Silurian Chitinozoa from Indiana I: The Mississinewa Shale Member of North-central Indiana

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Abstract

The Mississinewa Shale Member of the Wabash Formation (Upper Niagaran) contains a number of chitinozoa species. These are grouped into six genera *Ancyrochitina*, two species; *Conochitina*, four species – one new; *Cyathochitina*, one species; *Desmochitina*, two species – one new; *Lagenochitina*, one species; and *Sphaerochitina*, two species – one new. Eight localities were examined. Two were outcrops and six were from drill core. Four of the localities had chitinozoa. This is the first in a series of papers whose ultimate goal is to use chitinozoa to correlate the Silurian formations of northern and southern Indiana. Correlation of the Mississinewa Shale Member with Silurian formations in other parts of the United States is not possible due to the lack of research papers on chitinozoa. Correlation with formations in western Europe or North Africa is considered too speculative at this time.

Introduction

This report is the first in a series of studies which will attempt to gain knowledge of the Silurian chitinzoa in Indiana and some of the surrounding states. The Mississinewa Shale was chosen as the initial formation to be studied since it has a high percentage of argillaceous matter as compared to many of the other Silurian formations (10, 12). Chitinozoa have uusally been found in greatest quantities in calcareous or dolomitic shales. The Mississinewa Shale was named by Cumings and Shrock (3) from calcareous shale outcrops along the Mississinewa River near Wabash and Lagro, Indiana. The entire formation is not exposed at any one outcrop. In fact the base of the formation is only known from drill core samples. Cumings and Shrock (3) reported the total thickness of the formation to be about 250 feet. The largest single exposure of Mississinewa Shale is a roadcut on Indiana Highway 13 in south Wabash (Locality 1 of this report).

Cumings and Shrock (4) believed the Mississinewa Shale contained faunas of both late Rochester and early Lockport time. Shaver (14) summed up earlier work on the fossils of the Mississinewa Shale. He pointed out that earlier authors have considered the Mississinewa Shale to be of Rochester age, Lockport age, or transitional between the two ages since fossils of both ages have been reported from the formation. Shaver (14) believes that the fossils favor a Lockport age. Pinsak and Shaver (13) proposed that the Mississinewa Shale and the overlying Liston Creek Limestone be given member status in the newly proposed Wabash Formation. Also, that the Huntington Dolomite be abandoned since they believe it represents, for the most part, facies of the Mississinewa or Liston Creek Members. They further proposed that the term Huntington Lithofacies (no stratigraphic rank) be applied ". . . to any large body of reef rock and reeflike rock within the Wabash Formation."

<table>
<tr><th>Series</th><th colspan="2">Rock-Unit</th></tr>
<tr><td rowspan="2">Cayugan</td><td rowspan="2">Salina Formation</td><td>Kenneth Limestone Member</td></tr>
<tr><td>Kokomo Limestone Member</td></tr>
<tr><td rowspan="6">Niagaran</td><td rowspan="2">Wabash Formation</td><td>Liston Creek Limestone Member</td></tr>
<tr><td>Mississinewa Shale Member</td></tr>
<tr><td colspan="2">Louisville Limestone</td></tr>
<tr><td colspan="2">Waldron Formation</td></tr>
<tr><td rowspan="2">Salamonie Dolomite</td><td>Laurel Member</td></tr>
<tr><td>Osgood Member</td></tr>
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FIGURE 1. *Stratigraphic column of Silurian formations in central Indiana. Modified from Shaver* et al. *(15).*

Localities

1) Exposure in road cut of Indiana Highway 13 in the city of Wabash, Wabash County. SW ¼, Sec. 14, T27N, R6E. Approximately 50 feet of Mississinewa Shale Member, a light gray, dolomitic siltstone with 4 reddish-brown bands of argillaceous material varying in width from 0.5 to 2 inches. These less dolomitic layers contain all the chitinozoa specimens found at the outcrop. Approximately 5 feet of the Liston Creek Limestone Member is on top of and conformable with the Mississinewa Shale Member. Pinsak and Shaver (13) give a detailed section.

2) Railroad cut just northeast of the Big Four Railroad Station in the city of Wabash, Wabash County. SW ¼, Sec. 1, T27N, R6E. This is the site of the Wabash Reef of Cumings and Shrock (3). There is approximately 30 feet of Mississinewa Shale Member north of the reef structure. As at Locality 1 the rock is a light gray, dolomitic siltstone. Three reddish-brown bands of argillaceous material are present in the outcrop.

3) Indiana Geological Survey drill hole 169, just west of Wabash, Wabash County. SE ¼, Sec. 16, T27N, R6E. Mississinewa Shale Member 124 feet thick.

4) Indiana Geological Survey drill hole 25, near Sweetser, Grant County. NW ¼, NW ¼, Sec. 2, T24N, R6E. Mississinewa Shale Member 110 feet thick. Shaver and others (14) give a complete core description.

5) Indiana Geological Survey drill hole 72, Markland Avenue Quarry, Kokomo, Howard County. SW ¼, Sec. 36, T24N, R3E.

Mississinewa Shale Member 114.5 feet thick. Pinsak and Shaver (13) give a complete core description.

6) Indiana Geological Survey drill hole 41 near Groomville, Tipton County. NW ¼, NE ¼, SE¼, Sec. 17, T22N, R3E. Mississinewa Shale Member 102 feet thick. Pinsak and Shaver (13) give a complete core description.

7) Indiana Geological Survey drill hole 35, Indiana State Fair Grounds, Indianapolis, Marion County. NE ¼, NW ¼, SW ¼, Sec. 18, T16N, R4E. Mississinewa Shale Member 24 feet thick. Mound (11) gives a complete core description.

8) Indiana Geological Survey drill hole 11, near Westland, Hancock County. NE ¼, SE ¼, Sec. 28, T15N, R8E. Mississinewa Shale Member 8.5 feet thick. Pinsak and Shaver (13) give a complete core description.

Chitinozoa

Chitinozoa are a group of acid resistant microfossils whose systematic relationships are yet to be determined. Eisenack first described these fossils from glacial boulders which he found in the Baltic region of Germany (5, 6, 7, 8). Relatively few workers, other than Eisenack, wrote papers on chitinozoa for the next 20 years after their initial discovery. During the 1950's oil company geologists and other biostratigraphers found that many chitinozoan species were useful stratigraphic markers. Over the last 20 years numerous papers have been published on chitinozoa. The CIMP (2) has done an excellent job of cataloging all publications on chitinozoa through 1965.

Although there is still much debate over the systematic position of chitinozoa, their morphology is relatively well known. They occur in marine rocks ranging in age from Ordovician through Devonian. Their size range is from 50-1000μ but the majority of species have a size range somewhere between 100-300μ. Chitinozoa have a worldwide distribution since they have been reported from all the continents with the exception of Antarctica. Their classification is an artificial one based on the morphological characters of the vesicle. The vesicle shapes are diverse ranging from flask-, cylinder-, and spherical-shaped with many variations of these basic forms. The outer wall of the vesicle may be smooth or have various types of ornamentation ranging from small wart-like protuberances to long spines which may or may not branch. Some species are composed of single individuals while others have chains of connected vesicles sometimes containing as many as 12 or more individual vesicles. There is evidence that a few species may have two different growth forms (17).

Sampling and Processing Procedures

Each layer of reddish-brown, argillaceous dolomite was sampled in both outcrop and core sections. Otherwise, the outcrops were sampled at 1 m intervals and the cores at 2 m intervals.

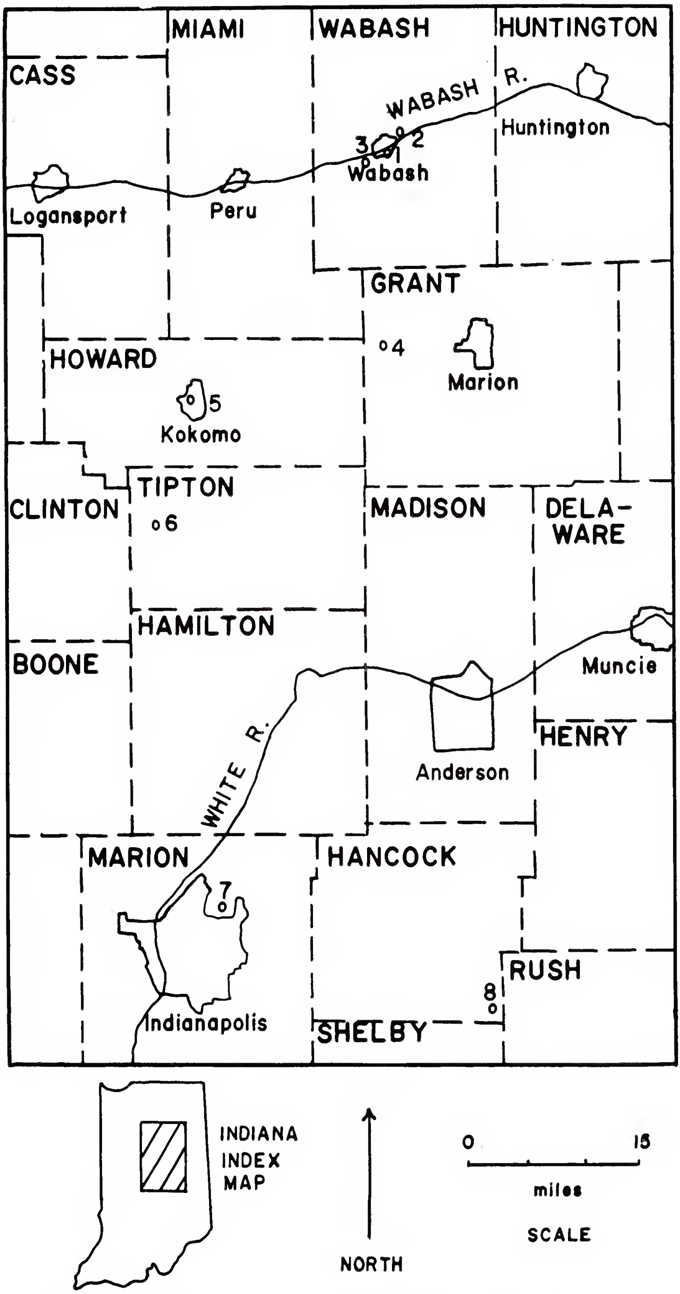

FIGURE 2. *Map of north-central Indiana with the collection localities.*

The field samples were processed by dissolving them in dilute hydrochloric acid. The chitinozoa were picked from the argillaceous residue with a small diameter pipette and mounted in glycerine jelly.

TABLE 1. *Distribution of chitinozoa in the Mississinewa Shale, Salina Formation and Waldron Shale. Localities 1, 2, 3 and 7 are in the Mississinewa Shale, locality 8 is in the Waldron Formation and locality 5 in the Salina Formation. Sixty individuals were counted from each sample. The following designation was used: Rare, 1-5 specimens; Frequent, 6-10 specimens; Common, 11 + specimens.*

	Locality						
Species	1 (30)[1]	2 (20)	3 (90)	7 (58)	7 (59)	8 (110)	5 (55)
Ancyrochitina ancyrea	C	C	C	C	C	R	
A. fragilis	R	R	R	C	C		
Conochitina dactylus	C	R				C	
C. seriola	R	R			R		R
C. cf. C. simplex	R	R	R			R	
C. cf. C. edjelensis elongata	R	R					
? *Cyathochitina* sp.	R	R			R		
Desmochitina sphaerica	R	R					
D. magna	R	R				R	C
Lagenochitina cylindrica	R	F				C	
Sphaerochitina sphaerocephala	R		F	F	R		
S. lacrimula	R	R	R	C			

[1] Numbers in parenthesis represent depth of member in feet.

Results

Table 1 indicates that the outcrops (Localities 1 and 2) contain the widest variety of chitinozoa species. All of the chitinozoa are located in the reddish-brown bands of shaly material. These bands are undoubtedly accentuated by the weathering process. It may be that the color of these bands is caused by oxidation of glauconite but this is only speculation at this time. Similar reddish-brown bands were located in the core samples. These bands were very difficult to find in the cores since they had not been subjected to aerial weathering.

It is obvious from Table 1 that Localities 1 and 2 correlate with each other. They also provide good reference sections since they have a relatively large number of species. The core samples had fewer individuals and were much less sasitfactory. In future papers we plan to include more outcrop sections and fewer cores.

The cores which contained Mississinewa chitinozoa were from Localities 3 and 7. An abundance of *Ancyrochitina ancyrea* appears to be characteristic of the Mississinewa Shale. To a lesser extent the presence of *Ancyrochitina fragilis*, *Conochitina* cf. *C. simplex*, *Sphaerochitina lacrimula*, and *S. sphaerocephala* are indicators of the Mississinewa Shale Member. The Mississinewa samples from Localities 4, 5, 6, and 8 had no chitinozoa.

As a test of our theory that chitinozoa could be used to aid in correlation of Indiana Silurian formations, we processed a few samples from cores which had no Mississinewa chitinozoa. We found chitinozoa at Locality 5 from the Salina Formation which is above the Mississinewa and at Locality 8 from the Waldron Shale which is below the Mississinewa. Esarey and Bieberman (9) believed the Mississinewa and Waldron were the same formation while others (13, 14, 15) believe they are separate formations of differing ages. The very reduced fauna of the Salina Formation at Locality 5 is certainly distinct from that of the Mississinewa. The fauna found in the Waldron Shale is less clearly separated from the Mississinewa. In a future paper we plan to do a detailed study of the Waldron chitinozoa.

The CIMP (2) has given the age ranges of all chitinozoa species reported through 1965. The age range of each of our positively identified species follows:

Ancyrochitina ancyrea Silurian—Lower Devonian

A. fragilis Silurian—Lower Devonian

Conochitina dactylus Middle Silurian

Desmochitina sphaerica Middle—Upper Silurian

Lagenochitina cylindrica Middle Ordovician—Middle Silurian

Sphaerochitina sphaerocephala Middle Silurian—Lower Devonian

Since there is little doubt that the Mississinewa Shale is Middle Silurian in age, as determined by the macrofossils, our findings indicate that the chitinozoa may also be used as age indicators in the Indiana Silurian. With one exception *(Conochitina dactylus)* the species listed above are mainly reported from Europe or North Africa. Thus there is an indication that the Indiana Silurian rocks may contain zonations of chitinozoa which might closely match those of Europe and especially North Africa where such zonations have been proven (16).

Conclusions

The Mississinewa Shale Member of the Wabash Formation contains a fairly diverse assemblage of chitinozoa species. Many of the individual species have been reported from Silurian formations. Unfortunately most of the papers have dealt with formations in Europe or North Africa. There is evidence to support the tentative conclusion that the Silurian chitinozoa from Indiana may be found in stratigraphic zonations which resemble similar zonations in North Africa.

Systematic Descriptions

Order Chitinozoa Eisenack 1931
Family Sphaerochitinidae Jansonius 1964
Genus *Ancyrochitina* Eisenack 1955

Ancyrochitina ancyrea (Eisenack 1931) Eisenack 1955 Fig. 3, Illus. 1-3

Conochitina ancyrea Eisenack 1931, p. 88-89, Pl. 2, figs. 8-11, Pl. 4, fig. 4.

Conochitina metancyrea Eisenack 1934, p. 64, Pl. 4, figs 22-25.

Conochitina protancyrea Eisenack 1937, p. 224, Pl. 15, figs. 16-20.

Ancyrochitina ancyrea Eisenack 1955, p. 163, Pl. 2, figs. 7-15.

Remarks: Our specimens usually have less than six basal spines. However, in all other details they agree with Eisenack's (5) original dscription. Some of the specimens also have two well developed, unbranched spines on the upper portion of the neck.

Occurrence: Lower Silurian through Lower Devonian. Midcontinent North America, North Africa and Baltic Region of Germany.

Ancyrochitina fragilis Eisenack 1955 Fig. 3, Illus. 4.

Ancyrochitina fragilis Eisenack 1955, p. 175, Pl. 2, figs. 1-6.

Remarks: The Mississinewa specimens bear a close resemblance in outline to *A. fragilis regularis* Taugourdeau and de Jekhowsky 1960. However our specimens are somewhat smaller and *A. fragilis regularis* has been reported (16) from Lower Devonian rocks. Our specimens may be a new subspecies but we prefer not to propose a new name until we have better material.

Occurrence: Lower Silurian to Lower Devonian (Gedinnien). Midcontinent North America, North Africa and Baltic Region of Germany.

Genus *Sphaerochitina* Eisenack 1955

Sphaerochitina sphaerocephala (Eisenack 1932) Eisenack 1955, Fig. 3, Illus. 5.

Lagenochitina sphaerocephala Eisenack 1932, p. 271-272, Pl. 12, figs. 14-15.

Sphaerochitina sphaerocephala Eisenack 1955, p. 162, Pl. 1, figs. 5-6.

Remarks: Our specimens are approximately 20-30μ smaller than the type specimen, otherwise they are the same.

Occurrence: Middle Silurian through Upper Devonian. Midcontinent North America, North Africa and Baltic Region of Germany.

Sphaerochitina lacrimula sp. n. Fig. 3, Illus. 6.

Diagnosis: Vesicle body ball-shaped. Neck conical to subcylindrical. Collar widened and occasionally slightly fringed. Surface smooth. Length 95-110μ. Length: Width approximately 1.4:1. Holotype (Illus. 6) dimensions 98μ $\times$ 70μ.

Etymology: From the Latin diminutive meaning little teardrop.

Remarks: This species somewhat resembles *S. brevispinosa* Grignani and Mantovani 1964. However *S. lacrimula* has a smooth surface and the body is more spherical than *S. brevispinosa*.

Occurrence: Middle Silurian of Indiana.

Family Conochitinidae Eisenack 1931

Genus *Conochitina* (Eisenack 1931) emend. Eisenack 1955

Conochitina dactylus Collinson and Schwalb 1955 Fig. 3, Illus. 8.

Conochitina dactylus Collinson and Schwalb 1955, p. 24, Pl. 2, figs. 16-19.

Remarks: Our specimens average about 350μ in length. This is approximately 100μ smaller than the holotype. However, *C. dactylus* has been reported from the interreef facies of the Niagaran Racine Formation in northeastern Illinois (1). Since the lithology and age of the Mississinewa are so similar to the Racine we have assigned our specimens to this species regardless of their somewhat smaller size.

Occurrence: Middle Silurian (Niagaran) of Illinois.

Conochitina cf. *C. edjelensis elongata* Taugourdeau 1963 Fig. 3, Illus. 9.

Conochitina edjelensis elongata Taugourdeau 1963, p. 138, Pl. 3, figs. 59-66.

Remarks: These specimens are rare in our samples. Their outline and size resemble *C. edjelensis elongata*. However the Mississinewa specimens are approximately 30μ larger than the holotype. Since there are so few individuals we cannot be certain of their specific identity.

Occurrence: Lower Silurian (Upper Llandovery) to Middle Silurian (Lower Wenlock) of North Africa.

Conochitina cf. *C. simplex* Eisenack 1931 Fig. 3, Illus. 10.

Conochitina simplex Eisenack 1931, p. 89-90, Pl. 2, Figs. 15-16.

Remarks: There are very few specimens of this type in our samples. None of the individuals is in good condition so our identification must be regarded as tentative.

Occurrence: Lower Ordovician (Arenig) through Lower Silurian of North Africa and the Baltic Region of Germany.

Conochitina seriola sp. n. Fig. 3, Illus. 11.

Diagnosis: Conical-shaped body blending into a very short conical-shaped neck. A very small, slightly flaired collar. Base convex. Surface smooth. Length 75-120μ. Length: Width 1.0-1.4:1. Holotype (Illus. 11) dimensions 115μ $\times$ 80μ.

Etymology: From the Latin diminutive meaning little jar.

Remarks: This species resembles *C. parvicolla* Taugourdeau 1965 in general outline. However *C. seriola* does not have the small verrucae and is somewhat smaller on the average than *C. parvicolla.*

Occurrence: Middle Silurian of Indiana.

Genus *Cyathochitina* Eisenack 1955

? *Cyathochitina* sp. Fig. 3, Illus. 7

Diagnosis: Conical-shaped vesicle. Body and neck blend together with no distinct shoulder. Base flattened or slightly convex. Surface smooth. Length approximately 150μ. Length: Width approximately 1.5-1.

Remarks: These specimens are rare in our samples. They resemble *Cyathochitina hymenophora* Taugourdeau 1961 in general outline except they do not have a distinct shoulder and are smaller. They more closely resemble *Cyathochitina* ? sp. of Taugourdeau and de Jekhowsky (16). The presence of a keel is not confirmed in our specimens and it may be that they belong in the genus *Conochitina.* Until we have more specimens we prefer to assign our specimens questionably to *Cyathochitina.*

Genus Lagenochitina Eisenack 1931

Lagenochitina cylindrica Eisenack 1931 Fig. 3, Illus. 13.

Lagenochitina cylindrica Eisenack 1931, p. 81-82, Pl. 2, Figs. 18-19.

Remarks: Our specimens are approximately 50μ smaller than the holotype of *L. cylindrica.* They are within the size range of *L. baltica* Eisenack 1931. However, the generally parallel sides of the body most closely resemble Eisenack's (5) description of *L. cylindrica* rather than *L. baltica.*

Occurrence: Middle Ordovician through Middle Silurian of North Africa and the Baltic Region of Germany.

Family Desmochitinidae (Eisenack 1931) Eisenack 1962

Genus *Desmochitina* (Eisenack 1931) emend. Eisenack 1962

Desmochitina sphaerica Taugourdeau and de Jekhowsky 1960 Fig. 3, Illus. 12.

Desmochitina sphaerica Taugourdeau and de Jekhowsky 1960, p. 1227, Pl. 7, Fig. 103.

Remarks: These specimens always occur attached in chains of two vesicles in the Mississinewa samples.

Occurrence: Middle through Upper Silurian of North Africa.

Desmochitina magna sp. n. Fig. 3, Illus. 14

Diagnosis: Vesicle jug-shaped. Greatest diameter approximately one-half way up vesicle. Body gradually merges with simple collar. No neck or shoulder. Basal area usually convex occasionally flattened. Copula usually present not always conspicuous. Surface smooth. Length 210-320μ, Length: Width approximately 1.5:1. Holotype (Illus. 14) dimensions 340μ $\times$ 230μ.

Etymology: From Latin meaning large.

Remarks: This species is most common in the Salina Formation which overlies the Mississinewa. In general outline *D. magna* most closely resembles *D. urna* Eisenack 1934. However it is considerably larger than *D. urna.*

Occurrence: Middle Silurian of Indiana.

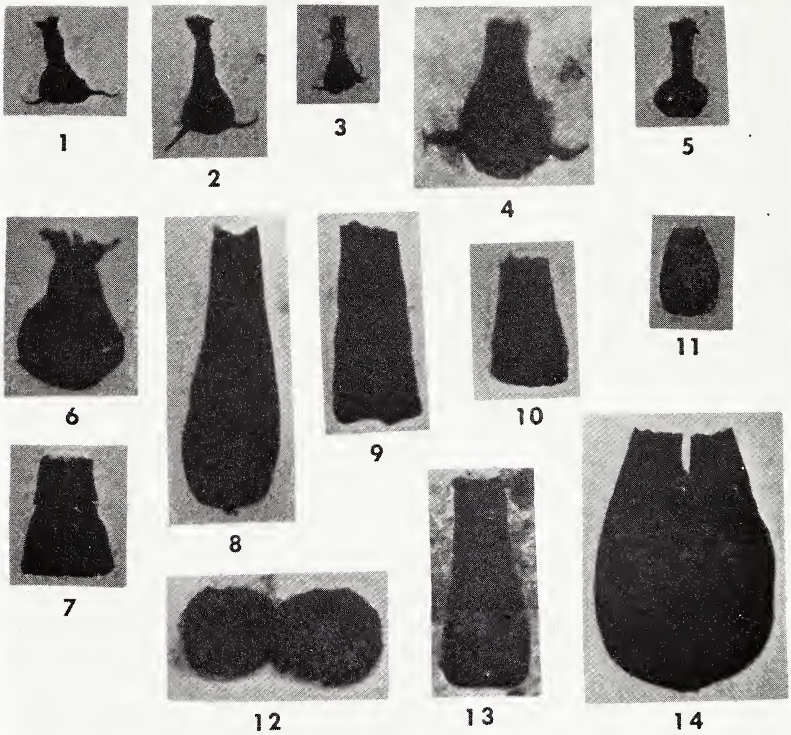

FIGURE 3. *1)* Ancyrochitina ancyrea, *115μ × 60μ, IU 12136J32/3; 2)* A. ancyrea, *155μ × 70μ, IU 12137F36/3; 3)* A. ancyrea, *×50, 190μ × 85μ, IU 12138R18/0; 4)* A. fragilis, *×200, 105μ × 60μ, IU 12139T36/1; 5)* Sphaerochitina sphaerocephala, *125μ × 70μ, IU 12140J18/2; 6)* S. lacrimula, *holotype, ×200, 98μ × 70μ, IU 12141F17/0; 7) ?* Cyathochitina *sp., 150μ × 120μ, IU 12142T26/1; 8)* Conochitina dactylus, *360μ × 120μ, IU 12143U45/0; 9)* C. cf. C. edjelensis elongata, *260μ × 105μ, IU 12144J49/3; 10)* C. cf. C. simplex, *170μ × 95μ, IU 12145Q35/0; 11)* C. seriola, *holotype, 115μ × 80μ, IU 12146U23/1; 12)* Desmochitina sphaerica, *×200, 130μ × 60μ, IU 12147X46/3; 13)* Lagenochitina cylindrica, *175μ × 110μ, IU 12148P28/0; 14)* Desmochitina magna, *holotype, 340μ × 230μ, IU 12149Y29/0. (Magnifications are ×100 unless otherwise specified. All slides are deposited with the Department of Geology, Indiana University, Bloomington. Individual figures are located on a given slide using an England Finder Slide.)*

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