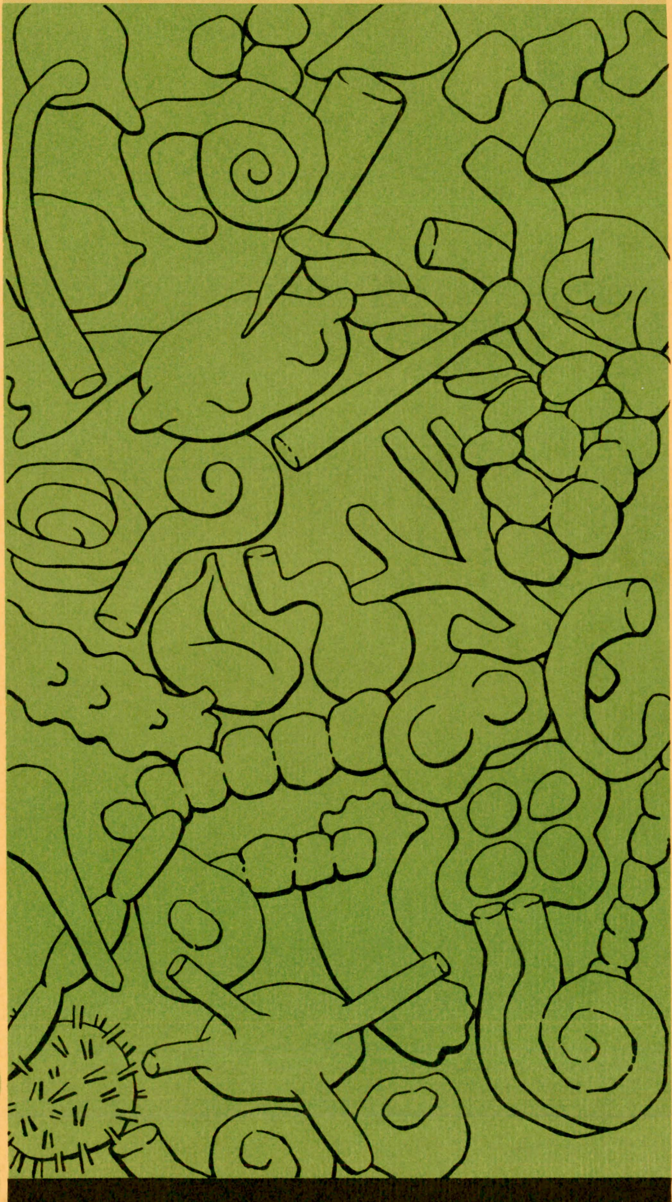
Arenaceous Foraminiferida and Zonation of the Silurian Rocks of Northern Indiana

BULLETIN 38



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Arenaceous Foraminiferida and Zonation of the Silurian Rocks of Northern Indiana

By MICHAEL C. MOUND

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Arenaceous Foraminiferida and Zonation of the Silurian Rocks of Northern Indiana

By MICHAEL C. MOUND[1]

Abstract

This report describes 82 species belonging to 31 genera of Silurian Foraminiferida recovered from cores from five deep wells and drill holes in Allen, Delaware, Howard, Marion, and Newton Counties, northern Indiana. The Families Ammodiscidae Reuss, Astrorhizidae Brady, and Saccamminidae Brady represent the Superfamily Ammodiscacea Reuss; the Family Hormosinidae Haeckel represents the Superfamily Lituolacea de Blainville. The species *Ammodiscus constrictodilatus, Lituotuba recurva, Tholosina phrixotheca,* and *Psammonyx ceratospirillus* are new. *Metamorphina,* a recently new name, is used for those forms previously assigned to *Webbinella* Rhumbler that cannot properly be included in either *Webbinelloidea* Stewart and Lampe or *Hemisphaerammina* Loeblich and Tappan.

Silurian rocks of the area studied that are pre-Cayugan in age are assigned to three biostratigraphic zones: the *Turritellella* Assemblage Zone, the *Ammodiscus-Thurammina* Assemblage Zone, and the *Ammodiscus-Lituotuba* Assemblage Zone. The *Turritellella* Assemblage Zone is restricted to the lowermost part of the Salamonie Dolomite in northwestern and north-central Indiana and to the lowermost part of the Salamonie and the underlying Brassfield Limestone in east-central and southeastern Indiana. The *Ammodiscus-Thurammina* Assemblage Zone includes the middle and upper parts of the Salamonie Dolomite, as represented in the drill hole in Marion County. The *Ammodiscus-Lituotuba* Assemblage Zone includes the Louisville Limestone and the Wabash Formation. The Salina Formation, here represented by the Kokomo Limestone Member and other Salina strata, contains sparsely represented ammodiscids and astrorhizids; they are not assigned to any zone.

Common associates of the Silurian Foraminiferida are crinoids, brachiopods, conodonts, scolecodonts, ostracods, graptolites, and sponges. Certain of these

[1]Presently paleontologist, Chevron Research Co., La Habra, Calif.; current address Chevron Oil Co., Oklahoma City, Okla.

faunal associates are common residents of shallow marine shelf environments. One preferential rock type for large foraminiferal assemblages is granular relatively pure biofragmental limestone or dolomite, such as that in the Salamonie Dolomite, which has been interpreted as representing optimum conditions for shallow marine invertebrate species.

Generally the foraminifers are either represented sparsely or are lacking in cherty and argillaceous rocks of the Wabash Formation and in reef sections; discounting diagenesis, preservation, and other postdepositional phenomena, the foraminifers may not have preferred the primary environments indicated by these rock types.

Introduction

Because the Silurian Foraminiferida of North America have received little attention, many taxa are poorly defined and few species have been used in stratigraphy. Most studies emphasize taxonomy and have been based on observations of only small portions of Silurian strata. Most of the earlier reports, as reviewed by Mound (1961), deal with early Silurian faunas, and only three reports treat Silurian foraminifers from Indiana, all from the lower part of the section.

The objectives of this study are to increase the knowledge and usefulness of Silurian arenaceous Foraminiferida by (1) systematically describing the genera and species represented in sections that are fairly complete for the Silurian System in northern Indiana, (2) establishing assemblage zones in the Silurian strata, and (3) interpreting the foraminiferal paleoecological relationships. More than 40,000 specimens representing 82 species of arenaceous foraminifers were recovered from cores from five deep wells and drill holes in Allen, Delaware, Howard, Marion, and Newton Counties in northern Indiana (fig. 1; Appendix).

I am grateful to Dr. Robert H. Shaver, Indiana University, for his guidance. Many thanks are due also to Dr. T. G. Perry, Indiana University, and Dr. Carl B. Rexroad, Indiana Geological Survey, for their helpful suggestions on taxonomy and for cooperation and advice on the preparation of samples. Mr. George R. Ringer, Indiana Geological Survey, made the photomicrographs, and other resources of the Survey were drawn upon. I am indebted to Mr. Jack Conley

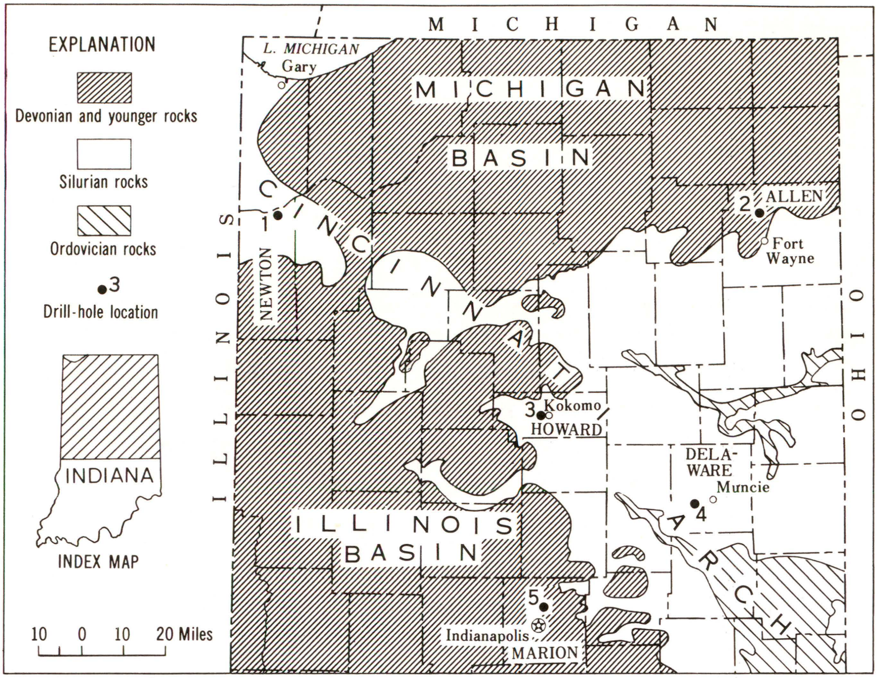

Figure 1. Map of northern Indiana showing outcrop areas of Silurian rocks and localities of cores yielding arenaceous Foraminiferida. Geology from Patton, 1956, and Shaver and others, 1961.

and the Northern Indiana Public Service Co. for making drill cores available. Part of the work was done while I held an Indiana Department of Conservation Fellowship at Indiana University.

Except for Loeblich and Tappan (1964), no publications later than March 1963 were considered during the preparation of this report.

Collection and Preparation of Material

Completely continuous halves were taken from three cores from deep wells in Allen and Newton Counties and a drill hole in Delaware County (fig. 1; Appendix, sections 1, 2, and 4). Crushed samples, representing 4 to 5 feet of core, were taken without gaps from the Silurian parts of the cores; most of these samples weighed 1 kilogram each. Representative samples were taken from two cores from drill holes in Howard and Marion Counties (fig. 1; Appendix, sections 3 and 5); samples from the latter localities each represented 4 to 5 feet of core and weighed 200 to 500 grams. Descriptions of localities 1 to 5 are given in the Appendix, sections 1 to 5.

Stratigraphy

Silurian rocks lie at the bedrock surface in a broad belt trending northwestward through the area studied (fig. 1). This belt corresponds generally to the crestal area of the Cincinnati Arch that pitches gently northwestward. Thus, in the outcrop area, younger Silurian rocks are present northwestward, in part because the Silurian section was affected by pre-Pleistocene erosion, as shown especially by the Delaware County core (fig. 1, locality 4).

On the flanks of the arch the Silurian rocks are covered by middle Devonian rocks, and they descend approximately 30 feet per mile both northward into the Michigan Basin and southwestward into the Illinois Basin. In these areas, pre-Devonian erosion affected the Silurian section, as shown especially in the Marion County core (fig. 1, locality 5).

The rock-unit names and descriptions used in this report are taken from Pinsak and Shaver (1964).

BRASSFIELD LIMESTONE

The Brassfield Limestone (Foerste, 1906, p. 10) of the Albion and Niagaran? Series is considered in this report to be the lowest Silurian rock unit in the area studied; it is mostly a noncherty and extremely variable carbonate unit containing some glauconite, and it ranges from 6 to 25 feet in thickness in the cored wells. The Brassfield in the subsurface is characteristically tan fine- to coarse-grained biofragmental dolomite or dolomite or dolomitic limestone containing, in places, some glauconitic material and chert. Shaly phases and brecciation on a minor scale are also characteristic to some degree (Appendix, sections 1 to 5). The rocks called Brassfield in this report may not be the same age everywhere; Pinsak and Shaver (1964, fig. 3) suggested that the Brassfield in east-central Indiana, as in the

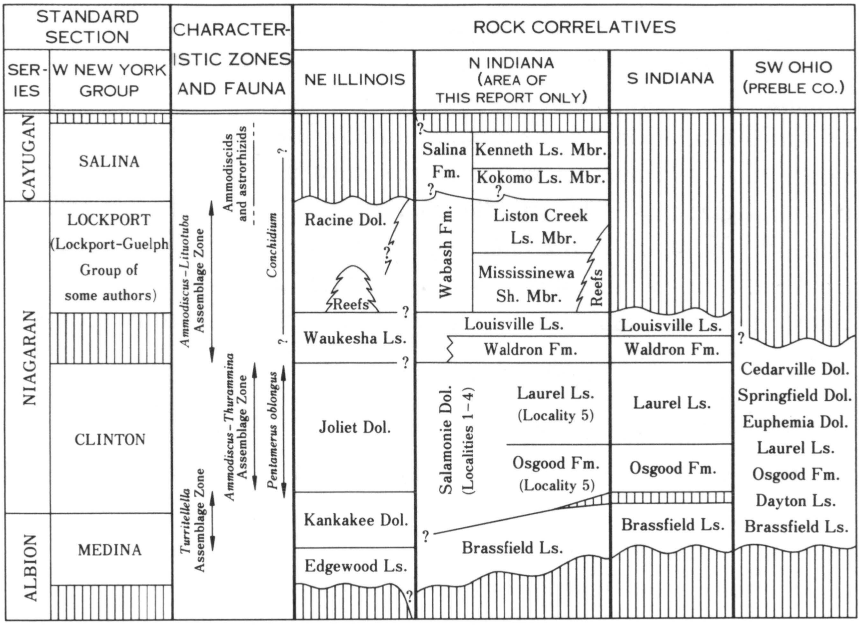

Figure 2. Correlation of Silurian rock units of northeastern Illinois, Indiana, and southwestern Ohio. Modified from Pinsak and Shaver, 1964.

Delaware County core, may be younger than the Brassfield represented in the Newton County core. Possibly, the Brassfield in northwestern Indiana has equivalents in the Edgewood Limestone of northeastern Illinois (fig. 2); for the most part, the Brassfield of this report lies below the cherty rocks that commonly have been referred to the so-called Brassfield in subsurface studies.

SALAMONIE DOLOMITE

The Salamonie Dolomite (Pinsak and Shaver, 1964, p. 24) includes the rocks above the Brassfield Limestone and below the Waldron Formation where the Waldron is present; in the Newton County core the Salamonie lies below the Louisville Limestone. Ranging in thickness from 86 to 215 feet in the cored wells, these rocks consist of light-colored granular dolomite and dolomitic limestone; the latter lithology is characteristic especially of the upper part of the formation (Appendix, sections 1 to 4).

The lower part of the Salamonie generally is cherty and glauconitic and corresponds mostly to the Osgood Formation of southern Indiana; the name Osgood is used here, however, for rocks in the Marion County core (Appendix, section 5). These lower cherty rocks commonly have been classified as the Brassfield Limestone by Indiana stratigraphers. The middle part of the Salamonie consists of relatively pure dolomite and represents the Laurel Limestone of southern Indiana. The upper part consists of gray and tan dolomitic limestone, and it may not have equivalent rocks exposed in southern Indiana.

WALDRON FORMATION AND LOUISVILLE LIMESTONE

The Waldron Formation (Elrod, 1883; Pinsak and Shaver, 1964) and equivalent rocks in the Newton County core overlie the Salamonie Dolomite. The Waldron consists of dark-colored argillaceous and shaly fine-grained nodular dolomitic limestone and ranges in thickness from 6 to 36 feet in the area studied. The Louisville Limestone (Foerste, 1897), ranging in thickness from 42 to 86 feet, consists of brown or gray argillaceous cherty biofragmental dolomite and gray fine-grained limestone; chert and argillaceous rocks are common. In the Newton County well the Louisville extends downward to include rocks in the Waldron position. This accords with the stratigraphy discussed in Pinsak and Shaver's report (1964) on the Silurian.

WABASH FORMATION

Pinsak and Shaver (1964, p. 34) applied the name Wabash Formation to more than 200 feet of upper Niagaran rocks lying above the Louisville Limestone. This unit includes the Mississinewa Shale Member (below) and the Liston Creek Limestone Member in their type areas in north-central Indiana and other reef-bearing argillaceous and cherty carbonate rocks, unnamed to member, in the area studied. The argillaceous and silty unit referred to as the Mississinewa Shale Member is as much as 115 feet thick in Howard County, and this lithology can also be observed in the cores from Delaware and Marion Counties. In the Howard County drill hole the Liston Creek Limestone Member is a gray granular cherty limestone 38 feet thick.

In the Newton County section (Appendix, section 1) the Wabash Formation is not divided into named members and consists of as much as 222 feet of alternating granular cherty dolomite and fine-grained argillaceous dolomite. In the Allen County section (Appendix, section 2) the Wabash Formation consists of 183 feet of light-colored granular vuggy fossil-fragmental dolomite that is part of a large reef system at both the Mississinewa and Liston Creek stratigraphic positions. The Wabash Formation is correlated (fig. 2) with most of the Racine Dolomite of northeastern Illinois as described by Willman (1943, 1962).

SALINA FORMATION

Rocks in northern Indiana of early Cayugan and (or) late Niagaran age that are called the Salina Formation (Landes, 1945) consist of dense banded shaly laminated dolomite, gray fine-grained argillaceous partly cherty dolomitic limestone, light-colored granular pure dolomite, and shale. The latter two rock types are sparsely represented in the three study wells that penetrate Salina rocks (Appendix, sections 1, 2, and 3). These rocks are as much as 80 feet thick in the Howard County drill hole, which penetrates the Kokomo Limestone Member in its type area (Foerste, 1904; Pinsak and Shaver, 1964); the overlying Kenneth Limestone Member (Cumings and Shrock, 1927; Pinsak and Shaver, 1964) of the Salina Formation is not represented in the wells of this study but is known to be present at least in Howard County. The wells in Allen and Newton Counties and the drill hole in Howard County penetrate only the thin updip part of the Salina, which, in its northern area of greater thickness, lies in juxtaposition with the Louisville Limestone and the Wabash Formation, so that the Salina rocks of the present study must be considered to overlie most of the Wabash Formation and to be mostly or entirely post-Wabash in age. Twenty-one feet of cored fine-grained arenaceous and shaly dolomite of the Salina from Newton County and thirty-six feet of tan and gray cherty argillaceous dolomite below the Kokomo Limestone Member are not assigned to a named member.

Composition, Age, and Distribution of the Foraminiferida

The foraminifers from the samples of this study represent 82 species assigned to 31 genera. They are assigned to the following supra-generic categories:[2]

	Number of genera
Order Foraminiferida Eichwald, 1830	31
Suborder Textulariina Delage and Herouard, 1896	31
Superfamily Ammodiscacea Reuss, 1861	30
Family Ammodiscidae Reuss, 1861	7
Subfamily Ammodiscinae Reuss, 1861	5
Subfamily Tolypammininae Cushman, 1928	2
Family Astrorhizidae Brady, 1881	5
Subfamily Astrorhizinae Brady, 1881	1
Subfamily Hippocrepininae Rhumbler, 1895	2
Subfamily Rhizammininae Rhumbler, 1895	2
Family Saccamminidae Brady, 1884	18
Subfamily Diffusulininae Loeblich and Tappan, 1964	1
Subfamily Hemisphaerammininae Loeblich and Tappan, 1961	6
Subfamily Psammosphaerinae Haeckel, 1894	6
Subfamily Saccammininae Brady, 1884	5
Superfamily Lituolacea de Blainville, 1825	1
Family Hormosinidae, Haeckel, 1894	1
Subfamily Hormosininae, Haeckel, 1894	1

The faunal distribution by rock units in each of the five localities (table 1) is generally similar in terms of the species represented. Samples from the Brassfield Limestone yielded moderately abundant and diverse faunas in the cores from Delaware and Howard Counties; few foraminifers were recovered from the Brassfield samples in the cores from Allen, Marion, and Newton Counties. In most of the individual cores, samples from the Salamonie Dolomite contained the most diverse and abundant faunas.

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[2]The suprageneric classification is taken from Loeblich and Tappan (1961; 1964, p. 153-163).

OVERSIZED DOCUMENT

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Foraminifers were not recovered from any sample of the Waldron Formation. Samples of the Louisville Limestone contained an abundant and diverse foraminiferal fauna in Marion and Newton Counties; a less abundant fauna was represented in samples from Delaware and Howard Counties. Samples of the Wabash Formation in Newton County contained few foraminifers; the Mississinewa Shale Member yielded an abundant fauna in Howard and Marion Counties and a less abundant fauna in Delaware County; the Liston Creek Limestone Member contained an abundant fauna in Howard County. Samples of the Salina Formation in Howard and Newton Counties yielded few foraminifers. These foraminifers are the basis for establishing the following three assemblage zones.

TURRITELLELLA ASSEMBLAGE ZONE

The *Turritellella* Assemblage Zone (pl. 1), here named, is characterized by the prominence of *Turritellella fisheri* Dunn, *T. osgoodensis* Dunn, *T. spirans* Cushman and Waters, and *T. workmani* Dunn; these four species are restricted to this zone. Associated with the species of *Turritellella* are large numbers of *Ammodiscus exsertus* Cushman, *A. incertus* (d'Orbigny), *Lituotuba exserta* Moreman, *Glomospira gordialis* (Jones and Parker), *Amphicervicis elliptica* Mound, *A. hemisphaerica* Mound, *Hyperammina curva* (Moreman), and *Bathysiphon exiguus* Moreman. The *Turritellella* Assemblage Zone includes the lower part of the Salamonie Dolomite (mostly Osgood equivalents) as recognized in the drill hole and well in Howard and Newton Counties and at least the lower part of the Osgood Formation as represented in the drill hole in Marion County (Appendix, sections 1, 3, and 5). The *Turritellella* Assemblage Zone in the Delaware County core (Appendix, section 4) includes both lower Salamonie rocks and all the Brassfield Limestone. The foraminifers and the Brassfield rocks in the area of outcrop in southeastern Indiana (Mound, 1961) should be assigned to this zone. Thus the *Turritellella* fauna suggests that in eastern Indiana the Brassfield may be younger than the named Brassfield in northwestern Indiana. Mound (1961) suggested that the Brassfield fauna of southeastern Indiana has some Niagaran affinities.

Dunn (1942, p. 320, 341) cited only one specific locality for species of *Turritellella* in Illinois, the Joliet Stone Co. Quarry in the southwestern part of Joliet, Will County. He believed that these species came from Osgood rocks at this site, where Brassfield (Kankakee Formation of Willman, 1943) rocks also were believed to be exposed.

AMMODISCUS-THURAMMINA ASSEMBLAGE ZONE

The *Ammodiscus-Thurammina* Assemblage Zone, here named, is characterized by large numbers of *Ammodiscus,* especially *A. exsertus* and *A. incertus,* and significant numbers of specimens assigned to 13 species of *Thurammina,* particularly *T. papillata* and *T. tubulata* (pl. 1). The number of specimens of *Ammodiscus* recovered per kilogram sample (table 1) far exceeds that of *Thurammina.* Associated species also present in large numbers are *Glomospira gordialis, Lituotuba excerta, L. inflata* Ireland, *Hyperammina curva, Bathysiphon exiguus,* and *Marsipella elongata.* This zone contains the greatest variety of species of the Foraminiferida described in this report; all but four of the described species are contained within, but not restricted to, this zone (pl. 1). The *Ammodiscus-Thurammina* Assemblage Zone includes the middle and upper parts of the Salamonie Dolomite, as represented in the wells and drill holes in Allen, Delaware, Howard, and Newton Counties, and the upper part of the Osgood Formation and the Laurel Limestone in Marion County.

A zone of abundant arenaceous Foraminiferida in northeastern Illinois has been used to mark the base of the Joliet Dolomite (Willman, 1962, p. 66). This zone probably corresponds to the *Ammodiscus-Thurammina* Assemblage Zone described here rather than to the *Turritellella* Assemblage Zone, because the rocks containing *Turritellella* in the Newton County core have been correlated well below the base of the Joliet Dolomite (Pinsak and Shaver, 1964, fig. 3 and p. 24; Appendix, section 5). Also, the brachiopod *Pentamerus oblongus* is found below the zone of foraminiferal abundance in Illinois (Willman, 1962, p. 65); in Indiana *Pentamerus* is known only in rocks above the *Turritellella* Assemblage Zone (Pinsak and Shaver, 1964, p. 23-24). The species that are common in this zone were described previously by Moreman (1930, 1933) and Ireland (1939) as from the Chimneyhill Limestone of Oklahoma; by Stewart and Priddy (1941) as from the Osgood Formation and the Dayton and Laurel Limestones of Ohio and the Osgood Formation and the Laurel Limestone of Indiana; and by Dunn (1942) as from the Osgood Formation of Indiana, Illinois, and Missouri, the Joliet Dolomite of Illinois, and the Bainbridge Limestone of Missouri. Some of the species resemble the ammodiscids recorded by Grohskopf and McCracken (1949, pl. 9) as from the lower part of the Bainbridge Limestone of Missouri.

AMMODISCUS-LITUOTUBA ASSEMBLAGE ZONE

The *Ammodiscus-Lituotuba* Assemblage Zone, here named, is characterized by the prominence of ammodiscids, including large numbers of *Ammodiscus exsertus, A. incertus, Lituotuba exserta,* and *L. inflata.* Other associated abundant or significant species are *Glomospira gordialis, Hyperammina curva, Bathysiphon exiguus,* and *Marsipella elongata.* Thuramminids are not as conspicuous an element of this zone as they are in the underlying zone. This zone includes the Louisville Limestone, except possibly its lower few feet in the Newton County section, and the Wabash Formation, the latter unit including the Mississinewa Shale Member and the Liston Creek Limestone Member (pl. 1). Future investigators should seek to refine and extend recognition of this upper zone.

HIGHER SILURIAN FAUNAS

The Cayugan rocks, as represented by the Kokomo Limestone Member of the Salina Formation in the Howard County drill hole, yielded small numbers of foraminifers (table 1). Ammodiscids are the most abundant group, including specimens of *Ammodiscus exsertus, A. incertus, Tolypammina nodosa,* and *T. serpens;* sparse numbers of *Bathysiphon exiguus* and *Hyperammina curva* represent the astrorhizids, but the saccamminids and aschemonellids are wanting. These faunas are represented so sparsely in the wells and drill holes that the higher Silurian rocks are not assigned to any zone.

Paleoecology

Generally, the habitats of members of the Order Foraminiferida have been studied more than those of most other groups of invertebrate fossils. Present-day forms related to Paleozoic genera, as for example, *Ammodiscus,* are widely distributed in various habitats but are most common in waters of medium depth in temperate regions (Cushman, 1935). Although modern arenaceous forms are found in both brackish and deep water, this range of habitat probably results from the ability of arenaceous forms to tolerate variations rather than to select them. Very shallow-water and very deep-water environments have not been known as optimum habitats for arenaceous foraminifers; they have their greatest diversity and numbers in shallow to medium depth, clear and well-oxygenated waters (Cushman, 1935). Assuming that the Silurian arenaceous faunas had the same ecological preferences as their modern morphological counterparts, we may conclude that the Silurian rocks of Indiana bearing profuse foraminifers were deposited in moderately shallow, clear waters, a conclusion supported by Pinsak and Shaver (1964, p. 58-62) in their view of much of northern Indiana as a broad shallow-water shelf.

Common associates of the Foraminiferida are crinoids especially and brachiopods, conodonts, scolecodonts, ostracods, graptolites, and certain sponges. Similar associations were reported by Gutschick and Treckman (1959, p. 231) for the Rockford Limestone (Mississippian) of Indiana and by Summerson (1958, p. 547) for the Dayton Limestone (early Niagaran) of Ohio. These workers suggested the normal shallow-marine environment as the principal habitat of their faunas. Except for graptolites and conodonts, the associations observed here do support this thesis; but in many samples, abundant crinoids and brachiopods, for example, were observed in the absence of foraminifers; other factors may be the cause, among them, preservation. Thus, the present study does not generally establish preferred associations.

Large numbers of siliceous hexactinellid and other sponge spicules (pl. 7, figs. 9-17) characteristically form major portions of residues lacking or having a low foraminiferal content. The upper rocks, unnamed to member, and the Liston Creek Limestone Member of the Wabash Formation commonly exhibit this inverse relationship, especially as represented in the cores from Newton and Howard Counties (Appendix, sections 1 and 3). One particularly striking morphologic group of spicules (pl. 7, figs. 9-10) belongs to the genus *Hyalostelia* Zittel according to Butler (1961, p. 192-196). Similarly, inverse relationships were observed for Salamonie samples which yielded monaxonid spicules in abundance and fewer trioxonid and polyaxonid forms (pl. 7, figs. 11-14, 16, 17). In Liston Creek samples where the hexactinellid sponge spicules were not so numerous as to dominate the microfauna, the foraminifers were present in moderate abundance. Samples which had small numbers of spicules, but more monaxonid than hexactinellid, did contain large numbers of foraminifers.

The inverse abundance relationship between foraminifers and sponge spicules, especially *Hyalostelia?* and other hexactinellids in the Liston Creek Limestone Member and other rocks of the upper part of the Wabash Formation, seems to present an enigma; according to Hyman (1940, p. 325, 332, 343) and Petelin (1954), many Recent hexactinellid and monaxonid sponges indicate a normal marine environment.

The foraminifers of this study come from a wide variety of carbonate rock types: limestones and dolomites that are described variously as very fine grained to coarse grained; argillaceous, silty, shaly, or cherty; fossil-fragmental; and vuggy. Some preferences do seem to be indicated, however. The Salamonie Dolomite contains by far the most predictably profuse faunas (pl. 1), and this formation more than others consists uniformly of granular relatively pure fossil-fragmental carbonate rock (Appendix, section 1, unit 16). (See also Pinsak and Shaver, 1964, Cumings and Shrock, 1928, and Busch, 1939, in their presentation of the Salamonie rocks as representing optimum conditions for hundreds of invertebrate species of shallow-water shelf faunas.)

The optimum conditions for invertebrates in the Silurian reef environment may not have applied to the arenaceous foraminifers, however. Approximately 180 feet of granular vuggy dolomite in a reef bank (Appendix, section 2, unit 3) was sampled continuously, and the samples were totally barren of foraminifers. Possibly these fragile foraminifers were unable to withstand the high-energy reef environment, or other primary factors contributed to their absence. Alternatively, their absence might be explained by secondary factors, preservation for example; degree of dolomitization, however, does not appear to have had any influence. The Allen County reef section is dolomitized, but throughout the rest of the Silurian sections studied here, limestones and dolomites alike yielded prolific faunas. For example, limestone in the Liston Creek (Appendix, section 3, unit 3), dolomite in the Louisville (Appendix, section 4, unit 4) and Salamonie, and limestone in the Brassfield (Mound, 1961) produced abundant foraminifers.

Argillaceous and shaly rocks that were sampled generally yielded poor faunas. Dense argillaceous and shaly nodular commonly unfossiliferous rocks of the Waldron Formation proved to be barren of foraminifers in all sections studied, for example, in the Howard County drill hole (Appendix, section 3, unit 7). Also, the finer grained argillaceous rocks of the Mississinewa Shale Member generally yielded few foraminifers, as, for example, in the Delaware County section (Appendix, section 4, unit 1). Discounting any preservation factor, the Silurian arenaceous Foraminiferida did not prefer the evidently quieter, muddier, less well-oxygenated, and possibly deeper conditions represented by the argillaceous Waldron and Mississinewa rocks. According to Pinsak and Shaver (1964, p. 63) and Lowenstam (1949), these fine-grained Mississinewa rocks represent low-energy conditions in interreef positions in a shelf area.

Most carbonate rock samples containing considerable chert yielded few or no foraminifers. For example, about 153 feet of dolomite of the Salamonie that is fine grained saccharoidal to medium grained, vuggy, and partly sparingly cherty was sampled continuously in Newton County (Appendix, section 1, unit 16). These samples contained abundant foraminifers except where chert was present. The upper 30 feet of section, which contained some chert, produced a sparse fauna; a sample containing minor amounts of chert 25 feet above the base also yielded few specimens.

The most cherty samples from the Liston Creek Limestone Member in the Howard County core (Appendix, section 3) also lacked foraminifers. Moreover, residues of Liston Creek samples showing over-silicification, such as beekite structures on crinoid columnals and colliform silica, contained few or no foraminifers. Whether this relationship between the presence of siliceous material and lack of arenaceous foraminifers is due to primary or secondary factors is not known.

The higher Silurian rocks, as represented by the Salina Formation and the Kokomo Limestone Member, contained meager foraminiferal faunas consisting of only eight species of ammodiscids and astrorhizids. In Howard County, for example, these rocks consist of banded and thinly laminated dolomitic limestone (Kokomo Limestone Member in part, Appendix, section 3, units 1 and 2). They were considered by Pinsak and Shaver (1964, p. 63) to have been deposited in and marginal to a restricted basin which received salt farther north in Michigan during Cayugan time. Probably the restriction of the foraminiferal fauna, both in numbers of specimens and variety, is related to the special conditions in the basin, possibly including greater salinity and (or) fluctuations in salinity in the area studied. Among the arenaceous foraminifers, certain of the ammodiscids and astrorhizids (pl. 1; table 1) apparently were more tolerant of these special conditions; the presence of these benthonic forms suggests that the environmental conditions in that part of the area of Salina deposition were not extreme.

Subphylum **Sarcodina** Schmarda, 1871

Class **Rhizopodea** von Siebold, 1845

Subclass **Granuloreticulosia** de Saedeleer, 1934

Order **Foraminiferida** Eichwald, 1830

Suborder **Textulariina** Delage and Herouard, 1896

Superfamily **Ammodiscacea** Reuss, 1861

Family **Ammodiscidae** Reuss, 1861

Subfamily **Ammodiscinae** Reuss, 1861

Genus **Ammodiscus** Reuss, 1861

Ammodiscus abbreviatus Ireland, 1939

Plate 2, figures 1, 2

Involutina longexsertus Gutschick, 1962 (part), Jour. Paleontology, v. 36., p. 1301, pl. 174, fig. 29, text-fig. 5B; Sappington Formation, Montana.

Ammodiscus exsertus var. *minutus* Ireland, 1939 (part), Jour. Paleontology, v. 13, p. 200, pl. B, fig. 20; Chimneyhill Limestone, Oklahoma.

Ammodiscus incertus Stewart and Priddy, 1941, Jour. Paleontology, v. 15, p. 374, pl. 54, fig. 19; Laurel Limestone, Indiana.

Ammodiscus abbreviatus Ireland, 1939, Jour. Paleontology, v. 13, p. 200, pl. B, figs. 32, 33; Chimneyhill Limestone, Oklahoma.

Wall rough or smooth exteriorly, less rough interiorly, having a single layer of fine silt-sized particles and much cement. Test free, regularly planispirally coiled, consisting of a small globular ovoid proloculus and a long, gradually or rapidly expanding undivided second chamber, which has three to five whorls that are closely coiled in early volutions, and which has a short part uncoiled in the same plane; uncoiled part of second chamber straight, at right angles to earlier direction of coiling tapering to slight constriction. Aperture circular, at end of constricted tube.

Dimensions: Holotype not designated; diameters of two syntypes, 0.21, 0.26 mm. Measurements of three Indiana specimens in mm:

Form	Maximum diameter	Length of exsert part	Diameter of proloculus	Number of whorls	Wall thickness
Microspheric	0.31	.03	.01	4	.02
Microspheric	0.34	.07	.02	5	.03
Megalospheric	0.36	.05	.09	3	.03

Remarks: Ammodiscus abbreviatus is characterized by the abbreviated exsert part of the second tubular chamber. It can be distinguished from broken tests of its closely allied congener, *Ammodiscus exsertus,* by the marked terminal constriction around the aperture.

Types: Figured hypotypes, InGS 4G 1; unfigured hypotypes, InGS 4G 2.

Distribution: Locality 1: Salamonie Dolomite, 456 to 488 and 524.0 to 598.6 ft; locality 3: Wabash Formation, Mississinewa Shale Member, 218.0 to 218.8 ft, and Liston Creek Limestone Member, 107.6 to 120.8 ft; locality 4: Salamonie Dolomite, 118 to 122 and 157.5 to 161.0 ft, and Brassfield Limestone, 177.5 to 179.0 ft; locality 5: Louisville Limestone, 208.0 to 217.3 and 244.8 to 266.9 ft.

Ammodiscus constrictodilatus n. sp.

Plate 2, figures 3-6; text figure 3

Wall rough or smooth exteriorly, most commonly smooth, less rough interiorly, having a single layer of medium to fine silt-sized particles and variable amounts of cement. Test free, regularly planispirally coiled, consisting of a small globular ovoid proloculus and an undivided tubular second chamber that forms three to five tightly coiled whorls and that uncoils in the same plane at right angles to earlier part. Exsert part consists distally from the point of uncoiling of a

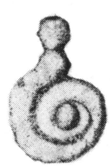

Figure 3. *Ammodiscus constrictodilatus* n. sp. View of holotype normal to plane of coiling, X 50.

cylindrical tube, a sharp constriction, and a bulbous terminal part. Aperture a round opening at end of tube.

Dimensions: Measurements on seven Indiana specimens in mm:

Specimen	Form	Maximum diameter	Length of exsert part		Diameter of proloculus	Number of whorls	Wall thickness
			below constric-tion	above constric-tion			
Holotype	Megalospheric	0.27	0.07	0.10	0.07	3	0.03
Figured paratypes	Microspheric	0.32	0.03	0.10	0.03	5	0.03
	Microspheric	0.03	0.03	0.12	0.03	4	0.03
	Megalospheric	0.28	0.07	0.10	0.07	3	0.03
Unfigured paratypes	Microspheric	0.20	0.05	0.09	0.03	4	0.03
	Microspheric	0.32	0.07	0.11	0.03	3	0.03
	Megalospheric	0.32	0.09	0.13	0.06	3	0.03

Remarks: Ammodiscus constrictodilatus is characterized by its constriction and by the bulbous termination of its exsert part. The swollen part has no constrictions around the apertural opening; *A. constrictodilatus* differs in this respect from almost all other species of *Ammodiscus* except *A. constrictus.*

Specimens of *Ammodiscus* having fractured exsert parts may belong to either *A. constrictodilatus* or *A. exsertus.*

Both megalospheric and microspheric forms have been observed in the Indiana collection.

The species name *constrictodilatus* refers to the constricted exsert tube and the swollen terminus: *constricto-,* L., *constrictus,* drawn together, and *dilatus,* L., *dilatus,* spread out.

Types: Holotype, InGS 4G 3; figured paratypes, InGS 4G 4; unfigured paratypes, InGS 4G 5.

Distribution: Locality 1: Salamonie Dolomite, 512 to 520, 536 to 540, and 588 to 592 ft; locality 3: Wabash Formation, Liston Creek Limestone Member, 102.0 to 102.8 ft, and Mississinewa Shale Member, 218.0 to 218.8 ft.

Ammodiscus constrictus Dunn, 1942

Plate 2, figures 7, 8

Involutina exserta Conkin, 1961 (part), Bull. Am. Paleontology, v. 43, p. 286-288, pl. 22, fig. 6; New Providence Formation, Kentucky.

Ammodiscus constrictus Dunn, 1942, Jour. Paleontology, v. 16, p. 339, pl. 44, fig. 27; Joliet Limestone, Illinois.

Wall rough or smooth exteriorly, smooth interiorly, having a single layer of fine silt-sized particles and variable amounts of cement. Test free, regularly planispirally coiled, consisting of a small ovoid to subspherical proloculus and a long, gradually or rapidly enlarging undivided second chamber that forms two to four whorls and that is closely coiled in early volutions. Terminal part of test uncoiled in the same plane as, and tangent to, earlier part. Exsert part unconstricted; aperture circular at end of terminal part of second chamber.

Dimensions: Holotype: diameter, 0.28 mm. Measurements on four Indiana specimens in mm:

Form	Maximum diameter	Length of exsert part	Diameter of proloculus	Number of whorls	Wall thickness
Microspheric	0.34	0.17	0.03	4	0.03
Microspheric	0.24	0.12	0.02	4	0.02
Microspheric	0.24	0.17	0.02	3	0.02
Megalospheric	0.41	0.12	0.10	2	0.03

Remarks: Ammodiscus constrictus is distinguished from its congeners by its tangential uncoiled part.

Types: Figured hypotypes, InGS 4G 6; unfigured hypotypes, InGS 4G 7.

Distribution: Locality 1: Salamonie Dolomite, 480 to 484, 504 to 540, 556 to 568, and 584.0 to 600.7 ft; locality 4: Salamonie Dolomite, 167.7 to 171.6 ft; locality 5: Louisville Limestone, 208.0 to 217.3 and 258.5 to 266.9 ft.

Ammodiscus exsertus Cushman, 1910

Plate 2, figures 9-11

Involutina exserta Gutschick and Treckman, 1959, Jour. Paleontology, v. 33, p. 241, pl. 35, figs. 8, 9; Rockford Limestone, Indiana. Mound, 1961, Indiana Geol. Survey Bull. 23, p. 20, 21, pl. 1, figs. 3-5; Brassfield Limestone, Indiana. Conkin, 1961 (part), Bull. Am. Paleontology, v. 43, p. 286-288, pl. 22, figs. 4, 8, text-fig. 21; New Providence Formation, Kentucky.

Lituotuba exserta Stewart and Priddy, 1941 (part), Jour. Paleontology, v. 15, p. 374, 375, pl. 54, fig. 20; Osgood Formation, Indiana.

Ammodiscus brevitubus Dunn, 1942, Jour. Paleontology, v. 16, p. 339, pl. 44, fig. 4; Osgood Limestone, Illinois.

Ammodiscus exsertus Cushman, 1910, U. S. Natl. Mus. Bull. 71, pt. 1, p. 75, figs. 97a, b; Recent, Japan. Moreman, 1930, Jour. Paleontology, v. 4, p. 58, pl. 7, figs. 4, 8; Chimneyhill Limestone, Oklahoma. Stewart and Priddy, 1941, Jour. Paleontology, v. 15, p. 373, pl. 54, fig. 18; Dayton Limestone, Ohio; Osgood Formation, Indiana. Dunn, 1942, Jour. Paleontology, v. 16, p. 338, pl. 44, fig. 23; Osgood Limestone, Missouri. Raymond, 1955, A. M. thesis, Indiana Univ., p. 20-21, pl. 4, fig. 2; Osgood Formation, Indiana. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 200, pl. 48, fig. 16; Osgood Formation, Indiana.

Dimensions: Holotype: diameter, 0.45 mm. Measurements on seven Indiana specimens in mm:

Form	Maximum diameter	Length of exsert part	Diameter of proloculus	Number of whorls	Wall thickness
Microspheric	0.29	0.10	0.03	4	0.02
Microspheric	0.31	0.12	0.03	4	0.03
Microspheric	0.36	0.10	0.01	5	0.02
Microspheric	0.29	0.09	0.03	4	0.02
Microspheric	0.36	0.09	0.01	6	0.03
Megalospheric	0.27	0.09	0.04	3	0.03
Megalospheric	0.43	0.20	0.09	4	0.04

Remarks: Ammodiscus exsertus is characterized by the exsert part of the tubular second chamber which departs from the early part of the test at a right angle in the plane of coiling.

The diameter of the tubular second chamber increases toward the later part of the test; the exsert part tapers slightly toward a constriction, beyond which is the circular aperture. The length of the exsert part is commonly one-third the maximum diameter.

Megalospheric tests are rare and commonly have only two or three whorls which are separated by a deeply depressed spiral suture.

Types: Figured hypotypes, InGS 4G 8; unfigured hypotypes, InGS 4G 9.

Distribution: Locality 1: Louisville Limestone, 396 to 405 and 415.5 to 421.6 ft, and Salamonie Dolomite, 424 to 432, 444 to 492, and 500.0 to 604.8 ft; locality 3: Salina Formation, Kokomo Limestone Member, 33.5 to 34.4 and 49.7 to 50.7 ft; Wabash Formation, Liston Creek Limestone Member, 102.0 to 120.8 ft, and Mississinewa Shale Member, 148.5 to 149.3 and 201.9 to 227.2 ft; Salamonie Dolomite, 300.7 to 338.4 ft; locality 4: Salamonie Dolomite, 118.0 to 126.5, 134.5 to 138.7, and 143.0 to 171.6 ft; Brassfield Limestone, 171.6 to 174.7 and 177.5 to 179.0 ft; locality 5: Wabash Formation, Mississinewa Shale Member, 166.6 to 180.6 ft, and Louisville Limestone, 182.9 to 217.3 and 230.0 to 266.9 ft.

Ammodiscus furcus Moreman, 1930

Plate 2, figures 12-14

Ammodiscus? furca Moreman, 1930, Jour. Paleontology, v. 4, p. 59, pl. 7, figs. 9, 10; Chimneyhill Limestone, Oklahoma.

Dimensions: Holotype: not designated. Diameters of two syntypes, 0.32 and 0.48 mm. Measurements on four Indiana specimens in mm:

Form	Maximum diameter	Length of exsert part	Diameter of proloculus	Number of whorls	Wall thickness
Microspheric	0.26	0.05, 0.07	0.03	3	0.02
Microspheric	0.31	0.09, 0.11	0.03	3	0.02
Megalospheric	0.34	0.12, 0.14	0.07	4	0.03
Megalospheric	0.29	0.09, 0.10	0.05	3	0.03

Remarks: Ammodiscus furcus is characterized by its two separate tubular exsert tapering parts, thus differing from any other species of *Ammodiscus.* On some of the Indiana specimens these tubular extensions are widely divergent.

The two exsert parts of *A. furcus* are the result of branching of the last whorl during the last stages of development of the second chamber. Each of the tubes extends outward from, and at right angles to, the coiled part of the test. In some specimens the point of branching coincides with a point of uncoiling that is common to both of the exsert tubes; other specimens have the last part of the second chamber branching into two parallel tubes which uncoil at different points and have the exsert parts widely separated; one specimen has the tubular extensions uncoiled at diametrically opposite ends of the test.

Types: Figured hypotypes, InGS 4G 10; unfigured hypotypes, InGS 4G 11.

Distribution: Locality 1: Salamonie Dolomite, 452 to 456, 504 to 508, 512 to 524, 546 to 540, 548 to 552, 560 to 568, and 600.7 to 602.8 ft; locality 3: Salamonie Dolomite, 337.5 to 338.4 ft; locality 4: Salamonie Dolomite, 151.3 to 154.5 ft.

Ammodiscus incertus (d'Orbigny), 1839

Plate 2, figures 15-18

Operculina incerta d'Orbigny, 1839, *in* Sagra, Ramon de la, Histoire physique, politique et naturelle de l'ile de Cuba, "Foraminiferes," p. 49, pl. 6, figs. 16, 17; Recent, Cuba.

Involutina exserta Conkin, 1961 (part), Bull. Am. Paleontology, v. 43, p. 286-288, pl. 22, fig. 5, pl. 26, figs. 17, 19, New Providence Formation, Kentucky; Bedford Shale, Ohio.

Involutina semiconstricta Conkin, 1961 (not *Ammodiscus semiconstricta* Waters), Bull. Am. Paleontology, v. 43, p. 290-294, pl. 22, figs. 1-3, pl. 26, fig. 20, text-fig. 20; Jacobs Chapel Shale and Rockford Limestone, Indiana; Eulie Shale, Tennessee; Paint Creek Formation, Kentucky.

Involutina incerta Mound, 1961, Indiana Geol. Survey Bull. 23, p. 19, 20, pl. 1, figs. 1, 2; Brassfield Limestone, Indiana.

Ammodiscus restinensis Berry, 1928, Eclogae geol. Helvetiae, v. 21, p. 131, text-fig. 4; Lobitos Formation, Peru.

Ammodiscus minutissimus Cushman and McCulloch, 1939, Allan Hancock Pacific Exped., v. 6, p. 70, pl. 5, figs. 3, 4; Recent, Peru.

Ammodiscus nitidus Parr, 1942, Royal Soc. Western Australia Jour., v. 27, p. 10, pl. 1, figs. 1a, b; Wandagee Formation, Western Australia; Crespin, 1947, Australia Bur. Mineral Resources Bull. 15, p. 24, table 5; Upper and Lower Marine Series, New South Wales, Australia. Crespin, 1958, Australia Bur. Mineral Resources Bull. 48, p. 68, 69, pl. 12, figs. 7-9; Wandagee and Noonkabah Formations, Western Australia.

Ammodiscus diminutivus Dunn, 1942 (nom. nov. of *Ammodiscus minutus* Dunn), Jour. Paleontology, v. 16, p. 339, pl. 44, fig. 28; Osgood Limestone, Missouri.

Ammodiscus coombsi Beck, 1943, Jour. Paleontology, v. 17, p. 591, pl. 98, fig. 1; Cowlitz Formation, California.

Ammodiscus proscus Rauser-Cernoussova, 1948, Akad. Nauk S. S. S. R., pt. 62, p. 227, pl. 15, figs. 2, 3; Stalinogorsk Formation, Moscow Basin, U.S.S.R.

Ammodiscus gigas Reitlinger, 1950, Akad. Nauk S. S. S. R., pt. 126, p. 15, pl. 2, fig. 22; Miachkovo Formation, Arkhangelsk Oblast, U.S.S.R.

Ammodiscus parvus Reitlinger, 1950, Akad. Nauk S. S. S. R., pt. 126, p. 14, pl. 2, fig. 4; Kashira and Podolsk Formations, Moscow Basin, U.S.S.R.

Ammodiscus variabilis Reitlinger, 1950, Akad. Nauk S. S. S. R., pt. 126, p. 14, pl. 2, figs. 16, 17; Kashira Formation, Moscow Oblast, U.S.S.R.

Ammodiscus orbis Lalicker, 1950, Kansas Univ. Paleont. Contr. 5, p. 11, pl. 1, fig. 2; Sawtooth Formation, Montana.

Ammodiscus annularis Ireland, 1956, Jour. Paleontology, v. 30, p. 846, pl. 4, figs. 4-6, upper Pennsylvanian, Kansas.

Ammodiscus leei Miller, 1956, Jour. Paleontology, v. 30, p. 1351, text-fig. 1, figs. 3, 4; "Hunton" Limestone, Kansas.

Ammodiscus erugatus Crespin, 1958, Australia Bur. Mineral Resources Bull. 48, p. 66, pl. 12, figs. 1-3; Liveringa and Noonkabah Formations, Australia.

Ammodiscus incertus Brady, 1884, Rept. Voyage Challenger, Zoology, v. 9, p. 330, pl. 38, figs. 1-3; Recent, North and South Atlantic and South Pacific. Cushman, 1910, U. S. Natl. Mus. Bull. 71, pt. 1, p. 73-76, text-figs. 95, 96a, b; Recent, North Pacific. Cushman, 1918, U. S. Natl. Mus. Bull. 104, pt. 1, p. 95, 96, pl. 39, figs. 1-7; Recent, Atlantic. Moreman, 1930, Jour. Paleontology, v. 4, p. 58, pl. 7, fig. 7; Chimneyhill Limestone, Oklahoma. Dunn, 1942, Jour. Paleontology, v. 16, p. 338, pl. 44, fig. 23; Osgood Limestone, Missouri. Raymond, 1955, A. M. thesis, Indiana Univ., p. 21-22, pl. 4, fig. 3; Osgood Formation, Indiana. McKnight, 1962, Bull. Am. Paleontology, v. 44, p. 101, pl. 9, fig. 13; Recent, Antarctic. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 200, pl. 49, figs. 3, 4; Osgood Formation, Indiana.

Dimensions: Holotype: diameter, 0.1 mm. Measurements on nine Indiana specimens in mm:

Form	Maximum diameter	Diameter of proloculus	Number of whorls	Wall thickness
Microspheric	0.29	0.01	3	0.02
Microspheric	0.37	0.01	4	0.02
Microspheric	0.34	0.03	6	0.03
Microspheric	0.32	0.03	6	0.02
Microspheric	0.26	0.02	5	0.02
Megalospheric	0.32	0.07	3	0.03
Megalospheric	0.39	0.07	4	0.03

Remarks: Ammodiscus incertus is characterized by its regularly planispirally coiled test, its gradually to rapidly expanding tubular second chamber, which is circular to oval in cross section, the strongly depressed spiral suture, and the constriction at the end of the second chamber preceding the subcircular aperture.

The number of whorls in the Indiana specimens varies from three to six in the microspheric forms and from three to four in the megalospheric forms; megalospheric forms are much less common than the microspheric forms.

Types: Figured hypotypes, InGS 4G 12; unfigured hypotypes, InGS 4G 13.

Distribution: Locality 1: Louisville Limestone, 396.9 to 405.0 and 415.5 to 424.0 ft; Salamonie Dolomite, 424.0 to 428.0 and 440.0 to 604.8 ft; locality 2: Brassfield Limestone, 821.0 to 825.0 ft; locality 3: Salina Formation, Kokomo Limestone Member, 49.7 to 50.7 ft; Wabash Formation, Liston Creek Limestone Member, 102.0 to 120.8 ft, and Mississinewa Shale Member, 148.5 to 165.3 and 201.9 to 237.9 ft; Louisville Limestone, 248.2 to 249.3 ft; Salamonie Dolomite, 300.7 to 301.8 ft; locality 4: Salamonie Dolomite, 118.0 to 126.5, 134.5 to 138.7, and 151.3 to 171.6 ft; Brassfield Limestone, 171.6 to 174.7 and 177.5 to 179.0 ft locality 5: Wabash Formation, Mississinewa Shale Member, 166.6 to 180.6 ft; Louisville Limestone, 182.9 to 249.0 ft; Osgood Formation, 311.7 to 321.8 ft; Brassfield Limestone, 340.6 to 345.6 ft.

Ammodiscus longexsertus (Gutschick and Treckman), 1959

Plate 2, figures 19-22

Involutina longexsertus Gutschick and Treckman, 1959, Jour. Paleontology, v. 33, p. 241, pl. 35, figs. 10-14; Rockford Limestone, Indiana. Conkin, 1961, Bull. Am. Paleontology, v. 43, p. 288-290, pl. 22, figs. 7, 9, pl. 26, fig. 18, text-fig. 22; Bedford Shale and New Providence Formation, Kentucky. Gutschick, 1962, Jour. Paleontology, v. 36, p. 1301, pl. 174, fig. 28, text-fig. 5A; Sappington Formation, Montana.

Dimensions: Holotype in mm: length, 0.85; diameter, 0.27; diameter of uncoiled tube, 0.06. Measurements on six Indiana specimens in mm:

Form	Maximum diameter	Length of exsert part	Diameter of proloculus	Number of whorls	Wall thickness
Microspheric	0.22	0.32	0.02	3	0.03
Microspheric	0.26	0.21	0.01	4	0.02
Microspheric	0.22	0.39	0.01	3	0.02
Microspheric	0.24	0.26	0.02	4	0.02
Microspheric	0.24	0.46	0.02	3	0.03
Megalospheric	0.21	0.31	0.05	3	0.03

Remarks: Ammodiscus longexsertus is recognized by its exceptionally long, straight tubular exsert part. As in *Ammodiscus exsertus* and *Ammodiscus abbreviatus,* this exsert part is at right angles to the earlier planispirally coiled part. The uncoiled tube of *Ammodiscus longexsertus* is much longer and more strongly tapered than the analogous tubes of closely allied species. The length of the uncoiled tube is commonly 1½ times greater than the maximum diameter of the coiled part.

Types: Figured hypotypes, InGS 4G 14; unfigured hypotypes, InGS 4G 15.

Distribution: Locality 1: Salamonie Dolomite, 508 to 510, 520 to 524, 552 to 556, 584 to 592, and 598.6 to 602.8 ft.

Genus **Bifurcammina** Ireland, 1939

Bifurcammina parallela Ireland, 1939

Plate 2, figures 23-25

Bifurcammina parallela Ireland, 1939, Jour. Paleontology, v. 13, p. 202, pl. B, fig. 37; Chimneyhill Limestone, Oklahoma. Raymond, 1955, Indiana Univ. A. M thesis, p. 23, pl. 4, fig. 1; Osgood Formation, Indiana. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 204, 205, pl. 48, figs. 24, 25; Osgood Formation, Indiana.

Dimensions: Holotype in mm: height, 0.50; width, 0.57. Measurements on five Indiana specimens in mm:

Maximum diameter	Length of exsert part	Diameter of proloculus	Number of whorls	Wall thickness
0.43	0.12	0.07	2	0.05
0.36	0.09	0.05	3	0.04
0.32	0.10	0.03	2	0.03
0.38	0.09	0.04	3	0.04
0.43	0.10	0.03	3	0.03

Remarks: Bifurcammina parallela is characterized by the branched late part of its second chamber which uncoils into equally developed double tubular exsert parts having oval apertures. *B. parallela* differs from other branched ammodiscids by having double parallel tubes that are joined along a deep suture for their entire lengths.

Types: Figured hypotypes, InGS 4G 16; unfigured hypotypes, InGS 4G 17.

Distribution: Locality 1: Louisville Limestone, 396.9 to 401.0 ft; Salamonie Dolomite, 448 to 452, 472 to 476, 484 to 488, and 500 to 512 ft; locality 3: Wabash Formation, Mississinewa Shale Member, 218.0 to 218.8 ft; Salamonie Dolomite, 337.5 to 338.4 ft; locality 4: Salamonie Dolomite, 147.0 to 151.3 ft.

Genus **Glomospira** Rzehak, 1885

Glomospira articulosa Plummer, 1945

Plate 2, figures 26-28

Glomospira diversa Cushman and Waters, 1930 (part), Texas Univ. Bull. 3019, p. 42, pl. 3, figs. 9, 10, 12, 14; Harpersville Formation, Texas.

Glomospira westgatei Ireland, 1939, Jour. Paleontology, v. 13, p. 200, pl. B, figs. 25-26; Chimneyhill Limestone, Oklahoma.

Glomospira pusilla Ireland, 1956 (not Geinitz), Jour. Paleontology, v. 30, p. 847, pl. 4, figs. 15-17; Waubaunsee beds, Kansas.

Glomospira gordialis McKnight, 1962, Bull. Am. Paleontology, v. 44, p. 101, pl. 9, fig. 14; Recent, Antarctic [not *Trochammina squamata* var. *gordialis* Jones and Parker, 1860 = *Glomospira gordialis* (Jones and Parker)].

Glomospira articulosa Plummer, 1945, Texas Univ. Pub. 4401, p. 233, pl. 16, figs. 21-25; Bend Group, Texas. Ireland, 1956, Jour. Paleontology, v. 30, p. 847, pl. 4, figs. 7-10; Waubaunsee beds, Kansas. Gutschick and Treckman, 1959, Jour. Paleontology, v. 33, p. 242, pl. 35, figs. 17-19; Rockford Limestone, Indiana. Mound, 1961, Indiana Geol. Survey Bull. 23, p. 22, 23, pl. 1, figs. 15, 16; Brassfield Limestone, Indiana. Conkin, 1961, Bull. Am. Paleontology, v. 43, p. 295, 296, pl. 22, fig. 10, pl. 27, fig. 1, text-fig. 17; New Providence Formation, Kentucky, and Cuyahoga Shale, Ohio.

Dimensions: Holotype: diameter, 0.5 mm. Measurements on 12 Indiana specimens in mm:

Maximum diameter	Wall thickness
0.27	0.03
0.29	0.03
0.29	0.02
0.36	0.03
0.36	0.02
0.49	0.04
0.46	0.04
0.54	0.05
0.41	0.02
0.37	0.02
0.36	0.03
0.39	0.04

Remarks: Glomospira articulosa is characterized by its loosely or tightly glomerately coiled tubular second chamber. The overall test shape is globular or roughly ellipsoidal.

Types: Figured hypotypes, InGS 4G 18; unfigured hypotypes, InGS 4G 19.

Distribution: Locality 1: Salamonie Dolomite, 472 to 476, 504 to 512, 560 to 568, and 592.0 to 602.8 ft.

Glomospira gordialis (Jones and Parker), 1860

Plate 2, figures 29, 30

Trochammina squamata var. *gordialis* Jones and Parker, 1860, Geol. Soc. London Quart. Jour., v. 16, p. 304; Recent, Atlantic. Parker and Jones, 1865, Royal Soc. London, Philos. Trans., v. 155, p. 408, pl. 15, fig. 32; Recent, Atlantic.

Trochammina annularis Brady, 1876, Paleontog. Soc. London, v. 30, p. 76, pl. 3, figs. 9, 10; Carboniferous, England.

Ammodiscus gordialis Burrows, Sherborn, and Bailey, 1890, Royal Micros. Soc. Jour., p. 552, pl. 8, fig. 7; Recent, Atlantic. Haeusler, 1890, Schweizer. palaeont. Gesell. Abh.: Soc. palaeont. Suisse Mem., v. 17, p. 59, pl. 10, fig. 1; middle Jurassic, Switzerland.

Glomospirella umbilicata Plummer, 1945, Texas Univ. Pub. 4401, p. 233-235, pl. 16, figs. 26-31; Smithwick Formation, Texas. Ireland, 1956, Jour. Paleontology, v. 30, p. 849, pl. 4, figs. 21, 22; Waubaunsee beds, Kansas.

Glomospirella nyei Crespin, 1958, Australia Bur. Mineral Resources Bull. 48, p. 70, 71, pl. 13, figs. 1-5; Permian, Australia.

Lituotuba irregularis Tappan, 1955 (part), U. S. Geol. Survey Prof. Paper 236-B, p. 41, pl. 9, fig. 7; Kingak Formation, Alaska.

Glomospira umbilicata Cushman and Waters, 1927, Cushman Lab. Foram. Research Contr., v. 3, p. 148, pl. 26, figs. 7, 8; Smithwick Formation, Texas.

Glomospira simplex Harlton, 1928, Jour. Paleontology, v. 1, p. 306, pl. 52, fig. 2a-c; Canyon Formation, Texas. Ireland, 1956, Jour. Paleontology, v. 30, p. 847, pl. 4, figs. 18-20, Waubaunsee beds, Kansas.

Glomospira diversa Cushman and Waters, 1930 (part), Texas Univ. Bull. 3019, p. 42, pl. 3, figs. 11, 13; Harpersville Formation, Texas.

Glomospira biplana Moreman, 1933, Jour. Paleontology, v. 7, p. 397, pl. 47, fig. 9; lower Paleozoic, Oklahoma.

Glomospira ammodiscoidea Rauser-Cernoussova, 1938, Akad. Nauk S. S. S. R., v. 7, p. 93, pl. 1, figs. 1-3; Vereia Formation, Volga River, U. S. S. R.

Glomospira siluriana Ireland, 1939, Jour. Paleontology, v. 13, p. 201, pl. B, figs. 27, 28; Chimneyhill Limestone, Oklahoma. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 207, 208, pl. 49, fig. 2; Osgood Formation, Indiana.

Glomospira disca Cooper, 1947, Jour. Paleontology, v. 21, p. 87, pl. 20, fig. 18; Kinkaid Limestone, Illinois.

Glomospira pattoni Tappan, 1955, U. S. Geol. Survey Prof. Paper 236-B, p. 40, pl. 8, figs. 15-17; Kingak Formation, Alaska.

Glomospira gordialis Cushman, 1918, U. S. Natl. Mus. Bull. 104, pt. 1, p. 99, pl. 36, figs. 7-9; Recent, Atlantic. White, 1928, Jour. Paleontology, v. 2, p. 187, pl. 27, fig. 8; Recent, Mexico. Mound, 1961, Indiana Geol. Survey Bull. 23, p. 22, pl. 1, figs. 12-14; Brassfield Limestone, Indiana.

Wall rough or smooth exteriorly, most commonly smooth, smooth interiorly, consisting of a single or multiple layer of medium to fine silt-sized particles having much cement. Test free, consisting of a small ovoid proloculus and a gradually enlarging undivided tubular second chamber that is glomerately coiled for most of its length and tends to form one or two planispiral whorls in the late stages of development. Aperture at the open end of the terminally constricted tube.

Dimensions: Holotype dimensions not given. Measurements on seven Indiana specimens in mm:

Width of glomerate part	Maximum diameter	Number of whorls	Wall thickness
0.07	0.29	2	0.02
0.10	0.29	2	0.02
0.15	0.32	1	0.02
0.22	0.36	1	0.02
0.32	0.46	1	0.03
0.15	0.29	1	0.03
0.10	0.33	2.5	0.02

Remarks: Glomospira gordialis is characterized by its late ontogenetic planispiral stage. The earlier stage of irregular coiling may be truly glomerate or may only represent slight shifts in the plane of coiling during development.

Types: Figured hypotypes, InGS 4G 20; unfigured hypotypes, InGS 4G 21.

Distribution: Locality 1: Louisville Limestone, 396.9 to 401.0 and 419.1 to 421.6 ft; Salamonie Dolomite, 424 to 428, 444 to 488, 496 to 544, 552 to 568, and 584.0 to 604.8 ft; locality 3: Wabash Formation, Liston Creek Limestone Member, 102.0 to 120.8 ft, and Mississinewa Shale Member, 148.5 to 149.3, 164.7 to 165.3, and 218.0 to 227.2 ft; Salamonie Dolomite, 311.6 to 338.4 and 363.4 to 364.1 ft; locality 4: Salamonie Dolomite, 118.0 to 126.5 and 151.3

to 161.0 ft; Brassfield Limestone, 171.6 to 174.7 and 177.5 to 179.0 ft; locality 5: Wabash Formation, Mississinewa Shale Member, 166.6 to 180.6 ft; Louisville Limestone, 182.9 to 266.9 ft; Osgood Formation, 310.4 to 321.8 ft.

Genus **Psammonyx** Doderlein, 1892

Psammonyx ceratospirillus n. sp.

Plate 2, figures 31-34; text figure 4

Wall finely to coarsely arenaceous, rough or smooth exteriorly, smoother interiorly, poorly to well cemented, consisting of unoriented medium sand-sized to fine silt-sized particles. Test free, horn shaped, consisting of a small spherical proloculus and a larger rapidly expanding nonseptate tubular second chamber, the latter separated from the proloculus by a sharp constriction; test forms one whorl, having a very loosely coiled planispiral early part and an uncoiled compressed later part. Aperture large, elongate, slightly constricted, formed by the open end of the second chamber.

Dimensions: Measurements on 13 Indiana specimens in mm:

Specimen	Form	Diameter of proloculus	Height	Coil diameter
Holotype	Microspheric	0.07	0.39	0.07-0.14
Figured paratypes	Megalospheric	0.10	0.53	0.07-0.10
	Microspheric	0.15	0.88	0.20-0.41
	Microspheric	0.05	0.43	0.07-0.21
Unfigured paratypes	Megalospheric	0.14	------	0.10
	Megalospheric	0.14	0.24	0.07-0.09
	Microspheric	0.05	0.24	0.05-0.09
	Microspheric	------	0.39	0.14-0.17
	Microspheric	0.09	0.53	0.15-0.22
	Microspheric	0.05	0.34	0.07-0.17
	Microspheric	0.09	0.70	0.14-0.24
	Microspheric	0.05	0.57	0.10-0.22
	Microspheric	------	0.26	0.09-0.14

Remarks: The megalospheric form of *Psammonyx ceratospirillus* is more uncoiled and has a narrower range of coil diameter than the microspheric form.

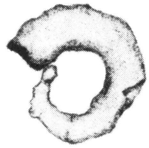

Figure 4. *Psammonyx ceratospirillus* n. sp. View of holotype normal to plane of coiling, X 50.

Psammonyx ceratospirillus differs from the Recent *P. vulcanicus* by possessing only one whorl and in being more uncoiled. The megalospheric forms of these two species are indistinguishable.

The etymology of the species name *ceratospirillus* refers to the spiral horn-shaped test: *cerato-*, Gr., *keratos,* horn, and *spirillus,* L., *spiralis,* spiral.

Types: Holotype, InGS 4G 22; figured paratypes, InGS 4G 23; unfigured paratypes, InGS 4G 24.

Distribution: Locality 1: Louisville Limestone, 372.7 to 376.6 ft; Salamonie Dolomite, 484 to 488, 504 to 516, and 588 to 592 ft; locality 3: Wabash Formation, Mississinewa Shale Member, 237.0 to 237.9 ft; Salamonie Dolomite, 337.5 to 338.4 and 355.7 to 364.1 ft; locality 4: Salamonie Dolomite, 151.3 to 154.5 ft.

Genus **Turritellella** Rhumbler, 1904

Turritellella Rhumbler, 1904, Archives Protistkunde, v. 3, p. 283.

The original generic concept is here expanded to provide for exsert terminal parts. Most earlier authors have assigned a given species to *Turritellella* if it does not exhibit evidence of attachment and if a part of the last chamber does not recurve along the length of the coiled part of the test; species having these features were referred invariably to *Trepeilopsis* Cushman and Waters, 1928.

Gutschick and Treckman (1959, p. 243) stated:

> Many specimens have been found which terminate at the end of regular coiling. It is not entirely clear whether such test is complete with aperture or that it has been broken off. In some specimens it is also not clear whether they are attached or free. If free and completely elongate close spiral, they should be referred to *Turritellella.* Since most, if not all, of the Rockford specimens show evidence of a spine of attachment and are associated with abundant specimens clearly assignable to *Trepeilopsis,* we are referring the close spiral tests also to *Trepeilopsis.*

Many species exhibit the terminal exsert part mentioned above which does not recurve in the manner of *Trepeilopsis* but extends in the direction of the axis of coiling. Where this part is absent, as commonly observed here, the lack of evidence of an attached habit and the absence of species clearly belonging to *Trepeilopsis* suggest assignment to *Turritellella.*

Turritellella fisheri Dunn

Plate 2, figures 35, 36

Turritellella fisheri Dunn, 1942, Jour. Paleontology, v. 16, p. 340, pl. 44, fig. 30; Osgood Limestone, Illinois, Indiana, Missouri, Kentucky, and Tennessee. Mound, 1961, Indiana Geol. Survey Bull. 23, p. 23, pl. 1, figs. 17, 18; Brassfield Limestone, Indiana.

Wall rough, thick (0.034 mm), medium to finely arenaceous, well cemented. Test free, consisting of a small subspherical proloculus that commonly is hidden by initial part of the second tubular chamber. Second chamber is undivided, circular in section, and closely coiled throughout most of length about a curved axis in an elongate high spiral; later region tending to be more openly coiled in some specimens, resulting in a terminal exsert part; coils and whorls large and unequal in diameter in immature and mature regions; diameters increase and decrease irrespective of growth region, imparting an irregular reversal of direction of tapering. Aperture round, constricted, formed by the end of the exsert terminal tube.

Dimensions: Holotype in mm: length, 0.67 (including exsert part); width, 0.15. Measurements on seven Indiana specimens in mm:

Spiral angle (degrees)	Length exclusive of exsert part	Length of exsert part	Width	Immature coil diameter	Mature coil diameter	Length of immature part
81	0.425	0.127	0.153	0.037	0.060	0.085
82	0.493	0.100	0.153	0.037	0.095	0.153
81	0.211	0.158	0.136	--------	0.055	---------
85	0.485	0.102	0.153	0.034	0.068	0.160
79	0.493	0.136	0.153	0.034	0.068	0.170
72.5	0.527	0.170	0.153	0.034	0.055	0.119
79	0.374	0.055	0.085	0.009	0.034	0.340

Remarks: T. fisheri differs from other species of *Turritellella* by possessing a second chamber coiled about a curved axis. This arrangement accounts for a large variation in spiral angle.

The reversal of direction of taper, which is found only in this species of *Turritellella,* is similar to the "hourglass tapering" described by Conkin (1954, p. 166) for *Hyperammina kentuckyensis.* Depressed and deeply incised sutures impart a lobulate test outline periphery.

Types: Figured hypotypes, InGS 4G 25; unfigured hypotypes, InGS 4G 26.

Distribution: Locality 1: Salamonie Dolomite, 588.0 to 602.8 ft.

Turritellella osgoodensis Dunn

Plate 2, figures 37, 38

Turritellella osgoodensis Dunn, 1942, Jour. Paleontology, v. 16, p. 341, pl. 44, fig. 22; Osgood Limestone, Illinois. Mound, 1961, Indiana Geol. Survey Bull. 23, p. 23, 24, pl. 1, figs. 19, 20; Brassfield Limestone, Indiana.

Wall rough, thick (0.026 mm), medium to coarsely arenaceous, well cemented. Test free, consisting of a small subspherical proloculus that is masked by a large coil of initial part of a long tubular second chamber; second chamber circular in section, nonseptate, coiled in an elongate high spiral, closely coiled throughout most of the length of test; coils tending to open in later part, large, and of equal size in immature and mature regions; individual whorls in a plane inclined at angles less than 90° to the straight axis of coiling and superposed on one another so as to impart subparallel sides to test. Aperture round, at end of exsert part of tubular chamber, slightly constricted.

Dimensions: Holotype in mm: length including exsert part, 0.50; width, 0.15. Measurements on nine Indiana specimens in mm:

Spiral angle (degrees)	Maximum length exclusive of exsert part	Length of exsert part	Maximum width	Immature coil diameter	Mature coil diameter	Length of immature part
78	0.391	0.085	0.158	0.043	0.051	0.068
78	0.340	0.095	0.136	0.049	0.065	0.085
86	0.527	0.085	0.136	0.043	0.065	0.085
85.5	0.358	0.068	0.136	0.034	0.051	0.085
83.5	0.391	0.110	0.139	0.034	0.060	0.127
77	0.511	0.120	0.170	0.034	0.055	0.120
72	0.476	-------	0.153	0.031	0.055	0.068
81	0.442	0.153	0.153	---------	0.060	---------
79	0.459	0.095	0.156	0.034	0.068	0.102

Remarks: Large size, less parallel sides, close and open coiling, and variation in spiral angle serve to distinguish *T. osgoodensis* from its congeners. Sutures of most specimens are depressed and deeply incised and impart a lobulate periphery.

Types: Figured hypotypes: InGS 4G 27; unfigured hypotypes, InGS 4G 28.

Distribution: Locality 1: Salamonie Dolomite, 584.0 to 602.8 ft; locality 4: Brassfield Limestone, 177.5 to 179.0 ft.

Turritellella spirans Cushman and Waters, 1927

Plate 2, figure 39

Turritellella spirans Cushman and Waters, 1927, Cushman Lab. Foram. Research Contr., v. 3, pt. 2, no. 40, p. 109, pl. 22, figs. 5, 6; Saginaw Formation, Michigan.

Wall moderately rough, thick (0.017 mm), medium to coarsely arenaceous, well cemented. Test free, no evidence of attachment throughout ontogeny, consisting of a small subspherical proloculus, which commonly is masked by a larger long undivided tubular second chamber coiled in an elongate spiral about a straight axis. The tubular chamber circular in section, varying in diameter from whorl to whorl; early part having nearly parallel sides; later (mature) part exhibiting a more fusiform appearance owing to the rapidly enlarging coils. Aperture slightly constricted, at the rounded, somewhat projecting part of the end of the second chamber, which departs slightly from the test body.

Dimensions: Holotype in mm: length, 0.37; width, 0.15. Measurements on three Indiana specimens in mm:

Spiral angle (degrees)	Length exclusive of exsert part	Length of exsert part	Maximum width	Immature coil diameter	Mature coil diameter	Length of immature part	Length of mature part
68	0.252	0.034	0.093	0.013	0.029	0.099	0.153
80	0.340	0.051	0.157	0.013	0.038	0.085	0.255
81	0.272	0.055	0.145	0.013	0.037	0.068	0.220

Remarks: Most specimens of *T. spirans* have deeply incised, depressed sutures. Some specimens resemble closely *Trepeilopsis spiralis* Gutschick and Treckman, but the latter species exhibits evidence of attachment. Further, no specimens of species belonging unequivocally to *Trepeilopsis* are in association with those of *Turritellella* in this fauna. *Turritellella spirans* differs from *T. fisheri* Dunn by having less open coiling and a fusiform-shaped test in its mature part; moreover, *T. spirans* invariably is straight. *T. spirans* differs from *T. workmani* Dunn by having a fusiform part that departs from the earlier parallel section; *T. spirans* generally is much larger than *T. workmani,* so that they do not represent stages of one species. *T. spirans* is easily distinguished from *T. osgoodensis* Dunn by having coil diameters that are variable within the individual specimens as shown in the list of measurements.

Distinct microspheric and megalospheric forms cannot be recognized, as the proloculus is almost invariably small and hidden by a coil of the initial part of the second chamber.

Types: Figured hypotypes, InGS 4G 29; unfigured hypotypes, InGS 4G 30.

Distribution: Locality 1: Salamonie Dolomite, 600.7 to 602.8 ft; locality 4: Brassfield Limestone, 177.5 to 179.0 ft.

Turritellella workmani Dunn

Plate 2, figures 40, 41

Turritellella workmani Dunn, 1942, Jour. Paleontology, v. 16, p. 341, pl. 44, fig. 31; Osgood Limestone, Illinois. Mound, 1961, Indiana Geol. Survey Bull. 23, p. 24, pl. 1, figs. 21, 22; Brassfield Limestone, Indiana.

Wall smooth, thin (0.005 mm), finely arenaceous, well cemented. Test free, no evidence of attachment at any ontogenetic stage, consisting of a small subspherical proloculus masked by a long second tubular chamber; second chamber circular in section, nonseptate, coiled in an elongate, high, close spiral; close coiling is continuous throughout length, last part departing from plane of coiling of earlier part along axis of coiling in some specimens; coils of equal size in immature and mature regions impart parallel sides to test. The rounded aperture is slightly constricted and is at the end of the exsert part of the second chamber.

Dimensions: Holotype in mm: length including exsert part, 0.35; width, 0.07. Measurements on six Indiana specimens in mm:

Spiral angle (degrees)	Maximum length exclusive of exsert part	Length of exsert part	Maximum width	Immature coil diameter	Mature coil diameter	Length of immature part
80	0.179	---------	0.095	0.026	0.026	0.034
82	0.153	0.060	0.088	0.017	0.026	0.026
82	0.312	---------	0.077	0.017	0.026	0.051
84	0.247	0.017	0.085	0.017	0.026	0.037
80	0.302	0.051	0.100	0.034	0.034	0.051
84	0.255	0.095	0.110	0.031	0.037	0.051

Remarks: T. workmani is distinguished from allied species of *Turritellella* especially by its wall size, thin wall, straight high tight spire, and sutures that appear to be at a high angle to the axis of coiling in lateral view. Because sutures of *T. workmani* characteristically are shallow and slightly depressed, the test outline is not distinctly lobulate.

Microspheric and megalospheric forms of *T. workmani* cannot be recognized because the proloculus is invariably enveloped by the initial coil of the second chamber.

Types: Figured hypotypes, InGS 4G 31; unfigured hypotypes, InGS 4G 32.

Distribution: Locality 1: Salamonie Dolomite, 588.0 to 602.8 ft.

Subfamily **Tolypammininae** Cushman, 1928

Genus **Lituotuba** Rhumbler, 1895

Lituotuba exserta Moreman, 1930

Plate 2, figures 42, 43

Involutina exserta Conkin, 1961 (part), Bull. Am. Paleontology, v. 43, p. 286-288, pl. 26, fig. 16; Henley Shale, Ohio.

Lituotuba elongata Dunn, 1942, Jour. Paleontology, v. 16, p. 340, pl. 44, fig. 36; Osgood Limestone, Missouri.

Lituotuba regularis Reitlinger, 1950, Akad. Nauk S. S. S. R., pt. 126, p. 22, pl. 3, fig. 17; Vereia Formation, Timan Upland, U. S. S. R.

Lituotuba chileana Todd and Kniker, 1952 (part), Cushman Lab. Foram. Research Contr., Spec. Pub. 1, p. 5, pl. 1, figs. 6a, b; Agua Fresca Formation, Chile.

Lituotuba exserta Moreman, 1930, Jour. Paleontology, v. 4, p. 59, pl. 7, figs. 5, 6; Chimneyhill Limestone, Oklahoma. Ireland, 1939, Jour. Paleontology, v. 13, p. 193, table 1, pl. B, fig. 29; Silurian, Oklahoma. Stewart and Priddy, 1941, Jour. Paleontology, v. 15, p. 374, pl. 54, figs. 20, 21; Dayton Limestone, Ohio; Laurel Limestone, Osgood Formation, Indiana. Dunn, 1942, Jour. Paleontology, v. 16, p. 339, pl. 44, figs. 33, 37; Bainbridge Limestone, Missouri. Raymond, 1955, A. M. thesis, Indiana Univ., p. 25, 26, pl. 4, fig. 7; Osgood Formation, Indiana. Mound, 1961, Indiana Geol. Survey Bull. 23, p. 21, pl. 1, figs. 6-8; Brassfield Limestone, Indiana. Brown and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 205, 206, pl. 48, figs. 18, 19; Osgood Formation, Indiana.

Dimensions: Holotype not designated; diameters of two syntypes, 0.34 and 0.48 mm. Measurements on seven Indiana specimens in mm:

Width of glomerate part	Maximum diameter	Length of uncoiled part	Number of whorls	Wall thickness
0.10	0.31	0.12	2	0.02
0.14	0.29	0.07	2	0.03
0.11	0.29	0.07	3	0.03
0.12	0.31	0.08	2	0.03
0.15	0.31	0.07	1	0.02
0.24	0.32	0.10	1	0.02
0.24	0.34	0.07	1	0.03

Remarks: Lituotuba exserta is characterized by its tubular second chamber, which has a glomerately coiled early part, a gradually enlarging planispiral later part, and a final exsert part.

Figured specimens that have been referred to *Lituotuba exserta* and that lack the distinctive exsert part should be referred to species of *Glomospira* Rzehak.

Types: Figured hypotypes, InGS 4G 33; unfigured hypotypes, InGS 4G 34.

Distribution: Locality 1: Louisville Limestone, 364.7 to 368.7 and 415.5 to 419.1 ft; Salamonie Dolomite, 440 to 460, 464 to 568, and 584.0 to 604.8 ft; locality 2: Brassfield Limestone, 821 to 825 ft; locality 3: Wabash Formation, Liston Creek Limestone Member, 102.0 to 120.8 ft, and Mississinewa Shale Member, 148.5 to 149.3, 164.7 to 165.3, and 218.0 to 227.2 ft; Salamonie Dolomite, 300.7 to 338.4 ft; locality 4: Salamonie Dolomite, 118.0 to 126.5, 134.5 to 138.7, and 147.0 to 171.6 ft; Brassfield Limestone, 171.6 to 174.7 ft; locality 5: Wabash Formation, Mississinewa Shale Member, 166.6 to 180.6 ft; Louisville Limestone, 182.9 to 266.9 ft.

Lituotuba furca Dunn, 1942

Plate 2, figures 44-46

Lituotuba? furca Dunn, 1942, Jour. Paleontology, v. 16, p. 340, pl. 44, fig. 34; Joliet Limestone, Illinois.

Wall rough or smooth exteriorly, commonly rough, smooth interiorly, having a thick multiple layer of medium and fine silt-sized particles and much cement. Test free, consisting of a small ovoid proloculus which commonly is obscured by an undivided tubular second chamber; second chamber is glomerately coiled in the early part, becomes planispiral forming one or two whorls, ultimately branching into two tubes which extend outward at right angles to earlier parts in plane of test coiling. Apertures at constricted end of each tubular exsert part.

Dimensions: Holotype: diameters including uncoiled tubes, 0.36 and 0.26 mm. Measurements of seven Indiana specimens in mm:

Width of glomerate part	Maximum diameter	Length of exsert parts	Number of whorls	Wall thickness
0.19	0.36	0.15, 0.15	1	0.03
0.14	0.26	0.05, 0.10	1	0.02
0.07	0.27	0.05, 0.10	2	0.02
0.14	0.36	0.08, 0.09	1	0.02
0.12	0.31	0.07, 0.14	1	0.03
0.09	0.29	0.05, 0.12	2	0.02
0.15	0.29	0.12, 0.12	1	0.03

Remarks: Lituotuba furca appears to be related to *L. exserta* in the same way *Ammodiscus furca* is related to *A. exsertus;* both *L. furca* and *A. furca* are characterized by branched exsert parts of the second chamber. *L. furca* differs from *A. furca* by having a glomerately coiled early part.

Types: Figured hypotypes, InGS 4G 35; unfigured hypotypes, InGS 4G 36.

Distribution: Locality 1: Salamonie Dolomite, 504 to 520 and 588.0 to 600.7 ft; locality 3: Salamonie Dolomite, 355.7 to 356.8 ft.

Lituotuba inflata Ireland, 1939

Plate 2, figures 47, 48

Lituotuba salinensis Dunn, 1942, Jour. Paleontology, v. 16, p. 340, pl. 44, fig. 29; Osgood Limestone, Illinois.

Lituotuba inflata Ireland, 1939, Jour. Paleontology, v. 13, p. 201, pl. B, figs. 34, 35; Chimneyhill Limestone, Oklahoma. Stewart and Priddy, 1941, Jour. Paleontology, v. 15, p. 375, pl. 54, fig. 22; Dayton Limestone, Ohio. Raymond, 1955, A. M. thesis, Indiana Univ., p. 26, pl. 4, fig. 8; Osgood Formation, Indiana. Mound, 1961, Indiana Geol. Survey Bull. 23, p. 21, 22, pl. 1, figs. 9-11; Brassfield Limestone, Indiana. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 206, pl. 48, fig. 17; Osgood Formation, Indiana.

Dimensions: Holotype in mm: width, 0.32; height, 0.50. Measurements on six Indiana specimens in mm:

Width of glomerate part	Maximum diameter	Length of uncoiled part	Diameter of last whorl	Wall thickness
0.12	0.29	0.09	0.09	0.03
0.17	0.29	0.05	0.09	0.03
0.19	0.26	0.10	0.10	0.03
0.18	0.36	0.15	0.09	0.04
0.15	0.34	0.07	0.14	0.04
0.17	0.34	0.22	0.11	0.03

Remarks: Lituotuba inflata is distinguished by its highly inflated last part of the tubular second chamber forming the final whorl which partly envelopes the earlier parts.

Some specimens of *Ammodiscus exsertus* in the Silurian collections of Indiana have highly inflated final whorls but lack glomerate initial parts characteristic of *Lituotuba.*

Lituotuba inflata if similar to *Lituotubella glomospiroides* Rauser-Cernoussova (1948) from the Carboniferous rocks of Russia but lacks the short internal septa.

Types: Figured hypotypes, InGS 4G 37; unfigured hypotypes, InGS 4G 38.

Distribution: Locality 1: Louisville Limestone, 364.7 to 368.7 and 396.9 to 401.1 ft; Salamonie Dolomite, 424 to 428, 444 to 540, 548 to 568, and 584.0 to 602.8 ft; locality 3: Wabash Formation, Liston Creek Limestone Member, 102.0 to 108.9 ft, and Mississinewa Shale Member, 218.0 to 218.8 ft; Salamonie Dolomite, 311.6 to 356.8 ft; locality 4: Salamonie Dolomite, 122.0 to 126.5 ft; locality 5: Wabash Formation, Mississinewa Shale Member, 179.2 to 180.6 ft; Louisville Limestone, 190.4 to 217.3 ft.

Lituotuba recurva n. sp.

Plate 2, figures 49-52; text figure 5

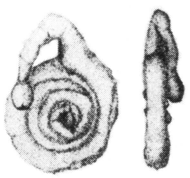

Figure 5. *Lituotuba recurva* n. sp. Views of paratype normal to and parallel to plane of coiling, X 50.

Wall rough or smooth exteriorly, most commonly smooth, smooth interiorly, having a single layer of fine silt-sized particles and much cement. Test free or attached, slightly flattened on one side, consisting of a small ovoid proloculus and a long undivided tubular second chamber; the second chamber is glomerately coiled in the early part, later planispirally coiled for one to three volutions, then uncoiled for a short distance, finally recurving back to coiled part along last whorl or crossing it; terminal part of tube has a slight constriction. Aperture a round opening at end of tube.

Dimensions: Measurements on six Indiana specimens in mm:

Specimen	Width of glomerate part	Maximum diameter	Length of uncoiled part	Length of recurved part	Number of whorls	Wall thickness
Holotype	0.07	0.32	0.14	0.24	3	0.03
Figured paratypes	0.07	0.41	0.19	0.49	2	0.03
	0.04	0.12	0.12	0.27	1	0.02
	0.05	0.20	0.09	0.32	3	0.03
Unfigured paratypes	0.03	0.34	0.09	0.32	3	0.03
	0.05	0.17	0.09	0.18	2	0.03

Remarks: Lituotuba recurva is similar to the Pennsylvanian form *Lituotuba calcarina* Waters, 1928 but differs from the latter species by its glomerately coiled early part; *L. calcarina* has a test which is approximately planispiral.

Some specimens in the Indiana collection have a sharp constriction around the apertural opening in addition to the constriction in the terminal part of the recurved second chamber.

The small ovoid proloculus commonly is masked by the glomerate coiling of the initial part of the second chamber.

The species name *recurva* refers to the recurving of the tubular second chamber during growth that is similar to the recurved terminal part characteristic of species of the Mississippian ammodiscid genus *Trepeilopsis.*

Types: Holotype, InGS 4G 39; figured paratypes, InGS 4G 40; unfigured paratypes, InGS 4G 41.

Distribution: Locality 1: Salamonie Dolomite, 484 to 488, 500 to 576, 520 to 536, and 596.5 to 602.8 ft; locality 4: Salamonie Dolomite, 118 to 122 ft; locality 5: Louisville Limestone, 190.4 to 196.9 ft.

Genus **Tolypammina** Rhumbler, 1859

Tolypammina nodosa Ireland, 1956

Plate 2, figures 53, 54; plate 3, figures 1-3

Tolypammina rugosa Ireland, 1956, Jour. Paleontology, v. 30, p. 850, text-fig. 4, figs. 25-29; Oread Formation, Kansas.

Tolypammina sp. A. Gutschick and Treckman, 1959, Jour. Paleontology, v. 33, p. 247, pl. 37, figs. 6, 7; Rockford Limestone, Indiana.

Tolypammina continuus Gutschick, 1962, Jour. Paleontology, v. 36, p. 1302, pl. 174, fig. 24, pl. 175, figs. 15, 17, 19, 21; Sappington Formation, Montana.

Tolypammina nodosa Ireland, 1956, Jour. Paleontology, v. 30, p. 851, text-fig. 5, figs. 1, 2; Oread Formation, Kansas.

Wall rough or smooth exteriorly, commonly rough, rough interiorly, having a single or multiple layer of medium to fine silt-sized particles and variable amounts of cement. Test attached, consisting of a small subspherical proloculus and a long, loosely and irregularly coiled undivided second chamber of nearly constant diameter except for constrictions. Constrictions at irregular intervals give an appearance of concameration to the second chamber. Aperture a round opening at end of tube.

Dimensions: Holotype: length, 0.40 mm; two Indiana specimens in mm: proloculus diameter, 0.20 and 0.15; maximum dimension of test, 1.96 and 1.22; wall thickness, 0.04 and 0.03.

Remarks: Tolypammina nodosa is characterized by its faintly to strongly depressed transverse constrictions. No internal evidence of these constrictions is apparent in sectioned specimens from the Indiana collection.

Types: Figured hypotypes, InGS 4G 42; unfigured hypotypes, InGS 4G 43.

Distribution: Locality 1: Salamonie Dolomite, 588.0 to 598.6 ft; locality 3: Salina Formation, Kokomo Limestone Member, 7.4 to 8.2 ft; Wabash Formation, 70.7 to 71.8 ft; Brassfield Limestone, 386.5 to 392.5 ft; Salamonie Dolomite, 382.5 to 383.5 ft; locality 4: Salamonie Dolomite, 122.0 to 126.5 ft.

Tolypammina serpens Ireland, 1956

Plate 3, figures 4-6

Tolypammina serpens Ireland, 1956, Jour. Paleontology, v. 30, p. 851, text-fig. 5, figs. 3-5; Wakarusa Limestone, Kansas.

Wall rough or smooth exteriorly, commonly smooth, smooth interiorly, having a thin layer of medium to fine silt-sized particles and much cement. Test attached, consisting of a small, irregularly shaped proloculus, which is rarely preserved, and a long, loosely and sinuously coiled undivided tubular second chamber of constant diameter. Aperture a simple opening at end of tube.

Dimensions: Holotype: end diameter of tube, 0.08 mm. Measurements on six Indiana specimens in mm:

Proloculus diameter	Maximum length of test	Wall thickness
0.17	0.92	0.05
------	0.55	0.03
------	1.28	0.03
0.05	0.65	0.03
------	1.22	0.05
------	0.83	0.07

Remarks: Tolypammina serpens is characterized by its loose, sinuous coiling. The Indiana specimens do not appear to have been attached along the entire length of the second chamber but were attached only by the proloculus.

Types: Figured hypotypes, InGS 4G 44; unfigured hypotypes, InGS 4G 45.

Distribution: Locality 1: Devonian carbonate rocks, 95 to 97 ft; Salamonie Dolomite, 508 to 512 and 588.0 to 598.6 ft; locality 3: Salina Formation, Kokomo Limestone Member, 7.4 to 8.2 ft and 49.7 to 50.7 ft; Salina Formation, 76.7 to 77.6 ft.

Family **Astrorhizidae** Brady, 1881

Subfamily **Astrorhizinae** Brady, 1881

Genus **Rhabdammina** M. Sars, 1869

Rhabdammina eocenica Cushman and Hanna

Plate 3, figures 7-9

Rhabdopleura abyssorum Dawson, 1870, Canadian Naturalist, new ser., v. 5, p. 175, text-fig. 7; Recent, Gaspe Bay.

Schizammina sp. Summerson, 1958, Jour. Paleontology, v. 32, p. 557, pl. 82, fig. 22; Columbus Limestone, Ohio.

Rhabdammina samanica Berry, 1928, Ecolgae geol. Helvetiae, v. 21, p. 392, text-fig. 21; Lobitos Formation, Peru.

Rhabdammina fusiformis Rhumbler, *in* Drygalski, E. von, Deutsche Sudpolar-Exped., 1901-3, v. 20, p. 77, pl. 2, fig. 18; Recent, Antarctic.

Rhabdammina cylindrica Glaessner, 1937, Univ. Moscow Paleont. Lab., v. 2-3, p. 354, pl. 1, fig. 1; Paleocene, Caucasus.

Rhabdammina geniculata Stewart and Priddy, 1941, Jour. Paleontology, v. 15, p. 369, pl. 54, fig. 1; Osgood Formation, Indiana.

Rhabdammina scabra Hogland, 1947, Uppsala Univ., Zool. Bidrag., v. 26, p. 28, pl. 1; figs. 3, 4; Recent, Skagerak (Sweden).

Rhabdammina vaciva Emiliani, 1954, Paleontographica Italica, v. 48 (new ser., v. 18), p. 158, pl. 25, fig. 11; Oligocene, Italy.

Rhabdammina sp. McKnight, 1962, Bull. Am. Paleontology, v. 44, p. 98, pl. 9, fig. 1, Recent, Antarctic.

Rhabdammina eocenica Cushman and Hanna, 1927, California Acad. Sci. Proc., ser. 4, v. 16, p. 209, pl. 13, fig. 1; Eocene, California.

Wall rough exteriorly, less rough interiorly, consisting of a multiple layer of sand-sized and medium to fine silt-sized particles, generally poorly cemented. Test free, cylindrical to subcylindrical, straight or geniculate, consisting of a nonseptate tubular chamber. Apertures at either end of tube, slightly constricted.

Dimensions: Holotype in mm: length, 3.0; width, 0.5. Measurements on 14 Indiana specimens in mm:

Maximum test length	Wall thickness	Apertural diameters
0.48	0.02	0.03, 0.07
0.46	0.02	0.03, 0.05
0.60	0.02	0.03, 0.07
1.19	0.03	0.03, 0.05
0.77	0.05	0.03, 0.05
0.60	0.07	0.05, 0.07
1.70	0.09	0.12, 0.17
1.26	0.03	0.07, 0.07
0.92	0.03	0.07, 0.07
1.04	0.03	0.03, 0.09
1.39	0.09	0.18, 0.22
2.38	0.09	0.07, 0.15
0.48	0.02	0.05, 0.04
0.54	0.06	0.05, 0.05

Remarks: Rhabdammina eocenica may be distinguished from closely allied species of *Hyperammina* Brady and *Bathysiphon* M. Sars by possessing two constricted apertures and by lacking transverse constrictions.

Test shapes of the Indiana specimens vary greatly. Specimens having shapes intermediate between straight and cylindrical and sharply bent, compressed, and tubular are common.

Types: Figured hypotypes, InGS 4G 46; unfigured hypotypes, InGS 4G 47.

Distribution: Locality 1: Wabash Formation, Mississinewa Shale Member, 294.5 to 298.5 ft; Louisville Limestone, 364.7 to 368.7 ft; Salamonie Dolomite, 424 to 428, 468 to 472, 500 to 524, 536 to 564, 584 to 592, and 598.6 to 600.7 ft; locality 3: Wabash Formation, Mississinewa Shale Member, 218.0 to 218.8 ft; Salamonie Dolomite, 300.7 to 301.8 ft, Brassfield Limestone, 391.4 to 392.3 ft; locality 4: Salamonie Dolomite, 134.5 to 138.7 ft.

Rhabdammina irregularis Carpenter

Plate 3, figures 10-12

Rhabdammina bifurcata Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 198, pl. 48, figs. 4, 5; Osgood Formation, Indiana.

Rhabdammina irregularis Carpenter, 1869, Royal Soc. London Proc., v. 18, p. 60, no fig.; Recent, North Atlantic. Brady, 1884, Rept. Voyage Challenger, Zoology, v. 9, p. 267, 268, pl. 21, fig. 9; Recent, Pacific. Cushman, 1910, U. S. Natl. Mus. Bull. 71, p. 26, text-figs. 11, 12; Recent, North Pacific. Cushman, 1918, U. S. Natl. Mus. Bull. 104, pt. 1, p. 17, pl. 8, fig. 1; Recent, Pacific.

Wall rough or smooth exteriorly, smooth interiorly, consisting of a multiple layer of medium to fine silt-sized particles, firmly cemented. Test free, composed of a dichotomously branching tubular nonseptate chamber of nearly constant diameter; there is no evidence of a primordial chamber. Apertures slightly constricted openings at the ends of the tubes.

Dimensions: Holotype dimensions not given. Measurements on five Indiana specimens in mm:

Test length	Number of branches	Wall thickness	Apertual diameters
1.02	7	0.03	0.02, 0.03, 0.03
0.80	6	0.07	0.03, 0.05, 0.05, 0.05, 0.05
0.88	5	0.07	0.02, 0.03, 0.03, 0.03
1.70	4	0.10	0.05, 0.07, 0.10
1.05	6	0.09	0.03, 0.05, 0.10

Remarks: Some Indiana specimens show a slight constriction of the test below the point of bifurcation.

Types: Figured hypotypes, InGS 4G 48; unfigured hypotypes, InGS 4G 49.

Distribution: Locality 1: Louisville Limestone, 384.6 to 388.7 ft; Salamonie Dolomite, 424 to 428, 556 to 560, 588 to 592, and 596.5 to 598.6 ft.

Subfamily **Hippocrepininae** Rhumbler, 1895

Genus **Hyperammina** Brady, 1878

Hyperammina bulbosa Cushman and Waters, 1927

Plate 3, figures 13-23

Hyperammina glabra Cushman and Waters, 1927, Cushman Lab. Foram. Research Contr., v. 3, pt. 3, p. 46, pl. 26, fig. 1; Palopinto Limestone, Texas.

Hyperammina hastula Moreman, 1933, Jour. Paleontology, v. 7, p. 396, p. 47, fig. 2; Chimneyhill Limestone, Oklahoma.

Hyperammina elegans Rauser-Cernoussova and Reitlinger, 1937, *in* Rauser-Cernoussova and Fursenko, Guide to the Foraminifera of the oil-bearing regions of the U.S.S.R., pt. 1, p. 256, text-fig. 191; Carboniferous, U.S.S.R.

Hyperammina harrisi Ireland, 1939, Jour. Paleontology, v. 13, p. 200, pl. A, fig. 26; Chimneyhill Limestone, Oklahoma. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 230, pl. 52, figs. 12, 13; Osgood Formation, Indiana.

Hyperammina cylindrica Parr, 1950, Antarctic Research Exped. Repts., ser. B., v. 5, pt. 6, p. 254, pl. 3, fig. 5; Recent, Antarctic.

Hyperammina bulbosa Cushman and Waters, 1927, Cushman Lab. Foram. Research Contr., v. 3, pt. 2, p. 109, 110, pl. 22, fig. 2; Saginaw Formation, Michigan. Gutschick and Treckman, 1959, Jour. Paleontology, v. 33, p. 235, pl. 34, fig. 6; Rockford Limestone, Indiana.

Wall smooth exteriorly and interiorly, consisting of a single or multiple layer of fine silt-sized particles, having much cement; thinnest part of wall is in the area of constriction between proloculus and and second chamber. Test free, straight or slightly arcuate, tapering, consisting of a medium to large proloculus and an undivided tubular second chamber that is circular in cross section. Proloculus is ovoid and pointed in microspheric forms and subspherical in megalospheric forms; proloculus is separated from second chamber by a constriction that is characteristically better developed in microspheric tests. Second chamber increases in diameter toward apertural end but in some specimens also tapers in this direction for a short distance. Faint transverse constrictions are common. Aperture at open end of tube.

Dimensions: Holotype dimension not given. Measurements on eight Indiana specimens in mm:

Form	Dimension of proloculus	Length	Second chamber	
			Minimum diameter	Maximum diameter
Microspheric	------	0.44	0.07	0.12
Microspheric	------	0.80	0.07	0.15
Microspheric	0.12	0.92	0.10	0.20
Microspheric	------	0.63	0.08	0.17
Microspheric	0.09	0.39	0.05	0.10
Microspheric	0.07	0.54	0.05	0.12
Megalospheric	0.17	0.44	0.09	0.11
Megalospheric	0.14	0.65	0.10	0.14

Remarks: Hyperammina bulbosa is characterized by its slender, tapering second chamber and large proloculus. Tapering in the second chamber is similar to the hourglass tapering as described by Conkin (1954) and others.

Types: Figured hypotypes, InGS 4G 50; unfigured hypotypes, InGS 4G 51.

Distribution: Locality 1: Louisville Limestone, 405.0 to 408.5 ft; Salamonie Dolomite, 432 to 436, 480 to 484, 500 to 528, 536 to 540, 576 to 580, and 592.0 to 596.5 ft; locality 3: Salamonie Dolomite, 363.4 to 388.5 ft; locality 4: Salamonie Dolomite, 118.0 to 126.5 ft; Brassfield Limestone, 171.6 to 174.7 ft; locality 5: Louisville Limestone, 208.0 to 217.3 ft; Osgood Formation, 311.7 to 321.8 ft.

Hyperammina curva (Moreman), 1930

Plate 3, figures 24-29

Bathysiphon curvus Moreman, 1930, Jour. Paleontology, v. 4, p. 45, 46, pl. 5, figs. 9, 10; Chimneyhill Limestone, Oklahoma. Ireland, 1939, Jour. Paleontology, v. 13, pl. A, fig. 7; Chimneyhill Limestone, Oklahoma. Stewart and Priddy, 1941, Jour. Paleontology, v. 15, p. 370, pl. 54, fig. 5; Osgood Formation, Indiana. Dunn, 1942, Jour. Paleontology, v. 16, p. 322, pl. 42, fig. 5; Osgood Limestone, Illinois.

Hyperamminoides acicula Parr, 1942, Royal Soc. Western Australia, v. 27, p. 105, pl. 1, figs. 4-5, pl. 2, fig. 4; Permian, Western Australia.

Hyperammina maxima Cushman, 1910, U. S. Natl. Mus. Bull. 71, pt. 1, p. 63, text-figs. 77-79; Recent, Pacific.

Hyperammina compressa Paalzow, 1936, Preuss. geol. Landesanstalt Jahrb., v. 56, no. 1, p. 28, pl. 3, figs. 1, 2; Permian, Germany. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 228, pl. 52, figs. 9, 10; Osgood Formation, Indiana.

Hyperammina elegantissima Plummer, 1945, Texas Univ. Pub. 4401, p. 222, figs. 17-25; Strawn Group, Texas. Crespin, 1958, Australia Bur. Mineral Resources, Geology, and Geophysics Bull. 48, p. 49, pl. 7, figs. 8-10; Callytharra Formation, Australia.

Hyperammina compacta Gurschick and Trackman, 1959, Jour. Paleontology, v. 33, p. 235, pl. 34, figs. 12-16, text-fig. 1 J-L; Rockford Limestone, Indiana.

Hyperammina rockfordensis Gutschick and Treckman, 1959, Jour. Paleontology, v. 33, p. 238, pl. 34, figs. 1-5, text-fig. 1 A-C; Rockford Limestone, Indiana. Conkin, 1961, Bull. Am. Paleontology, v. 43, p. 267-272, pl. 21, figs. 10-13, pl. 26, fig. 10, text-fig. 9; New Providence Formation, Kentucky.

Hyperammina curva Mound, 1961 (part), Indiana Geol. Survey Bull. 23, p. 35, pl. 3, figs. 15, 16; Brassfield Limestone, Indiana. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 227, 228, pl. 52, figs. 14-16; Osgood Formation, Indiana.

Dimensions: Holotype not designated; lengths of two syntypes, 1.4 and 1.2 mm. Measurements on nine Indiana specimens in mm:

Form	Dimension of proloculus	Length	Second chamber	
			Minimum diameter	Maximum diameter
Microspheric	0.09	0.80	0.05	0.12
Microspheric	0.09	1.50	0.05	0.14
Microspheric	0.09	1.35	0.05	0.12
Microspheric	0.02	0.90	0.02	0.07
Microspheric	0.03	0.85	0.02	0.07
Megalospheric	0.19	1.35	0.09	0.14
Megalospheric	0.07	0.37	0.03	0.09
Megalospheric	0.09	0.37	0.05	0.10
Megalospheric	0.10	1.07	0.07	0.12

Remarks: Moreman's (1930, p. 45, 46) assignment of this species to *Bathysiphon* was apparently based on specimens that had proloculi broken off. Most specimens of *Hyperammina* have a very thin-walled constriction between the characteristically small proloculus and second chamber; breakage at this point is common, resulting in a tapering tubular test, open at both ends. Many Indiana specimens are similarly broken and are identical with Moreman's figures. Among the Indiana examples, however, are also very many specimens which are unfragmented and were found in association with the incomplete tests. Both broken and complete specimens having arcuate, tapering tests are here included in *Hyperammina curva.*

Most specimens from the Indiana collection are finely arenaceous and have smooth walls; tests are rarely very coarsely arenaceous. Some calcareous grains are incorporated in the wall.

Types: Figured hypotypes, InGS 4G 52; unfigured hypotypes, InGS 4G 53.

Distribution: Locality 1: Wabash Formation, 158.25 to 171.5 ft; Louisville Limestone, 350.7 to 361.2, 396.9 to 412.0, and 419.1 to 421.6 ft; Salamonie Dolomite, 424 to 568 and 580.0 to 604.8 ft; locality 2: Salamonie Dolomite, 684 to 688 ft; locality 3: Salina Formation, Kokomo Limestone Member, 49.7 to 50.7 ft; Wabash Formation, 52.0 to 77.6 ft, Liston Creek Limestone Member, 102.0 to 120.8 ft, and Mississinewa Shale Member, 148.5 to 149.3, 164.7 to 173.7, 201.9 to 227.2, and 248.2 to 249.3 ft; Salamonie Dolomite, 300.7 to 383.5 ft.; Brassfield Limestone, 391.4 to 392.3 ft; locality 4: Louisville Limestone, 61 to 65 ft; Salamonie Dolomite, 118.0 to 126.5 and 134.5 to 167.0 ft; Brassfield Limestone, 171.6 to 174.7 and 177.5 to 179.0 ft; locality 5: Wabash Formation, Mississinewa Shale Member, 166.6 to 180.6 ft; Louisville Limestone, 182.9 to 266.9 ft.

Genus **Jaculella** Brady, 1879

Jaculella acuta Brady

Plate 3, figures 30-32

Rhabdammina elliptica Deecke, 1884, Abh. geol. Specialkarte Preussen, v. 4, no. 1, p. 23, pl. 1, fig. 1; Jurassic, Alsace-Lorraine.

Hyperammina dubia Lacroix, 1928, Monaco Inst. Oceanography Bull. 527, p. 13, 14, text-figs. 12a-e; Recent, Monaco.

Hyperammina johnsvalleyensis Harlton, 1933, Jour. Paleontology, v. 7, p. 8, pl. 1, fig. 2; Johns Valley Shale, Oklahoma.

Hyperammina sublaevigata Dunn, 1942, Jour. Paleontology, v. 16, p. 337, pl. 44, fig. 6; Bainbridge Limestone, Missouri.

Hyperammina elegantissima Plummer, 1945, Texas Univ. Pub. 4401, p. 222, pl. 15, figs. 17-25; Strawn Group, Texas.

Hyperammina aljutovica Reitlinger, 1950, Akad. Nauk S. S. S. R., pt. 126, p. 13, pl. 3, fig. 10; Vereia Formation, Aliutovo, U. S. S. R.

Hyperammina nitida Gutschick and Treckman, 1959 (part), Jour. Paleontology, v. 33, p. 238, pl. 34, figs. 8, 9; Rockford Limestone, Indiana.

Hyperammina constricta Gutschick and Treckamn, 1959 (part), Jour. Paleontology, v. 33, p. 237, pl. 34, fig. 17; Rockford Limestone, Indiana.

Hyperammina casteri Conkin, 1961 (part), Bull. Am. Paleontology, v. 43, p. 260-264, pl. 20, figs. 1, 2, 4, 13; New Providence Formation, Indiana and Kentucky, and Falling Run Member of Sanderson Formation, Kentucky.

Hyperammina curva Mound, 1961 (part), Indiana Geol. Survey Bull. 23, p. 35, pl. 3, figs. 13, 14; Brassfield Limestone, Indiana.

Hyperamminella minuta Cushman and Waters, 1928 (part), Cushman Lab. Foram. Research Contr., v. 4, pt. 2, p. 37, pl. 4, fig. 8; Strawn Group, Texas.

Hyperamminella protea Cushman and Waters, 1928 (part), Cushman Lab. Foram. Research Contr., v. 4, pt. 2, p. 36, pl. 4, fig. 5; Strawn Group, Texas.

Hyperamminoides acicula Parr, 1942 (part), Royal Soc. Western Australia Jour., v. 27, p. 105, pl. 1, fig. 4, pl. 2, fig. 4; Wandagee Stage, Lingula beds, Western Australia.

Arenosiphon gigantea Grubbs, 1939, Jour. Paleontology, v. 13, pl. 61, figs. 1-3; Niagaran, Illinois.

Jaculella liassica Brand, 1937 (part), *in* Bartenstein and Brand, Senckenberg. naturf. Gesell. Abh., no. 439, p. 129, pl. 2 B, fig. 1; Jurassic, Germany.

Jaculella obtusa Earland, 1933 (not Brady), Foraminifera; pt. 2, Discovery Repts., v. 7, p. 68, pl. 2, fig. 11; Recent, South Georgia.

Jaculella acuta Brady, 1879, Quart. Jour. Micros. Sci., new ser., v. 19, p. 35, pl. 3, figs. 12, 13; Recent, North Atlantic. Cushman, 1910, U. S. Natl. Mus. Bull. 71, pt. 1, p. 70, text-figs. 90, 91; Recent, North Pacific. Cushman, 1919, U. S. Natl. Mus. Bull. 104, pt. 1, p. 84, pl. 32, figs. 1-4; Recent, Atlantic. McKnight, Jr., 1962, Bull. Am. Paleontology, v. 44, p. 99, pl. 9, fig. 5; Recent, Antarctic.

Wall generally rough exteriorly, smoother interiorly, consisting of a thick layer of sand-sized and medium to fine silt-sized particles, having much cement; some specimens show an inner chitinous layer beneath a layer of amorphous siliceous cement; others contain minute monaxon sponge spicules. Test free, elongate-conical, consisting of a single nonseptate chamber having no internal or external constriction; the tubular chamber is slightly compressed and broadens aperturally. Wide end slightly constricted, with terminal sperture.

Dimensions: Holotype dimensions not given. Measurements on 13 Indiana specimens in mm:

Maximum test length	Apertural diameter	Wall thickness
0.70	0.05	0.05
0.31	0.05	0.03
1.11	0.07	0.07
0.66	0.07	0.02
0.94	0.05	0.02
0.94	0.05	0.02
0.75	0.07	0.03
1.13	0.20	0.06
0.83	0.04	0.02
0.65	0.12	0.03
1.12	0.17	0.07
0.95	0.09	0.05
0.77	0.10	0.05

Remarks: Jaculella acuta has only been reported from Recent material and has generally been ignored by students of Paleozoic faunas. Forms virtually identical with those figured by Brady are common in the Indiana collections; specimens figured by many other workers and bearing as close a resemblance to the original *J. acuta* commonly have been assigned to species of *Hyperammina* as microspheric forms with indistinct proloculi. These hyperamminids are here placed in synonymy, following Brady's (1884, p. 64, 229) original distinction between *Jaculella* and *Hyperammina,* which is:

Jaculella: Test elongate, tapering; aperture at the broad end...

Hyperammina: Test elongated, tubular, the closed end broad and rounded, sometimes inflated so as to form a distinct chamber; tube simple or branched, free or adherent.... The tubular series with firmly cemented arenaceous tests constituting the Subfamily Rhabdamminae of which *Saccammina* is but a globular modification, may be said to commence with *Jaculella,* which is represented by a tapering sandy tube, closed at the narrow end. Some specimens of this genus are scarcely distinguishable from the simpler species of *Hyperammina,* which also is typified by a nearly straight tube, but with the broad end closed and rounded. The remainder of the Hyperamminae present very diverse forms; they are all tubular, either straight or sinuate, simple or branched, free or adherent, but invariably when perfect have a rounded initial chamber.

The Indiana specimens that contain abundant spicular material came from sample residues having considerable poriferan spicules; thus test composition of some specimens of *J. acuta* depends upon material available at the time of construction of the test.

Types: Figured hypotypes, InGS 4G 54; unfigured hypotypes, InGS 4G 55.

Distribution: Locality 1: Wabash Formation, 137.4 to 141.4 and 158.3 to 167.5 ft; Louisville Limestone, 350.7 to 354.2 and 364.7 to 368.7 ft; Salamonie Dolomite, 448 to 452, 484 to 488, 500 to 516, and 588.0 to 596.5 ft; locality 3: Salamonie Dolomite, 300.7 to 312.9 and 382.5 to 383.5 ft; Brassfield Limestone, 391.4 to 393.3 ft; locality 4: Wabash Formation, Mississinewa Shale Member, 4.4 to 9.0 ft; Salamonie Dolomite, 157.3 to 154.5 and 161.0 to 162.5 ft; Brassfield Limestone, 174.7 to 177.5 ft.

Subfamily **Rhizamminae** Rhumbler, 1895

Genus **Bathysiphon** M. Sars, 1872

Bathysiphon exiguus Moreman

Plate 3, figures 33-36

Bathysiphon curvus var. *gracilis* Ireland, 1939, Jour. Paleontology, v. 13, p. 192, pl. A, figs. 13, 14; Chimneyhill Limestone, Oklahoma.

Bathysiphon rugosus Ireland, 1939, Jour. Paleontology, v. 13, p. 192, pl. A, figs. 2, 3; Henryhouse Shale, Oklahoma. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 232, 233, pl. 52, fig. 11; Osgood Formation, Indiana.

Bathysiphon parallelus Dunn, 1942, Jour. Paleontology, v. 16, p. 322, pl. 42, fig. 1; Osgood Limestone, Missouri.

Bathysiphon angelseaensis Crespin, 1950, Cushman Lab. Foram. Research Contr., v. 1, p. 71, pl. 10, fig. 1; Oligocene, Australia.

Bathyshipon exiguus Moreman, 1930, Jour. Paleontology, v. 4, p. 46, pl. 6, fig. 8, Viola Limestone, Oklahoma. Stewart and Priddy, 1941, Jour. Paleontology, v. 15, p. 370, pl. 54, fig. 7; Laurel Limestone and Osgood Formation, Indiana. Dunn, 1942, Jour. Paleontology, v. 16, p. 322, pl. 42, fig. 27; Brassfield Limestone and Niagaran Series, Illinois. Mound, 1961, Indiana Geol. Survey Bull. 23, p. 36, pl. 3, figs. 17-20; Brassfield Limestone, Indiana. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 232, pl. 52, figs. 7, 8; Osgood Formation, Indiana.

Dimensions: Holotype: length, 0.25 mm. Twenty Indiana specimens in mm: lengths, 0.17 to 1.85; wall thickness, 0.02 to 0.07; modal thickness, 0.02.

Remarks: Bathysiphon exiguus exhibits a wide range of variability in test shape; tests are straight and cylindrical or irregular to slightly curved, and some Indiana specimens have external constrictions imparting a distinctly lobulate shape. The walls of many specimens are smooth on all surfaces and consist of fine silt and much cement; uncommonly, specimens are coarsely arenaceous and have small amounts of interstitial cement. Specimens with thinner walls are slightly compressed; several stouter walled specimens were broken and recemented.

B. exiguus is characterized by its cylindrical, slightly tapering test and its variation in wall composition.

Types: Figured hypotypes, InGS 4G 56; unfigured hypotypes, InGS 4G 57.

Distribution: Locality 1: Wabash Formation, Mississinewa Shale Member, 286.5 to 290.5 ft; Salamonie Dolomite, 424 to 428, 452 to 460, 472 to 568, and 584.0 to 604.8 ft; Brassfield Limestone, 604.8 to 606.8 ft; locality 2: Brassfield Limestone, 821 to 825 ft; locality 3: Salina Formation, Kokomo Limestone Member, 41.0 to 50.7 ft; Wabash Formation, unnamed member, 52.0 to 77.6 ft, Liston Creek Limestone Member, 102.0 to 120.8 ft, and Mississinewa Shale Member, 148.5 to 237.9 ft; Louisville Limestone, 248.2 to 249.3 ft; Salamonie Dolomite, 300.7 to 383.5 ft; locality 4: Salamonie Dolomite, 118.0 to 126.5 and 147 to 171 ft; Brassfield Limestone, 171.6 to 179.0 ft; locality 5: Wabash Formation, Mississinewa Shale Member, 166.6 to 180.6 ft; Louisville Limestone, 182.9 to 266.9 ft; Osgood Limestone, 311.7 to 345.6 ft.

Genus **Marsipella** Norman, 1878

Marsipella elongata Norman

Plate 4, figures 1-3

Marsipella granulosa Brady, 1879, Quart. Jour. Micros. Sci., new ser., v. 19, p. 36, pl. 3, figs. 8, 9; Recent, Azore Islands.

Marsipella cylindrica Cushman, 1918 (not Brady), U. S. Natl. Mus. Bull. 104, pt. 1, p. 24-26, pl. 8, figs. 4-6; Recent, Caribbean.

Marsipella? torta Stewart and Priddy, 1941, Jour. Paleontology, v. 47, p. 496, pl. 54, fig. 4; Osgood Formation, Ohio.

Marsipella elongata Norman, 1878, Annals and Mag. Nat. History, ser. 5, v. 1, p. 281, pl. 16, fig. 7; Recent, Scotland. Brady, 1884, Rept. Voyage Challenger, Zoology, v. 9, p. 264, pl. 24, figs. 10-19; Recent, North Atlantic. Cushman, 1918, U. S. Natl. Mus. Bull. 104, pt. 1, p. 23, 24, pl. 8, figs. 2, 3; Recent, North Atlantic.

Dimensions: Holotype: length, 4.5 mm. Thirty-two Indiana specimens range from 0.40 to 3.51 mm in length; modal length is 1.11 mm.

Remarks: Several Indiana specimens clearly show incorporation of monaxon sponge spicules in the test wall. Those specimens that contain spicular material were recovered from residues of samples which yielded abundant siliceous spicules of varied morphological types (stylose and klostose monaxons, triaxons, tetraxons, polyaxons, etc.), whereas those specimens virtually lacking spicular material came from residues containing little or no loose poriferan debris. Thus *Marsipella elongata* shows a wide range of adaptability to its environments.

The characteristic clublike knob of spicules and (or) mud closing off the aperture at one end of the tests of modern examples is not present in the Indiana specimens; this feature is rarely found in the fossilized state, because the constituent particles are loosely fitted about the aperture in the living test.

Types: Figured hypotypes, InGS 4G 58; unfigured hypotypes, InGS 4G 59.

Distribution: Locality 1: Wabash Formation 158.25 to 163.4, 286.5 to 290.5, and 334.5 to 338.6 ft; Louisville Limestone, 350.7 to 368.7 and 401 to 405 ft; Salamonie Dolomite, 428 to 432, 448 to 460, 468 to 472, 480 to 504, 512 to 532, 544 to 564, and 598.6 to 602.8 ft; locality 2; Salamonie Dolomite, 640 to 644 ft; Brassfield Limestone, 821 to 825 ft; locality 3: Wabash Formation, Mississinewa Shale Member, 218.0 to 237.9 ft; Salamonie Dolomite, 300.7 to 338.4 ft; locality 4: Salamonie Dolomite, 122.0 to 126.5 and 134.5 to 171.6 ft; locality 5: Wabash Formation, Mississinewa Shale Member, 179.2 to 180.6 ft; Louisville Limestone, 182.9 to 217.3 ft; Osgood Formation, 310.4 to 311.6 ft.

Family **Saccamminidae** Brady, 1884

Subfamily **Diffusulininae** Loeblich and Tappan, 1964

Genus **Crithionina** Goes

Crithionina pisum Goes

Plate 4, figure 4

Crithionina abyssorum (part) Klaer, 1889, Norske Nordays-Exped., p. 7, pl. 1, fig. 2; Recent, Norway.

Crithionina pisum Goes, 1896, Harvard Coll. Mus. Comp. Zoology Bull., v. 29, p. 24, pl. 2, figs. 1, 2; Recent, Gulf of Mexico. Millett, 1899, Royal Micros. Soc. Jour., p. 250, pl. 4, fig. 3; Recent, England.

Dimensions: Holotype and paratypes range from 1 to 3 mm in maximum diameter; nine Indiana specimens range from 0.41 to 0.70 mm.

Remarks: The characteristic labyrinthic interior of *Crithionina pisum* can be seen only in broken specimens; unbroken specimens are virtually indistinguishable from species of the externally similar *Psammosphaera.*

Types: Figured hypotypes, InGS 4G 60; unfigured hypotypes, InGS 4G 61.

Distribution: Locality 1: Louisville Limestone, 396.9 to 401.0, 405.0 to 408.5, and 415.5 to 419.1 ft; Salamonie Dolomite, 456 to 460, 472 to 476, 500 to 504, 524 to 528, and 580 to 584 ft; locality 3: Wabash Formation, Mississinewa Shale Member, 218.0 to 218.8 ft; Salamonie Dolomite, 337,5 to 364.1 ft; locality 4: Louisville Limestone, 58.5 to 61.0 ft; Salamonie Dolomite, 118 to 122 and 167.7 to 171.6 ft.

Subfamily **Hemisphaeramminae** Loeblich and Tappan, 1961

Genus **Amphicervicis** Mound, 1961

Amphicervicis elliptica Mound

Plate 4, figures 5-7

Amphicervicis elliptica Mound, 1961, Indiana Geol. Survey Bull. 23, p. 29, 30, pl. 2, figs. 14-20, text-fig. 4; Brassfield Limestone, Indiana. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 214, 215, pl. 50, fig. 7; Osgood Formation, Indiana.

Dimensions: Holotype: maximum diameter, 0.30 mm; minimum diameter, 0.20 mm; d_1/d_2, 0.66. Measurements on five specimens in mm:

Maximum diameter (d_2)	Minimum diameter (d_1)	Lengths of protuberances	d_1/d_2
0.26	0.20	0.02, 0.02	0.77
0.29	0.21	0.02, 0.01	0.73
0.26	0.20	0.03, -----	0.77
0.65	0.56	0.03, -----	0.80
0.26	0.19	0.03, -----	0.73

Remarks: The holotype of *Amphicervicis elliptica* was lost; I have selected one of the original unfigured paratypes and here designate it as the neoholotype, retaining the original InGS holotype number (InGS 416).

Amphicervicis is differentiated from species of *Thurammina* Brady and *Amphitremoidea* Eisenack by possessing three spirally wound chambers, the first two enveloped by the third. These internal features may be seen without breaking or sectioning specimens by using transmitted light.

Amphicervicis elliptica is further characterized by its elliptically shaped test, its two apertural protuberances, and its flattened base.

Types: Figured neoholotype, InGS 416; figured autotypes, InGS 4G 62; unfigured autotypes, InGS 4G 63.

Distribution: Locality 1: Salamonie Dolomite, 496 to 500 ft; locality 3: Wabash Formation, Liston Creek Limestone Member, 102.0 to 102.8 and 119.7 to 120.8 ft, and Mississinewa Shale Member, 237.0 to 237.9 ft; Louisville Limestone, 248.2 to 249.3 ft; locality 4: Salamonie Dolomite, 167.7 to 171.6 ft; Brassfield Limestone, 171.6 to 179.0 ft.

Amphicervicis hemisphaerica Mound

Plate 4, figure 8

Amphicervicis hemisphaerica Mound, 1961, Indiana Geol. Survey Bull. 23, p. 31, 32, pl. 2, figs. 21-28, text-fig. 5; Brassfield Limestone, Indiana.

Dimensions: Holotype: maximum diameter, 0.17 mm; minimum diameter, 0.16 mm; d_1/d_2, 0.94. Measurements on three specimens in mm:

Maximum diameter (d_2)	Minimum diameter (d_1)	Lengths of protuberances	d_1/d_2
0.46	0.43	0.03, 0.02	0.94
0.43	0.37	0.02, 0.01	0.81
0.26	0.27	0.02, 0.02	0.97

Remarks: Amphicervicis hemisphaerica differs from *A. elliptica* because of its hemispherical test. The presence of the characteristic two internal chambers distinguishes *A. hemisphaerica* from *Thurammina foerstei.*

Types: Figured autotypes, InGS 4G 64; unfigured autotypes, InGS 4G 65.

Distribution: Locality 1: Salamonie Dolomite, 496 to 500 and 536 to 540 ft; locality 3: Salamonie Dolomite, 337.5 to 338.4 ft; locality 4: Brassfield Limestone, 171.6 to 179.0 ft.

Genus **Fairliella** Summerson

Fairliella carmani Summerson

Plate 4, figures 9, 10

Fairliella carmani Summerson, 1958, Jour. Paleontology, v. 32, p. 556, pl. 82, figs. 15, 16; text-figs. 4a, b; Columbus Limestone, Ohio.

Wall coarsely arenaceous, rough interior and exterior surfaces, thin to thick, greatest thickness at test base, composed of medium and fine silt-sized particles, one to several layers thick, and varying amounts of cement. Test attached, composed of an undivided plano-convex single chamber that is circular in dorsal view; upper and lower surfaces meet at a narrow angle to form a wedge-shaped flange; exterior of lower test surface exhibits attachment contours; basal wall is thinner than upper wall. Aperture not apparent.

Dimensions: Holotype in mm: greatest diameter, 0.57; height, about 0.24. Measurements on 10 Indiana specimens in mm:

Greatest diameter	Height	Wall thickness	Intervallum distance
0.71	0.31	0.03	0.07
0.65	-----	0.03	------
0.61	0.34	0.03	0.20
0.85	0.32	0.07	0.10
1.12	0.34	0.10	0.14
0.99	0.32	0.12	-----
0.99	0.26	0.03	0.05
0.97	0.19	0.03	0.05
1.04	0.56	0.05	0.17
0.31	0.14	0.03	------

Remarks: Fairliella carmani possesses a peripheral flange which is wedge shaped and formed by the junction of the upper and lower test walls, thus differing from species of *Polyhemisphaerammina*.

The dimension herein termed intervallum distance is measured parallel to the direction of height; when compared with height it fundamentally expresses the shape of the living space that is shown to vary in sectioned view between crescentic and lens shape.

Types: Figured hypotypes, InGS 4G 66; unfigured hypotypes, InGS 4G 67.

Distribution: Locality 1: Louisville Limestone, 421.6 to 424.0 ft; Salamonie Dolomite, 424.0 to 428.6, 452 to 456, 532 to 536, 548 to 552, and 564 to 568 ft; locality 3: Wabash Formation, Mississinewa Shale Member, 218.0 to 218.8 ft; Salamonie Dolomite, 311.6 to 356.0 ft; locality 4: Wabash Formation, Mississinewa Shale Member, 4.4 to 9.0 ft.

Fairliella clitellata Summerson

Plate 4, figures 11, 12

Fairliella clitellata Summerson, 1958, Jour. Paleontology, v. 32, p. 556, pl. 82, figs. 17, 18, text-figs. 5a, b, c; Columbus Limestone, Ohio.

Wall thin to thick, composed of medium and fine silt-sized particles, one layer thick, and much cement. Test attached, consisting of an undivided single semiovoid chamber of low convexity, upper and lower surfaces rough and meeting to form a sharp, wedgelike flange; upper exterior surface marked by irregularly spaced ridges and depressions. Aperture not apparent.

Dimensions: Holotype in mm: greatest diameter, 0.63; height, about 0.30 (from Summerson's, 1958, text-fig. 5a). Measurements on three Indiana specimens in mm:

Greatest diameter	Height	Wall thickness	Intervallum distance
0.74	0.22	0.05	0.10
0.74	0.20	0.05	0.09
1.02	0.27	0.10	0.19

Remarks: Summerson recorded two distinct sizes for *Fairliella clitella,* considering them to be representative dimorphic forms. The present examples have sizes comparable only to the larger of Summerson's forms.

Types: Figured hypotypes, InGS 4G 68; unfigured hypotypes, InGS 4G 69.

Distribution: Locality 1: Louisville Limestone, 415.5 to 419.1 ft; Salamonie Dolomite, 464 to 468, 532 to 536, and 548 to 552 ft; locality 4: Louisville Limestone, 57.8 to 65.0 ft.

Fairliella discoidea Summerson

Plate 4, figures 13-15

Fairliella discoidea Summerson, 1958, Jour. Paleontology, v. 32, p. 557, pl. 82, fig. 20, text-figs. 6a, b; Columbus Limestone, Ohio.

Dimensions: Holotype in mm: greatest diameter, 0.45; height, about 0.16 (from Summerson's, 1958, text-fig. 6b). Measurements on six Indiana specimens in mm:

Greatest diameter	Height	Wall thickness	Intervallum distance
0.85	0.39	0.07	0.31
0.70	0.32	------	------
0.73	0.34	------	------
0.90	0.52	0.05	0.41
0.50	0.32	0.05	0.21
0.87	0.41	0.03	0.36

Remarks: This species differs from other species of *Fairliella* by its biconvex shape and from *Psammosphaera laevigata* White by its wedge-shaped flange.

Types: Figured hypotypes, InGS 4G 70; unfigured hypotypes, InGS 4G 71.

Distribution: Locality 1: Salamonie Dolomite, 424 to 432, 492 to 496, and 532 to 536 ft; locality 4: Louisville Limestone, 57.8 to 65.0 ft; locality 5: Louisville Limestone, 182.9 to 185.0 ft.

Fairliella lameyi Summerson

Plate 4, figures 16, 17

Fairliella lameyi Summerson, 1958, Jour. Paleontology, v. 32, p. 557, pl. 82, fig. 21, text-figs. 7a, b; Columbus Limestone, Ohio.

Dimensions: Holotype in mm: greatest diameter, 0.96; height, about 0.20 (from Summerson's, 1958, text-fig. 7b). Measurements on three Indiana specimens in mm:

Greatest diameter	Height	Wall thickness	Intervallum distance
0.83	0.09	0.05	0.02
1.09	0.16	0.04	0.10
0.98	-----	0.05	-----

Remarks: Fairliella lameyi has a characteristically elliptical test outline in dorsal view, which serves to distinguish it from *F. carmani,* its most closely allied congener. It differs from *F. clitellata* by lacking dorsal ridges and depressions.

Types: Figured hypotypes, InGS 4G 72; unfigured hypotypes, InGS 4G 73.

Distribution: Locality 1: Salamonie Dolomite, 424 to 432 and 488 to 492 ft.

Genus **Hemisphaerammina** Loeblich and Tappan

Loeblich and Tappan (1957) intended the generic name *Hemisphaerammina* to accommodate the single-chambered hemispherical agglutinated specimens formerly assigned to the emended *Webbinella.* The concept is restricted further here to include only forms not possessing a definite peripheral flange.

Hemisphaerammina battaleri Loeblich and Tappan

Plate 4, figures 18-20

Webbina hemisphaerica Brady, 1884 (not Jones, Parker, and Brady), Rept. Voyage Challenger, Zoology, v. 9, p. 350, pl. 41, fig. 11; Recent, Durham, England.

Hemisphaerammina bradyi Loeblich and Tappan, 1957, U. S. Natl. Mus. Bull. 215, p. 224, pl. 72, fig. 2; Recent, Durham, England.

Hemisphaerammina battaleri Loeblich and Tappan, 1957, U. S. Natl. Mus. Bull. 215, p. 224, pl. 72, fig. 3; Santonian, Spain.

Wall rough or smooth exteriorly, most commonly smooth; interior smooth, composed of medium to fine silt-sized particles, one grain thick, and much cement; more cement is included in wall at base to about double the wall thickness. Test attached, consisting of a single undivided hemispherical chamber of varying degrees of inflation, most commonly of low convexity; test outline is irregularly circular or oval in dorsal view; wall at base of test and peripheral flange lacking. Aperture probably multiple between thickened basal edge and attachment surface, not apparent.

Dimensions: Holotype: greatest diameter, 0.83 mm. Diameters of 34 Indiana specimens in mm: maximum, 0.32 to 0.97; mean, 0.60; standard deviation, 0.12.

Remarks: Grain size of material incorporated into the wall, degree of prominence of these grains, thickness of the wall, test size and outline, and degree of convexity have considerable variation. The standard deviation of the test diameters, for example, is 0.12 mm as compared with a mean diameter of 0.60 mm. The Indiana specimens show gradational series for all these characters, and all the specimens are considered to belong to a single species.

The basal edge has a greater proportion of cement and is thicker than the rest of the wall, and it served as an edge of attachment. A foreign surface served the purpose of a basal wall, which is found in allied forms.

Types: Figured hypotypes, InGS 4G 74; unfigured hypotypes, InGS 4G 75.

Distribution: Locality 1: Louisville Limestone, 396.9 to 401.0, 408.5 to 412.0, and 419.1 to 424.0 ft; Salamonie Dolomite, 424 to 436, 476 to 520, 548 to 552, and 600.7 to 602.8 ft; locality 3: Wabash Formation, Mississinewa Shale Member, 218.0 to 237.9 ft; Louisville Limestone, 266.2 to 267.2 ft; locality 4: Wabash Formation, Mississinewa Shale Member, 4.4 to 9.0 ft; Louisville Limestone, 57.8 to 65.0 ft; Salamonie Dolomite, 157.7 to 161.0 ft; locality 5: Louisville Limestone, 244.8 to 249.0 ft.

Genus **Metamorphina** Browne and Schott, 1963

Browne and Schott (1963, p. 223, 224) described the new genus *Metamorphina* "to fill a vacancy for forms left without assignment when Loeblich and Tappan (1957) revised the description of the genus *Webbinella.*" *Metamorphina* includes those arenaceous forms that Browne believed to be representative of species previously assigned to *Webbinella* and some of the Paleozoic species that Loeblich and Tappan (1957) left to *Webbinelloidea* Stewart and Lampe, 1947. True species of *Webbinelloidea* lack the flattened border (basal flange) so characteristic of the forms that Browne termed "non-Webbinelloidea" (1963, p. 224) and assigned to *Metamorphina.*

Browne and Schott (1963) included previously named species of *Webbinella* under the single species name *Metamorphina tholus* [*nom. correct.* herein (*pro M. tholsus* Browne and Schott, 1963, *nom. imperfect.*)], species that differ in the number and arrangement of chambers. I do not subscribe to their concept of an all-inclusive species, and Browne and Schott also doubted that the forms they included in *M. tholus* should be considered as one species.

Metamorphina bipartita (Ireland)

Plate 4, figure 21

Webbinella bipartita Ireland, 1939, Jour. Paleontology, v. 13, p. 198, pl. B, figs. 14-15; Haragan Shale, Oklahoma. Summerson, 1958, Jour. Paleontology, v. 32, p. 553, pl. 82, fig. 2; Columbus? Limestone, Ohio.

Wall thin, thickening toward test base to form a marginal flange, composed of fine to medium silt-sized particles, one layer thick, and much cement. Test attached, composed of two unequal nonseptate chambers that are firmly joined but not interconnected; larger chamber envelops smaller. Aperture not apparent.

Dimensions: Holotype in mm: length, 0.47; width, 0.26; height, 0.10 and 0.14. Measurements on four Indiana specimens in mm:

Diameter	Chamber height
0.561	0.411
--------	--------
0.27	0.19
0.27	0.16
0.23	0.14
0.19	0.14
0.23	0.23
0.23	0.22

Remarks: The larger enveloping second chamber distinguishes *Metamorphina bipartita* from closely allied species.

Types: Figured hypotypes, InGS 4G 76; unfigured hypotypes, InGS 4G 77.

Distribution: Locality 1: Louisville Limestone, 415.5 to 419.1 ft; Salamonie Dolomite, 496 to 500 ft; locality 4: Louisville Limestone, 72.3 to 75.6 ft.

Metamorphina gibbosa (Ireland)

Plate 4, figure 22

Webbinella gibbosa Ireland, 1939, Jour. Paleontology, v. 13, p. 198, pl. B, figs. 23, 24; Chimneyhill Limestone, Oklahoma. Raymond, 1955, A. M. thesis, Indiana Univ., p. 17, 18, pl. 3, fig. 11; Osgood Formation, Indiana.

Wall thick, increasing slightly in thickness toward base to form a marginal flange, composed of fine silt-sized particles, one layer thick, and much cement. Test attached, composed of two unequal undivided noncommunicative chambers that are separated by septum; space near juncture of chambers filled with cement, so that only slight lobulation is apparent. Aperture indefinite.

Dimensions: Holotype in mm: length, 0.35; width, 0.25; height, 0.10. Measurements on four Indiana specimens in mm:

Chamber diameter	Height
0.315	0.230
0.380	0.315
0.290	0.275
0.270	0.180
0.315	0.225
0.223	0.140
0.360	0.140
0.250	0.110

Remarks: Metamorphina gibbosa may be distinguished from *M. bipartita* by its more sublobulate periphery.

Types: Figured hypotypes, InGS 4G 78; unfigured hypotypes, InGS 4G 79.

Distribution: Locality 1: Salamonie Dolomite, 496 to 500 ft.

Metamorphina quadripartita (Moreman)

Plate 4, figures 23-25

Webbinella quadripartita Moreman, 1933, Jour. Paleontology, v. 7, p. 396, pl. 47, figs. 4, 7; Haragan Shale, Oklahoma. Raymond, 1955, A. M. thesis, Indiana Univ., p. 18, 19, pl. 3, fig. 12; Osgood Formation, Indiana.

Wall thin, thickening toward test base to form a marginal flange, composed of medium and fine silt-sized particles, one layer thick, having interstices filled with cement. Test attached, composed of two unequal pairs of undivided, firmly connected, noncommunicative chambers that lie in a single plane and form a crude diamond shape; each chamber of a pair diametrically opposite its partner; chambers of the smaller pair in contact with each other; chambers of the larger pair do not touch but contact each of the smaller two chambers. Sutures between chambers at invariable angles of 120°. Aperture not apparent, probably multiple, at base of test.

Dimensions: Holotype: length, 0.95 mm. Measurements on five Indiana specimens in mm:

Chamber diameter (large pair)	Chamber diameter (small pair)
0.315	0.270
0.318	0.280
0.360	0.315
0.360	--------
0.315	0.225
--------	0.225
0.220	0.180
0.225	-------
0.370	0.270
-------	0.285

Remarks: The two unequal pairs of chambers and their suture angles distinguish *Metamorphina quadripartita* from forms of *Sorosphaera* Brady. The characteristic marginal keel is produced by a decided thickening of the wall at the junctions of the sides and floor of the test. No evidence suggests that *M. quadripartita* represents an intermediate ontogenetic stage of a form possessing either less or more chambers.

Types: Figured hypotypes, InGS 4G 80; unfigured hypotypes, InGS 4G 81.

Distribution: Locality 1: Salamonie Dolomite, 496 to 500 ft.

Genus **Tholosina** Rhumbler, 1895

Tholosina bulla Brady

Plate 4, figures 26, 27

Placopsilina bulla Brady, 1881, Quart. Jour. Micros. Sci., v. 21, p. 51; Recent, Buenos Aires.

Tholosina? dubia Dunn (part), 1942, Jour. Paleontology, v. 16, p. 337, pl. 44, figs. 12, 13; Bainbridge Limestone, Missouri.

Tholosina bulla Rhumbler, 1895, Kgl. Gesell. Wiss. Nachr., p. 82; Recent, Atlantic. Cushman, 1910, U. S. Natl. Mus. Bull. 71, pt. 1, p. 49, text-fig. 55; Recent, Pacific. Cushman and McCulloch, 1939, Allan Hancock Pacific Exped., v. 6, p. 49, 50, pl. 2, fig. 6; Recent, Mexico.

Wall generally rough exteriorly, smoother interiorly, consisting of a single layer of medium to fine silt-sized particles, having varying amounts of cement. Test attached, hemispherical, circular to subcircular in outline, consisting of a single undivided chamber; specimens possess a basal wall. Aperture simple, circular, elliptical, or crescentic, single or at either end, basal, at the end of a very short cylindrical protuberance.

Dimensions: Holotype dimensions not given. Measurements on eight Indiana specimens in mm:

Maximum diameter	Length of apertural neck	Apertural diameter
0.53	0.03	0.01
0.46	0.02, 0.02	0.09, 0.05
0.48	0.02, 0.01	0.10, 0.07
0.26	0.02, 0.01	0.03, 0.03
0.74	------	0.07, 0.07
0.28	------	0.11, 0.05
0.65	------	0.28, 0.14
0.43	------	0.14, 0.12

Remarks: Tholosina bulla is characterized by its hemispherical test and its circular outline when viewed from above. Most forms of *Tholosina* placed in this species lack the basal wall.

Types: Figured hypotypes, InGS, 4G 82; unfigured hypotypes, InGS 4G 83.

Distribution: Locality 1: Salamonie Dolomite, 424 to 428 and 496 to 500 ft; locality 3: Wabash Formation, Mississinewa Shale Member, 152.8 to 153.6 and 226.1 to 227.2 ft; Louisville Limestone, 248.2 to 249.3 ft; locality 4: Louisville Limestone, 72.3 to 75.6 ft; Salamonie Dolomite, 134.5 to 138.7 and 161.0 to 162.5 ft.

Tholosina convexa Moreman

Plate 4, figures 28, 29

Tholosina sedentata Ireland, 1939, Jour. Paleontology, v. 13, p. 198, pl. B, text-figs. 16, 17; Chimneyhill Limestone, Oklahoma.

Tholosina convexa Moreman, 1930, Jour. Paleontology, v. 4, p. 55, pl. 5, fig. 17; Chimneyhill Limestone, Oklahoma. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 221, 222, pl. 51, fig. 14; Osgood Formation, Indiana.

Dimensions: Holotype: length, 0.74 mm. Measurements on eight Indiana specimens in mm:

Maximum diameter	Length of apertural neck	Apertural diameter
0.49	0.09	0.02
0.26	0.10	0.02
0.29	0.07	0.02
0.29	0.03	0.01
0.21	0.03	0.01
0.34	0.09	0.02
0.26	0.10	0.03

Remarks: Tholosina convexa is distinguished from *T. bulla* by possessing a short tapering apertural neck and a characteristic basal wall.

Types: Figured hypotypes, InGS 4G 84; unfigured hypotypes, InGS 4G 85.

Distribution: Locality 1: Salamonie Dolomite, 500 to 512 ft; locality 3: Wabash Formation, Liston Creek Limestone Member, 107.6 to 108.7 ft, and Mississinewa Shale Member, 218.0 to 218.8 ft; Louisville Limestone, 248.2 to 249.3 ft; Salamonie Dolomite, 335.7 to 456.8 ft; locality 4: Salamonie Dolomite, 157.3 to 154.5 ft; Brassfield Limestone, 177.5 to 179.0 ft.

Tholosina phrixotheca n. sp.

Plate 5, figures 1-4; text figure 6

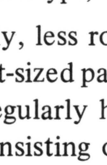

Figure 6. *Tholosina phrixotheca* n. sp. Lateral view of holotype, X25.

Wall generally rough exteriorly, less rough interiorly, consisting of a single layer of sand-sized to silt-sized particles, having varying amounts of cement. Test attached, irregularly hemispherical, elliptical to subelliptical in dorsal outline, consisting of a single undivided chamber, lacking a basal wall but possessing an irregular border; surface of the test moderately convoluted into ridges and depressions. Apertures circular, elliptical, or crescentic, at either end near the base, one at the end of a short neck, the other a simple opening.

Dimensions: Measurements on seven Indiana specimens in mm:

Specimen	Maximum diameter	Length of apertural neck	Apertural diameters
Holotype	1.11	0.26	0.09. 0.12
Figured paratype	0.46	0.07	0.09, 0.10
Unfigured paratypes	0.31	0.07	0.09, 0.10
	0.27	0.07	0.03, 0.07
	0.24	0.03	0.03, 0.03
	0.48	-----	0.14
	0.31	0.02	0.09, 0.14

Remarks: The wrinkled surface of the upper test wall and the characteristic elliptical outline distinguish *Tholosina phrixotheca* from allied species. As in *T. bulla,* the surface of attachment undoubtedly functioned as a basal wall for *T. phrixotheca.* In no other species of *Tholosina* are the apertures as clearly defined.

The species name *phrixotheca* refers to the rippled surface of the upper wall of the test: *phrixo-,* Gr., *phrix,* ruffling of a smooth surface, and *theca,* Gr., *theke,* case, envelope.

Types: Holotype, InGS 4G 86; figured paratypes, InGS 4G 87; unfigured paratypes, InGS 4G 88.

Distribution: Locality 1: Salamonie Dolomite, 456 to 460 and 500 to 504 ft; locality 3: Wabash Formation, Liston Creek Limestone Member, 102.0 to 108.7 ft, and Mississinewa Shale Member, 152.8 to 153.6 ft; locality 4: Louisville Limestone, 57.8 to 72.3 ft; Salamonie Dolomite, 151.3 to 154.5 and 167.7 to 171.6 ft; Brassfield Limestone, 174.7 to 177.5 ft.

Genus **Webbinelloidea** Stewart and Lampe, 1947

Webbinelloidea hemisphaerica Stewart and Lampe

Plate 5, figure 5

Tholosina? circularis Stewart and Lampe, 1947, Jour. Paleontology, v. 21, p. 536, pl. 79, figs. 4a, b; Columbus Formation, Ohio.

Tholosina? ovoidea Stewart and Lampe, 1947, Jour. Paleontology, v. 21, p. 536, pl. 79, fig. 5; Columbus Formation, Ohio.

Webbinelloidea sola Stewart and Lampe, 1947, Jour. Paleontology, v. 21, p. 535, pl. 79, figs. 2a, b, c; Columbus Formation, Ohio. Summerson, 1958, Jour. Paleontology, v. 32, p. 554, pl. 82, fig. 7; Columbus Limestone, Ohio.

Webbinelloidea rugosa Summerson, 1958, Jour. Paleontology, v. 32, p. 555, pl. 82, fig. 9, text-fig. 3; Columbus Limestone, Ohio.

Webbinelloidea hemisphaerica Stewart and Lampe, 1947, Jour. Paleontology, v. 21, p. 535, pl. 79, figs. 1a, b; Columbus Formation, Ohio. Summerson, 1958, Jour. Paleontology, v. 32, p. 553, pl. 82, figs. 4, 5; Columbus Limestone, Ohio.

Wall rough, thin or thick, commonly thick, composed of medium to fine silt-sized particles, poorly sorted, one layer thick, and moderate amounts of cement; basal wall is thinnest part of test. Test attached, consisting of a single undivided hemispherical chamber, commonly well inflated, having circular to oval outline in dorsal view. Aperture not apparent, probably multiple.

Dimensions: Holotype: greatest diameter, 0.76 mm. Eighteen Indiana specimens in mm: greatest diameter, 0.27 to 0.97; modal diameter, about 0.80.

Remarks: Webbinelloidea hemisphaerica is distinguished by its thin basal wall, which is lacking from forms of *Psammosphaera* and *Hemisphaerammina.*

W. hemisphaerica is very closely allied to species of *Tholosina* Rhumbler but lacks the minute multiple basal apertures, which are only suggested in the Indiana specimens.

Types: Figured hypotypes, InGS 4G 89; unfigured hypotypes InGS 4G 90.

Distribution: Locality 1: Louisville Limestone, 361.2 to 364.7, 376.6 to 380.6, and 412.0 to 421.6 ft; Salamonie Dolomite, 432 to 436, 492 to 532, and 544 to 592 ft; Brassfield Limestone, 604.8 to 606.8 ft; locality 2: Salamonie Dolomite, 644 to 648 and 784 to 788 ft; locality 3: Wabash Formation, Mississinewa Shale Member, 218.0 to 218.8 ft; Salamonie Dolomite, 337.5 to 338.4 and 363.4 to 364.1 ft; locality 4: Salamonie Dolomite, 143.0 to 151.3 ft.

Webbinelloidea similis Stewart and Lampe

Plate 5, figures 6, 7

Sorosphaera bicelloidea Stewart and Lampe, 1947, Jour. Paleontology, v. 21, p. 534, pl. 78, fig. 6; Columbus Formation, Ohio. Summerson, 1958, Jour. Paleontology, v. 32, p. 551, pl. 81, fig. 14; Columbus Limestone, Ohio.

Webbinelloidea similis Stewart and Lampe, 1947, Jour. Paleontology, v. 21, p. 535, pl. 78, fig. 8; Columbus Formation, Ohio. Summerson, 1958, Jour. Paleontology, v. 32, p. 554, pl. 82, fig. 6; Columbus Limestone, Ohio.

Dimensions: Holotype in mm: greatest diameter of individual chambers, 0.59 and 0.55 (second dimension from Stewart and Lampe's published figure). Greatest diameter of individual chambers for nine Indiana specimens in mm:

Specimen No.	1	2	3	4	5	6	7	8	9
Diameters	0.17 0.15	0.43 0.51	0.31 0.32	0.19 0.17	0.65 ------	0.31 0.32	0.32 0.34	0.46 0.40	0.12 0.13

Remarks: No intermediate stages between *Webbinelloidea similis* and *W. hemisphaerica* Stewart and Lampe have been observed in the Indiana and other faunas. The two chambers are about equal in each specimen, whatever the overall size.

Types: Figured hypotypes, InGS 4G 91; unfigured hypotypes, InGS 4G 92.

Distribution: Locality 1: Salamonie Dolomite, 428 to 432 and 500 to 504 ft; locality 3: Wabash Formation, Mississinewa Shale Member, 218.0 to 218.8 ft; Salamonie Dolomite, 311.6 to 312.9 ft; Brassfield Limestone, 384.8 to 392.5 ft.

Subfamily **Psammosphaerinae** Haeckel, 1894

Genus **Ceratammina** Ireland, 1939

Ceratammina cornucopia Ireland

Plate 5, figure 8

Ceratammina cornucopia Ireland, 1939, Jour. Paleontology, v. 13, p. 196, pl. A, figs. 31, 32; Haragan Shale, Oklahoma. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 211, pl. 49, figs. 17, 18; Osgood Formation, Indiana.

Wall thick to thin (0.017 to 0.035), finely to coarsely arenaceous, poorly to well cemented, surface commonly rough. Test free, horn shaped, consisting of a small spherical proloculus and rapidly expanding nonseptate second chamber coiled in an evolute planispire. Second chamber separated from the proloculus by a slight constriction;

terminal part possesses a septal face, which is rarely absent. Aperture not apparent, probably multiple, on septal face.

Dimensions: Holotype not designated; two syntypes in mm: height, 0.47 and 0.49; diameter, 0.27 and 0.39. Measurements on nine Indiana specimens in mm:

Height	Immature diameter	Mature diameter	Diameter of proloculus
0.374	0.068	0.187	0.068
0.323	0.068	0.119	0.051
0.374	0.102	0.136	0.080
0.323	0.068	0.119	0.051
0.323	0.080	0.119	0.068
0.306	0.068	0.119	0.051
0.306	0.080	0.119	--------
0.306	0.080	0.187	--------
0.220	0.068	0.119	-------

Remarks: Provision was not made in the original description for the planispiral scheme of coiling, the spherical proloculus, and the constriction between the proloculus and the succeeding second chamber.

The proloculus commonly is broken off at the constriction. Several specimens have proloculi that are small and slightly pointed and that lack conspicuous constrictions, so that the test more nearly approximates a horn shape.

These forms are smaller than Ireland's specimens but are proportionally similar.

Types: Figured hypotypes, InGS 4G 93; unfigured hypotypes, InGS 4G 94.

Distribution: Locality 1: Salamonie Dolomite, 496 to 520 ft.

Genus **Psammophax** Rhumbler

Psammophax hormiscoides Summerson

Plate 5, figures 9, 10

Psammophax hormiscoides Summerson, 1958, Jour. Paleontology, v. 32, p. 552, pl. 81, figs. 20, 21; Columbus Limestone, Ohio.

Dimensions: Holotype: chamber diameter, 0.55 mm. Greatest diameters of chamber of two three-chambered Indiana specimens in mm: 0.13, 0.14, 0.14 and 0.48, 0.48, 0.48.

Remarks: Psammophax hormiscoides is distinguished by its regular linear arrangement of chambers. No evidence of a fourth chamber in the series was found on either of the Indiana specimens as was observed in Summerson's forms.

Types: Figured hypotypes, InGS 4G 95; unfigured hypotypes, InGS 4G 96.

Distribution: Locality 1: Salamonie Dolomite, 424 to 428 and 476 to 480 ft; locality 3: Wabash Formation, Mississinewa Shale Member, 218.0 to 218.8 ft.

Genus **Psammosphaera** Schulze, 1875

Psammosphaera angularis Ireland

Plate 5, figures 11, 12

Psammosphaera rotunda Stewart and Lampe, 1947, Jour. Paleontology, v. 21, p. 533, pl. 78, fig. 4; Columbus Formation, Ohio. Summerson, 1958, Jour. Paleontology, v. 32, p. 550, pl. 81, fig. 9; Columbus Limestone, Ohio.

Psammosphaera angularis Ireland, 1939, Jour. Paleontology, v. 13, p. 192-194, pl. A, figs. 8, 9; Chimneyhill Limestone, Oklahoma.

Dimensions: Measurements on four Indiana specimens in mm:

Diameter	Wall thickness	Average grain diameter
0.204	-------	0.019
0.425	0.051	0.050
0.391	0.034	0.038
0.490	-------	0.050

Remarks: The angularity of the test outline is produced in part to the arrangement of the larger grains. The agglutinated particles are poorly sorted and form a texturally compact wall. The test is smooth interiorly and normally rough exteriorly. The lack of definite apertures distinguishes *P. angularis* from species of *Thurammina.*

Types: Figured hypotypes, InGS 4G 97; unfigured hypotypes, InGS 4G 98.

Distribution: Locality 1: Salamonie Dolomite, 472 to 476 and 496 to 500 ft; locality 2: Salamonie Dolomite, 624 to 628 and 704 to 708 ft; locality 3: Brassfield Limestone, 384.8 to 392.5 ft; locality 4: Salamonie Dolomite 157.7 to 161.0 ft; Brassfield Limestone, 171.6 to 174.7 ft.

Psammosphaera cava Moreman

Plate 5, figures 13-15

Psammosphaera micrograna Eisenack, 1932, Palaeont. Zeitschr., v. 14, p. 261, pl. 11, fig. 19; Beyrichenkalk, East Prussia.

Psammosphaera gracilis Ireland, 1939, Jour. Paleontology, v. 13, p. 194, pl. A, figs. 10, 11; Henryhouse Shale, Oklahoma.

Psammosphaera subsphaerica Stewart and Priddy, 1941, Jour. Paleontology, v. 15, p. 371, pl. 54, figs. 8, 9; Massie Shale, Ohio.

Psammosphaera minuta Dunn, 1942, Jour. Paleontology, v. 16, p. 323, pl. 42, figs. 10-12; Bainbridge Limestone, Missouri.

Psammosphaera arcuata Dunn, 1942, Jour. Paleontology, v. 16, p. 323, pl. 42, figs. 14a, b, 24; Brassfield Limestone, Illinois.

Psammosphaera cava Moreman, 1931, Jour. Paleontology, v. 4, p. 48, pl. 6, fig. 12; Chimneyhill Limestone, Oklahoma. Ireland, 1939, Jour. Paleontology, v. 15, p. 371, pl. 54, figs. 8, 9; Osgood Formation, Indiana. Dunn, 1942, Jour. Paleontology, v. 16, p. 322, pl. 42, fig. 6; Osgood Limestone, Missouri. Raymond, 1955, A. M. thesis, Indiana Univ., p. 11, 12, pl. 3, fig. 4; Osgood Formation, Indiana. Gutschick and Treckman, 1959, Jour. Paleontology, v. 33, p. 232, pl. 33, figs. 6, 7; Rockford Limestone, Indiana. Mound, 1961, Indiana Geol. Survey Bull. 23, p. 26, 27, pl. 2, figs. 2-6; Brassfield Limestone, Indiana. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 208, 209, pl. 49, figs. 7-10; Osgood Formation, Indiana.

Wall thin, composed of medium to fine silt-sized particles, one layer thick, having interstices filled with cement. Test is free, lacking evidence of having been attached, spherical to subspherical, most commonly spherical. Aperture not apparent.

Dimensions: Holotype dimensions not given. Measurements on eight Indiana specimens in mm:

Diameter	Wall thickness	Average grain dimension
0.748	0.034	0.035
0.697	0.035	0.035
0.374	0.034	0.032
0.748	0.040	0.042
0.629	0.034	0.034
0.595	0.051	0.055
0.680	0.068	0.051
0.578	0.085	0.051

Remarks: The Indiana forms of this species show wide variation in wall thickness, from 0.051 to 0.068 mm in one specimen, for example. This variation is due to the random orientation of elongate quartz grains, many of which are subhedral.

Types: Figured hypotypes, InGS 4G 99; unfigured hypotypes, InGS 4G 100.

Distribution: Locality 1: Salamonie Dolomite, 472 to 572 and 584.0 to 604.8 ft; Brassfield Limestone, 610.8 to 612.9 ft; locality 2: Salamonie Dolomite, 644 to 648 and 704 to 712 ft; locality 3: Wabash Formation, Liston Creek Limestone Member, 102.0 to 120.8 ft, and Mississinewa Shale Member, 152.8 to 237.9 ft; Louisville Limestone, 248.2 to 249.3 ft; Salamonie Dolomite, 311.6 to 312.9 and 363.4 to 364.1 ft; locality 4: Louisville Limestone, 61 to 65 ft; Salamonie Dolomite, 151.3 to 171.6 ft; Brassfield Limestone, 171.6 to 174.7 ft; locality 5: Louisville Limestone, 244.8 to 266.9 ft.

Psammosphaera fusca Schulze

Plate 5, figures 16, 17

Psammosphaera excerpta Dunn, 1942, Jour. Paleontology, v. 16, p. 323, pl. 42, figs. 7, 8; Osgood Limestone, Illinois. Summerson, 1958, Jour. Paleontology, v. 32, p. 550, pl. 81, fig. 7; Columbus Limestone, Ohio.

Psammosphaera rugosa Eisenack, 1954, Senckenberg. Lethaea, v. 35, p. 58, pl. 3, figs. 8-10; Wasalemm Formation, Estonia.

Psammosphaera aspera Summerson, 1958, Jour. Paleontology, v. 32, p. 550, pl. 81, figs. 10, 11; Columbus Limestone, Ohio.

Psammosphaera cava Mound (part; not Moreman), 1961, Indiana Geol. Survey Bull. 23, p. 26, 27, pl. 2, figs. 2-6; Brassfield Limestone, Indiana.

Psammosphaera fusca Schulze, 1875, Deutsche Meere Kiel, Comm. Wiss., Untersuchung, v. 2-3, p. 113, pl. 2, figs. 8a-f; Recent, Norway. Chapman and Parr, 1937, Australasian Antarctic Exped., Sci. Rept., v. 1, pt. 2, p. 160; Recent, Antarctic.

Dimensions: Holotype dimensions not given. Measurements on 11 Indiana specimens in mm:

Diameter	Wall thickness	Average grain dimension
0.510	0.102	0.100
0.357	0.051	0.045
0.306	-------	0.051
0.272	0.034	0.040
0.731	0.068	0.050
0.425	0.068	0.034
0.714	0.040	0.034
0.510	---------	0.038
0.374	0.051	0.036
0.629	0.051	0.050
0.404	0.070	0.082

Remarks: Psammosphaera fusca, the type species of the genus, is recognized here for the first time in the geologic records. It is characterized by having a smaller proportion of cement to grains than its congeners.

Types: Figured hypotypes, InGS 4G 101; unfigured hypotypes, InGS 4G 102.

Distribution: Locality 1: Salamonie Dolomite, 472 to 476, 484 to 500, and 524 to 540 ft; locality 3: Salamonie Dolomite, 355.7 to 356.8 ft; locality 4: Salamonie Dolomite, 118 to 122 ft.

Psammosphaera laevigata White

Plate 5, figures 18, 19

Psammosphaera conjunctiva Dunn, 1942, Jour. Paleontology, v. 16, p. 323, pl. 42, fig. 28; Osgood Formation, Missouri.

Psammosphaera delicutula Stewart and Lampe, 1947, Jour. Paleontology, v. 21, p. 532, pl. 78, figs. 1a, b; Columbus Formation, Ohio. Summerson, 1958, Jour. Paleontology, v. 32, p. 549, pl. 81, fig. 4; Columbus Limestone, Ohio.

Psammosphaera devonica Stewart and Lampe, 1947, Jour. Paleontology, v. 21, p. 533, pl. 78, fig. 2; Columbus Formation, Ohio. Summerson, 1958, Jour. Paleontology, v. 32, p. 549, pl. 81, fig. 5; Columbus Limestone, Ohio.

Psammosphaera discoidea Stewart and Lampe, 1947, Jour. Paleontology, v. 21, p. 533, pl.78, figs.3a, b; Columbus Formation, Ohio. Summerson, 1958, Jour. Paleontology, v. 32, p. 549, pl. 81, fig. 6; Columbus Limestone, Ohio.

Psammosphaera elongata Summerson, 1958, Jour. Paleontology, v. 32, p. 551, pl. 81, fig. 12; Columbus Limestone, Ohio.

Psammosphaera laevigata White, 1928, Jour. Paleontology, v. 2, p. 183, pl. 27, figs. 1a, b; Velasco Formation, Texas. Mound, 1961, Indiana Geol. Survey Bull. 23, p. 27, pl. 2, figs. 7, 8; Brassfield Limestone, Indiana. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 209, 210, pl. 49, fig. 19; Osgood Formation, Indiana.

Dimensions: Holotype dimensions not given. Measurements on 11 Indiana specimens in mm:

Diameter	Wall thickness	Average grain diameter
0.782	--------	0.070
0.663	0.051	0.040
0.884	0.053	0.038
0.068	--------	0.030
1.110	0.090	0.090
0.306	--------	0.036
0.782	--------	0.050
1.020	0.085	0.075
0.690	--------	0.035
0.690	--------	0.052
0.544	--------	0.019

Remarks: Psammosphaera laevigata differs from *P. cava* by having walls that are uniformly thick. The homogeneity results from orientation of the greater dimensions of grains mostly perpendicular to the surface of the test and from uniform distribution of cementing material.

Types: Figured hypotypes, InGS 4G 103; unfigured hypotypes, InGS 4G 104.

Distribution: Locality 1: Salamonie Dolomite, 472 to 500 ft; locality 4: Louisville Limestone, 58.5 to 69.0 ft; locality 5: Louisville Limestone, 221.4 to 227.8 ft.

Psammosphaera pusilla Parr

Plate 5, figure 20

Psammosphaera eocenica Cushman and Stainforth, 1951, Jour. Paleontology, v. 25, p. 142, pl. 25, figs. 6, 7; Seca Shale, Ecuador.

Psammosphaera pusilla Parr, 1942, Royal Soc. Western Australia Jour., v. 27, p. 106, pl. 1, figs. 6, 7; *Lingula* beds, Western Australia.

Dimensions: Holotype dimensions not given. Measurements on seven Indiana specimens in mm:

Diameter	Wall thickness	Average grain dimension
0.187	0.035	0.008
0.680	0.050	0.030
0.884	0.060	0.030
0.750	0.050	0.025
0.544	0.038	0.015
0.391	0.039	0.018
0.340	0.035	0.015

Remarks: Psammosphaera pusilla has greater wall thickness, relative to the individual component grain dimensions, and a much larger proportion of cement than other species of this genus.

Types: Figured hypotypes, InGS 4G 105; unfigured hypotypes, InGS 4G 106.

Distribution: Locality 1: Salamonie Dolomite, 472 to 500 ft.

Genus **Sorosphaera** Brady, 1879

The distinguishing characteristics among the described species of *Sorosphaera* are the numbers and arrangement of chambers and the shapes of the individual chambers. Some paleontologists emphatically advocate that all subgeneric taxa that are differentiated by these means should be included in a single embracive species. They believe that multiple-chambered specimens are mature individuals in an ontogenetic sequence and that all intermediate stages of growth are represented by the two-, three-, and four-celled tests commonly grouped into separate species. The concept of ontogenetic sequence is impossible to verify from the Indiana specimens. All samples are dominated separately by one of two, rarely three, so-called growth stages and always to the exclusion of some stages expectable in an ontogenetic series. Although Brady (1884), in studying living specimens of *S. confusa,* observed that an individual adds chambers whenever sufficient protoplasm accumulates exteriorly in one place, the numbers of chambers are used in small part in the present report for specific differentiation.

Many Indiana specimens of *Sorosphaera* have definite external apertures and internal foramina in each of what are here considered to be single species, whereas some individuals of a species do not appear to have these openings.

Sorosphaera bicella Dunn

Plate 5, figures 21, 22

Sorosphaera socialis Earland, 1934 (part), Foraminifera; pt. 3, Discovery Rept., Discovery Commun., Colonial Office, London, v. 10, p. 61, pl. 1, fig. 22; Recent, Antarctic.

Sorosphaera columbiense Stewart and Lampe, 1947, Jour. Paleontology, v. 21, p. 533, 534, pl. 78, figs. 5a, b, c; Delaware Formation, Ohio. Summerson, 1958, Jour. Paleontology, v. 32, p. 551, pl. 81, fig. 15; Columbus Limestone, Ohio.

Sorosphaera bicelloidea Stewart and Lampe, 1947, Jour. Paleontology, v. 21, p. 534, pl. 78, fig. 6; Columbus Formation, Ohio. Summerson, 1958, Jour. Paleontology, v. 32, p. 551, pl. 81, fig. 14; Columbus Limestone, Ohio.

Sorosphaera bicella Dunn, 1942, Jour. Paleontology, v. 16, p. 325, pl. 42, figs. 17, 18; Bainbridge Limestone, Missouri; Brassfield Limestone, Illinois. Summerson, 1958, Jour. Paleontology, v. 32, p. 551, pl. 81, fig. 13; Columbus Limestone, Ohio. Mound, 1961, Indiana Geol. Survey Bull. 23, p. 33, 34, pl. 3, figs. 4-6; Brassfield Limestone, Indiana. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 211, pl. 49, fig. 16; Osgood Formation, Indiana.

Wall smooth or rough exteriorly, most commonly smooth, smooth interiorly, consisting of a multiple layer of medium to fine silt-sized particles and much cement. Test free, consisting of two inflated spherical or ellipsoidal chambers that are closely joined and rarely communicative by means of a foramen. Aperture not apparent.

Dimensions: Holotype: diameters of individual chambers, both 0.26 mm. Measurements on six Indiana specimens in mm:

Diameters of individual chambers	Wall thickness
0.51	0.04
0.32, 0.31	0.03
0.31	0.05
0.26, 0.24	0.03
0.27, 0.22	0.03
0.20	0.03
0.31, 0.24	0.03
0.26, 0.24	0.03
0.29, 0.27	0.03
0.24	0.02

Remarks: Sorosphaera bicella is characterized by its two ellipsoidal to spherical, closely joined chambers.

Types: Figured hypotypes, InGS 4G 107; unfigured hypotypes, InGS 4G 108.

Distribution: Locality 1: Salamonie Dolomite, 496 to 520 and 596.5 to 598.6 ft; locality 3: Wabash Formation, Mississinewa Shale Member, 152.8 to 153.6 ft; Louisville Limestone, 266.2 to 267.2 ft; Salamonie Dolomite, 363.4 to 364.1 ft.

Sorosphaera confusa Brady

Plate 5, figures 23, 24

Sorosphaera confusa Brady, 1879, Quart. Jour. Micros. Sci., new ser., v. 19, p. 28, pl. 4, figs. 18, 19; Recent, Atlantic. Brady, 1884, Rept. Voyage Challenger, v. 9, p. 251, pl. 18, figs. 9, 10; Recent, Atlantic. Pearcey, 1914, Royal Soc. Edinburgh Trans., v. 49, p. 1000; Recent, Antarctic. Cushman, 1918, U. S. Natl. Mus. Bull. 104, pt. 1, p. 39, pl. 15, figs. 4, 5; Recent, Atlantic. Mound, 1961, Indiana Geol. Survey Bull. 23, p. 33, pl. 3, figs. 1-3; Brassfield Limestone, Indiana.

Wall rough or smooth exteriorly, most commonly smooth interiorly, consisting of a multiple layer of medium and fine silt-sized particles having much cement. Test free, consisting of a variable number of closely joined, randomly arranged spherical to subellipsoidal globular inflated chambers; some individual chambers communicating by means of internal circular foramen. Aperture a simple round opening, variable in diameter, rarely externally apparent.

Dimensions: Holotype not designated. Measurements on eight Indiana specimens in mm:

Number of chambers	Average diameter	Wall thickness
6	0.17	0.02
6	0.27	0.03
7	0.24	0.02
8	0.19	0.03
8	0.24	0.02
10	0.20	0.03
13	0.26	0.02

Remarks: Many Indiana specimens have circular openings between individual chambers ranging in diameter from 0.02 to 0.06 mm. These appear to be true foramina; other specimens have irregular openings that may be either enlarged natural openings or broken areas in the test wall.

S. confusa is characterized by having spherical chambers that are arrayed in compact or irregular aggregates, but adjacent chambers are strongly united and mutually embracive. Incomplete Indiana specimens have parts of broken chambers adhering, and they have not been assigned to two- and three-chambered forms.

Types: Figured hypotypes, InGS 4G 109; unfigured hypotypes, InGS 4G 110.

Distribution: Locality 1: Salamonie Dolomite, 496 to 504 and 516 to 524 ft.

Sorosphaera geometrica Eisenack

Plate 5, figures 25-27

Sorosphaera geometrica Eisenack, 1954, Senckenberg. Lethaea, v. 35, nos. 1-2, p. 61, pl. 4, figs. 19, 20, text-figs. 1-6; upper Llandoverian, Gotland. Gutschick, Weiner, and Young, 1961, Jour. Paleontology, v. 35, p. 1205-1207, pl. 147, figs. 11-14, 16; Lodgepole Limestone, Montana.

Dimensions: Holotype: greatest dimension, 0.73 mm. Measurements on 11 Indiana specimens in mm:

Number of chambers	Average diameter of individual chambers	Wall thickness
1	0.68	0.05
2	0.68	0.03
2	0.26	0.02
3	0.20	0.04
3	0.36	0.03
3	0.34	0.03
3	0.32	0.02
4	0.20	0.03
5	0.17	0.02
5	0.29	0.02
6	0.26	0.03

Remarks: Sorosphaera geometrica differs from its congeners by having an attached, flattened test composed of a variable number of planoconvex chambers. Compressed specimens have flattened rims resembling the more flaring borders characteristic of *Polyhemysphaerammina.* Departures from hemispherical shapes probably are due to the contours of the object to which the test was attached.

Forms from the Indiana samples range from one broken specimen, having only a single complete chamber, to a specimen with six chambers. The Indiana specimens compare well with Eisenack's (1954) figured types from Silurian rocks in the Baltic region.

Types: Figured hypotypes, InGS 4G 111; unfigured hypotypes, InGS 4G 112.

Distribution: Locality 1: Louisville Limestone, 396.9 to 401.0 ft; Salamonie Dolomite, 424 to 428, 484 to 528, 584 to 588, and 598.6 to 600.7 ft.

Sorosphaera osgoodensis Stewart and Priddy, 1941

Plate 5, figures 28, 29

Sorosphaera socialis Earland, 1934 (part), Foraminifera; pt. 2, Discovery Rept., Discovery Commun., Colonial Office, London, v. 10, p. 61, pl. 1, fig. 23; Recent, Antarctic.

Sorosphaera multicella Dunn, 1942, Jour. Paleontology, v. 16, p. 325, pl. 42, figs. 19a, b; Waldron Shale, Indiana.

Sorosphaera subconfusa Dunn, 1942, Jour. Paleontology, v. 16, p. 325, pl. 42, figs. 16, 20; Osgood Limestone, Missouri.

Sorosphaeroidea polygonia Stewart and Lampe, 1947, Jour. Paleontology, v. 21, p. 534, pl. 78, figs. 7a, b, c; Columbus Formation, Ohio. Summerson, 1958, Jour. Paleontology, v. 32, p. 551, pl. 81, fig. 16; Columbus Limestone, Ohio.

Sorosphaeroidea pentachora Summerson, 1958, Jour. Paleontology, v. 32, p. 552, pl. 81, fig. 18; Columbus Limestone, Ohio.

Sorosphaera osgoodensis Stewart and Priddy, 1941, Jour. Paleontology, v. 15, p. 371, pl. 54, fig. 11; Niagaran Series, Indiana and Ohio. Raymond, 1955, A. M. thesis, Indiana Univ., p. 12, 13, pl. 3, fig. 3; Osgood Formation, Indiana. Mound, 1961, Indiana Geol. Survey Bull. 23, p. 34, pl. 3, figs. 11, 12; Brassfield Limestone, Indiana.

Dimensions: Holotype not designated; average diameters of individual chambers of two syntypes, 0.25 mm. Measurements on eight Indiana specimens in mm:

Number of chambers	Average diameter of individual chambers	Wall thickness
5	0.19	0.05
4	0.20	0.03
4	0.31	0.03
4	0.22	0.02
5	0.20	0.04
5	0.17	0.02
4	0.17	0.02

Remarks: Sorosphaera osgoodensis is characterized by having four or more closely joined spherical chambers arranged in a single plane; some specimens have chambers arranged in irregularly linear series. Openings resembling external apertures are common.

Types: Figured hypotypes, InGS 4G 113; unfigured hypotypes, InGS 4G 114.

Distribution: Locality 1: Salamonie Dolomite, 496 to 516 ft; locality 3: Wabash Formation, Mississinewa Shale Member, 152.8 to 153.6 ft; locality 4: Brassfield Limestone, 171.6 to 174.7 ft.

Sorosphaera tricella Moreman, 1930

Plate 5, figures 30, 31

Sorosphaeroidea trichora Summerson, 1958, Jour. Paleontology, v. 32, p. 552, pl. 81, fig. 17; Columbus Limestone, Ohio.

Sorosphaera irregularis Grubbs, 1939, Jour Paleontology, v. 13, p. 544, pl. 61, fig. 4, Niagaran Series, Illinois.

Sorosphaera tricella Moreman, 1930, Jour. Paleontology, v 4, p. 49, pl. 5, figs. 12, 14, Chimneyhill Limestone, Oklahoma. Dunn, 1942, Jour. Paleontology, v 16, p. 325, pl. 42, fig. 15; Bainbridge Limestone, Missouri. Mound, 1961, Indiana Geol. Survey Bull. 23, p. 34, pl. 3, figs. 7-10, Brassfield Limestone, Indiana. Browne and Schott, 1963, Bull. Am. Paleontology, v 46, p. 212, pl. 49, fig. 15, Osgood Formation, Indiana.

Dimensions. Holotype not designated, average diameters of individual chambers of two syntypes, 0.18 and 0.36 mm. Measurements on six Indiana specimens in mm

Average diameter of individual chambers	Wall thickness
0.24	0.02
0.21	0.03
0.24	0.03
0.24	0.03
0.27	0.03
0.22	0.03

Remarks. Sorosphaera tricella is characterized by having three spherical chambers of equal size that are closely united along sutures that appear straight and at 120° angles to one another in plan view. Several specimens have one aperture on each chamber near the point where the three sutures meet, other specimens have circular foramina between chambers. Apertures are inconspicuous on or absent from some specimens. Another variety of *S. tricella,* common among the Indiana specimens, has three linearly arranged chambers.

Types. Figured hypotypes, InGS 4G 115, unfigured hypotypes, InGS 4G 116.

Distribution. Locality 1 Salamonie Dolomite, 464 to 468 and 496 to 516 ft, locality 5 Louisville Limestone, 258.5 to 266.9 ft.

Genus **Stegnammina** Moreman, 1930

Stegnammina cylindrica Moreman

Plate 5, figures 32, 33

Stegnammina triangularis Moreman, 1930, Jour. Paleontology, v. 4, p. 49, pl. 7, fig. 11, Chimneyhill Limestone, Oklahoma.

Stegnammina hebesta Moreman, 1930, Jour Paleontology, v 4, p. 50, pl. 7, fig. 13, Chimneyhill Limestone, Oklahoma.

Stegnammina elongata Ireland, 1939, Jour Paleontology, v 13, p. 194, pl. A, fig. 17, Haragan Shale, Oklahoma.

Stegnammina cylindrica brevis Dunn, 1942, Jour Paleontology, v 16, p. 325, pl. 42, fig. 25, Brassfield Limestone, Missouri.

Stegnammina cylindrica Moreman, 1930, Jour Paleontology, v 4, p. 49, pl. 7, fig. 12, Chimneyhill Limestone, Oklahoma. Mound, 1961, Indiana Geol. Survey Bull. 23, p. 25, pl. 1, figs. 26, 27, Brassfield Limestone, Indiana. Browne and Schott, 1963, Bull. Am. Paleontology, v 46, p. 210, pl. 49, figs. 11, 12, Osgood Formation, Indiana.

Wall generally rough exteriorly, smoother interiorly, consisting of a single to multiple layer of sand-sized and medium to fine silt-sized particles, having varying amounts of cement, some specimens show an inner chitinous layer; others have monaxon sponge spicules oriented parallel to the test length and incorporated in the wall. Test free or attached, cylindrical to triangularly prismatic, straight or slightly arcuate, consisting of a single undivided chamber, terminal parts of prismatic tests slightly flattened. Aperture not apparent

Dimensions Holotype in mm length, 0.76, width, 0.20 Twenty-three Indiana specimens range from 0.29 to 1 24 mm in length, from 0.14 to 0.43 mm in width, and from 0.02 to 0.11 mm in wall thickness, modal thickness is 0.03 mm

Remarks. Moreman designated *Stegnammina cylindrica* as type species of the genus *Stegnammina* but described it in paragraphs following the description of *S. triangularis.* The two species are here considered to be synonymous, and although *S. cylindrica* normally would be suppressed as a junior subjective synonym, it is here appropriately retained as primary name bearer following Recommendation 24a of the International Code of Zoological Nomenclature (Stoll and others, 1961).

Specimens with shapes between cylindrical and prismatic are characteristic of *S. cylindrica.* Several prismatic forms lack complete walls, apparently having a smooth, flat surface of attachment which functioned as the absent part.

Types. Figured hypotypes, InGS 4G 117, unfigured hypotypes, InGS 4G 118.

Distribution. Locality 1 Louisville Limestone, 401 to 405 ft, Salamonie Dolomite, 456 to 468, 496 to 504, 508 to 536, and 552 to 564 ft, locality 3 Wabash Formation, Mississinewa Shale Member, 218.0 to 218.8 ft, Salamonie Dolomite, 337.5 to 356.8 ft.

Genus **Thekammina** Dunn, 1942

Thekammina moremani Dunn

Plate 5, figure 34

Thekammina moremani Dunn, 1942, Jour Paleontology, v 16, p. 326, pl. 42, fig. 22; Brassfield Limestone, Missouri. Mound, 1961, Indiana Geol. Survey Bull. 23, p. 26, pl. 1, fig. 29; Brassfield Limestone, Indiana.

Wall rough exteriorly and interiorly, consisting of a single to multiple layer of sand- and silt-sized particles, having varying amounts of cement. Test free, slightly depressed, consisting of a single undivided chamber, subtriangular in outline. Aperture not apparent.

Dimensions Holotype greatest length, 0.30 mm. Three Indiana specimens have lengths of 0.36, 0.74, and 0.94 mm and wall thicknesses of 0.04, 0.04, and 0.05 mm.

Remarks. Thekammina moremani is easily distinguished by its characteristic triangular outline.

Types. Figured hypotypes, InGS 4G 119, unfigured hypotypes, InGS 4G 120.

Distribution Locality 1 Salamonie Dolomite, 424 to 428, 496 to 500, and 516 to 520 ft.

Thekammina quadrangularis Dunn

Plate 5, figures 35, 36

Thekammina quadrangularis Dunn, 1942, Jour Paleontology, v 16, p. 326, pl 42, fig. 23, Brassfield Limestone, Illinois. Mound, 1961, Indiana Geol. Survey Bull. 23, p. 25, pl. 1, fig. 28, Brassfield Limestone, Indiana. Browne and Schott, 1963, Bull. Am. Paleontology, v 46, p. 210, 211, pl. 49, figs. 13, 14, Osgood Formation, Indiana.

Wall rough exteriorly and interiorly, thick, consisting of a single to multiple layer of sand- and silt-sized particles, poorly cemented. Test free, consisting of a single undivided chamber, square to rectangular in outline, flattened. Aperture not apparent.

Dimensions. Holotype maximum length, 0.39 mm. Seventeen Indiana specimens range from 0.37 to 1 28 mm in length and from 0.03 to 0.09 mm in wall thickness, modal thickness is 0.05 mm.

Remarks *Thekammina quadrangularis* is characterized by its thick heterogeneous wall and its flattened boxlike test.

Types. Figured hypotypes, InGS 4G 121, unfigured hypotypes, InGS 4G 122.

Distribution Locality 1 Louisville Limestone, 364.7 to 368.7, 388.7 to 392.8, and 396.9 to 401.0 ft, Salamonie Dolomite, 464 to 468, 496 to 504, 516 to 540, 576 to 580, and 584 to 588 ft, locality 4: Salamonie Dolomite, 143 to 147 ft, Brassfield Limestone, 177.5 to 179.0 ft.

Subfamily **Saccammininae** Brady, 1884

Genus **Lagenammina** Rhumbler, 1911

Proteonina Williamson, 1858, Recent Foraminifera Great Britian, p. 1, Recent, Scotland.

Proteonina (part) of authors.

Reophax (part) of authors.

Lagenammina Rhumbler, 1911, Die Foraminiferen, Plankton-Exped. Humboldt-Stiftung, Ergeb., v 2, p. 92, Recent, North Atlantic.

Type species. Lagenammina laguncula Rhumbler, 1911

The affinities of the foraminiferal genera *Lagenammina* Rhumbler, 1911, *Proteonina* Williamson, 1858, and *Saccammina* M Sars, 1869 are not clear Many species that lack chitinous inner walls originally were assigned to *Lagenammina* and later were included in *Proteonina,* whose modern examples lack chitinous layers. All three of these genera have been recorded in faunas ranging from Silurian to Recent in age. Conkin (1961, p. 250) suggested that the chitinous layers of the living tests, if present, were not preserved in fossil form Thus the means of separation of these genera may be mostly artificial.

Loeblich and Tappan (1955, p 7) examined the types of *Proteonina fusiformis,* the type species, and discovered that the species belongs to the genus *Reophax* Montfot, 1808. The name *Proteonina* is therefore considered to be a synonym of *Reophax* and is no longer available for a single-chambered form, species of this form, including those previously assigned to *Proteonina,* should be placed in either *Lagenammina* or *Saccammina.* If a chitinous inner layer is present (Mound, 1961, p 26), the foraminifer belongs without a doubt to *Lagenammina,* but as practiced here its absence does not require assignment to *Saccammina.* A further distinction is in the short cylindrical apertural neck of *Saccammina.*

Lagenammina distorta Ireland

Plate 6, figure 1

Lagenammina tortuotrigonalis Smith, 1948, Louisiana Geol. Survey Bull. 26, p. 41, pl. 12, fig. 4, Miocene, Louisiana.

Lagenammina distorta Ireland, 1939, Jour Paleontology, v. 13, p. 196, pl. A, figs. 20, 21, Hunton Formation, Oklahoma.

Dimensions. Holotype in mm maximum diameter, 0.35, length of neck, 0.10. Measurements on five Indiana specimens in mm

Maximum chamber diameter	Length of neck	Diameter of neck	
		Base	Terminus
0.23	0.05	0.03	0.02
0.38	0.05	0.05	0.02
0.20	0.07	0.09	0.04
0.17	0.09	0.07	0.05
0.27	0.06	0.04	0.02

Remarks. Lagenammina distorta is similar to *L. sphaerica* but has a shorter twisted neck. No chitinous inner wall can be observed in the Indiana specimens of *L. distorta.*

Types. Figured hypotypes, InGS 4G 123, unfigured hypotypes, InGS 4G 124.

Distribution. Locality 1 Salamonie Dolomite, 496 to 500 and 540 to 544 ft, locality 3 Wabash Formation, Liston Creek Limestone Member, 119.7 to 120.8 ft, locality 4 Brassfield Limestone, 174.7 to 177.5 ft.

Lagenammina laguncula Rhumbler

Plate 6, figures 2, 3

Proteonina crassa Hada, 1931, Tohoku Imp. Univ Sci. Repts., ser. 4, v. 6, p. 54, text-figs. 5a, b; Recent, Japan.

Proteonina longicollis Wiesner, 1931, Deutsche Sudpolar-Exped. 1901-3, v. 20, p. 82, pl. 6, fig. 55, Recent, Antarctic.

Proteonina testacea ten Dam, 1947 [=*P reinholdi* ten Dam, 1947, new name; not *Proteonina testacea* (Flint) (=*Reophax difflugiformis* Brady var. *testacea* Flint)], Geol. & Mijnbouw, 's-Gravenhage, v. 9, p. 25, text-fig. 1, Albian, Netherlands.

Lagenammina urniformis Dunn, 1942, Jour Paleontology, v. 16, p. 328, pl. 43, fig. 4, Osgood Limestone, Missouri.

Lagenammina laguncula Rhumbler, 1911, Die Foraminiferen, Plankton-Exped. Humboldt-Stiftung, Ergeb., v 3, p. 92, 111, pl. 1, fig. 4, Recent, North Atlantic.

Wall finely to coarsely arenaceous, generally smooth exteriorly, smooth interiorly, composed of medium silt-sized particles, having varying amounts of cement, thin chitinous layer attached to part of wall in some specimens. Test free, monothalamous, fusiform to ellipsoidal. Aperture circular, at the terminal part of an elongate neck, which is formed without sharp break as an attenuated part of the test.

Dimensions. Holotype. length including neck, 0.16 to 0.17 mm Measurements on four Indiana specimens in mm

Maximum chamber diameter	Length of neck	Diameter of neck	
		Base	Terminus
0.18	0.08	0.05	0.03
0.46	0.14	0.11	0.03
0.15	0.05	0.03	0.02
0.18	0.05	0.06	0.03

Remarks. Lagenammina laguncula may be distinguished from its congeners by its elongate neck and fusiform test. Several specimens exhibit an inner chitinous wall which may be seen best in transmitted light.

Types: Figured hypotypes, InGS 4G 125; unfigured hypotypes, InGS 4G 126.

Distribution: Locality 1: Salamonie Dolomite, 496 to 500, 508 to 512, and 520 to 524 ft; locality 2: Salamonie Dolomite, 640 to 648 ft; locality 3: Louisville Limestone, 266.2 to 267.2 ft; Salamonie Dolomite, 337.5 to 338.4 ft; locality 4: Salamonie Dolomite, 157.3 to 154.5 ft.

Lagenammina sphaerica Moreman

Plate 6, figures 4, 5

Lagenammina cucurbita Moreman, 1933, Jour. Paleontology, v. 7, p. 395, pl. 47, fig. 5; Chimneyhill Limestone, Oklahoma.

Lagenammina sphaerica Moreman, 1930, Jour. Paleontology, v. 4, p. 51, pl. 5, fig. 15; Chimneyhill Limestone, Oklahoma. Gutschick and Treckman, 1959, Jour. Paleontology, v. 33, p. 233, pl. 33, fig. 14; Rockford Limestone, Indiana. Gutschick, Weiner, and Young, 1961, Jour. Paleontology, v. 35, p. 1207-1208, pl. 147, figs. 15, 16, 17, 18, text-figs. 3-8, 4-8; Welden Limestone, Oklahoma; Chappel Limestone, Texas.

Wall finely to coarsely arenaceous, generally rough exteriorly, smooth interiorly, composed of medium to fine silt-sized particles, having much cement. Test free, consisting of a single undivided oblate chamber. Aperture slightly constricted, circular, at the end of an elongate neck, which is commonly two-fifths the length of the test; apertural neck begins abruptly at base, tapers slightly to terminus.

Dimensions: Holotype in mm: length, including neck, 0.65; width, 0.38. Measurements on 17 Indiana specimens in mm:

Maximum chamber diameter	Length of neck	Diameter of neck	
		Base	Terminus
0.25	0.11	0.05	0.02
0.23	0.09	0.06	0.06
0.23	0.09	0.06	0.03
0.20	0.09	0.05	0.03
0.15	0.11	0.05	0.03
0.23	0.09	0.05	0.03
0.25	0.09	0.05	0.03
0.23	0.11	0.07	0.05
0.54	0.14	0.14	0.09
0.23	0.11	0.05	0.02
0.23	0.09	0.07	0.03
0.23	0.07	0.05	0.02
0.18	0.11	0.05	0.02
0.18	0.09	0.07	0.02
0.20	0.09	0.05	0.06
0.23	0.09	0.09	0.05
0.25	0.09	0.07	0.03

Remarks: Some Indiana specimens have a basal spine. No chitinous inner layers were observed

Types: Figured hypotypes, InGS 4G 127; unfigured hypotypes, InGS 4G 128.

Distribution: Locality 1: Salamonie Dolomite, 496 to 500, 512 to 516, and 520 to 532 ft; locality 4: Salamonie Dolomite, 143 to 147 ft; Brassfield Limestone, 177.5 to 179.0 ft.

Lagenammina stilla Moreman

Plate 6, figures 6, 7

Saccamina? fabianii Silvestri, 1932, Soc. geol. italiana, v. 51, p. 260, pl. 1, fig. 15, pl. 2, fig. 11; Permian, Sicily.

Proteonina jolietensis Dunn, 1942, Jour. Paleontology, v. 16, p. 326, pl. 43, fig. 2; Brassfield Limestone, Illinois.

Proteonina acuta Dunn, 1942, Jour. Paleontology, v. 16, p. 326, pl. 43, fig. 3; Osgood Limestone, Illinois. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 215, pl. 50, fig. 4; Osgood Formation, Indiana.

Proteonina helena Summerson, 1958, Jour. Paleontology, v. 32, p. 552, pl. 82, fig. 1; Columbus Limestone, Ohio.

Proteonina cumberlandiae Conkin, 1961, Bull. Am. Paleontology, v. 43, p. 248-250, pl. 19, figs. 1-3, pl. 26, figs. 4, 5, text-figs. 2, 3; Sunbury Shale, Kentucky; Sanderson and New Providence Formations, Indiana; Brodhead and

Cuyahoga Formations and Maxville Limestone, Ohio. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 215, pl. 50, figs. 11, 12; Osgood Formation, Indiana.

Lagenammina stilla Moreman, 1930, Jour. Paleontology, v. 4, p. 51, pl. 6, fig. 9; Chimneyhill Limestone, Oklahoma. Ireland, 1939, Jour. Paleontology, v. 13, p. 193, table 1, pl. A, fig. 22; Silurian, Oklahoma. Dunn, 1942, Jour. Paleontology, v. 16, p. 327, pl. 42, figs. 30, 31; Joliet Limestone, Illinois. Raymond, 1955, A. M. thesis, Indiana Univ., p. 10, 11, pl. 3, fig. 2; Osgood Formation, Indiana. Mound, 1961, Indiana Geol. Survey Bull. 23, p. 26, pl. 2, fig. 1; Brassfield Limestone, Indiana. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 213, 214, pl. 49, fig. 20; Osgood Formation, Indiana.

Wall finely to coarsely arenaceous, generally smooth exteriorly, smooth interiorly, composed of fine to medium silt-sized particles and a chitinous inner layer. Test free, consisting of a single undivided chamber, pyriform, ellipsoidal below the short tapering neck. Aperture circular, at the terminal part of the neck.

Dimensions: Holotype in mm: length, including neck, 0.44; width, 0.38. Measurements on seven Indiana specimens in mm:

Maximum chamber diameter	Length of neck	Diameter of neck	
		Base	Terminus
0.38	0.11	0.09	0.01
0.29	0.07	0.07	0.02
0.20	0.03	0.02	0.01
0.18	0.03	0.03	0.02
0.25	0.05	0.05	0.03
0.32	0.09	0.08	0.02
0.38	0.16	0.18	0.03

Remarks: Lagenammina stilla is distinguished from *L. laguncula* by having a shorter, basally thicker neck.

Types: Figured hypotypes, InGS 4G 129; unfigured hypotypes, InGS 4G 130.

Distribution: Locality 1: Salamonie Dolomite, 496 to 524 ft; locality 3: Wabash Formation, Mississinewa Shale Member, 218.0 to 218.8 ft; Salamonie Dolomite, 311.6 to 312.9 ft; locality 4: Salamonie Dolomite, 122.0 to 126.5 ft; Brassfield Limestone, 171.6 to 179.0 ft.

Genus **Saccammina** Carpenter, 1869

Saccammina sphaerica M. Sars

Plate 6, figures 8, 9

Lagenammina cornuta Grubbs, 1939, Jour. Paleontology, v. 13, p. 544, pl. 61, figs. 5, 6; Niagaran, Illinois.

Lagenammina bulbosa Dunn, 1942, Jour. Paleontology, v. 16, p. 327, pl. 42, figs. 21, 26; Brassfield Limestone, Illinois. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 214, pl. 50, fig. 1; Osgood Formation, Indiana.

Proteonina wallingfordensis Conkin, 1961, Bull. Am. Paleontology, v. 43, p. 250-253, pl. 19, figs. 4-8, pl. 26, fig. 6, text-figs. 4, 5; Sanderson, Brodhead, Somerset, and New Providence Formations, Maury, New Albany, and Bedford Shales, and Berea Sandstone, Kentucky; Bedford Shale, Ohio; New Providence Formation and Salem Limestone, Indiana.

Saccammina fragilis Le Calvez, 1925, Archives zoologie experimentale et gen., v. 77, p. 87, text-figs. 6a, b, c; Recent, France.

Saccammina silurica Eisenack, 1938, Palaeont. Zeitschr., v. 19, p. 233, pl. 16, fig. 10; Silurian, East Prussia.

Saccammina moremani Ireland, 1939, Jour. Paleontology, v. 13, p. 196, pl. A, fig. 12; Hunton Formation and Chimneyhill Limestone, Oklahoma.

Saccammina sphaerica M. Sars, 1872, Vidensk selsk. Christiania Forh., p. 250; Recent, Norway. Cushman, 1910, U. S. Natl. Mus. Bull. 71, pt. 1, p. 39, 40, figs. 33-36; Recent, Pacific. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 214, pl. 50, fig. 2; Osgood Formation, Indiana.

Wall finely to coarsely arenaceous, generally rough exteriorly, smooth interiorly, composed of medium to fine silt-sized particles, having varying amounts of cement; no chitinous inner layer. Test free, consisting of a single undivided oblate chamber, rarely pyriform. Aperture at the end of a weakly developed short cylindrical neck.

Dimensions: Holotype dimensions not given. Measurements on five Indiana specimens in mm:

Maximum chamber diameter	Length of neck	Diameter of neck	
		Base	Terminus
0.47	0.11	0.09	0.07
0.27	0.07	0.09	0.08
0.27	0.05	0.10	0.10
0.23	0.09	0.08	0.07
0.45	0.05	0.07	0.07

Remarks: Saccammina sphaerica may be distinguished from species of *Lagenammina* by its much shorter neck and by lacking an inner chitinous wall.

Types: Figured hypotypes, InGS 4G 131; unfigured hypotypes, InGS 4G 132.

Distribution: Locality 1: Salamonie Dolomite, 472 to 476 and 496 to 532 ft.

Genus **Shidelerella** Dunn, 1942

Shidelerella bicuspidata Dunn

Plate 6, figures 10, 11

Shidelerella bicuspidata Dunn, 1942, Jour. Paleontology, v. 16, p. 329, pl. 43, fig. 1; Osgood Limestone, Illinois. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 212, pl. 49, fig. 21; Osgood Formation, Indiana.

Wall generally rough exteriorly, smooth interiorly, consisting of a single layer of sand-sized to fine silt-sized particles, well cemented. Test free, cylindrical to subcylindrical, consisting of a single undivided chamber. Major aperture at the extremity of an attenuated elongate neck; each of two auxiliary apertures at other end of test, at the end of short protuberances.

Dimensions: Holotype in mm: length, 0.89; width, 0.40. Measurements on four Indiana specimens in mm:

Test length	Wall thickness	Length of apertural necks		Apertural diameter	
		Anterior	Posterior	Anterior	Posterior
0.51	0.03	0.02	0.03, ------	0.01	0.01, 0.01
0.81	0.07	0.09	0.05, 0.01	0.03	0.02, 0.01
0.65	0.03	0.09	0.03, 0.01	0.02	0.02, 0.01
0.36	0.03	0.03	0.02, 0.01	0.02	0.01, 0.01

Remarks: Shidelerella bicuspidata is easily distinguished from closely allied species of *Thurammina* Brady by its attenuated major apertural neck and elongate chamber.

Types: Figured hypotypes, InGS 4G 133; unfigured hypotypes, InGS 4G 134.

Distribution: Locality 1: Louisville Limestone, 412.0 to 415.5 ft; Salamonie Dolomite, 464 to 468 and 598.6 to 602.8 ft.

Shidelerella elongata Dunn

Plate 6, figure 12

Croneisella typa Dunn, 1942, Jour. Paleontology, v. 16, p. 335, pl. 44, figs. 10, 11; Osgood Limestone, Missouri, and Brassfield Limestone, Illinois.

Pelosinella bicaudata Parr, 1950, Antarctic Research Exped. Repts. 1929, 1931, ser. B, v. 5, pt. 6, p. 261, pl. 4, figs. 1, 2; Recent, Antarctic.

Pelosinella didera Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 16, pl. 1, fig. 2; Recent, Alaska.

Shidelerella cylindrica Dunn, 1942, Jour. Paleontology, v. 16, p. 329, pl. 43, fig. 7; Bainbridge Limestone, Missouri.

Shidelerella elongata Dunn, 1942, Jour. Paleontology, v. 16, p. 329, pl. 43, figs. 32, 33; Bainbridge Limestone, Missouri. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 213, pl. 49, fig. 23; Osgood Formation, Indiana.

Dimensions: Holotype in mm: length, 0.72; diameter, 0.26. Measurements on four Indiana specimens in mm:

Test length	Wall thickness	Length of apertural necks		Apertural diameters	
		Anterior	Posterior	Anterior	Posterior
0.53	0.04	0.03	-------	0.02	-------
0.65	0.04	0.05	0.03	0.03	0.02
0.58	0.03	0.07	0.05	0.02	0.02
0.31	0.03	0.05	0.03	0.02	0.02

Remarks: The tests of the Indiana specimens of *Shidelerella elongata* have a pronounced constriction in the middle, which imparts an hourglass shape.

Types: Figured hypotypes, InGS 4G 135; unfigured hypotypes, InGS 4G 136.

Distribution: Locality 1: Salamonie Dolomite, 460 to 464, 480 to 484, and 600.7 to 602.8 ft; locality 4: Wabash Formation, Mississinewa Shale Member, 4.4 to 9.0 ft; Salamonie Dolomite, 122.0 to 126.5 and 151.3 to 154.5 ft; Brassfield Limestone, 171.6 to 179.0 ft.

Genus **Stomasphaera** Mound, 1961

Stomasphaera brassfieldensis Mound

Plate 6, figures 13-15

Stomasphaera brassfieldensis Mound, Indiana Geol. Survey Bull. 23, p. 28, 29, pl. 2, figs. 9-13, text-fig. 3; Brassfield Limestone, Indiana.

Dimensions: Holotype: diameter 0.22 mm. Measurements on seven specimens in mm:

Maximum diameter	Apertural diameter	Wall thickness
0.26	0.03	0.02
0.26	0.03	0.02
0.26	0.05	0.03
0.12	0.02	0.02
0.14	0.02	0.03
0.20	0.07	0.02
0.20	0.04	0.03

Remarks: Specimens from the present collections are identical with the typical specimens from the Brassfield samples; some specimens have thicker walls and are more finely arenaceous than the types.

Specimens with ellipsoidal tests have elliptical apertures; spheroidal tests or subspherical tests have circular apertures. This relationship probably is the result of deformation and is not considered to be of specific importance.

Types: Figured autotypes, InGS 4G 137; unfigured autotypes, InGS 4G 138.

Distribution: Locality 1: Louisville Limestone, 415.5 to 419.1 ft; Salamonie Dolomite, 472 to 480, 496 to 524, and 600.7 to 604.8 ft; locality 3: Salamonie Dolomite, 337.5 to 338.4 ft; locality 4: Louisville Limestone, 61 to 65 ft.

Genus **Thurammina** Brady, 1879

Thurammina Rhumbler, 1904, Archiv Protistenkunde, v. 3, p. 236; Recent, Atlantic.

Thurammina Brady, 1879, Quart. Jour. Micros. Sci., new ser., v. 19, p. 45; Recent, North Atlantic.

Type species: Thurammina papillata Brady, 1879.

The different species commonly assigned to *Thurammina* have these distinctively characteristic test shapes: spherical, ellipsoidal, cylindrical, and irregular; few species fail to qualify for one or another of these gross forms.

The genus *Thurammina* has been divided still further, especially by Moreman (1930, p. 52), Earland, (1933, p. 66), and Dunn (1942, p. 329), using variations in length, spacing, prominence, and type of the apertural protuberance. Two types of thuramminid protuberances are cylindrical and mammilate.

Specimens of *Thurammina* are extremely abundant in the Indiana collections, and they are easily assigned to species by using the listed criteria.

Thurammina albicans Brady, 1879

Plate 6, figures 16, 17

Thurammina quadritubulata Dunn, 1942, Jour. Paleontology, v. 16, p. 334, pl. 43, fig. 22; Bainbridge Limestone, Missouri. Gutschick and Treckman, 1959, Jour. Paleontology, v. 33, p. 233, pl. 33, fig. 18; Rockford Limestone, Indiana.

Thurammina congesta Gutschick, Weiner, and Young, 1961 (part), Jour. Paleontology, v. 35, p. 1208, 1209, pl. 148, figs. 2, 3, text-fig. 6; Chappel Limestone, Texas.

Thurammina albicans Brady, 1879, Quart. Jour. Micros. Sci., new ser., v. 19, p. 49; Recent, Buenos Aires. Brady, 1884, Rept. Voyage Challenger, Zoology, v. 9, p. 323, 324, pl. 37, figs. 2-7; Recent, Buenos Aires. Cushman, 1910, U. S. Natl. Mus. Bull. 71, pt. 1, p. 58, 59, text-figs. 67-72; Recent, North Pacific. Cushman, 1918, U. S. Natl. Mus. Bull. 104, pt. 1, p. 71, pl. 28, figs. 4-8; Recent, Atlantic.

Dimensions: Holotype not designated; diameter of one figured syntype, 0.25 mm. Measurements on five Indiana specimens in mm:

Maximum diameter	Number of protuberances	Average length of protuberances	Wall thickness
0.37	5	0.02	0.03
0.31	3	0.03	0.02
0.29	3	0.04	0.03
0.43	6	0.03	0.03
0.24	4	0.03	0.02

Remarks: Thurammina albicans is characterized by its regularly spaced apertural protuberances, which may be in the form of either mammilate or short cylindrical necks. Most Indiana specimens of *T. albicans* have a greater proportion of cement in their comparatively thick walls than do specimens of other species of *Thurammina* in the collections.

Types: Figured hypotypes, InGS 4G 139; unfigured hypotypes, InGS 4G 140.

Distribution: Locality 1: Salamonie Dolomite, 496 to 520, 540 to 544, 564 to 568, 588 to 592, and 600.7 to 602.8 ft; Brassfield Limestone, 384.8 to 392.5 ft; locality 3: Salamonie Dolomite, 363.4 to 364.1 ft; Brassfield Limestone, 604.8 to 606.8 ft; locality 4: Salamonie Dolomite, 118.0 to 126.5 ft.

Thurammina arcuata Moreman, 1930

Plate 6, figures 18, 19

Thurammina delicata Ireland, 1939, Jour. Paleontology, v. 13, p. 196, pl. A, text-figs. 28, 29; Chimneyhill Limestone, Oklahoma.

Thurammina coronata Dunn, 1942, Jour. Paleontology, v. 16, p. 331, pl. 43, fig. 18; Bainbridge Limestone, Missouri. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 218, pl. 50, fig. 20; Osgood Formation, Indiana.

Thurammina hexagona Dunn, 1942, Jour. Paleontology, v. 16, p. 332, pl. 44, fig. 15; Osgood Limestone, Illinois.

Thurammina arcuata Moreman, 1930, Jour. Paleontology, v. 4, p. 54, 55, pl. 6, figs. 2, 3; Chimneyhill Limestone, Oklahoma. Raymond, 1955, A. M. thesis, Indiana Univ., p. 14, 15, pl. 3, fig. 6; Osgood Formation, Indiana. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 217, 218, pl. 50, figs. 21, 22; Osgood Formation, Indiana.

Wall smooth or rough exteriorly, smooth interiorly, consisting of a single layer of medium to fine silt-sized particles, having variable amounts of cement. Test free or attached, discoidal, having an irregular circular to polygonal outline, monothalamous. Apertures two or more, at the ends of broad rounded mammilate protuberances located at angles in equatorial plane of the test.

Dimensions: Holotype not designated; two syntypes in mm: length, 0.32, and 0.34; width, 0.34 and 0.36. Measurements on four Indiana specimens in mm:

Maximum dimensions	Average tube length	Wall thickness
-.31	0.03	0.05
0.31	0.02	0.03
0.29	0.04	0.02
0.24	0.02	0.02

Remarks: Thurammina arcuata is distinguished from the closely allied *T. compressa* by its polygonal outline and the location of the apertural protuberances at the polygonal angles.

Types: Figured hypotypes, InGS 4G 151; unfigured hypotypes, InGS 4G 142.

Distribution: Locality 1: Salamonie Dolomite, 484 to 508 and 588 to 592 ft; locality 4: Brassfield Limestone, 177.5 to 179.0 ft.

Thurammina compressa Brady, 1879

Plate 6, figures 20-22

Thurammina texana Cushman and Waters, 1928, Cushman Lab. Foram. Research Contr., v. 4, pt. 2, no. 59, p. 33, pl. 4, fig. 2; Strawn Group, Texas.

Thurammina triangularis Dunn, 1942 (not Moreman), Jour. Paleontology, v. 16, p. 331, pl. 43, fig. 17; Osgood Limestone, Missouri.

Thurammina limbata var. *disciformis* Dunn, 1942, Jour. Paleontology, v. 16, p. 332, 333, pl. 43, figs. 39a, b; Brassfield Limestone, Illinois.

Thurammina compressa Brady, 1879, Quart. Jour. Micros. Sci., new ser., v. 19, p. 46, pl. 5, figs. 9a, b; Recent, North Atlantic. Cushman, 1918, U. S. Natl. Mus. Bull. 104, pt. 1, p. 73, pl. 28, fig. 9; Recent, Atlantic.

Dimensions: Holotype: diameter, 0.5 mm. Measurements on six Indiana specimens in mm:

Test diameter excluding projections	Average length of projections	Wall thickness
0.24	0.03	0.03
0.32	0.05	0.03
0.66	0.03	0.04
0.54	0.07	0.05
0.48	0.05	0.04
0.77	0.09	0.04

Remarks: The specimens from the Indiana collections have a rougher, coarser wall than those figured by Brady. The mammilate projections are restricted to the equatorial belt of this disk-shaped foraminifer.

Types: Figured hypotypes, InGS 4G 143; unfigured hypotypes, InGS 4G 144.

Distribution: Locality 1: Salamonie Dolomite, 424 to 456, 480 to 488, 500 to 528, and 588.0 to 602.8 ft; locality 3: Salamonie Dolomite, 363.4 to 364.1 ft; locality 4: Salamonie Dolomite, 167.7 to 171.6 ft.

Thurammina echinata Dunn

Plate 6, figures 23-25

Thurammina pustulosa Gutschick, Weiner, and Young, 1961, Jour. Paleontology, v. 35, p. 1210, text-figs. 4-22; Chappel Limestone, Texas.

Thurammina echinata Dunn, 1942 (part), Jour. Paleontology, v. 16, p. 331, pl. 43, figs. 21, 23; Joliet Limestone, Illinois; Osgood Limestone, Tennessee. Ireland, 1939, Jour. Paleontology, v. 13, table 1, pl. A, fig. 27; Chimneyhill Limestone, Oklahoma.

Wall rough or smooth exteriorly, rough interiorly, consisting of a single layer of medium to fine silt-sized particles, having variable amounts of cement. Test free or attached, subspherical to hemispherical, monothalamous. Apertures numerous, at the ends of strongly tapered tubes, irregularly distributed over most of test surface.

Dimensions: Holotype: greatest diameter, with projections, 0.62 mm. Measurements on six Indiana specimens in mm:

Maximum test diameter	Average length of tubes	Wall thickness
0.29	0.03	0.02
0.51	0.13	0.02
0.44	0.03	0.02
0.46	0.05	0.03
0.44	0.05	0.03
0.49	0.03	0.03

Remarks: Thurammina echinata is distinguished from *T. subsphaerica* by its great abundance of pointed, tapering apertural tubes, which are so numerous as to effectively mask the test surface of some Indiana specimens. A few hemispherical specimens have concentrations of apertural tubes only on the convex surface, probably having been attached on the flat, even surface.

The variations in test shape in specimens of *T. echinata* is not considered here to be of specific rank; hemispherical shapes may have resulted from attachment.

Types: Figured hypotypes, InGS 4G 145; unfigured hypotypes, InGS 4G 146.

Distribution: Locality 1: Salamonie Dolomite, 492 to 540, 560 to 568, and 588.0 to 602.8 ft; locality 3: Salamonie Dolomite, 300.7 to 356.8 ft; locality 4: Salamonie Dolomite 154.5 to 157.5 and 167.7 to 171.6 ft; Brassfield Limestone, 171.6 to 179.0 ft.

Thurammina elliptica Moreman

Plate 6, figures 26-28

Thurammina congesta Gutschick, Weiner, and Young, 1961 (part), Jour. Paleontology, v. 35, p. 1208, 1209, pl. 148, fig. 9, text-fig. 4-4; Chappel Limestone, Texas.

Thurammina elliptica Moreman, 1930, Jour. Paleontology, v. 4, p. 54, pl. 5, figs. 2, 4; Chimneyhill Limestone, Oklahoma. Ireland, 1939, Jour. Paleontology, v. 13, table 1, pl. B, fig. 7; Chimneyhill Limestone, Oklahoma. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 218, 219, pl. 50, fig. 23; Osgood Formation, Indiana.

Wall smooth or rough exteriorly, less rough interiorly, consisting of a single layer of medium to fine silt-sized particles, having much cement. Test free, ellipsoidal, monothalamous. Each of two apertures at the end of a tapered, tubelike projection near test extremities along an axis that is parallel but does not coincide with the major axis of the ellipsoid.

Dimensions: Holotype not designated; lengths of two syntypes, 0.3 and 0.4 mm. Measurements on six Indiana specimens in mm:

Maximum length	Lengths of apertural tubes	Wall thickness
0.32	0.03, 0.03	0.03
0.41	0.03, 0.07	0.05
0.20	0.05, 0.05	0.03
0.29	0.03, 0.03	0.03
0.18	0.04, 0.05	0.03
0.31	0.02, 0.03	0.04

Remarks: The eccentric location of the apertural tube axis and the ellipsoidal test characterize *Thurammina elliptica.*

Types: Figured hypotypes, InGS 4G 147; unfigured hypotypes, InGS 4G 148.

Distribution: Locality 1: Salamonie Dolomite, 484 to 448, 516 to 520, 532 to 540, and 588 to 592 ft; locality 3: Wabash Formation, Liston Creek Limestone Member, 102.0 to 120.8 ft; locality 4: Brassfield Limestone, 171.6 to 174.7 ft.

Thurammina furcata Gutschick and Treckman, 1959

Plate 6, figures, 29-31

Thurammina furcata Gutschick and Treckman, 1959, Jour. Paleontology, v. 33, p. 233, pl. 33, figs. 19, 20; Rockford Limestone, Indiana. Gutschick, Weiner, and Young, 1961, Jour. Paleontology, v. 35, p. 1210, pl. 148, fig. 19, text-figs. 3-13, 23; Welden Limestone, Oklahoma.

Wall smooth or rough exteriorly, smooth interiorly, consisting of a thin multiple layer of fine silt-sized particles and much cement. Test free, spherical, monothalamous. Apertures at the ends of two or three pairs of tapering, tubelike protuberances, most commonly two pairs each at opposite ends of test; individual tubes of a pair are slightly or strongly divergent.

Dimensions: Holotype in mm: diameter less projections, 0.38; length of projections, 0.12. Measurements on five Indiana specimens in mm:

Maximum diameter	Number of pairs of tubes	Average tube length	Wall thickness
0.29	2	0.05	0.03
0.32	2	0.04	0.04
0.29	2	0.09	0.02
0.26	2	0.03	0.02
0.24	3	0.05	0.02

Remarks: Thurammina furcata is characterized by its spherical shape and its several paired divergent, tubular apertural protuberances. Gutschick and Treckman (1959, p. 233) allowed for only two pairs of protuberances in the original description, and that concept is here expanded.

Types: Figured hypotypes, InGS 4G 149; unfigured hypotypes, InGS 4G 150.

Distribution: Locality 1: Salamonie Dolomite, 500 to 512, 520 to 524, and 596.5 to 602.8 ft; locality 4: Brassfield Limestone, 171.6 to 174.7 ft.

Thurammina papillata Brady

Plate 6, figures 32-34

Thurammina mammilata Franke, 1928, Preuss. geol. Landesanstalt Abh., no. 111, p. 10-11, 206, pl. 1, fig. 8; Cretaceous, Germany.

Thurammina sphaerica Ireland, 1939, Jour. Paleontology, v. 13, p. 197, pl. A, figs. 33, 34; Chimneyhill Limestone, Oklahoma.

Thurammina papillata var. *monticulifera* Ireland, 1939, Jour. Paleontology, v. 13, p. 197, pl. A, fig. 35; Chimneyhill Limestone, Oklahoma. Dunn, 1942, Jour. Paleontology, v. 16, p. 330, pl. 43, figs. 15, 24; Osgood Limestone, Illinois.

Thurammina echinata Dunn, 1942 (part), Jour. Paleontology, v. 16, p. 331, pl. 43, fig. 20; Bainbridge Limestone, Missouri.

Thurammina limbata Dunn, 1942, Jour. Paleontology, v. 16, p. 332, pl. 43, fig. 34; Bainbridge Limestone, Missouri.

Thurammina stelliformis Dunn, 1942, Jour. Paleontology, v. 16, p. 334, pl. 44, fig. 9; Bainbridge Limestone, Missouri.

Thurammina pattei Payard, 1947, Ph. D. thesis, Univ. Paris, p. 54, pl. 1, fig. 1; Jurassic, France.

Thurammina miniscula Pokorny, 1951, Vestnik Kralovske Ceske Spolecnosti Nauk Trida Matematicko-Prirodovedecka, v. 9, p. 2, pl. 1, fig. 1; middle Devonian, Czechoslavakia.

Thurammina papillata Brady, 1879, Quart. Jour. Micros. Sci., new ser., v. 19, p. 45, pl. 5, figs. 4-8; Recent, Atlantic. Cushman, 1910, U. S. Natl. Mus. Bull. 71, pt. 1, p. 58, text-fig. 66; Recent, North Pacific. Cushman, 1918, U. S. Natl. Mus. Bull. 104, pt. 1, p. 70, pl. 28, figs. 10, 11; Recent, Atlantic. Moreman, 1930, Jour. Paleontology, v. 4, p. 51, pl. 5, fig. 13; Chimneyhill Limestone, Oklahoma. Dunn, 1942, Jour. Paleontology, v. 4, p. 51, pl. 5, fig. 13; Chimneyhill Limestone, Oklahoma. Dunn, 1942, Jour. Paleontology, v. 16, p. 330, pl. 43; Osgood Limestone, Illinois.

Dimensions: Holotype dimensions not given. Measurements on 10 Indiana specimens in mm:

Test diameter excluding projections	Average length of projections	Wall thickness
0.54	0.09	0.02
0.51	0.08	0.04
0.44	0.05	0.03
0.41	0.07	0.04
0.43	0.04	0.03
0.90	0.03	0.04
0.90	0.05	0.09
0.51	0.14	0.07
0.59	0.17	0.09
0.34	0.14	0.05

Remarks: The Indiana specimens of *Thurammina papillata* have a rougher surface interiorly and exteriorly than Brady's types. The spherical shape is a characteristic feature of all specimens in the Indiana collections notwithstanding the crushed and broken tests of other more fragile foraminifers from identical samples.

In several specimens the apertural protuberances are so prominently formed as to impart a polygonal or hexagonal outline to the test. This feature is here regarded as being of infraspecific importance.

Types: Figured hypotypes, InGS 4G 157; unfigured hypotypes, InGS 4G 152.

Distribution: Locality 1: Louisville Limestone, 415.5 to 419.1 ft; Salamonie Dolomite, 424 to 456, 472 to 508, and 524.0 to 602.8 ft; locality 3: Wabash Formation, Liston Creek Limestone Member, 119.7 to 120.8 ft, and Mississinewa Shale Member, 218.0 to 218.8 ft; locality 4: Salamonie Dolomite, 122.0 to 126.5, 151.3 to 154.5, and 162.5 to 167.0 ft; locality 5: Louisville Limestone, 230.0 to 236.6 ft.

Thurammina parallela Heron-Allen and Earland

Plate 6, figures 35-37

Thurammina rectangularis Ireland, 1956, Jour. Paleontology, v. 30, p. 843, pl. 3, text-fig. 8; Lecompton Formation, Kansas.

Thurammina congesta Gutschick, Weiner, and Young, 1961, Jour. Paleontology, v. 35, p. 1208, 1209, pl. 148, fig. 5, text-figs. 4-7; Chappel Limestone, Texas.

Thurammina papillata var. *parallela* Heron-Allen and Earland, 1917, Royal Micros. Soc. Jour., pt. 6, art. 10, p. 546, pl. 27, figs. 14-17; Recent, North Sea.

Thurammina parallela Earland, 1933, Foraminifera; pt. 2, Discovery Repts., v. 7, p. 66; Recent, South Georgia.

Dimensions: Holotype not designated; three syntypes in mm: length, 1.1, 1.03, and 1.15; width, 0.2, 0.18, and 0.2. Measurements on nine Indiana specimens in mm:

Length	Width	Average length of projections	Wall thickness
1.04	0.26	0.03	0.03
0.80	0.56	0.07	0.05
0.37	0.24	0.03	0.02
0.48	0.39	0.05	0.03
0.41	0.24	0.02	0.03
0.53	0.34	0.05	0.03
0.56	0.32	0.07	0.05
0.32	0.19	0.03	0.02
0.63	0.37	0.04	0.03

Remarks: Thurammina parallela is characterized by its cylindrical, straight or arcuate test. The mammilate protuberances are distributed irregularly along the length of the test and spaced more evenly at the test extremities.

Types: Figured hypotypes, InGS 4G 153; unfigured hypotypes, InGS 4G 154.

Distribution: Locality 1: Salamonie Dolomite, 496 to 500, 508 to 528, 560 to 568, and 588.0 to 602.8 ft; locality 3: Wabash Formation, Mississinewa Shale Member, 148.5 to 149.3 ft; Salamonie Dolomite, 337.5 to 338.4 ft.

Thurammina parvituba Dunn, 1942

Plate 6, figure 38

Thurammina? seminaformis Dunn, 1942, Jour. Paleontology, v. 16, p. 333, pl. 44, figs. 2-5; Brassfield Limestone, Illinois and Missouri.

Thurammina elliptica Raymond, 1955 (not Moreman), A. M. thesis, Indiana Univ., p. 15, 16, pl. 3, fig. 7; Osgood Formation, Indiana. Mound, 1961, Indiana Geol. Survey Bull. 23, p. 24, pl. 1, fig. 23; Brassfield Limestone, Indiana.

Thurammina verrucosa Ireland, 1956, Jour. Paleontology, v. 30, p. 843, pl. 3, text-fig. 9; Wakarusa Limestone, Kansas.

Thurammina parvituba Dunn, 1942, Jour. Paleontology, v. 16, p. 333, pl. 43, figs. 28, 29; Osgood Limestone, Illinois, Missouri.

Wall smooth to rough exteriorly, less rough interiorly, consisting of a single layer of medium to fine silt-sized particles, well cemented. Test free, spherical or ellipsoidal, most commonly ellipsoidal. Each of two apertures at ends of tapering apertural necks along major axis of ellipsoid.

Dimensions: Holotype in mm: length, 0.28; short diameter, 0.24. Measurements on three Indiana specimens in mm:

Length	Width	Lengths of apertural tubes	Wall thickness
0.34	0.32	0.03, 0.03	0.03
0.34	0.27	0.02, 0.02	0.02
0.21	0.14	0.02, 0.02	0.01

Remarks: The central axial position of the apertural necks is characteristic of *Thurammina parvituba.*

Types: Figured hypotypes, InGS 4G 155; unfigured hypotypes, InGS 4G 156.

Distribution: Locality 1: Salamonie Dolomite, 472 to 508 ft.

Thurammina phasela Moreman

Plate 6, figures 39, 40

Thurammina elliptica Stewart and Priddy, 1941 (not Moreman), Jour. Paleontology, v. 15, p. 373, pl. 54, fig. 16; Osgood Formation, Indiana.

Thurammina irregularis Dunn, 1942 (not Moreman), Jour. Paleontology, v. 16, p. 330, pl. 43, figs. 13, 14; Osgood and Joliet Limestones, Illinois.

Thurammina inflata Dunn, 1942, Jour. Paleontology, v. 16, p. 332, pl. 43, figs. 37, 38; Bainbridge Limestone, Missouri.

Thurammina melleni Dunn, 1942, Jour. Paleontology, v. 16, p. 333, pl. 43, fig. 32; Joliet Limestone, Illinois.

Thurammina phasela Moreman, 1930, Jour. Paleontology, v. 4, p. 54, pl. 5, figs. 3, 5; Chimneyhill Limestone, Oklahoma. Dunn, 1942, Jour. Paleontology, v. 16, p. 330, pl. 43, fig. 16; Osgood Limestone, Missouri.

Wall rough or smooth exteriorly, less rough interiorly, consisting of a single layer of medium silt-sized particles, well cemented. Test free, cylindrical, arcuate, monothalamous. Apertures at test extremities; one end has apertures at the end of mammilate projections, and the other extremity has apertures at end of short tubes.

Dimensions: Holotype not designated; two syntypes in mm: length, 0.32 and 0.04; width, 0.24 and 0.24. Measurements on five Indiana specimens in mm:

Length	Width	Apertural protuberances				Wall thickness
		Mammilate		Tubular		
		No.	Average length	No.	Average length	
0.49	0.26	5	0.05	7	0.02	0.02
0.63	0.26	3	0.04	12	0.02	0.03
0.32	0.18	1	0.03	5	0.02	0.03
0.68	0.61	1	0.17	2	0.09	0.06
0.58	0.28	1	0.03	3	0.02	0.02

Remarks: Thurammina phasela is characterized by its bean-shaped test and the terminal positions and distribution of both types of thuramminid apertural protuberances. The mammilate projections are larger and less numerous than the tubular projections.

Types: Figured hypotypes, InGS 4G 157; unfigured hypotypes, InGS 4G 158.

Distribution: Locality 1: Salamonie Dolomite, 496 to 540 and 600.7 to 602.8 ft; locality 4: Salamonie Dolomite, 167.7 to 171.6 ft; Brassfield Limestone, 171.6 to 174.7 ft; Louisville Limestone, 221.4 to 227.8 ft.

Thurammina slocomi Dunn, 1942

Plate 6, figures 41, 42

Thurammina slocomi Dunn, 1942, Jour. Paleontology, v. 16, p. 333, 334, pl. 43, figs. 8, 12; Osgood Limestone, Illinois. Browne and Schott, 1963, Bull. Am. Paleontology, v. 46, p. 221, pl. 50, fig. 16; Osgood Formation, Indiana.

Wall rough or smooth exteriorly, smooth interiorly, consisting of a single layer of medium to fine silt-sized particles, well cemented. Test free or attached, imperfectly ellipsoidal to cylindrical, commonly having one flattened surface, monothalamous. Apertures at ends of two pairs of tapered tubelike protuberances at test extremities; one pair in an axis parallel to, but not coinciding with, major axis; each individual of the other pair extending outward from the test at an oblique angle.

Dimensions: Holotype in mm: length of test, less projections, 0.30; height, 0.22; distance between lower projections, 0.20. Measurements on four Indiana specimens in mm:

Length	Width	Average length of tubes	Wall thickness
0.27	0.24	0.03	0.02
0.34	0.27	0.03	0.03
0.32	0.20	0.03	0.03
0.10	0.19	0.03	0.02

Remarks: Dunn (1942, p. 333, 334) originally described the apertual protuberances as nipples, but neither the Indiana specimens nor those figured in the original publication show protuberances of the mammilate type; instead, the type figures and the Indiana examples display the thuramminid apertural neck commonly described as tubes. The two oblique protuberances have been described as having an attitude of 45° to the test length. The angle varies from 40° to 65°, as measured from Dunn's figures and the Indiana specimens, and cannot therefore be used as a reliable criterion for distinguishing *T. slocomi* from other closely allied species. The oblique apertural tubes, together with the linearly arranged upper pair described by Dunn and the cylindrical or ellipsoidal test, characterize *T. slocomi.*

Types: Figured hypotypes, InGS 4G 159; unfigured hypotypes, InGS 4G 160.

Distribution: Locality 1: Salamonie Dolomite, 496 to 500, 512 to 524, 552 to 556, 584 to 588, and 598.6 to 600.7 ft; locality 3: Salamonie Dolomite, 335.7 to 356.8 ft; locality 4: Brassfield Limestone, 177.5 to 179.0 ft.

Thurammina subsphaerica Moreman

Plate 7, figures 1, 2

Thurammina corrugata Earland, 1934, Foraminifera; pt. 3, Discovery Repts., v. 10, p. 70, pl. 2, figs. 15-18; Recent, Antarctic.

Thurammina polygona Ireland, 1939, Jour. Paleontology, v. 13, p. 197, pl. B, figs. 1, 2; Chimneyhill Limestone, Oklahoma.

Thurammina globula Grubbs, 1939, Jour. Paleontology, v. 13, p. 545, pl. 61, figs. 9, 10; Niagaran, Illinois.

Thurammina cylindrica Grubbs, 1939, Jour. Paleontology, v. 13, p. 545, pl. 61, fig. 13; Niagaran, Illinois.

Thurammina arcuata Stewart and Priddy, 1941 (not Moreman), Jour. Paleontology, v. 15, p. 372, 373, pl. 54, fig. 14; Osgood Formation, Indiana. Dunn, 1942, Jour. Paleontology, v. 16, p. 329, pl. 43, fig. 35; Joliet Limestone, Illinois.

Thurammina magna Dunn, 1942, Jour. Paleontology, v. 16, p. 333, pl. 43, fig. 10; Osgood Limestone, Missouri.

Thurammina quadrata Dunn, 1942, Jour. Paleontology, v. 16, p. 334, pl. 43, fig. 25; Bainbridge Limestone, Missouri.

Thurammina texana Plummer, 1945 (not Cushman and Waters), Texas Univ. Pub. 4401, p. 218, pl. 15, figs. 2, 3; Strawn Group, Texas.

Thurammina congesta Gutschick, Weiner, and Young, 1961, Jour. Paleontology, v. 35, p. 1208, 1209, pl. 148, figs. 4, 8, 10, text-figs. 5, 16; Chappel Limestone, Texas.

Thurammina subsphaerica Moreman, 1930, Jour. Paleontology, v. 4, p. 52, pl. 5, fig. 16; Chimneyhill Limestone, Oklahoma. Dunn, 1942, Jour. Paleontology, v. 16, p. 331, pl. 43, figs. 31a, b; Joliet Limestone, Missouri.

Wall rough exteriorly, less rough interiorly, consisting of a single layer of medium to fine silt-sized particles, having much cement.

Test free or attached, irregularly ellipsoidal, monothalamous, slightly compressed; test outline elliptical to oval in all views. Apertures numerous, circular, at the end of broad rounded nipplelike protuberances, irregularly spaced, more numerous in a plane perpendicular to axis of compression.

Dimensions: Holotype in mm: length, 1.2; width, 1.08; thickness, 0.6. Measurements on 10 Indiana specimens in mm:

Length	Width	Average length of projections	Wall thickness
0.85	0.63	0.14	0.07
0.77	0.53	0.05	0.04
0.38	0.35	0.05	0.03
0.46	0.37	0.03	0.02
0.68	0.56	0.09	0.03
0.94	0.73	0.09	0.14
0.77	0.73	0.05	0.05
0.94	0.65	0.07	0.05
0.68	0.34	0.09	0.03
0.77	0.68	0.17	0.09

Remarks: Thurammina subsphaerica differs from *T. compressa* by having apertures located sparingly on upper and lower surfaces that are not entirely restricted to the equatorial belt. The irregular shape distinguishes *T. subsphaerica* from the closely allied congener, *T. papillata.*

Types: Figured hypotypes, InGS 4G 161; unfigured hypotypes, InGS 4G 162.

Distribution: Locality 1: Wabash Formation, 158.3 to 163.4 ft; Louisville Limestone, 415.5 to 419.1 ft; Salamonie Dolomite, 424 to 524, 540 to 544, 552 to 560, and 580.0 to 604.8 ft; locality 3: Salamonie Dolomite, 355.7 to 356.8 ft; locality 4: Brassfield Limestone, 171.6 to 174.7 ft.

Thurammina **tubulata** Moreman

Plate 7, figures 3, 4

Thurammina irregularis Moreman, 1930, Jour. Paleontology, v. 4, p. 52, pl. 6, figs. 1, 5; Chimneyhill Limestone, Oklahoma.

Thurammina globosa Ireland, 1939, Jour. Paleontology, v. 13, p. 196, pl. B, text-figs. 5, 6; Chimneyhill Limestone, Oklahoma.

Thurammina subpapillata Ireland, 1939, Jour. Paleontology, v. 13, p. 197, pl. A, fig. 36; Chimneyhill Limestone, Oklahoma.

Thurammina elegans Dunn, 1942 (new name, = T. splendens), Jour. Paleontology, v. 16, p. 334, pl. 44, fig. 9; Bainbridge Limestone, Missouri.

Thurammina lawrencensis Ireland, 1956, Jour. Paleontology, v. 30, p. 843, pl. 3, text-fig. 10; Lecompton Formation, Kansas.

Thurammina limbata Gutschick and Treckman, 1959 (not Dunn), Jour. Paleontology, v. 33, p. 234, pl. 33, fig. 22; Rockford Limestone, Indiana.

Thurammina echinata Gutschick, Weiner, and Young, 1961 (not Dunn), Jour. Paleontology, v. 35, p. 1209, 1210, pl. 148, fig. 6; Chappel Limestone, Texas.

Thurammina tubulata Moreman, 1930, Jour. Paleontology, v. 4, p. 52, pl. 5, fig. 8; Chimneyhill Limestone, Oklahoma. Ireland, 1939, Jour. Paleontology, v. 13, table 1, pl. B, fig. 4; Chimneyhill Limestone, Oklahoma. Dunn, 1942, Jour. Paleontology, v. 16, p. 330, 331, pl. 43, fig. 11; Bainbridge Limestone, Missouri. Gutschick, Weiner, and Young, 1961, Jour. Paleontology, v. 35, p. 1211, 1212, pl. 148, figs. 12, 17; text-fig. 4-23; Chappel Limestone, Texas.

Wall rough or smooth exteriorly, less rough interiorly, consisting of a thin multiple layer of medium to fine silt-sized particles, well cemented. Test free, spherical or subspherical, most commonly spherical, monothalamous. Apertures numerous, irregularly distributed over test surface, at the ends of well-formed cylindrical tubes.

Dimensions: Holotype: diameter, 0.44 mm. Measurements on eight Indiana specimens in mm:

Test diameter including tubes	Test diameter excluding tubes	Average length of tube	Wall thickness
0.95	0.87	0.05	0.04
0.83	0.80	0.03	0.04
0.70	0.65	0.05	0.03
0.78	0.73	0.03	0.03
0.83	0.77	0.05	0.07
0.70	0.67	0.03	0.05
0.63	0.61	0.03	0.04
0.71	0.65	0.05	0.07

Remarks: The Indiana specimens are much larger and have a rougher and more coarsely arenaceous wall than do Moreman's types; otherwise they compare well. The present examples are very well preserved, some being replaced by pyrite, and have their delicate tubes intact and the test unbroken. They have very strong and well-cemented walls, so that their spherical shape has been retained in contrast to the many deformed foraminifers of other species that came from samples in common with *Thurammina tubulata.*

Types: Figured hypotypes, InGS 4G 163; unfigured hypotypes, InGS 4G 164.

Distribution: Locality 1: Louisville Limestone, 421.6 to 424.0 ft; Salamonie Dolomite, 424 to 436, 448 to 460, 468 to 568, and 588.0 to 602.8 ft; locality 3: Wabash Formation, Liston Creek Limestone Member, 102.0 to 108.7 ft, and Mississinewa Shale Member, 152.8 to 165.3 and 201.9 to 237.9 ft; Louisville Limestone, 248.2 to 267.2 ft; Salamonie Dolomite, 311.6 to 338.4 ft; locality 4: Louisville Limestone, 47.0 to 50.5 and 57.8 to 58.5 ft; locality 5: Wabash Formation, Mississinewa Shale Member, 179.2 to 180.6 ft; Louisville Limestone, 221.4 to 227.8 ft; Osgood Formation, 310.4 to 311.6 ft.

Superfamily **Lituolacea** de Blainville, 1825

Family **Hormosinidae** Haeckel, 1894

Subfamily **Hormosininae** Haeckel, 1894

Genus **Reophax** Montfort, 1808

Reophax elongatus Grzybowski

Plate 7, figures 7, 8

Reophax formosensis Ishizaki, 1939, Taiwan Tigaku Kizi, v. 10, p. 110, pl. 8, fig. 1; Miocene, Formosa.

Reophax bendensis Plummer, 1945, Texas Univ. Pub. 4401, p. 226, pl. 17, figs. 7-9; Strawn Group, Texas.

Reophax angoti Cuvillier and Szakall, 1949 (part), Soc. natl. petroles d'Aquitaine, p. 5, pl. 1, fig. 1; Miocene, France.

Reophax elongata Grzybowski, 1898, Akad. Umietjetnosc w Krakowie, v. 33 (ser. 2, v. 13), p. 279, pl. 10, figs. 19, 20; Eocene, Poland.

Wall rough or smooth exteriorly, less rough interiorly, consisting of a thick layer of sand-sized and medium to fine silt-sized particles, having varying amounts of cement; some specimens contain spicules in small numbers. Test free, uniserial, rectilinear, margins slightly lobulate, straight or slightly curved; chambers elongate, cylindrical to fusiform, separated by short stolons, variable in number; sutures distinct or faint, depressed, straight or oblique. Aperture not constricted, formed terminally on the stolon of the last formed chamber.

Dimensions: Holotype dimensions not given. Measurements on 10 Indiana specimens in mm:

Test length	Number of chambers	Average chamber diameter	Wall thickness
0.88	4	0.27	0.05
1.55	2	0.36	0.10
0.70	3	0.36	0.04
0.70	3	0.16	0.05
1.75	6	0.15	0.04
1.34	4	0.17	0.04
0.77	3	0.16	0.07
0.60	3	0.16	0.02
1.46	4	0.37	0.08
0.93	3	0.22	0.08

Remarks: Reophax elongatus differs from most other species of *Reophax* by having a finer textured wall and slender cylindrical chambers. All specimens apparently are broken so that the number of observed chambers is related to the state of presentation; the Indiana specimens have as many as six chambers.

Types: Figured hypotypes, InGS 4G 165; unfigured hypotypes, InGS 4G 166.

Distribution: Locality 1: Louisville Limestone, 364.7 to 368.7 and 376.6 to 388.7 ft; Salamonie Dolomite, 448 to 452, 472 to 488, and 596.5 to 598.6 ft; locality 3: Brassfield Limestone, 384.8 to 392.5 ft.

Reophax texanus Cushman and Waters

Plate 7, figures 5, 6

Reophax asperus Cushman and Waters, 1928, Cushman Lab. Foram. Research Contr., v. 4, pt. 2, p. 37, pl. 4, fig. 7; Graham Formation, Texas.

Reophax friabilis Parr, 1932, Royal Soc. Victoria Proc., v. 44 (new ser.), p. 3, pl. 1, fig. 2, text-fig. 1a; Recent, Australia.

Reophax depressus Cushman and McCulloch, 1939 (part; not Natland), Allan Hancock Pacific Exped., v. 6, p. 62, 63, pl. 3, fig. 17; Recent, Pacific.

Reophax tumidulus Plummer, 1945, Texas Univ. Pub. 4401, p. 231, pl. 17, fig. 31; Strawn Group, Texas.

Reophax imitator Finlay, 1947, New Zealand Jour. Sci. Technology, v. 28, sec. B, p. 260, pl. 1, figs. 5-7; Paleocene, New Zealand.

Reophax davepopei Smith, 1948, Louisiana Geol. Survey Bull. 26, p. 42, pl. 11, figs. 7, 8; Miocene, Louisiana.

Reophax davisi Parr, 1950, Antarctic Research Exped. Rept., 1929-31, ser. B, v. 5, pt. 6, p. 265, pl. 4, fig. 11; Recent, Indian Ocean.

Reophax lawensis Cummings, 1955, Micropaleontology, v. 1, p. 234, pl. 1, figs. 7, 13, 16, 18, text-fig. 9; Dockra Limestone, Scotland.

Reophax texana Cushman and Waters, 1927, Cushman Lab. Foram. Research Contr., v. 2, p. 82, pl. 10, fig. 2; Navarro Formation, Texas.

Wall generally rough exteriorly, less rough interiorly, consisting of a thick layer of sand- and silt-sized particles, having varying amounts of cement. Test free, uniserial to rectilinear, tapering slightly toward proloculus, straight or slightly arcuate, having lobulate periphery; chambers inflated, globular, variable in number, slightly embracive, increasing slightly in size toward apertural end; sutures distinct, depressed, straight or slightly oblique. Aperture circular or polygonal, terminal.

Dimensions: Holotype dimensions not given, but the type specimens are as much as 1.25 mm long. Measurements on eight Indiana specimens in mm:

Test length	Number of chambers	Average chamber diameter	Wall thickness
1.41	7	0.22	0.04
0.63	5	0.16	0.05
1.12	3	0.33	0.09
0.73	3	0.15	0.05
1.20	6	0.24	0.07
0.63	7	0.11	0.04
0.90	3	0.24	0.10
2.04	9	0.25	0.11

Remarks: Reophax texanus is characterized by its globular chambers of nearly equal diameter, its thick wall, and its deeply depressed sutures. Characteristic numbers of chambers in mature specimens cannot be determined because the chambers tend to separate along the deeply incised sutures. The largest Indiana specimen is probably a complete individual, having nine chambers and more than average taper.

Types: Figured hypotypes, InGS 4G 167; unfigured hypotypes, InGS 4G 168.

Distribution: Locality 1: Wabash Formation, 158.3 to 167.5 ft; Louisville Limestone, 401 to 405 ft; Salamonie Dolomite, 428 to 432, 472 to 476, 480 to 484, 496 to 500, and 548 to 560 ft; locality 4: Brassfield Limestone, 177.5 to 179.0 ft.

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Appendix

Section 1. Log of core from Northern Indiana Public Service Co. Clara J. Boyle No. 2 well, Newton County, Ind. (SW¼ SW¼ SW¼ sec. 5, T. 31 N., R. 8 W.) Surface elevation, 642 ft. Modified from log by Robert H. Shaver, January 1962.

	Depth (ft)
Devonian System:	
Unassigned carbonate rocks, 21 ft cored:	
1. Gray fine-grained dolomite; has some black carbonaceous partings at 95.0 to 95.7 ft; core loss at 90 to 95 ft	90.0- 97.0
2. Gray or grayish-tan coarse- to fine-grained dolomite; finely porous and vuggy in part; some gray shaly laminae	97.0-100.8
3. Gray and yellow finely arenaceous shale	100.8-101.2
4. Gray and light-gray fine-grained brecciated dolomite; gray part is argillaceous and has thin contorted laminae	101.2-101.5
5. Gray and grayish-tan fine-grained dolomite; finely arenaceous; some core loss	101.5-111.0
Wabash Formation, 227.6 ft:	
6. Alternating gray fine-grained argillaceous dolomite and light tan-gray fine-grained porous cherty dolomite	111.0-137.4
7. Gray fine-grained shaly dolomite; gray-tan sublithographic cherty dolomite at 153.5 to 158.2 ft	137.4-163.4
8. Gray cherty fine-grained argillaceous dolomite; has patches of gray-tan saccharoidal finely vuggy dolomite and many chert nodules	163.4-196.5
9. Gray fine-grained argillaceous dolomite with some chert	196.5-215.5
10. Gray fine-grained argillaceous and silty dolomite	215.5-266.5
11. Gray and light-colored, fine-grained argillaceous, and fine-grained cherty dolomite; grades into subjacent unit	266.5-338.6
Louisville Limestone, 86 ft:	
12. Gray dolomite having alternating cherty and argillaceous aspects; lower 24 ft of unit 12 and units 13 and 14 included in the *Ammodiscus-Lituotuba* Assemblage Zone	338.6-388.7

	Depth (ft)
Devonian System–Continued	
Louisville Limestone–Continued	
13. Gray alternating fine- to medium-grained cherty dolomitic limestone and fine-grained argillaceous dolomite; lower 15 ft has irregular green-gray laminae ------	388.7-419.1
14. Gray and gray-tan fine-grained dolomitic limestone, slightly cherty; has one-half in. bands of green and black shale in lower 6 in.; includes Waldron equivalents- -	419.1-424.6
Salamonie Dolomite, 180.2 ft:	
15. Gray fine-grained argillaceous dolomitic limestone and dolomite; has greenish splotches and chert nodules; grades into subjacent unit; unit 15 and upper 140 ft of unit 16 included in the *Ammodiscus-Thurammina* Assemblage Zone -	424.6-444.0
16. Gray and tan fine-grained saccharoidal to medium-grained finely vuggy dolomite; has sparse chert in upper 30 ft and at 25 ft above base; has a few irregular carbonaceous partings; lower 12.5 ft of unit 16 and unit 17 included in the *Turritellella* Assemblage Zone -	444.0-596.5
17. Gray fine-grained argillaceous dolomite; has many dark wavy laminae; grades into subjacent unit - - - - - - - -	596.5-604.8
Brassfield Limestone, 10.1 ft:	
18. Light pinkish-tan fine-grained saccharoidal dolomite; has some thin green laminae and argillaceous intercalations resembling recemented breccia; grades down into a brown and brassy coarse-grained biofragmental vuggy dolomite; has some earthy chert - - - - - - - - - -	604.8-614.9
Ordovician System:	
Cincinnatian rocks, 14.5 ft examined:	
19. Dark gray-green dense dolomitic shale - - - - - - - - - - -	614.9-629.4

Section 2. Log of core from Northern Indiana Public Service Co. Carl Wyneken No. 1 well, 6 miles north of Fort Wayne, Allen County, Ind. (SE¼ SW¼ SE¼ sec. 11, T. 31 N., R. 12 E.) Altitude, 827 ft. Modified from log by Robert H. Shaver, April 1962.

	Depth (ft)
Devonian System:	
Unassigned carbonate rocks:	-270.0
Silurian System:	
Salina Formation, Kokomo Limestone Member, 30.5 ft:	
1. Brown, tan, and gray dense to fine-grained dolomite; vuggy and argillaceous in part	270.0-282.5
2. Banded tan, brown, and gray sublithographic and fine-grained saccharoidal to medium-grained and vuggy thin-bedded dolomite and dolomitic limestone; lower 2 in. have black carbonaceous sandy shale partings	282.5-300.5
Wabash Formation, 182.5 ft:	
3. Gray and buff fine-grained saccharoidal vuggy dolomite; has sparry calcite and barite, partly stylolitic; has conspicuous coarse dolomitized fossil fragments	300.5-483.0
Louisville Limestone, 83.4 ft:	
4. Light-brown, slightly mottled, fine- to medium-grained partly saccharoidal, vuggy, and stylolitic dolomite; has white corroded chert nodules and coarse dolomitized fossil fragments; grades into superjacent and subjacent units	483.0-495.4
5. Brown, gray, and mottled tan and gray, fine-grained saccharoidal, medium-grained, and dense argillaceous dolomite and dolomitic limestone; stylolitic and vuggy in part; has irregular carbonaceous laminae and some white corroded chert	495.4-566.4
Waldron Formation, 35.7 ft:	
6. Gray sublithographic to fine-grained argillaceous nodular dolomitic limestone; has black carbonaceous shale laminae around nodules; shale laminae are planar, and dolomite is brown in lower 2 ft	566.4-602.1
Salamonie Dolomite, 214.9 ft:	
7. Brown fine-grained to dense stylolitic dolomitic limestone; has shaly partings in upper part and some white weathered chert	602.1-615.8

	Depth (ft)
Silurian System–Continued	
Salamonie Dolomite–Continued	
8. Light-colored fine-grained saccharoidal coarsely vuggy dolomite; has sporadic white corroded chert and coarse dolomitized fossil fragments; rocks from 640 to 708 ft included in the *Ammodiscus-Thurammina* Assemblage Zone -	615.8-817.0
Brassfield Limestone, 24.6 ft:	
9. Gray and gray-green fine-grained to dense and argillaceous pyritic fossiliferous dolomite; glauconitic in upper part; has intercalated dolomitic shale; rocks from 821 to 825 ft included in the *Turritellella* Assemblage Zone -	817.0-836.9
10. Brown medium- to coarse-grained vuggy dolomite; lower 6 in. is ferruginous - - - - - - - - - - - - - - - - - - -	836.9-841.6
Ordovician System:	
Cincinnatian rocks, 16.1 ft examined:	
11. Gray-green shale; has graptolites - - - - - - - - - - - - - - -	841.6-857.7

Section 3. Log of core from Indiana Geological Survey drill hole 72, Markland Avenue Quarry, Kokomo, Howard County, Ind. (SW¼ SW¼ sec. 36, T. 24 N., R. 3 E.) Altitude, 804 ft. Modified from Shaver and others, 1961, p. 13, 14.

	Depth (ft)
Silurian System:	
Salina Formation, Kokomo Limestone Member, 44.3 ft cored:	
1. Tan and gray, buff, yellow, and pale-green thinly banded dolomitic limestone; conspicuously uniformly thin bedded; spottily petroliferous to 42.5 ft - - - - - - - - -	6.9- 51.2
Salina Formation, rocks unassigned to member, 36.1 ft:	
2. Light tan-gray and dark-gray fine- to medium-grained cherty dolomitic limestone; argillaceous in part and has thin indistinct contorted laminae; has white to gray porcellaneous chert from 61.0 to 79.5 ft; grades into subjacent unit -	51.2- 87.3

Silurian System–Continued	Depth (ft)
Wabash Formation, Liston Creek Limestone Member, 38.2 ft:	
3. Tan and gray medium- to fine-grained cherty limestone; has fossil fragments; at least the rocks from 102 to 248 ft in units 3 to 6 included in the *Ammodiscus-Lituotuba* Assemblage Zone ----------------	87.3-125.5
Wabash Formation, Mississinewa Shale Member, 114.5 ft:	
4. Gray dolomitic siltstone --------------------	125.5-146.0
5. Gray and green-gray silty dolomite; interbedded with limestone at 146 to 180 ft and becoming limestone at 197 to 210 ft and at 215 to 240 ft; limestone is tan, fine grained to medium grained, and biofragmental; grades into subjacent unit; lower 25 ft possibly should be assigned to the Louisville Limestone ---------	146.0-240.0
Louisville Limestone, 42.5 ft:	
6. Gray and tan limestone, dense to lithographic in part; has irregular shaly to clastic carbonate partings ----	240.0-282.5
Waldron Formation, 10 ft:	
7. Tan-gray and tan dense nodular limestone; has wavy black shaly partings around nodules -----------	282.5-292.5
Salamonie Dolomite, 94 ft:	
8. Mottled tan and gray-tan fine- to medium-grained biofragmental dolomitic limestone; units 8 and 9 included in the *Ammodiscus-Thurammina* Assemblage Zone -	292.5-323.5
9. Light-gray and gray vuggy dolomite; transitional to overlying units ---------------------------	323.5-362.7
10. Tan fine-grained saccharoidal cherty dolomite; grades into subjacent unit; unit 10 included in the *Turritellella* Assemblage Zone --------------------	362.7-386.5
Brassfield Limestone, 6 ft:	
11. Tan fine-grained glauconitic noncherty dolomite ----	386.5-392.5
Ordovician System:	
Cincinnatian rocks, 4.5 ft examined:	
12. Tan medium-grained biofragmental limestone; has intercalated green fossiliferous shale---------------	392.5-397.0

Section 4. Description of exposure in abandoned quarry at site of cored hole and log of core from Indiana Geological Survey drill hole 96, 5 miles west of Muncie, Delaware County, Ind. (SE¼ NW¼ SW¼ sec. 14, T. 20 N., R. 9 E.) Altitude at top of section, 910 ft. Modified from log by Robert H. Shaver, August 1962.

	Depth (ft)
Silurian System:	
Wabash Formation, Mississinewa Shale Member, 4.6 ft:	
1. Gray and olive-drab dense argillaceous dolomitic limestone; units 1 and 2 described from exposure - - - - -	4.4- 9.0
Louisville Limestone, 71.3 ft:	
2. Gray fine-grained dolomite; weathers with a slabby aspect -	9.0- 16.2
No observation -	16.2- 18.5
3. Mottled light-gray and buff fine- to medium-grained vuggy dolomite; saccharoidal in part; at least the lower 0.7 ft of unit 3 and upper 7.1 ft of unit 4 are included in the *Ammodiscus-Lituotuba* Assemblage Zone -	18.5- 58.5
4. Buff fine-grained vuggy dolomite; upper 2.5 ft argillaceous; has dark irregular carbonaceous laminae; lower part grades into subjacent unit - - - - - - - - - - - - - - -	58.5- 80.3
Waldron Formation, 5.6 ft:	
5. Dark-gray dolomitic shale; has fucoidal markings in part -	80.3- 85.9
Salamonie Dolomite, 85.7 ft:	
6. Light-colored fine-grained saccharoidal dolomite; has sparse corroded chert in upper part and abundant chert nodules and bands from 126.5 to 134.5 ft; at least lower 16.5 ft of unit 6, unit 7, and upper 16.4 ft of unit 8 included in the *Ammodiscus-Thurammina* Assemblage Zone -	85.9-134.5
7. Gray fine-grained argillaceous dolomite; has dark-colored irregular shaly laminae and white nodular bands of corroded chert; grades into subjacent unit - - - - - - -	134.5-151.3
8. Gray and light-colored fine-grained saccharoidal dolomite; coarse-grained stylolitic vuggy dolomite; has coarse crinoidal fragments in upper and lower parts	

	Depth (ft)
Silurian System–Continued	
Salamonie Dolomite–Continued	
and some dark wavy carbonaceous laminae in lower part; grades into subjacent unit; lower 3.9 ft of unit 8 and units 9 and 10 included in the *Turritellella* Assemblage Zone	151.3-171.6
Brassfield Limestone, 7.4 ft:	
9. Mottled gray and light gray-green fine-grained vuggy and pyritic dolomite	171.6-177.5
10. Tan and gray fine- to coarse-grained dolomite; also gray-green, dense, and pyritic	177.5-179.0
Ordovician System:	
Cincinnatian rocks, 11 ft examined:	
11. Gray and tan fine-grained biofragmental dolomite interbedded and mixed with gray-green shale; unit includes two 3-ft core losses	179.0-190.0

Section 5. Log of core from Indiana Geological Survey drill hole 35, at Indiana State Fair Grounds, Indianapolis, Marion County, Ind. (NE¼ NW¼ SW¼ sec. 18, T. 16 N., R. 4 E.) Altitude, 375 ft. Modified from log by John B. Patton, October 1956.

	Depth (ft)
Devonian System:	
Geneva Dolomite	-162.4
Silurian System:	
Wabash Formation, Mississinewa Shale Member, 23.6 ft:	
1. Gray fine-grained silty limestone	162.4-164.6
2. Gray fine-grained silty argillaceous limestone	164.6-166.6
3. Gray fine-grained silty limestone; contains thin bands and small nodules of pyrite	166.6-179.2
4. Gray fine-grained silty argillaceous limestone; at least units 4 to 9 included in the *Ammodiscus-Lituotuba* Assemblage Zone	179.2-186.0
Louisville Limestone, 82 ft:	
No recovery	186.0-190.4
5. Gray-tan and gray-green fine-grained limestone; silty in upper 6 ft	190.4-199.7
Not observed	199.7-208.0

	Depth (ft)
Silurian System–Continued	
Louisville Limestone–Continued	
6. Gray and granular limestone; lower part tan and crystalline; argillaceous partings in upper part - - - - -	208.0-214.6
7. Gray and tan fine-grained argillaceous limestone - - - -	214.6-217.5
Not observed- -	217.5-221.4
8. Gray and tan fine- to coarse-grained argillaceous limestone; upper 1 ft contains dark-gray shale; has argillaceous partings and bands - - - - - - - - - - - - - - - - - - -	221.4-230.0
9. Gray, gray-tan, brown, and tan fine-grained limestone; has argillaceous partings in upper part and is slightly mottled in lower part -	230.0-268.0
Waldron Formation, 6.3 ft:	
10. Gray, light-colored, and mottled argillaceous limestone	268.0-274.3
Laurel Limestone, 36.1 ft:	
11. Light-gray dolomitic limestone and dark-gray and tan fine-grained dolomite; corresponds to part of the Salamonie Dolomite of sections 1 to 4, probably including rocks younger than any of the Laurel Limestone exposed in southern Indiana; at least the rocks of unit 11 from 286.7 to 296.6 ft included in the *Ammodiscus-Thurammina* Assemblage Zone - - -	274.3-310.4
Osgood Formation, 30.2 ft:	
12. Light-gray fine-grained dolomitic limestone and saccharoidal vuggy dolomite; limestone contains one-fourth-in. chert seams; dolomite has abundant chalky white and vitreous chert; corresponds to lower part of the Salamonie Dolomite; at least lower 11.4 ft of unit 12 included in the *Turritellella* Assemblage Zone - - - - -	310.4-340.6
Brassfield Limestone, 6.3 ft:	
13. Tan and gray-tan saccharoidal and fine-grained dolomite, partly glauconitic -	340.6-346.9
Ordovician System:	
Cincinnatian rocks, 27.3 ft cored - - - - - - - - - - - - - - - - - - -	346.9-374.2

Plates 2-7

PLATE 2

All figures are X 50 except as otherwise indicated

Family **Ammodiscidae**

1, 2 *Ammodiscus abbreviatus* Ireland (p. 16).
1, Locality 1, Salamonie Dolomite.
2, Locality 3, Wabash Formation, Mississinewa Shale Member.

3-6 *Ammodiscus constrictodilatus* n. sp. (p. 17).
3, Holotype, locality 3, Wabash Formation, Liston Creek Limestone Member.
4, Paratype, locality 3, Wabash Formation, Mississinewa Shale Member.
5, 6, Paratypes showing constricted terminal part and bulbous swelling, locality 1, Salamonie Dolomite.

7, 8 *Ammodiscus constrictus* Dunn (p. 19).
Locality 1, Salamonie Dolomite.

9-11 *Ammodiscus exsertus* Cushman (p. 20).
9, 10, Locality 1, Salamonie Dolomite.
11, Locality 3, Wabash Formation, Mississinewa Shale Member.

12-14 *Ammodiscus furcus* Moreman (p. 21).
Locality 1, Salamonie Dolomite.

15-18 *Ammodiscus incertus* (d'Orbigny) (p. 22).
Locality 1, Louisville Limestone and Salamonie Dolomite.

19-22 *Ammodiscus longexsertus* (Gutschick and Treckman) (p. 25).
Locality 1, Salamonie Dolomite (fig. 19, X 40).

23-25 *Bifurcammina parallela* Ireland (p. 26).
Locality 1, Louisville Limestone and Salamonie Dolomite.

26-28 *Glomospira articulosa* Plummer (p. 26).
Locality 1, Salamonie Dolomite.

29, 30 *Glomospira gordialis* (Jones and Parker) (p. 28).
29, Locality 1, Louisville Limestone.
30, Locality 3, Wabash Formation, Liston Creek Limestone Member (X 40).

31-34 *Psammonyx ceratospirillus* n. sp. (p. 30).
31, Holotype, microspheric form, locality 1, Salamonie Dolomite.
32, Paratype, megalospheric form, locality 3, Wabash Formation, Mississinewa Shale Member.
33, 34, Paratypes, microspheric forms, localities 1 and 3, Salamonie Dolomite.

35, 36 *Turritellella fisheri* Dunn (p. 32).
Locality 1, Salamonie Dolomite.

37, 38 *Turritellella osgoodensis* Dunn (p. 33).
37, Locality 1, Salamonie Dolomite.
38, Locality 4, Brassfield Limestone.

39 *Turritellella spirans* Cushman and Waters (p. 34).
Locality 4, Brassfield Limestone.

40, 41 *Turritellella workmani* Dunn (p. 35).
Locality 1, Salamonie Dolomite.

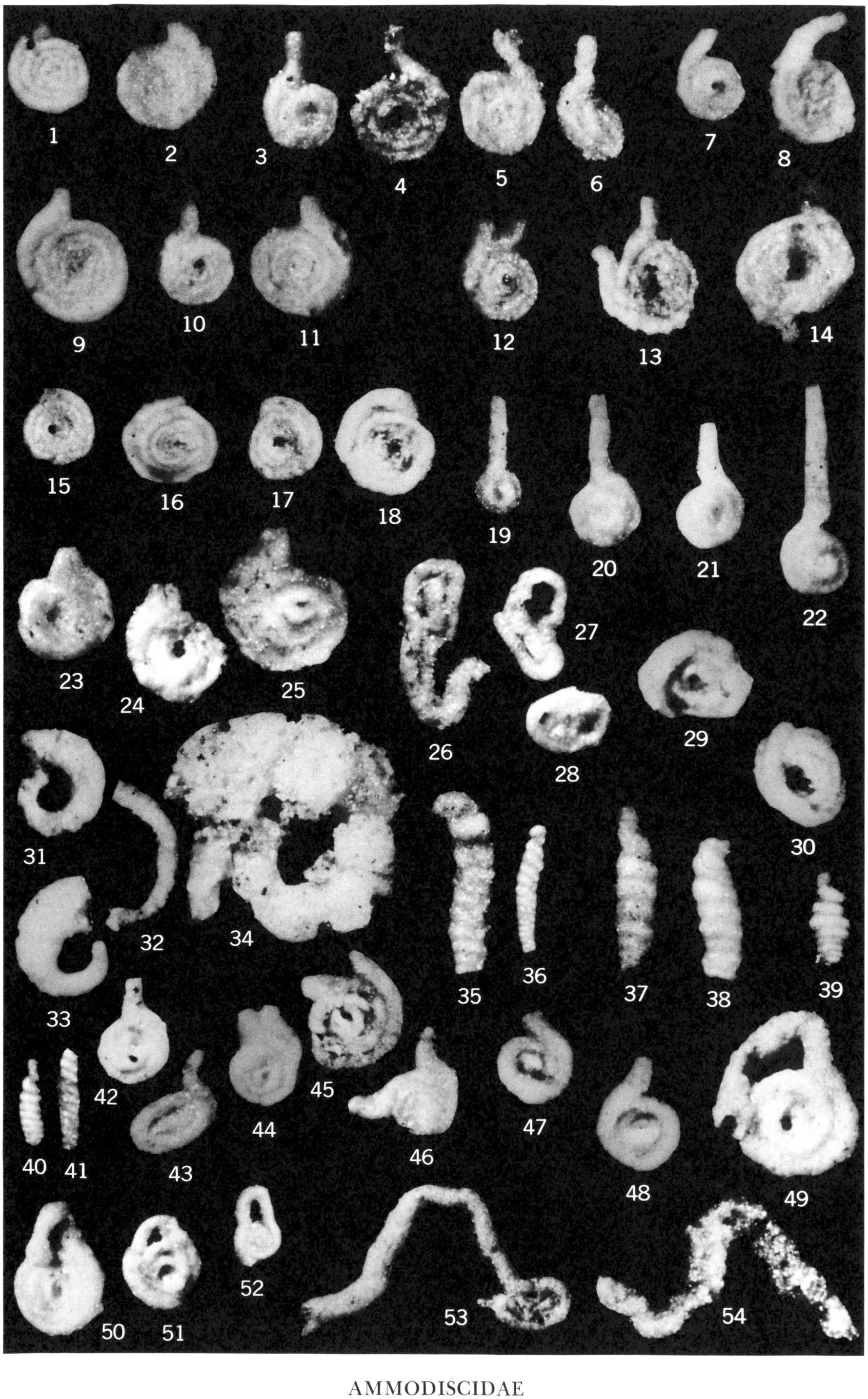
42, 43 *Lituotuba exserta* Moreman (p. 37).
Locality 1, Salamonie Dolomite (fig 43, X 40).

44-46 *Lituotuba furca* Dunn (p. 38).
Locality 1, Salamonie Dolomite.

47, 48 *Lituotuba inflata* Ireland (p. 39).
Locality 1, Salamonie Dolomite (X 40).

49-52 *Lituotuba recurva* n. sp. (p. 40).
49, Holotype, locality 1, Salamonie Dolomite.
50-52, Paratypes showing recurved terminal part, locality 1, Salamonie Dolomite.

53, 54 *Tolypammina nodosa* Ireland (p. 42).
Localities 1 and 3, Salamonie Dolomite.



AMMODISCIDAE

PLATE 3

All figures are X 50

Family **Ammodiscidae**

1-3 *Tolypammina nodosa* Ireland (p. 42).
Three hypotypes showing irregular annular constrictions.
1, 2, Locality 1, Salamonie Dolomite.
3, Locality 3, Salamonie Dolomite.

4-6 *Tolypammina serpens* Ireland (p. 43).
4, 5, Locality 1, Devonian carbonate rocks, unassigned to formation, and Salamonie Dolomite.
6, Locality 3, Salina Formation, Kokomo Limestone Member.

Family **Astrorhizidae**

7-9 *Rhabdammina eocenica* Cushman and Hanna (p. 44).
7, 8, Locality 1, Louisville Limestone and Salamonie Dolomite.
9, Locality 3, Salamonie Dolomite.

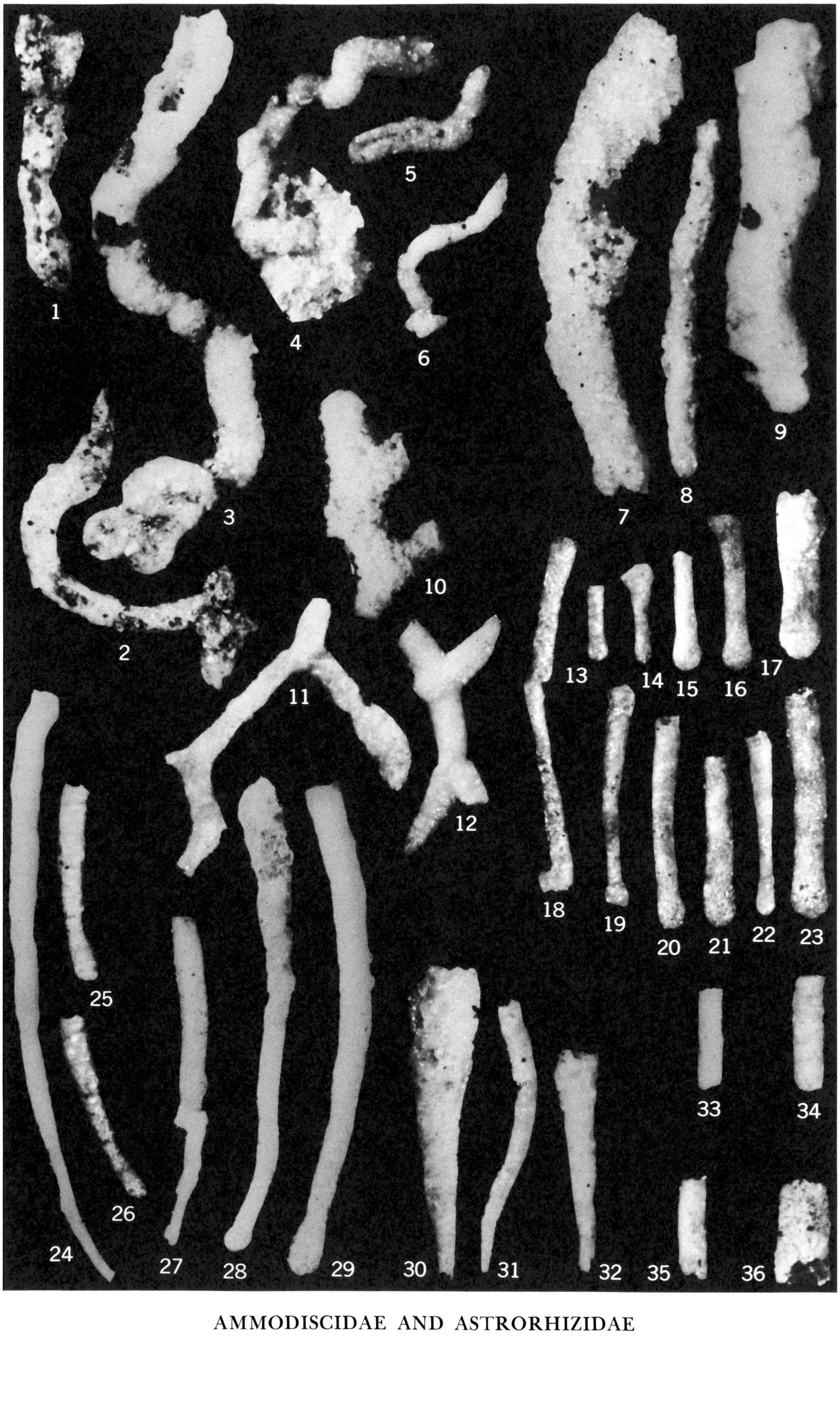
10-12 *Rhabdammina irregularis* Carpenter (p. 45).
10, 11, Locality 1, Louisville Limestone.
12, Locality 1, Salamonie Dolomite.

13-23 *Hyperammina bulbosa* Cushman and Waters (p. 46).
Locality 1, Salamonie Dolomite.

24-29 *Hyperammina curva* (Moreman) (p. 48).
24-26, Locality 1, Louisville Limestone.
27-29, Locality 1, Salamonie Dolomite.

30-32 *Jaculella acuta* Brady (p. 50).
30, 31, Locality 1, Wabash Formation.
32, Locality 1, Salamonie Dolomite.

33-36 *Bathysiphon exiguus* Moreman (p. 53).
33, Locality 1, Salamonie Dolomite.
34, 35, Locality 3, Wabash Formation, Liston Creek Limestone Member.
36, Locality 3, Salamonie Dolomite.



AMMODISCIDAE AND ASTRORHIZIDAE

PLATE 4

All figures are X 50 except figure 5, which is X 40

Family **Astrorhizidae**

1-3 *Marsipella elongata* Norman (p. 54).
1, Locality 1, Louisville Limestone.
2, Locality 3, Wabash Formation, Mississinewa Shale Member.
3, Locality 5, Louisville Limestone.

Family **Saccamminidae**

4 *Crithionina pisum* Goes (p. 56).
Locality 1, Salamonie Dolomite.

5-7 *Amphicervicis elliptica* Mound (p. 56).
5, Neoholotype, locality 3 of Mound (1961), Brassfield Limestone.
6, 7, Locality 4, Brassfield Limestone.

8 *Amphicervicis hemisphaerica* Mound (p. 57).
Locality 1, Salamonie Dolomite.

9, 10 *Fairliella carmani* Summerson (p. 58).
Locality 3, Salamonie Dolomite.

11, 12 *Fairliella clitellata* Summerson (p. 59).
Locality 1, Louisville Limestone.

13-15 *Fairliella discoidea* Summerson (p. 60).
Locality 1, Salamonie Dolomite.

16, 17 *Fairliella lameyi* Summerson (p. 61).
Locality 1, Salamonie Dolomite.

18-20 *Hemisphaerammina battaleri* Loeblich and Tappan (p. 62).
18, Locality 1, Salamonie Dolomite.
19, 20, Locality 3, Wabash Formation, Mississinewa Shale Member.

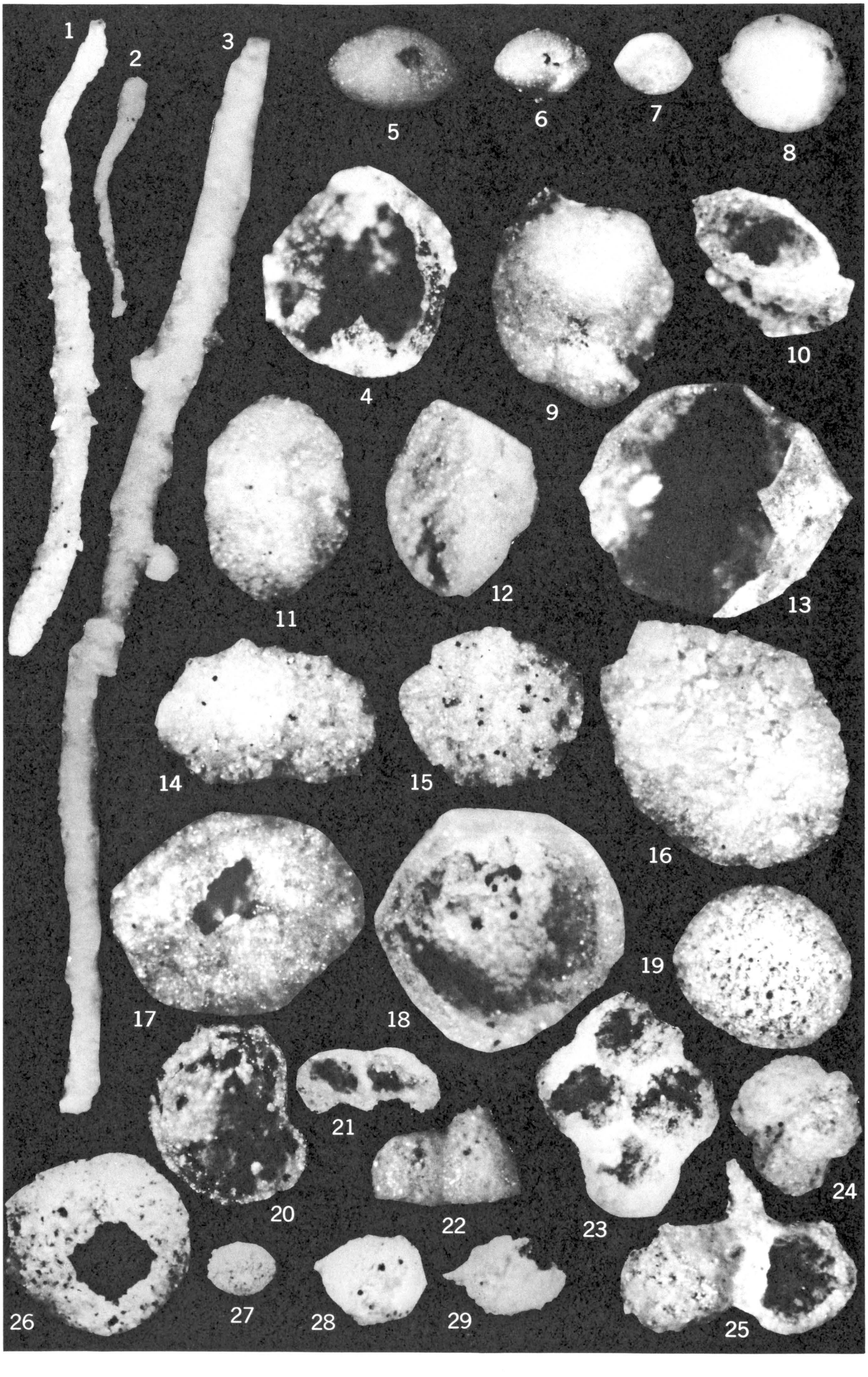
21 *Metamorphina bipartita* (Ireland) (p. 63).
Locality 1, Salamonie Dolomite.

22 *Metamorphina gibbosa* (Ireland) (p. 64).
Locality 1, Salamonie Dolomite.

23-25 *Metamorphina quadripartita* (Moreman) (p. 65).
Locality 1, Salamonie Dolomite.

26, 27 *Tholosina bulla* Brady (p. 66).
26, Locality 1, Salamonie Dolomite.
27, Locality 3, Louisville Limestone.

28, 29 *Tholosina convexa* Moreman (p. 67).
Locality 1, Salamonie Dolomite.



ASTRORHIZIDAE AND SACCAMMINIDAE

PLATE 5

All figures are × 50 except figure 9, which is × 40

Family **Saccamminidae**

1-4 *Tholosina phrixotheca* n. sp. (p. 68).
- 1, Paratype, locality 1, Salamonie Dolomite.
- 2, Holotype showing characteristically wrinkled surface, locality 1, Salamonie Dolomite.
- 3, 4, Paratypes, locality 3, Wabash Formation, Liston Creek Limestone Member; locality 4, Louisville Limestone.

5 *Webbinelloidea hemisphaerica* Stewart and Lampe (p. 69).
Locality 3, Wabash Formation, Mississinewa Shale Member.

6, 7 *Webbinelloidea similis* Stewart and Lampe (p. 70).
Locality 3, Wabash Formation, Mississinewa Shale Member.

8 *Ceratammina cornucopia* Ireland (p. 71).
Locality 1, Salamonie Dolomite.

9, 10 *Psammophax hormiscoides* Summerson (p. 72).
- 9, Locality 1, Salamonie Dolomite.
- 10, Locality 2, Wabash Formation, Mississinewa Shale Member.

11, 12 *Psammosphaera angularis* Ireland (p. 73).
Locality 1, Salamonie Dolomite; locality 3, Brassfield Limestone.

13-15 *Psammosphaera cava* Moreman (p. 74).
Locality 1, Salamonie Dolomite.

16, 17 *Psammosphaera fusca* Schulze (p. 75).
Localities 1 and 3, Salamonie Dolomite.

18, 19 *Psammosphaera laevigata* White (p. 76).
Locality 1, Salamonie Dolomite.

20 *Psammosphaera pusilla* Parr (p. 78).
Locality 1, Salamonie Dolomite.

21, 22 *Sorosphaera bicella* Dunn (p. 79).
Locality 1, Salamonie Dolomite.

23, 24 *Sorosphaera confusa* Brady (p. 80).
Locality 1, Salamonie Dolomite.

25-27 *Sorosphaera geometrica* Eisenack (p. 81).
Locality 1, Salamonie Dolomite.

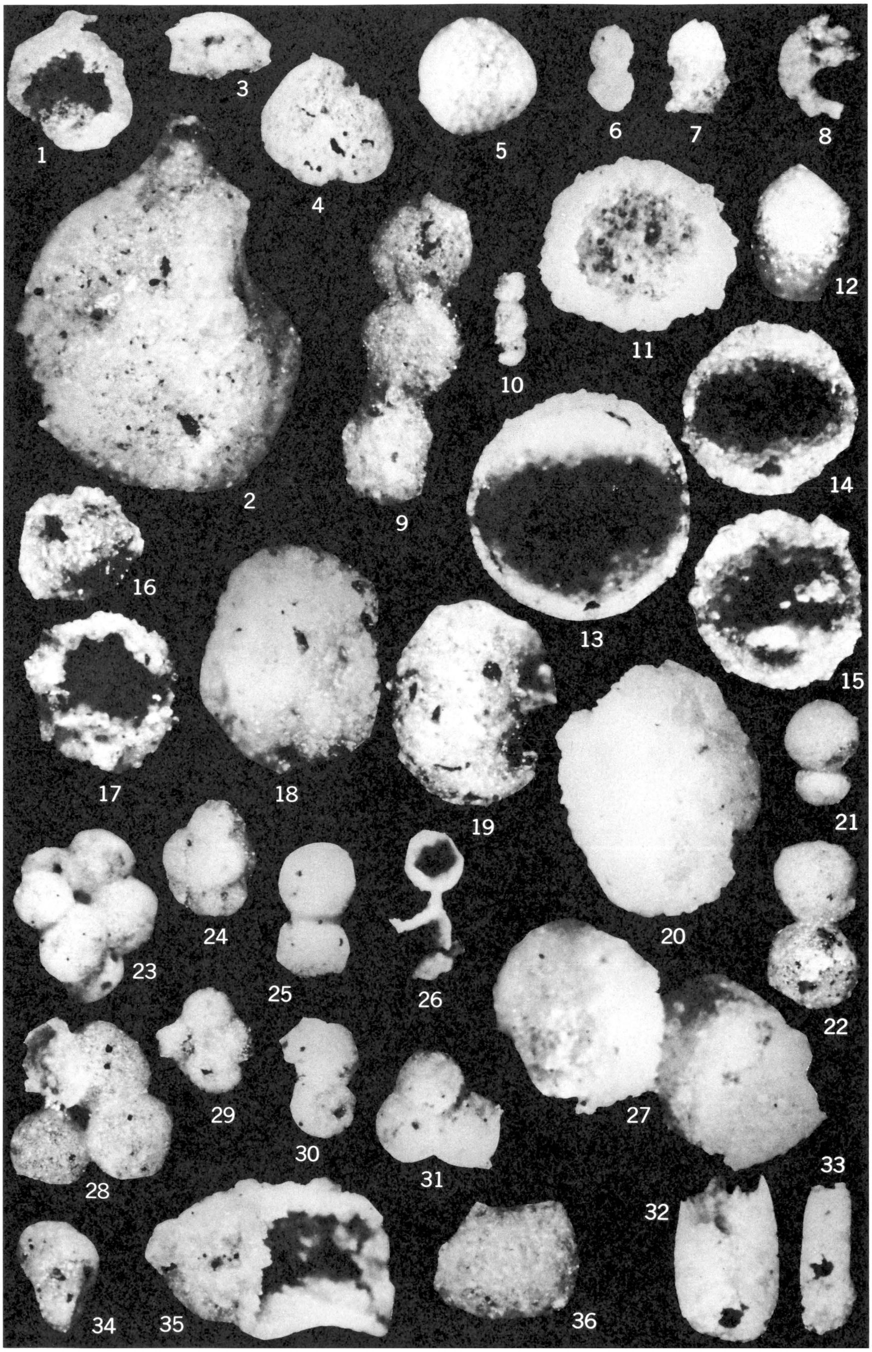
28, 29 *Sorosphaera osgoodensis* Stewart and Priddy (p. 82).
Locality 1, Salamonie Dolomite.

30, 31 *Sorosphaera tricella* Moreman (p. 83).
Locality 1, Salamonie Dolomite.

32, 33 *Stegnammina cylindrica* Moreman (p. 84).
- 32, Locality 1, Louisville Limestone.
- 33, Locality 3, Wabash Formation, Mississinewa Shale Member.

34 *Thekammina moremani* Dunn (p. 86).
Locality 1, Salamonie Dolomite.

35, 36 *Thekammina quadrangularis* Dunn (p. 86).
- 35, Locality 1, Louisville Limestone.
- 36, Locality 1, Salamonie Dolomite.



SACCAMMINIDAE

PLATE 6

All figures are X 50 except as otherwise indicated

Family **Saccamminidae**

1 *Lagenammina distorta* Ireland (p. 88).
Locality 1, Salamonie Dolomite.

2, 3 *Lagenammina laguncula* Rhumbler (p. 89).
Locality 1, Salamonie Dolomite.

4, 5 *Lagenammina sphaerica* Moreman (p. 90).
Locality 1, Salamonie Dolomite (fig. 5, X 40).

6, 7 *Lagenammina stilla* Moreman (p. 91).
Locality 1, Salamonie Dolomite.

8, 9 *Saccammina sphaerica* M. Sars (p. 93).
Locality 1, Salamonie Dolomite.

10, 11 *Shidelerella bicuspidata* Dunn (p. 94).
Locality 1, Salamonie Dolomite.

12 *Shidelerella elongata* Dunn (p. 95).
Locality 1, Salamonie Dolomite.

13-15 *Stomasphaera brassfieldensis* Mound (p. 96).
13, 14, Locality 1, Salamonie Dolomite.
15, Locality 4, Louisville Limestone.

16, 17 *Thurammina albicans* Brady (p. 97).
Localities 1 and 3, Salamonie Dolomite.

18, 19 *Thurammina arcuata* Moreman (p. 98).
Locality 1, Salamonie Dolomite.

20-22 *Thurammina compressa* Brady (p. 99).
20, 21, Locality 1, Salamonie Dolomite.
22, Locality 3, Louisville Limestone.

23-25 *Thurammina echinata* Dunn (p. 100).
Locality 1, Salamonie Dolomite (figs. 23 and 24, X 40).

26-28 *Thurammina elliptica* Moreman (p. 101).
26, 27, Locality 1, Salamonie Dolomite.
28, Locality 3, Wabash Formation, Liston Creek Limestone Member.

29-31 *Thurammina furcata* Gutschick and Treckman (p. 102).
Locality 1, Salamonie Dolomite (fig. 29, X 40).

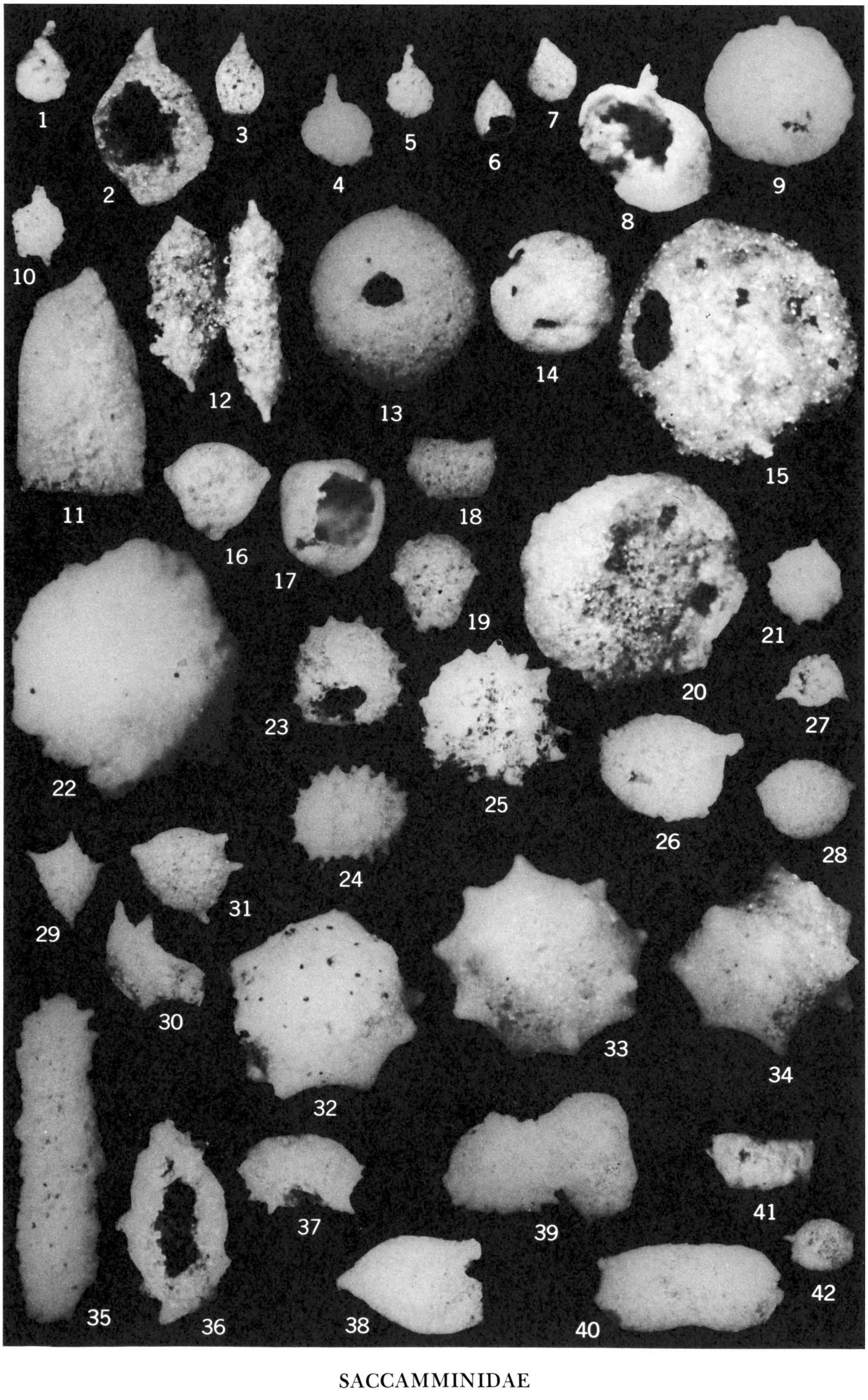
32-34 *Thurammina papillata* Brady (p. 103).
32, 33, Locality 1, Salamonie Dolomite.
34, Locality 3, Wabash Formation, Mississinewa Shale Member.

35-37 *Thurammina parallela* Heron-Allen and Earland (p. 105).
Locality 1, Salamonie Dolomite.

38 *Thurammina parvituba* Dunn (p. 106).

39, 40 *Thurammina phasela* Moreman (p. 106).
Locality 1, Salamonie Dolomite.

41, 42 *Thurammina slocomi* Dunn (p. 108).
41, Locality 1, Salamonie Dolomite.
42, Locality 4, Brassfield Limestone.



SACCAMMINIDAE

PLATE 7

All figures are × 50

Family **Saccamminidae**

1, 2 *Thurammina subsphaerica* Moreman (p. 109).
Locality 1, Salamonie Dolomite.

3, 4 *Thurammina tubulata* Moreman (p. 110).
Locality 1, Salamonie Dolomite.

Family **Hormosinidae**

5, 6 *Reophax texanus* Cushman and Waters (p. 113).
Locality 4, Brassfield Limestone.

7, 8 *Reophax elongatus* Grzybowski (p. 112).
Locality 1, Salamonie Dolomite.

Porifera

9, 10 *Triaxons of Hyalostelia?* sp. (p. 13).
9, Clinohexactine, locality 1, Salamonie Dolomite.
10, Orthohexactine, locality 3, Wabash Formation, Liston Creek Limestone Member.

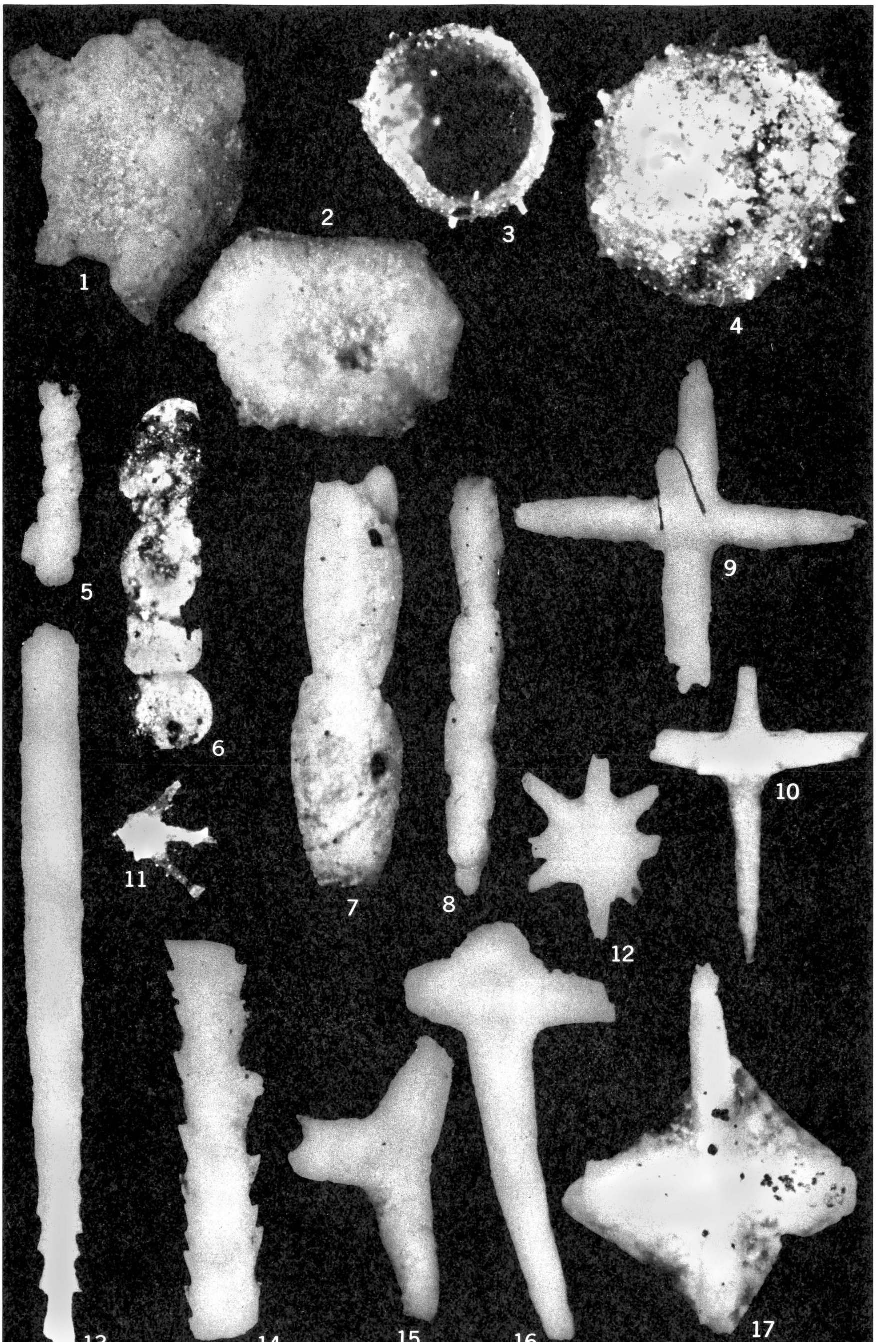
11, 12 *Polyaxons* (p. 13).
Strongylasters, locality 1, Salamonie Dolomite.

13 *Monaxon* (p. 13).
Acanthostyle, locality 1, Salamonie Dolomite.

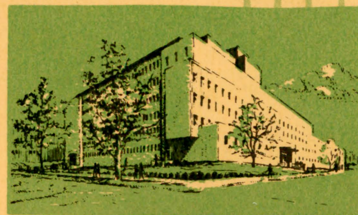
14 *Monaxon* (p. 13).
Sandiaster, locality 4, Salamonie Dolomite.

15 *Tetraxon* (p. 13).
Plagiotriaene, locality 1, Louisville Limestone.

16, 17 *Triaxon* (p. 13).
Isomekactinal orthopentactine, locality 4, Salamonie Dolomite.



FORAMINIFERIDA AND PORIFERA



OVERSIZED DOCUMENT

The following pages are oversized and need to be printed in correct format.

Species	Newton County				Allen County						Howard County								Delaware County					Marion County						Number of specimens recovered
										Salina					Wabash		Salina						Wabash						Wabash	
	Brassfield	Salamonie	Louisville	Wabash	Brassfield	Salamonie	Waldron	Louisville	Wabash	Kokomo	Brassfield	Salamonie	Waldron	Louisville	Mississinewa	Liston Creek	Unnamed member	Kokomo	Brassfield	Salamonie	Waldron	Louisville	Mississinewa	Brassfield	Osgood	Laurel	Waldron	Louisville	Mississinewa	
Ammodiscidae																														
Ammodiscus abbreviatus	-	C	-	-	-	-	-	-	-	-	-	-	-	-	U	U	-	-	S	S	-	-	-	-	-	-	-	S	-	108
A. constrictodilatus	-	S	-	-	-	-	-	-	-	-	-	-	-	-	S	S	-	-	-	-	-	-	-	-	-	-	-	-	-	13
A. constrictus	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	S	-	-	-	-	-	-	-	S	-	73
A. exsertus	-	V	S	-	-	-	-	-	-	-	-	C	-	-	S	V	-	S	S	V	-	-	-	-	-	S	-	U	U	8, 078
A. furcus	-	U	-	-	-	-	-	-	-	-	-	S	-	-	-	-	-	-	-	S	-	-	-	-	-	-	-	-	-	17
A. incertus	-	V	S	-	S	-	-	-	-	-	-	S	-	S	V	V	-	S	U	V	-	-	-	S	S	-	-	A	U	6, 815
A. longexsertus	-	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19
Bifurcammina parallela	-	S	S	-	-	-	-	-	-	-	-	S	-	-	S	-	-	-	-	S	-	-	-	-	-	-	-	-	-	12
Glomospira articulosa	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	37
G. gordialis	-	V	S	-	-	-	-	-	-	-	-	S	-	-	U	V	-	-	S	A	-	-	-	-	S	-	-	C	C	2, 280
Psammonyx ceratospirillus	-	U	S	-	-	-	-	-	-	-	-	S	-	-	S	-	-	-	-	S	-	-	-	-	-	-	-	-	-	19
Turritellella fisheri	-	V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	259
T. osgoodensis	-	V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	U	-	-	-	-	-	-	-	-	-	-	284
T. spirans	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	S	-	-	-	-	-	-	-	-	-	-	45
T. workmani	-	V	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	118
Lituotuba exserta	-	V	S	-	S	-	-	-	-	-	-	U	-	-	A	V	-	-	S	V	-	-	-	-	-	-	-	C	C	6, 909
L. furca	-	S	-	-	-	-	-	-	-	-	-	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12
L. inflata	-	V	S	-	-	-	-	-	-	-	-	U	-	-	S	C	-	-	-	S	-	-	-	-	-	-	-	S	S	543
L. recurva	-	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	S	-	-	-	-	-	-	-	S	-	16
Tolypammina nodosa	-	S	-	-	-	-	-	-	-	-	S	S	-	-	-	-	S	S	S	-	-	-	-	-	-	-	-	-	-	8
T. serpens	-	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	S	-	-	-	-	-	-	-	-	-	-	-	-	10
Astrorhizidae																														
Rhabdammina eocenica	-	C	S	S	-	-	-	-	-	-	S	S	-	-	S	-	-	-	-	U	-	-	-	-	-	-	-	-	-	75
R. irregularis	-	S	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7
Hyperammina bulbosa	-	A	S	-	-	-	-	-	-	-	-	S	-	-	-	-	-	-	S	S	-	-	-	-	S	-	-	S	-	90
H. curva	-	V	U	S	-	S	-	-	-	-	S	U	-	-	V	V	C	S	S	V	-	S	-	-	-	-	-	V	V	3, 308
Jaculella acuta	-	C	U	U	-	-	-	-	-	-	S	S	-	-	-	-	-	-	S	S	-	-	S	-	-	-	-	-	-	87
Bathysiphon exiguus	S	V	-	S	S	-	-	-	-	-	-	C	-	S	V	V	C	S	U	V	-	-	-	-	S	-	-	V	V	8, 314
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Saccamminidae																														
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Amphicervicis elliptica	-	S	-	-	-	-	-	-	-	-	-	-	-	S	S	S	-	-	A	S	-	-	-	-	-	-	-	-	-	97
A. hemisphaerica	-	S	-	-	-	-	-	-	-	-	-	S	-	-	-	-	-	-	U	-	-	-	-	-	-	-	-	-	-	31
Fairliella carmani	-	S	S	-	-	-	-	-	-	-	-	S	-	-	S	-	-	-	-	-	-	-	S	-	-	-	-	-	-	17
F. clitellata	-	S	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	S	-	-	-	-	-	-	-	7
F. discoidea	-	S	-	-	-	-	-	-	-	-	-	-	-	S	-	-	-	-	-	-	-	-	-	-	-	-	-	S	-	10
F. lameyi	-	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Hemisphaerammina battaleri	-	C	S	-	-	-	-	-	-	-	-	-	-	-	S	U	-	-	-	S	-	S	S	-	-	-	-	S	-	72
Metamorphina bipartita	-	S	S	-	-	-	-	-	-	-	-	-	-	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24
M. gibbosa	-	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6
M. quadripartita	-	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
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T. convexa	-	S	-	-	-	-	-	-	-	-	-	S	-	S	S	S	-	-	S	S	-	-	-	-	-	-	-	-	-	14
T. phrixotheca	-	S	-	-	-	-	-	-	-	-	-	-	-	-	S	S	-	-	S	S	-	S	-	-	-	-	-	-	-	19
Webbinelloidea hemisphaerica	S	A	S	-	-	S	-	-	-	-	-	S	-	-	S	-	-	-	-	S	-	-	-	-	-	-	-	-	-	86
W. similis	-	S	-	-	-	-	-	-	-	-	S	S	-	-	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7
Ceratammina cornucopia	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	57
Psammophax hormiscoides	-	S	-	-	-	-	-	-	-	-	-	-	-	-	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
Psammosphaera angulans	-	C	-	-	-	S	-	-	-	-	S	-	-	-	-	-	-	-	S	S	-	-	-	-	-	-	-	-	-	55
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P. fusca	-	U	-	-	-	-	-	-	-	-	-	S	-	-	-	-	-	-	-	S	-	-	-	-	-	-	-	-	-	21
P. laevigata	-	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	S	-	-	-	-	-	S	-	21
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S. osgoodensis	-	S	-	-	-	-	-	-	-	-	-	-	-	-	S	-	-	-	S	-	-	-	-	-	-	-	-	-	-	13
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L. stilla	-	U	-	-	-	-	-	-	-	-	-	S	-	-	S	-	-	-	S	S	-	-	-	-	-	-	-	-	-	26
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Shidelerella bicuspidata	-	S	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
S. elongata	-	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	S	S	-	-	S	-	-	-	-	-	-	10
Stomasphaera brassfieldensis	-	C	S	-	-	-	-	-	-	-	-	S	-	-	-	-	-	-	-	-	-	S	-	-	-	-	-	-	-	41
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T. arcuata	-	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	S	-	-	-	-	-	-	-	-	-	-	8
T. compressa	-	C	-	-	-	-	-	-	-	-	-	S	-	S	-	-	-	-	-	S	-	-	-	-	-	-	-	-	-	56
T. echinata	-	V	-	-	-	-	-	-	-	-	-	S	-	-	-	-	-	-	U	S	-	-	-	-	-	-	-	-	-	133
T. elliptica	-	S	-	-	-	-	-	-	-	-	-	-	-	-	-	S	-	-	S	-	-	-	-	-	-	-	-	-	-	12
T. furcata	-	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	S	-	-	-	-	-	-	-	-	-	-	20
T. papillata	-	A	S	-	-	-	-	-	-	-	-	-	-	-	S	S	-	-	-	S	-	-	-	-	-	-	-	S	-	119
T. parallela	-	U	-	-	-	-	-	-	-	-	-	S	-	-	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26
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T. phasela	-	U	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	S	S	-	-	-	-	-	-	-	S	-	21
T. slocomi	-	S	-	-	-	-	-	-	-	-	-	S	-	-	-	-	-	-	S	-	-	-	-	-	-	-	-	-	-	12
T. subsphaerica	-	C	S	S	-	-	-	-	-	-	-	S	-	-	-	-	-	-	S	-	-	-	-	-	-	-	-	-	-	62
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Hormosinidae																														
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R. texanus	-	S	S	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	S	-	-	-	-	-	-	-	-	-	-	11

Abundance in number per kilogram sample:

None	0
Sparse (S)	1-10
Uncommon (U)	11-30
Common (C)	31-60
Abundant (A)	61-100
Very abundant (V)	100+

GEOLOGICAL SURVEY
JOHN B. PATTON, State Geologist

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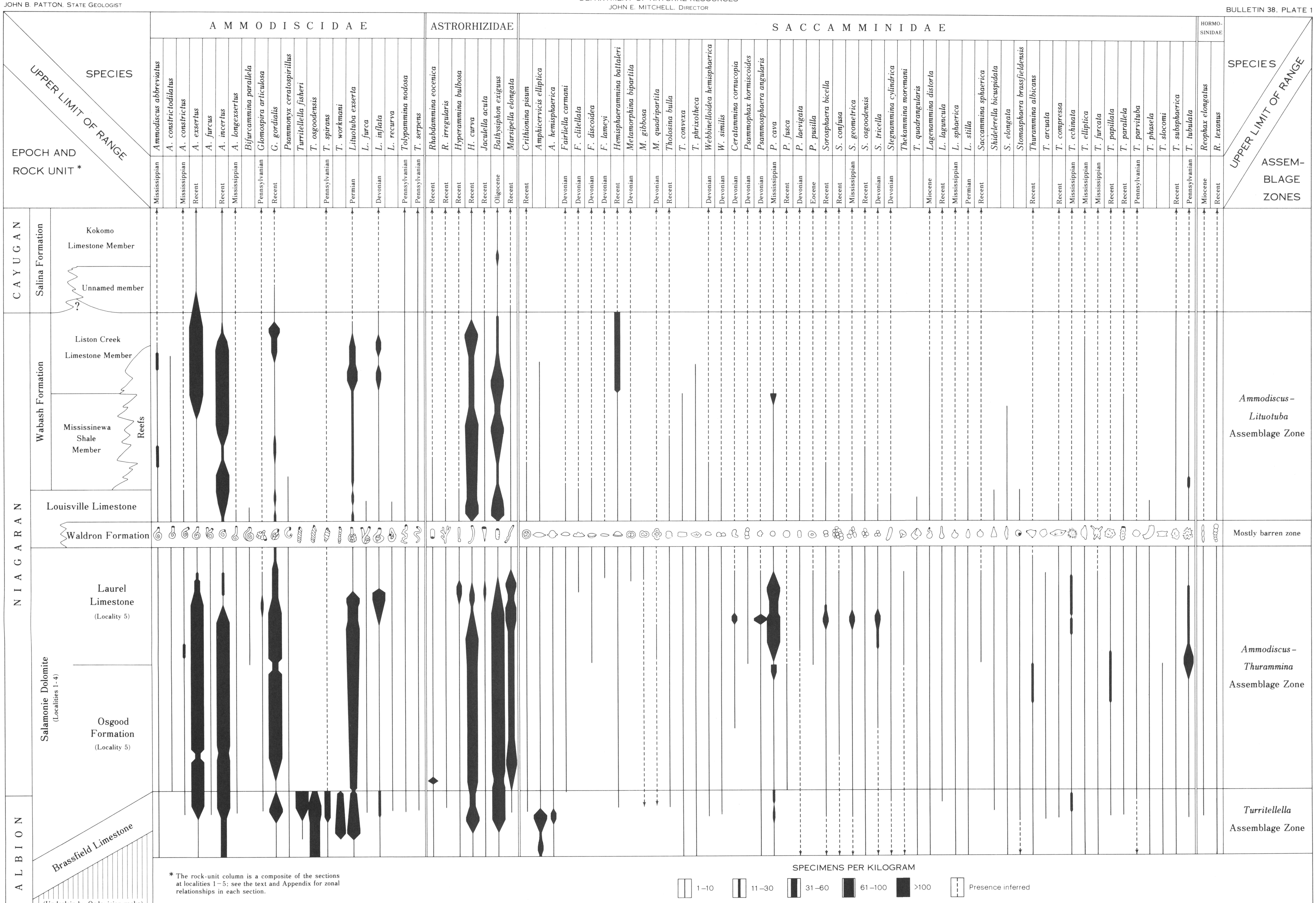
DEPARTMENT OF NATURAL RESOURCES
JOHN E. MITCHELL, Director

BULLETIN 38, PLATE 1



Drafted by James R. Tolen

RANGE CHART OF SILURIAN ARENACEOUS FORAMINIFERIDA FROM INDIANA

By Michael C. Mound

1968