3-7.
8. Oral view showing the circular aperture surrounded by a low rim, OSU 33685, × 550, 4-3-7.



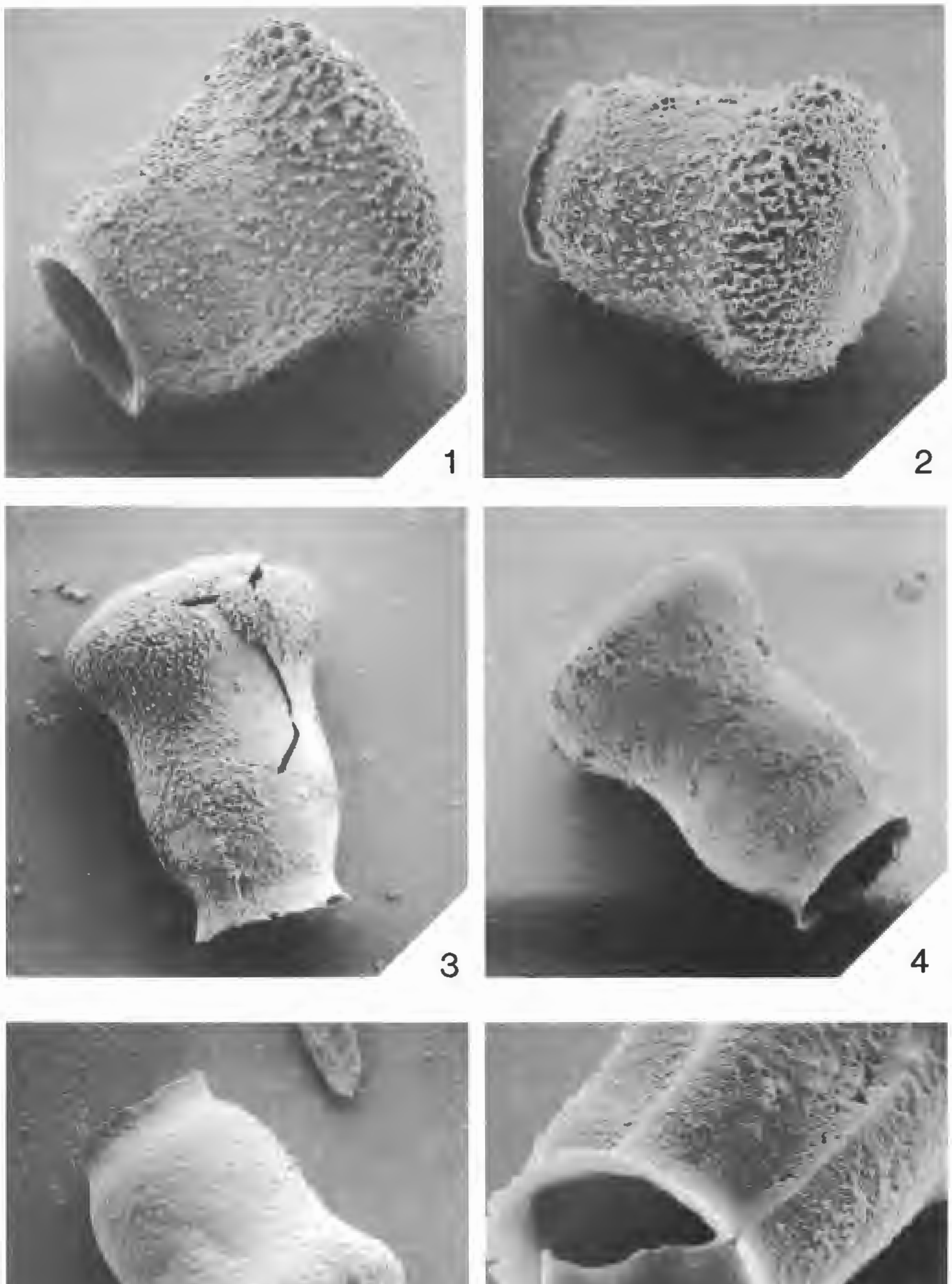
DEVONIAN CHITINOZOA FROM THE MUSCATATUCK GROUP

PLATE 5

[All figures are scanning electron micrographs]

1-6 *Eisenackitina inflata* (Wood, 1974)

1. Side view showing the circular aperture and short neck rimmed with a narrow collar, OSU 33686, × 400, 1-8-20.
2. Slightly aboral view of specimen 1 showing verrucate ornamentation most intensely developed around inflated basal edge, OSU 33686, × 370, 1-8-20.
3. Side profile. Note how this specimen has patches of verrucae as well as smooth areas. OSU 33687, × 320, 5-9-43.
4. Specimen showing the typical profile shape of this taxon, OSU 33688, × 350, 5-9-43.
5. Slightly aboral view showing the well-developed callus, OSU 33689, × 330, 1-10-20.
6. Closeup of circular aperture with part of external operculum in place, OSU 33690, × 730, 1-10-13.



DEVONIAN CHITINOZOA FROM THE MUSCATATUCK GROUP

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OVERSIZED DOCUMENT

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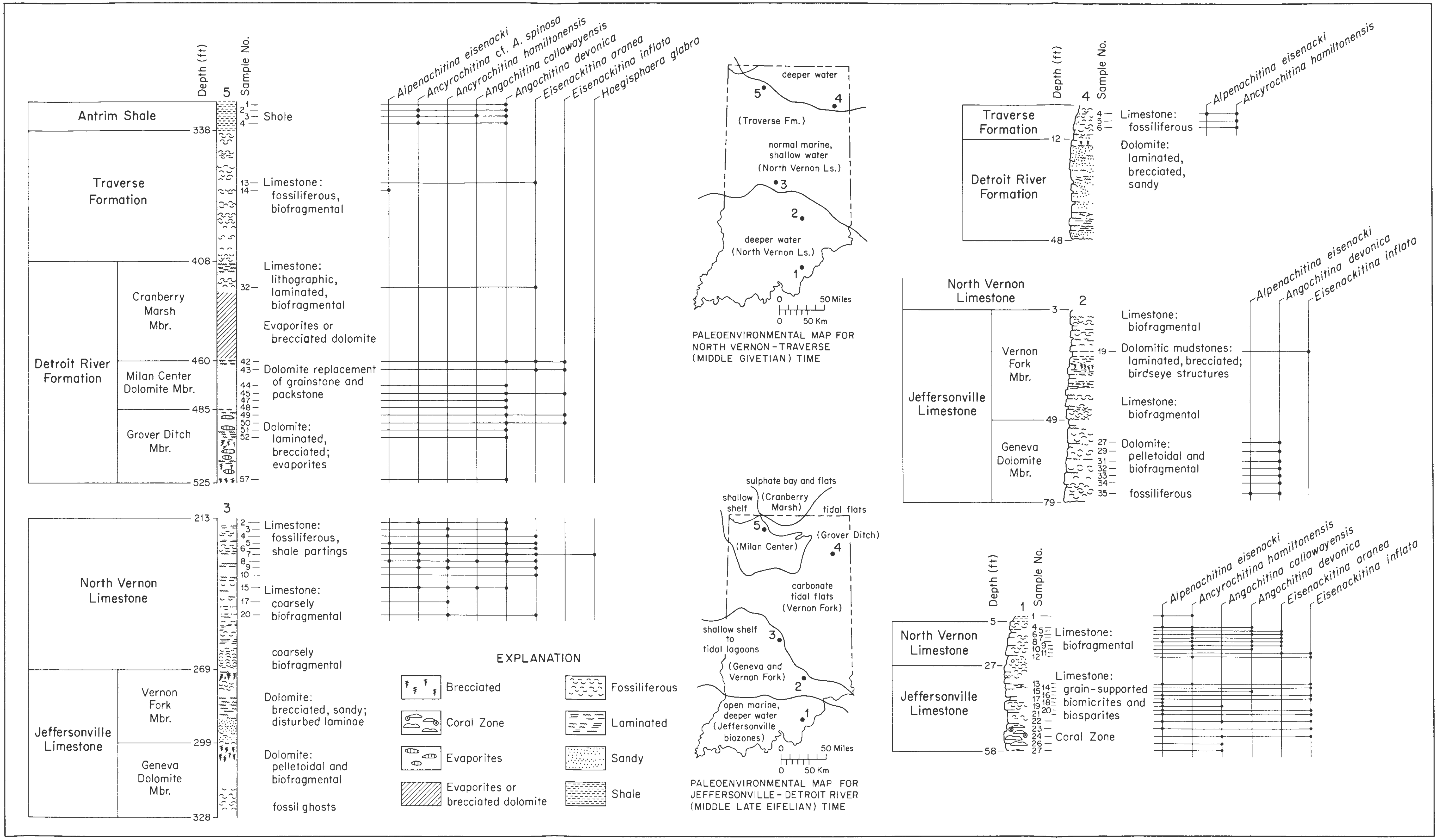

Drafted by Roger L. Purcell

STRATIGRAPHIC DISTRIBUTION OF CHITINOZOA AND DEPOSITIONAL ENVIRONMENTS DURING MIDDLE DEVONIAN TIME