

# The Stratigraphy and Paleontology of the Tanner's Creek Section of the Cincinnati Series of Indiana.\*

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## INTRODUCTION.

The present report is the result of three continuous years of study in the laboratory of collections and notes taken in the field by Professor Cumings and students of the Department of Geology of Indiana University during the summers of 1910 and 1911. The collections were made from the eighteen new railroad cuts on the Big Four Railroad from Weisburg to Guilford, Indiana, and at Section 5.9A, and consist of about a ton of clean fossils, mostly Bryozoa.

The fossils were collected zonally, great care being taken to locate exactly the horizon of every specimen. The laboratory work has involved the preparation and study of 1,550 microscopic slides with sections of Bryozoa from this collection alone.

We are under obligations to Mr. Lyle Shank and Mr. Robert Payton, who assisted in the field work, and to Dr. R. S. Bassler, of the United States National Museum, for kindly furnishing specimens for comparison. Mr. H. N. Coryell has been of inestimable service to us. He has assisted in the preparation of slides, charts and plates and has been of great assistance in many other ways. Dr. J. W. Beede has kindly given suggestions and advice on many points.

## PART I. STRATIGRAPHY.

The most complete section of the Cincinnati Series so far known is the section exposed in the eighteen railroad cuts on the Chicago and Cincinnati Division of the C. C. C. & St. L. Railroad along Tanner's Creek, Dearborn county, Indiana, from Guilford to Weis-

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\* The present report is supplementary to the senior author's work on "The Stratigraphy and Paleontology of the Cincinnati Series of Indiana", published in the 32d Annual Report of the Department of Geology and Natural Resources of Indiana, 1907.

burg. The railroad cuts were opened in 1902-3, and expose the strata from the middle Eden to near the top of the Whitewater division of the Richmond, with the exception of ten feet in the upper Liberty. The section exposed is 505 feet thick. Since the westerly dip is five feet to the mile the difference in elevation between the base and top of the section is 460 feet.

Many of the cuts overlap stratigraphically, that is, the same strata are exposed in several cuts, so that the chances of getting the entire fauna of a stratum are greatly increased by collecting from the same horizon in different cuts. The elevation of the railroad track at every point is accurately known, so that it would scarcely be possible to find a section where more accurate stratigraphic measurements could be made, or the horizon of specimens and range of species determined with more exactness.

When the cuts were first opened and the strata were freshly exposed, accurate zonal collecting would have been a simple matter, but it is becoming more and more difficult to collect in these cuts on account of the slumping, and overgrowth of vegetation. In the spring of the year, however, before the weeds get started, it is still an easy matter to find the fossils in place. Great quantities of fossils in a fine state of preservation may be picked up from the talus and dumps, but such collections are of little value for stratigraphic studies.

The following classification of the Cincinnati rocks is applicable to the Tanner's Creek Section:

Cincinnati	Richmond	(Elkhorn)
		Whitewater ( <i>Homotrypa wortheni</i> zone)
		Saluda ( <i>Tetradium minus</i> zone)
		Liberty ( <i>Strophomena planumbona</i> zone)
		Waynesville ( <i>Dalmanella meeki</i> zone)
	Maysville	Corryville-Arnheim (Harmon)
		( <i>Rafinesquina fracta</i> zone)
		Bellevue ( <i>Rafinesquina ponderosa</i> zone)
		Mt. Hope-Fairmount (Fairview)
		( <i>Plectorthis plicatella</i> zone)
	Eden	McMicken ( <i>Heterotrypa ulrichi</i> zone)
		Southgate ( <i>Hallopora onealli</i> zone)
(Economy)		

## EXPLANATION OF FAUNAL CHARTS.

At the left of each chart is given an alphabetical list of all the species identified in the 1910 and 1911 collections from Tanner's Creek. The occurrence of each species is indicated by a straight line, the weight of the line indicating the relative abundance of the species. Where the species is very abundant or dominant in the fauna the space is filled in solid black.

At the top of the charts the interval exposed by each railroad cut is indicated by a bracket. The elevations above sea level are also indicated, each space, reading across the chart, equaling five feet.

In these charts the dip is disregarded. This introduces an error of about eight per cent., that is, each formation is eight per cent. thicker than is indicated by the differences in sea level.

The 565 foot level of Section 5.9A (opposite the mouth of the Miami River, in the Kentucky bank of the Ohio River) corresponds to the 515 foot level of the Tanner's Creek section, since the dip between the two sections amounts to at least 50 feet.

The profile and map were taken from surveys made by the engineers of the C. C. C. & St. L. R. R. Co., and show the interval exposed by each cut, the dip and thickness of the strata, the elevation above sea level, etc.

## THE EDEN GROUP.

The rocks of the Eden group consist largely of soft, blue, sometimes sandy shale with occasional thin beds of blue or gray limestone. The limestone layers are made up largely of fossils, but most of the shale is relatively barren, though occasionally containing large numbers of Graptolites, Trilobites, etc. About 160 feet of these shales are exposed on Tanner's Creek and at Section 5.9A, across the Ohio river from Lawrenceburg.

*Southgate.*—The lowest strata exposed in the Tanners' Creek section are seen in an exposure about a mile and a half down the creek from Guilford. This section, numbered 1.34E\*, is about 20 feet thick, and consists principally of thinly laminated, fine-grained, friable, soft blue shale, with a few thin layers of fine-grained limestone and sandstone. The principal fossils are *Climacograptus typicalis* Hall, and *Bythocypris cylindrica* (Hall), both of which occur in great abundance. These species were not obtained

\* The exact elevation of Section 1.34E is not known, but it is about 25 feet lower than as shown on the faunal charts.

from any higher horizon, and it seems quite probable that they are restricted to the Economy and Southgate.

We consider Section 1.34E as belonging to the Southgate member of the Eden. Nickles calls the middle Eden the *Batostoma jamesi* beds.\* Not a single specimen, however, of this species was obtained from Section 1.34E, so that Nickles' faunal name would not apply to this part of the section. Neither the top nor the bottom, however, of the Southgate is exposed at this locality. Higher up, in Cut 1, in the McMicken, *Batostoma jamesi* is abundant. Bassler says that at the type locality, Southgate, Kentucky, "throughout the entire member, *Ctenobolbina ciliata*, *Aspidopora eccentrica*, and *Batostoma jamesi* are particularly abundant and characteristic."† None of these species were found in this member on Tanner's Creek. *Ctenobolbina ciliata* occurs in the McMicken. Six miles southeast of Guilford, at Section 5.9A, on the Kentucky bank of the Ohio river opposite Lawrenceburg, we found *Aspidopora eccentrica* and *Batosoma jamesi* in considerable numbers in the Southgate. This would seem to indicate that the typical Southgate fauna did not extend into Indiana.

*McMicken*.—These beds are exposed in Cuts 1, 2, 3, 4 and 5, and at Section 1.34C12a (on the creek just south of Cut 6). They consist mainly of soft, blue shale with occasional irregular layers of limestone from a few inches to a foot thick. The whole thickness of the upper Eden represented in these cuts is about 75 feet. Fossils are abundant throughout this division and the number of species is large. We have identified no fewer than 66 species from these beds, 47 of which are Bryozoa. The most abundant species are *Heterotrypa ulrichi*, *Coeloclema commune*, *Coeloclema alternatum*, *Batostoma jamesi*, *Batostoma implicatum*, *Hallopora onealli* and varieties, *Amplexopora septosa* and varieties, and *Dalmanella multisecta*. All of these occur in great profusion. The most fossiliferous horizon is from 545 to 565 feet above sea level, in the top of Cut 1, and bottom of Cuts 2 and 3.

The McMicken of Tanner's Creek agrees very well in thickness, lithological characters and fossil contents with the same strata elsewhere in Indiana and Kentucky and at Cincinnati. The base is not exposed in our section, but it cannot be much below the bottom of Cut 1.

There are three fairly well marked faunal divisions of the McMicken, the lower 25 feet, the middle 20 feet and the upper 25

\* Jour. Cin. Soc. Nat. Hist., XX, p. 72, 1902.

† Proc. U. S. Nat. Mus., XXX, pp. 9, 10.

feet. The lower 25 feet is not very fossiliferous, the species enumerated occurring sparingly at the bottom and in increasing abundance toward the top. At this point, and continuing for 20 feet, there is a marked increase in the number of species and the abundance of individual specimens. *Heterotrypa ulrichi*, as well as most of the other species listed above, occurs most abundantly at this horizon. In the upper 25 feet there is a marked decrease in the number of individuals and an equally well-marked increase in the number of species, *Batostoma jamesi*, *Coeloclema commune* and *Heterotrypa ulrichi* occur only sparingly, and *Hallopora onealli* not at all in this division. On the other hand, *Bythopora arctipora*, *Dekayia aspera*, *Hallopora dalei*, *Heterotrypa ulrichi lobata*, *Heterotrypa ulrichi robusta* and *Peronopora vera* become increasingly abundant.

The McMicken differs from the Economy and Southgate both in being more calcareous, and faunally; but there is no sharp dividing line between them. The top of the Eden is not marked by any sharp lithological break, nor by a pronounced change in the fauna. The horizon we use as the top of the Eden is at an elevation of 590 feet in the top of Cut 3. This horizon is somewhat arbitrary, since any other horizon from 70 feet below to 50 feet above could be used with some justification, considering this section alone; but we believe that this horizon is substantially the same as that which former workers have considered as marking the top of the Eden, and there is at this level a fairly well-defined lithologic transition.

While at this horizon there is no very sharp change in the character of the sediments, there is a considerable change in the character of the fauna, particularly in the item of relative abundance. Many species which occur in abundance in the McMicken suddenly become rare or extinct at this level, while a number of other species first appear or become abundant. Among the species which make their last appearance at the top of the McMicken are *Trinucleus concentricus*, *Batostoma jamesi*, *Coeloclema alternatum*, *Coeloclema commune*, *Dekayia obscura*, *Hallopora onealli communis* and *Hallopora onealli sigillarioides*. *Constellaria constellata prominens* is characteristic of the base of the Maysville.

It is possible that the level 25 feet lower, which is indicated on the faunal charts by a heavy line, is the horizon which students of the Cincinnati section consider as the top of the Eden.

## THE MAYSVILLE GROUP.

The rocks of the Maysville group, in this section, as well as elsewhere in Indiana, Ohio and Kentucky, consist largely of thin, slabby, irregular, often sandy, beds of limestone, intercalated with soft, usually yellowish shale. The Maysville is more calcareous than the Eden below and the Richmond above, and this constitutes its chief distinguishing feature lithologically. The most abundant fossils occurring throughout the Maysville are *Rafinesquina alternata* and its varieties, and *Hallopora ramosa* and *Heterotrypa frondosa*.

*Mt. Hope-Fairmount (Fairview).*—This division is 75 feet thick in this section, and is considerably more calcareous than the underlying McMicken beds. In this section the Mt. Hope cannot be distinguished from the Fairmount, either lithologically or faunally. Nickles\* calls the Mt. Hope the *Amplexopora septosa* beds, and designates as a dividing line between them and the McMicken a thin layer of limestone made up mainly of *Dalmanella multisecta*. In the present section *Amplexopora septosa* is not confined to the lower Maysville, but occurs in almost equal abundance throughout the McMicken and 50 feet of the Maysville, a vertical range of at least 120 feet. Consequently the Mt. Hope cannot be identified by this species alone. The layer of *Dalmanella multisecta* cannot be identified in this section. This species occurs very abundantly in the middle and upper McMicken, and commonly in the Mt. Hope-Fairmount.

The Mt. Hope-Fairmount is very fossiliferous, a large number of species occurring and a great abundance of individuals. The species occurring most commonly are *Plectorthis plicatella*, *Platystrophia laticosta*, *Amplexopora septosa* and its varieties, *Batostoma implicatum*, *Bythopora arctipora*, *Dekayia aspera* (in the lower 20 feet), *Escharopora falciformis*, *Escharopora pavonia*, *Hallopora andrewsi*, *Hallopora dalei*, *Heterotrypa subfrondosa* and its allies, *Homotrypa curvata* and its allies, and *Peronopora vera*. *Constellaria constellata* and varieties, while not common, is very characteristic of the basal Maysville.

*Bellevue.*—The rocks of this division are similar to those of the division below, but the limestone layers are less sandy and more fissile, and weather more rapidly. There are fewer species of fossils in these beds, but these occur in great numbers. The most common species are *Hallopora ramosa*, *Heterotrypa frondosa*, *Hebertella*

\* Jour. Cin. Soc. Nat. Hist., XX, p. 76.

*sinuata*, *Platystrophia laticosta*, *Rafinesquina alternata* and its varieties *R. fracta* and *R. ponderosa*. Many of the limestone layers are made up largely of the shells of *Rafinesquina*. *Monticulipora mammulata d'Orbigny* (= *Monticulipora molesta* Nicholson) is abundant in the Bellevue at Cincinnati and characteristic of the formation, but not a single specimen has been found in these beds on Tanner's Creek. A few specimens were found in the division immediately below.

*Corryville-Arnheim*.\*—This division, which is about 110 feet thick, consists of limestones and shales, similar to the rest of the Maysville. Limestones predominate at the base and are gradually replaced by shale toward the top, where the rocks consist largely of thin-bedded, sandy, yellow, nodular shale. Fossils occur in fair abundance, surpassing the lower Maysville in the number of species. Our collection from this division contains 85 species.

The lower 20 feet are apparently less fossiliferous than the rest, but part of this lack may be due to the difficulty of collecting. The most conspicuous fossils are *Hallopora ramosa* and *Rafinesquina alternata fracta*, neither of which is confined to these beds. The characteristic fossils are *Atactoporella ortonii*, *Coeloclema oweni*, *Homotrypa pulchra* and *Dinorthis retrorsa*. *Chiloporella flabelata* occurs in considerable numbers at an elevation of 710 feet in Cut 8, and sparingly for 35 feet below and 15 feet above this level. This species has been considered as being characteristic of the Corryville member of the Maysville. Its occurrence enables us to correlate these strata in a general way with the Corryville elsewhere, but we are unable to set any very definite limits to the Corryville in this section. The horizon of the Mt. Auburn is indicated by a thick layer of limestone containing the gerontic form of *Platystrophia lynx*. This horizon, which in this section is at an elevation of 725 feet, is considered by most geologists as marking the top of the Maysville, and Ulrich considers it as the top of the Ordovician.

\* If a single name is desired for this division we propose the name *Harmon*, from Harmon's Station, near which in Cuts 8 to 11 the entire formation is exposed. Owing to an error in drawing the faunal charts, several species that are restricted to the lower Arnheim, are shown as persisting throughout the division. The correct range is indicated in the lists on pp. 380-384.

We do not agree either that the Arnheim should be placed in the Richmond, or that the Richmond belongs in the Silurian. There is no lithologic or faunal break at this level, at least in the present section. Most of the Arnheim species range without interruption from within the Corryville to the middle Arnheim, and many of them throughout the Maysville. These facts are graphically shown on the faunal charts.

The Arnheim fauna, which has heretofore been little studied, is large and varied. It is interesting that *Homotrypa bassleri*, which characterizes the Arnheim in Ohio, should be entirely wanting in the present section. Our collections from the Arnheim are very extensive, yet we have searched in vain for a specimen of this species. Many species occur in large numbers, but only one, *Dinorthis retrorsa* (*D. carleyi* Hall) seems to be characteristic of these beds, and this is confined to a few feet of rock near the top of the Arnheim. All the other species either occur lower in the Maysville, or continue into the Waynesville.

#### THE RICHMOND GROUP.

At the top of the Arnheim the rocks are irregularly bedded and nodular and almost barren of fossils. At this point limestones cease to predominate, and are replaced by soft, argillaceous shale and thin beds of limestone. Shale predominates throughout the Waynesville, which is 105 feet thick. There is also a marked faunal break at the top of the Arnheim. Not less than 30 species of Bryozoa fail at this point or abruptly become rare. Over 20 species make their first appearance at this horizon. The Waynesville fauna is quite distinct from the Arnheim and shows a change of life conditions. There are also numerous migrants from other regions, especially from the northwest, indicating a pronounced epirogenic movement at this time. At no horizon throughout the Maysville is there any faunal or lithologic change comparable with the one at the top of the Arnheim. Hence, we maintain that the Arnheim should be classed with the Maysville sediments and that the Richmond should begin with the lower Waynesville. On the other hand, we believe that the Richmond is most intimately associated with the subjacent Ordovician, both lithologically and faunally, and that it should be retained in the Ordovician System.

*Waynesville.*—These beds consist of soft, blue shale, with occasional thin beds of limestone. Fossils are very abundant, and both the number of species and of individual specimens is great. Several species of *Heterotrypa* occur abundantly throughout the



Waynesville and are confined to these beds, especially *Heterotrypa prolifica*, which occurs in large numbers. The Waynesville species of *Heterotrypa* can, however, always be distinguished from the Maysville species of the genus by the presence of diaphragms in the axial region of the former.

The three divisions of the Waynesville proposed by Foerste, in ascending order, Fort Ancient, Clarksville and Blanchester,\* cannot be very definitely delimited in this section and we prefer not to subdivide the formation. The upper 17 feet, corresponding in part to the Blanchester, is marked by the occurrence of *Hebertella insculpta*, *Leptaena rhomboidalis* and *Platystrophia laticosta* in great numbers.

The fauna of the Waynesville is the most prolific of any division of the Cincinnati. Our collection from the Tanner's Creek Section contains 116 recognizable species. Most of the fossils, except the Mollusca, are in an excellent state of preservation.

*Dalmanella meeki* occurs abundantly throughout this formation but is not restricted to the Waynesville. The lower and middle Waynesville are not characterized by any fauna markedly distinct from the upper part. The upper 17 feet are characterized by the abundant occurrence of *Protarea vetusta*, *Streptelasma divaricans*, *Hebertella insculpta*, *Leptaena rhomboidalis*, *Platystrophia laticosta* and *Calymene callicephala*. This upper portion is by some geologists placed in the Liberty formation.

The common forms which make their first appearance in the Waynesville, and probably represent an invasion from the northwest, are *Streptelasma rusticum*, *Protarea vetusta*, *Rhynchotrema capax*, *Rhynchotrema dentata*, *Strophomena planumbona* and its allies, *Heterotrypa prolifica* and the associated species of the genus, *Homotrypella hospitalis*, *Batostoma prosseri* and *Rhombotrypa quadrata*.

*Liberty*.—The Liberty formation is 50 feet thick and consists almost entirely of limestone, the base being marked by layers of rock almost wholly made up of *Plectambonites sericeus*. A considerably smaller number of species occurs in the Liberty than in the Waynesville, but there is a large increase in the abundance of individuals of several of the holdovers from the Waynesville.

The most abundant and characteristic species of the Liberty are *Dinorthis subquadrata*, *Plectambonites sericeus*, *Rhynchotrema capax*, *Strophomena planumbona*, *Amplexopora granulosa* and *Homotrypa austini*.

\* Bull. Sci. Labs. of Denison University, XIV, p. 291, 1909.

*Saluda*.—The Saluda in this section is about 10 feet thick, and made up of a basal member, the 'shale bed,' of exactly the same character as the same member at Versailles, Indiana; and an upper bed of massive limestone containing *Tetradium*. The fauna is very meager. The most abundant species is *Tetradium minus*, which occurs in large masses at the top of the division, representing the upper *Tetradium* reef of sections farther southwest.

*Whitewater*.\*—The lower 30 feet of the Whitewater is exposed in Cut 18, just north of the station at Weisburg, Indiana, and consists of a soft, very nodular, shaly limestone, exactly like the Whitewater of the type section at Richmond, Indiana.

Only a few species, outside of the Bryozoa, are restricted to the Whitewater, most of the fauna being the same as that of the Liberty. *Strophomena sulcata* occurs abundantly. The Bryozoa characteristic of the Whitewater are *Batostoma variabile*, *Bythopora delicatula*, *Homotrypa constellariformis*, *Homotrypa cylindrica*, *Homotrypa nicklesi*, *Homotrypa nitida*, *Homotrypa ramulosa* and *Homotrypa wortheni*. Those restricted to this division are *Batostoma variabile*, *Homotrypa constellariformis*, *H. nitida* and *H. nicklesi*.

The Elkhorn division is not present in this section.

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\* Mr. Ulrich believes that the base of the Whitewater division should be taken at a horizon about 15 feet below the Saluda 'shale bed', where a number of species enter that are characteristic of the Whitewater. He believes, furthermore, that the 'Saluda' is merely a series of northwardly thinning wedges in the Whitewater.



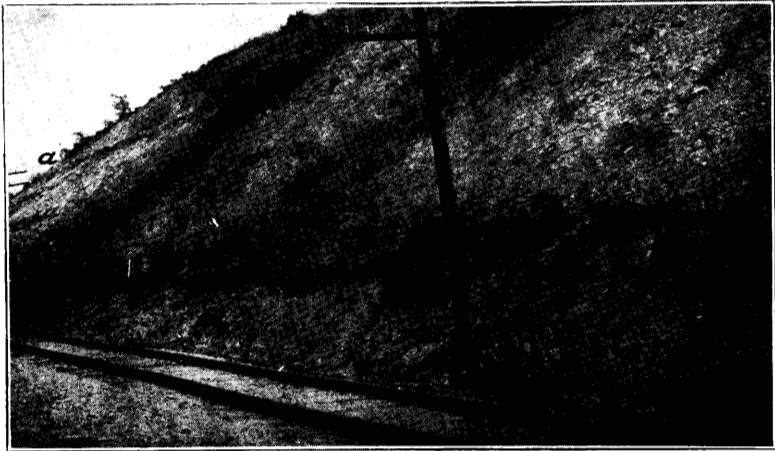
Cut 1.—Just east of Guilford. Lower McMicken.



Cut 2.—Just west of Guilford. Upper McMicken. Base of Maysville at *a*.



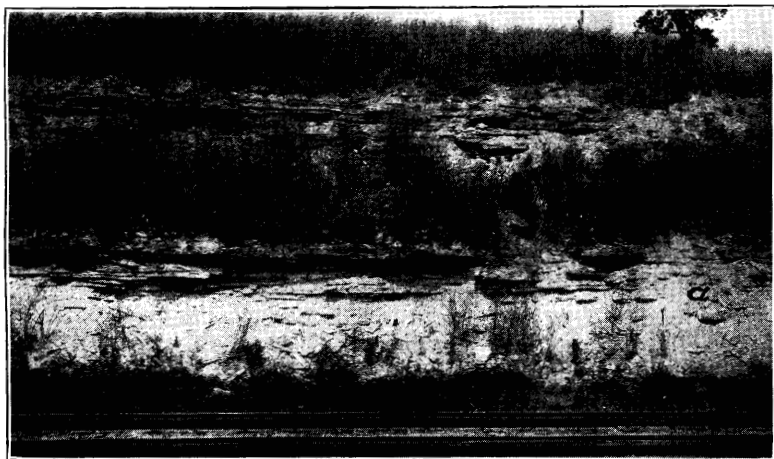
Cut 3.—South side. Upper McMicken.



Cut 4.—South side. Upper McMicken. Base of Maysville at a.



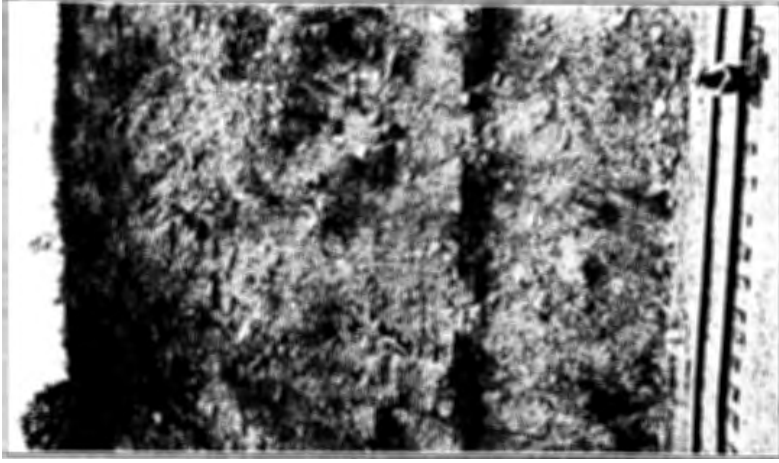
Cut 5.—North side. Zone of abundant *Dekayia aspera*.



Cut 7.—North side. Lower Fairmount. *Strophomena planoconvexa* layer at a.



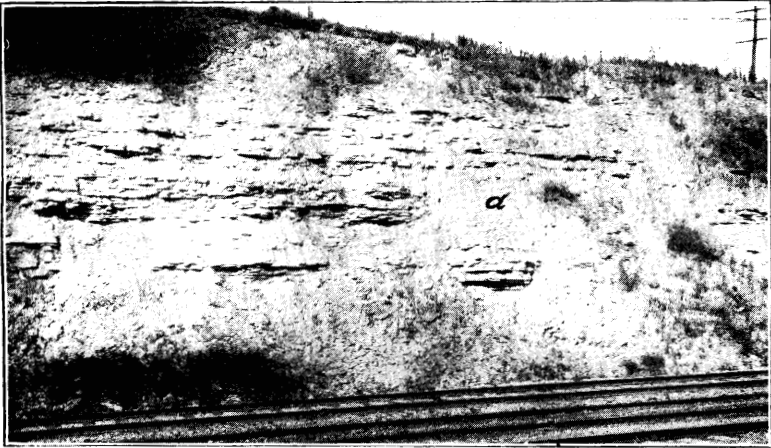
Cut 9.—Corryville. Bellvue at base.



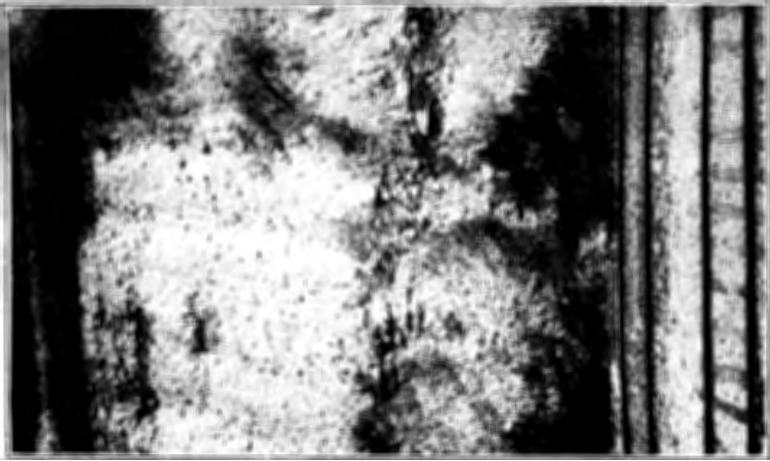
Cut 5—South side, McMicken and Mt. Hope. Base of the Maysville at *a*.



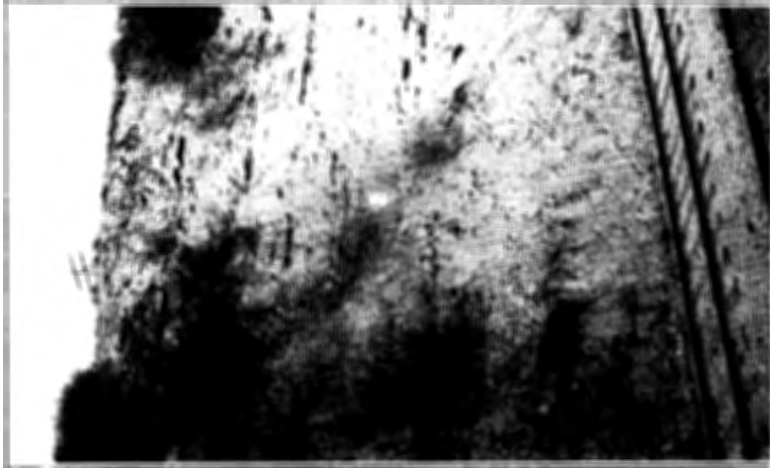
Cut 10.—Corryville-Araheim. The *Platystrophia lynx* layer is at *a*.



Cut 16.—Top of the Waynesville and base of the Liberty. The *Plectambonites sericeus* layer is at *a*.



Cut 11. Arnheim.



Cut 15. Upper Waynesville and base of the Liberty.

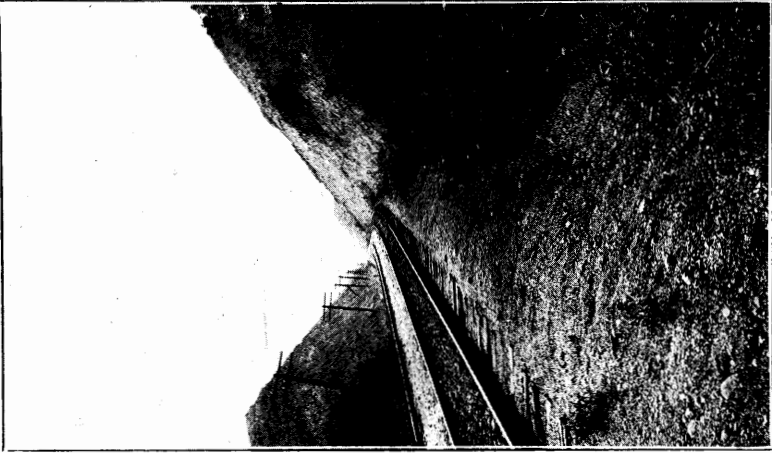




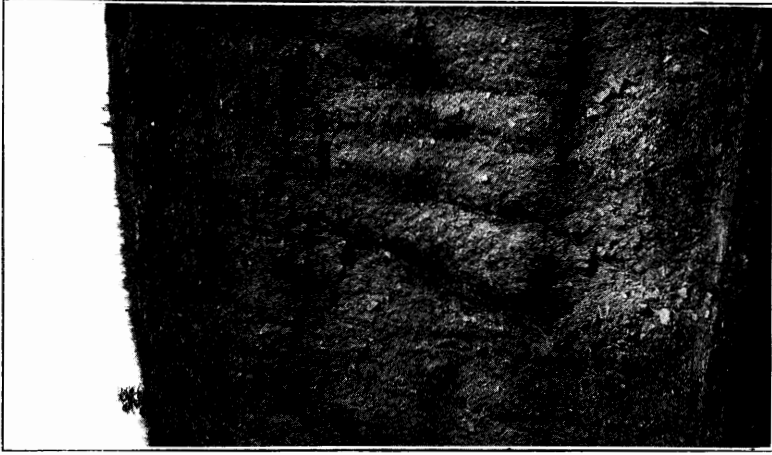
Cut 13.—Waynesville.



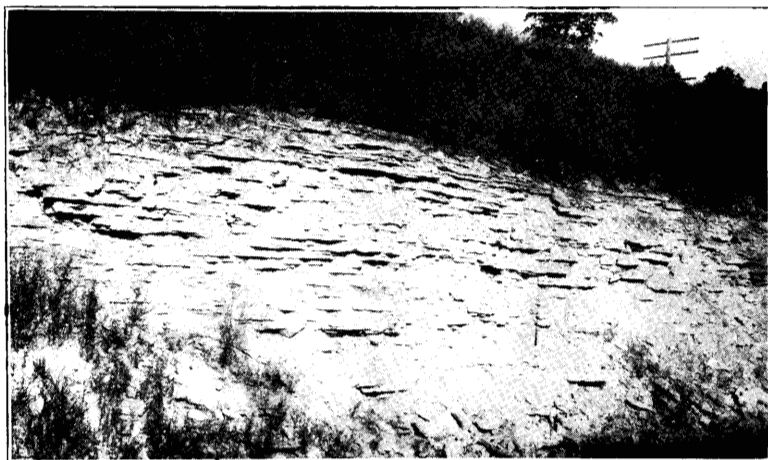
Cut 12.—Top of the Arnhem and base of the Waynesville. The man is standing at the base of the Waynesville.



Cuts 13 and 14.



Cut 14.—Waynesville. *Hebertella inscripta* zone at the top.



Cut 17.—Middle and Upper Liberty.



Cut 18.—Just north of Weisburg. The hammer rests on the *Tetradium* layer *a*. Just below this layer is the black, carbonaceous shale bed *b* and below this the "shale bed" *c*.

PART II. DETAILED FAUNAL LISTS OF THE TANNER'S  
CREEK SECTION.

*Fauna of Section 1.34E. Southgate.*

Climacograptus typicalis (a)	Trematis millepunctata (r)
	Zygospira modesta (r)
Iocrinus subcrassus (r)	
	Bellerophon cf. gorbyi (r)
Cornulites flexuosus (c)	
	Orthoceras sp. (r)
Amplexopora petasiformis (r)	
Aspidopora areolata (r)	Acidaspis sp. (r)
Bythopora parvula (r)	Calymene callicephala (c)
Hallopora onealli (c)	Isotelus maximus (c)
Stigmatella clavis (r)	Proetus spurlocki (r)
Dalmanella multisecta (r)	Bythocypris cylindrica (a)
Lingula modesta (c)	Leperditia caecigena (c)
Leptobolis lepis (r)	Primitia centralis (c)
Plectambonites sericeus (r)	
Rafinesquina alternata (r)	Lepidocoleus jamesi (r)

*Fauna of Cut 1, Upper Part. Lower McMicken.*

Cornulites sp. (a)	Hallopora onealli communis (c)
	onealli sigillarioides (a)
Amplexopora septosa (a)	nodulosa (c)
septosa minima (c)	subplana (c)
septosa maculosa (c)	Heterotrypa ulrichi (aaa)
septosa multispinosa (a)	Peronopora vera (a)
petasiformis (r)	Proboscina frondosa (c)
Arthropora shafferi (c)	Stigmatella clavis (c)
Arthrostylus tenuis (r)	Stomatopora arachnoidea (a)
Batostoma implicatum (aa)	
jamesi (aa)	Dalmanella multisecta (a)
Bythopora arcipora (c)	Rafinesquina alternata (r)
Ceramoporella distincta (a)	Zygospira cincinnatiensis (r)
ohioensis (c)	modesta (r)
triloba (r)	
granulosa milfordensis (r)	Acidaspis sp. (c)
Coeloclema alternatum (aaa)	Isotelus maximus (r)
commune (aaa)	
Dekayia maculata (r)	Ceratopsis chambersi (r)
obscura (c)	
Hallopora dalei (c)	Crinoid segments (c)
onealli (aa)	

*Fauna of Cut 2, 0-26 Feet Above Railroad. Middle McMicken.*

Cornulites flexuosus (r)	Homotrypa glabra (r)
	Peronopora vera (a)
Arthropora cleavelandi (c)	Petigopora asperula (r)
shafferi (c)	Stomatopora arachnoidea (c)
Bythopora arctipora (c)	
parvula (rr)	Dalmanella multisecta (c)
Ceramoporella distincta (r)	Rafinesquina alternata (c)
Coeloclema alternatum (c)	Zygospira modesta (c)
commune (r)	
Dekayia maculata (r)	Pterinea demissa (r)
obscura (r)	
Hallopora dalei (a)	Acidaspis sp. (r)
nodulosa (c)	Isotelus maximus (c)
onealli communis (c)	Trinucleus concentricus (r)
onealli sigillarioides (c)	
Heterotrypa ulrichi (a)	Ctenobolbina ciliata (c)

*Fauna of Cut 2, 26-62 Feet Above Railroad. Upper McMicken.*

Cornulites flexuosus (r)	Hallopora onealli sigillarioides (a)
	Heterotrypa ulrichi (c)
	ulrichi robusta (r)
Amplexopora septosa (a)	Peronopora vera (c)
septosa maculosa (r)	
Arthropora shafferi (c)	Rafinesquina alternata (c)
Batostoma implicatum (c)	
Bythopora arctipora (a)	Acidaspis sp. (c)
Escharopora pavonia (r)	Isotelus maximus (r)
Hallopora dalei (a)	
nodulosa (r)	

*Fauna of Cut 2, Upper 40 Feet. Mt. Hope-Fairmount.*

Amplexopora septosa (a)	subpulchella (r)
septosa minima (c)	ulrichi (r)
Arthropora shafferi (c)	ulrichi lobata (a)
Batostoma implicatum (r)	Homotrypa alta (a)
Bythopora arctipora (a)	cincinnatiensis (c)
Ceramoporella distincta (c)	curvata praecipua (c)
Constellaria constellata (r)	dumosa (r)
Dekayia aspera (c)	spinea (c)
cf. aspera (c)	Peronopora vera (aa)
Hallopora andrewsi (a)	Petigopora asperula (r)
dalei (aa)	Proboscina frondosa (r)
nodulosa (a)	Stigmatella clavis (r)
ramosa (a)	Stomatopora arachnoidea (c)
Escharopora faleiformis (c)	
Heterotrypa frondosa (a)	Dalmanella multisecta (r)
solitaria (r)	Platystrophia laticosta (c)
subfrondosa (a)	

Plectorthis plicatella (r)	Cyclonema bilix (c)
Rafinesquina alternata (a)	
Strophomena planoconvexa (r)	Isotelus maximus (r)
Zygospira modesta (c)	

*Fauna of Cut 2, Upper 10 Feet, Fairmount.*

Amplexopora ampla (r)	Petigopora asperula (r)
septosa (c)	Stomatopora arachnoidea (r)
Constellaria constellata (a)	
Dekayia appressa (c)	Cornulites flexuosus (c)
aspera (c)	
Escharopora falciformis (r)	Dalmanella multisecta (r)
Hallopora dalei (a)	Hebertella sinuata (r)
nodulosa (r)	Platystrophia costata (c)
Heterotrypa frondosa (a)	Plectorthis plicatella (c)
subpulchella (r)	Rafinesquina alternata (c)
ulrichi (c)	Strophomena planoconvexa (r)
ulrichi lobata (c)	Zygospira cincinattiensis (r)
Homotrypa cincinattiensis (c)	
dumosa (r)	Isotelus maximus (r)
glabra (r)	
obliqua (c)	

*Fauna of Cut 2, Highest Ledge, Fairmount.*

Amplexopora septosa (c)	Hallopora andrewsi (r)
septosa multispinosa (c)	dalei (a)
Dekayia multispinosa (r)	ramosa (c)
Escharopora falciformis (c)	Heterotrypa subpulchella (r)
pavonia (r)	
	Rafinesquina alternata (c)

*Fauna of Cut 3, 0-15 Feet Above Railroad, Middle McMicken.*

Amplexopora septosa (a)	Dekayia maculata (c)
septosa maculosa (c)	obscura (c)
septosa minima (c)	Hallopora dalei (c)
septosa multispinosa (a)	nodulosa (c)
Arthropora cincinattiensis (r)	onealli sigillarioides (c)
shafferi (r)	Heterotrypa subpulchella (r)
Atactoporaella sp. (r)	ulrichi (aa)
Batostoma implicatum (c)	Peronopora vera (c)
Ceramoporella distincta (r)	Stomatopora arachnoidea (c)
ohicensis (c)	
Coeloclema commune (c)	Dalmanella multisecta (a)
Dekayia aspera (r)	Platystrophia laticosta (r)

*Fauna of Cut 3, 17-40 Feet Above Railroad, Upper McMicken.*

Amplexopora septosa (a)	Arthropora cleavelandi (r)
septosa maculosa (r)	Atactopora intermedia (r)
septosa minima (c)	Batostoma implicatum (c)
septosa multispinosa (c)	jamesi (r)

Bythopora aretipora (r)	Petigopora asperula (c)
Ceramoporella distincta (c)	petechialis (r)
ohioensis (c)	Phylloporina variolata (r)
tubulosa (c)	Stomatopora arachnoidea (c)
Consteliaria constellata (c)	
Dekayia aspera (c)	Dalmanella multisecta (c)
maculata (r)	Platystrophia laticosta (c)
Dicranopora meeki (c)	Rafinesquina alternata (c)
Hallopora dalei (a)	Zygospira cincinnatiensis (r)
nodulosa (c)	modesta (r)
onealli communis (a)	
onealli sigillarioides (c)	Orthoceras sp. (r)
Heterotrypa subpulchella (c)	
ulrichi (c)	Acidaspis sp. (r)
ulrichi lobata (c)	Calymene callicephala (r)
ulrichi robusta (c)	Isotelus maximus (r)
Peronopora vera (a)	

*Fauna of Cut 3, Top 5 Feet. Top of McMicken. (Base of Maysville.)*

Cornulites flexuosus (a)	Heterotrypa subpulchella (r)
	ulrichi (r)
Amplexopora septosa (c)	Peronopora vera (aa)
septosa maculosa (r)	Stigmatella clavis (r)
septosa minima (c)	
septosa multispinosa (r)	Crania laelia (r)
Arthropora cincinnatiensis (r)	scabiosa (r)
Batostoma implicatum (c)	Dalmanella multisecta (r)
Ceramoporella distincta (r)	Platystrophia laticosta (r)
ohioensis (r)	Plectorthis plicatella (r)
Consteliaria constellata (r)	Zygospira cincinnatiensis (r)
Dekayia aspera (c)	modesta (c)
Hallopora dalei (a)	
subplana (aa)	Ctenobolbina ciliata (r)

*Fauna of Section 1.34(12a). Top of McMicken. (Base of Maysville.)*

OEnonites cuneatus (r)	Homotrypa obliqua (r)
sp. (r)	Peronopora vera (a)
	Stomatopora arachnoidea (r)
Amplexopora septosa (a)	
Arthropora cincinnatiensis (r)	Plectorthis plicatella (c)
shafferi (r)	Rafinesquina alternata (c)
Dekayia aspera (r)	Zygospira modesta (c)
Escharopora falciformis (c)	
Hallopora dalei (a)	Acidaspis sp. (r)
subplana (a)	Calymene callicephala (r)
Heterotrypa ulrichi lobata (r)	Isotelus maximus (r)

*Fauna of Cut 4, Upper 25. Mt. Hope-Fairmount.*

Cornulites flexuosus (r)	Heterotrypa subfrondosa (r)
	subpulchella (r)
Amplexopora septosa (a)	ulrichi (r)
septosa minima (c)	ulrichi lobata (c)
septosa multispinosa (c)	ulrichi robusta (r)
Arthropora cincinnatiensis (r)	Homotrypa alta (r)
shafferi (r)	curvata praecipita (r)
Atactoporella typicalis (r)	spinea (r)
Bythopora arctipora (r)	Peronopora vera (a)
Ceramoporella distincta (r)	Petigopora asperula (r)
ohioensis (r)	Proboscina frondosa (r)
Constellaria constellata (r)	Stomatopora arachnoidea (a)
Dekayia multispinosa (r)	
Escharopora faleiformis (c)	Crania scabiosa (r)
Hallopora dalei (aa)	Platystrophia laticosta (a)
subplana (r)	Zygospira modesta (c)
Heterotrypa frondosa (r)	
	Cyclonema bilix (r)

*Fauna of Cut 5, North Side. McMicken-Mt. Hope.*

Amplexopora cf. robusta (r)	Heterotrypa ulrichi lobata (r)
septosa (c)	Peronopora vera (aa)
septosa maculosa (r)	Petigopora asperula (r)
septosa multispinosa (a)	Stigmatella clavis (r)
Arthropora shafferi (r)	Stomatopora arachnoidea (c)
Batostoma implicatum (c)	
Ceramoporella distincta (r)	Crinoid segments (c)
ohioensis (r)	
Constellaria constellata (r)	Platystrophia laticosta (r)
Dekayia aspera (aa)	Plectorthis plicatella (r)
cf. aspera (c)	Zygospira modesta (c)
maculata (r)	
Dicranopora emacerata (r)	Cyclora minuta (c)
Hallopora dalei (aa)	
cf. subplana (aa)	Orthoceras sp. (r)
Heterotrypa subfrondosa (r)	
ulrichi (c)	Isotelus maximus (r)

*Fauna of Cut 5, Upper 30 Feet. Mt. Hope-Fairmount.*

Amplexopora septosa (c)	Heterotrypa subfrondosa (r)
Arthropora cincinnatiensis (r)	subpulchella (r)
shafferi (c)	ulrichi lobata (r)
Atactoporella sp. (r)	ulrichi robusta (r)
Corynotrypa inflata (r)	Homotrypa cincinnatiensis (r)
Dekayia aspera (r)	spinea (c)
Escharopora faleiformis (a)	Peronopora vera (r)
Hallopora dalei (c)	Petigopora asperula (r)
subplana (r)	petechialis (c)



Stomatopora arachnoidea (r)	Zygospira modesta (c)
Crania scabiosa (r)	Cyclora minuta (r)
Dalmanella multisepta (r)	
Platystrophia costata (c)	Acidaspis sp. (r)
Plectorthis plicatella (c)	Isotelus maximus (c)
Rafinesquina alternata (c)	

*Fauna of Cut 5, Upper 15 Feet. Fairmount.*

Amplexopora septosa (c)	Homotrypa curvata praecipua (r)
septosa multispinosa (c)	spinea (r)
Arthropora cincinnatiensis (r)	Petigopora asperula (c)
Ceramoporella distincta (r)	Stigmatella aleicornis (c)
ohioensis (r)	Stomatopora arachnoidea (r)
Constellaria constellata (c)	
Corynotrypa delicatula (r)	Dalmanella cf. meeki (c)
inflata (r)	Platystrophia costata (c)
Dekayia aspera (r)	Plectambonites sericeus (r)
cf. aspera (c)	Plectorthis plicatella (c)
Escharopora faleiformis (a)	Rafinesquina alternata (a)
Hallopora dalei (a)	Zygospira modesta (a)
Heterotrypa inflecta (r)	
subfrondosa (c)	Calymene callicephala (r)
subpulchella (r)	Isotelus maximus (c)
ulrichi (r)	
ulrichi lobata (c)	

*Fauna of Cut 7, 10-30 Feet Above Railroad. Fairmount.*

Atactoporella multigranosa (r)	Homotrypa flabellaris spinifera (c)
Bythopora gracilis (r)	obliqua (r)
Ceramoporella ohioensis (c)	spinea (r)
Constellaria constellata (r)	Monticulipora mammulata (r)
Dekayia appressa (c)	Stigmatella sessilis (r)
aspera (r)	
Escharopora pavonia (c)	Hebertella sinuata (r)
Hallopora andrewsi (a)	Platystrophia costata (r)
dalei (a)	laticosta (r)
Heterotrypa frondosa (c)	lynx (r)
pelliculata (r)	Plectorthis plicatella (r)
solitaria (c)	Rafinesquina alternata (r)
subfrondosa (r)	alternata fracta (r)
subpulchella (c)	Strophomena planoconvexa
ulrichi (r)	Zygospira cincinnatiensis (r)
ulrichi lobata (a)	modesta (r)
ulrichi robusta (c)	
Homotrypa cincinnatiensis (r)	Cyclora minuta (c)
curvata (r)	
dumosa (r)	Orthoceras sp. (r)

*Fauna of Cut 7, Upper 20 Feet. Upper Fairmount.*

Cora: unidentified	Homotrypa curvata (r)
	obliqua (r)
Cornulites flexuosus (r)	spinea (r)
	Petigopora asperula (r)
Amplexopora septosa multispinosa (r)	Stomatopora arachnoidea (r)
Arthropora shafferi (c)	Platystrophia laticosta (r)
Ceramoporella ohioensis (r)	Plectorthis plicatella (r)
Constellaria constellata (r)	Rafinesquina alternata (r)
Crepipora solida (r)	alternata fracta (r)
Dekayia appressa (r)	Strophomena planoconvexa (r)
aspera (r)	Zygospira cincinnatiensis (c)
multispinosa (r)	modesta (c)
Hallopora andrewsi (r)	
dalei (c)	Byssonychia radiata (r)
ramosa rugosa (r)	sp. (r)
Heterotrypa frondosa (a)	
paupera (r)	Cyclora minuta (c)
solitaria (r)	Cyrtolites ornatus (r)
ulrichi (r)	
Homotrypa cincinnatiensis (r)	Calymene callicephala (r)
	Isotelus maximus (r)

*Fauna of Cut 7, 50 Feet Above Railroad. Top of Fairmount.*

Amplexopora septosa (r)	Hebertella sinuata (r)
Bythopora gracilis (r)	Platystrophia laticosta (r)
Dekayia aspera (r)	Plectorthis plicatella (r)
multispinosa (r)	Rafinesquina alternata (c)
Escharopora pavonia (r)	alternata fracta (r)
Hallopora andrewsi (aa)	Zygospira modesta (r)
cf. subplana (a)	
dalei (c)	Calymene callicephala (r)
Heterotrypa cf. ulrichi lobata (r)	Isotelus maximus (r)

*Fauna of Section 134C13, Lower 5 Feet. Base of Mt. Hope.*

Amplexopora septosa (a)	Homotrypa spinea (r)
septosa multispinosa (r)	Peronopora vera (a)
Arthropora cincinnatiensis (r)	Petigopora asperula (r)
shafferi (c)	
Ceramoporella ohioensis (r)	Dalmanella multisecta (c)
Constellaria constellata prominens (r)	Platystrophia laticosta (c)
	Rafinesquina alternata (a)
Dekayia aspera (r)	Zygospira modesta (c)
Dicranopora emacerata (c)	
Escharopora faleiformis (c)	Acidaspis sp. (r)
Hallopora dalei (a)	Calymene callicephala (r)
Heterotrypa ulrichi lobata (r)	Isotelus maximus (r)

*Fauna of Section 13½C13, Upper Part. Mt. Hope-Fairmount.*

Amplexopora septosa (r)	Heterotrypa ulrichi (c)
septosa multispinosa (r)	ulrichi lobata (r)
Ceramoporella ohioensis (r)	ulrichi robusta (r)
Constellaria constellata (r)	Homotrypa cincinnatiensis (r)
Dekayia aspera (c)	glabra (r)
cf. aspera (r)	Stomatopora arachnoidea (r)
Escharopora pavonia (r)	
Hallopora dalei (c)	Dalmanella multisepta (r)
Heterotrypa paupera (r)	Platystrophia laticosta (r)
subfrondosa (c)	Rafinesquina alternata (r)
subpulchella (r)	Zygospira modesta (r)

*Fauna of Section 13½C13, All. Mt. Hope-Fairmount.*

Amplexopora septosa (r)	Heterotrypa subfrondosa (r)
septosa multispinosa (r)	Heterotrypa ulrichi lobata (r)
Arthropora shafferi (c)	ulrichi robusta (r)
Ceramoporella distincta (r)	Homotrypa cincinnatiensis (r)
ohioensis (r)	dumosa (r)
Dekayia aspera (r)	spinea (r)
Dicranopora enacerata (c)	Peronopora vera (r)
sp. (c)	Proboscina frondosa (r)
Escharopora falciformis (r)	
pavonia (r)	Rafinesquina alternata (c)
Hallopora dalei (a)	Zygospira modesta (r)

*Fauna of Cut 8, 5-25 Feet Above Railroad. Bellevue.*

<del>Amplexopora</del> filiosa (c)	Petigopora asperula (r)
robusta (r)	
Arthropora shafferi (c)	Hebertella sinuata (c)
Afctoporella mundula (r)	Platystrophia laticosta (c)
Bythopora gracilis (a)	Rafinesquina alternata (c)
Dekayia appressa (c)	alternata fracta (r)
multispinosa (r)	Zygospira modesta (c)
Hallopora andrewsi (r)	
ramosa (a)	Byssonychia radiata (r)
ramosa rugosa (r)	Pterinea demissa (r)
Heterotrypa frondosa (a)	
cf. singularis (r)	Cyclonema bilix (r)
solitaria (r)	Cyclora minuta (r)
Peronopora pavonia (c)	
	Calymene callicephala (r)

*Fauna of Cut 8, 36 Feet Above Railroad. Top of Bellevue.*

Cornulites flexuosus (r)	Hallopora ramosa (a)
	ramosa rugosa (r)
Amplexopora robusta (r)	Heterotrypa frondosa (c)
Bythopora gracilis (c)	Homotrypa obliqua (r)
Dekayia appressa (c)	Peronopora pavonia (a)
magna (r)	Petigopora petechialis (r)
multispinosa (c)	

Rafinesquina alternata (r)	Cyclonema bilix (r)
Zygospira modesta (r)	Cyclora minuta (r)

*Fauna of Cut 8, 60 Feet Above Railroad. Corryville.*

Amplexopora pustulosa (c)	Homotrypa curvata (r)
Arthropora shafferi (c)	obliqua (r)
Bythopora gracilis (aaa)	Peronopora pavonia (aa)
Chiloporella flabellata (a)	
Dekayia appressa (c)	Dalmanella meeki (r)
cf. maculata (r)	Platystrophia lynx (r)
Dicranopora emacerata (r)	Rafinesquina alternata (r)
Eucharopora sp. (r)	Zygospira modesta (c)
Hallopora cf. andrewsi (c)	
ramosa (a)	Orthoceras sp. (r)
ramosa rugosa (c)	
Heterotrypa frondosa (a)	Calymene callicephalo (r)
paupera (r)	Isotelus maximus (r)
cf. singularis (c)	

*Fauna of the Borrow Cut. Bellevue.*

Cornulites flexuosus (r)	Peronoporella dubia (c)
	Petigopora asperula (r)
Amplexopora filiosa (r)	petechialis (r)
Bythopora gracilis (a)	Stomatopora arachnoidea (r)
Chiloporella flabellata (r)	
Dekayia magna (r)	Hebertella sinuata (r)
Hallopora andrewsi (r)	Platystrophia laticosta (c)
ramosa (a)	Rafinesquina alternata (c)
ramosa rugosa (c)	alternata fracta (c)
sp. (c)	alternata ponderosa (c)
Heterotrypa frondosa (aa)	Zygospira modesta (c)
pelliculata (c)	
cf. singularis (c)	Cyrtolites ornatus (r)
Homotrypa curvata (r)	
Peronopora pavonia (a)	Isotelus maximus (r)

*Fauna of Cut 10, 15 Feet Above Railroad. Mt. Auburn.*

Cornulites flexuosus (c)	Dekayia appressa (a)
	multispinosa (a)
Amplexopora pustulosa (a)	Hallopora cf. onealli (r)
robusta (r)	ramosa (c)
Atactoporella ortonii (c)	ramosa rugosa (r)
Bythopora delicatula (c)	Heterotrypa frondosa (r)
Ceramoporella distincta (c)	Homotrypa pulchra (c)
ohioensis (r)	Peronopora pavonia (aa)
Chiloporella flabellata (r)	Proboscina frondosa (r)
Coeloclema cf. alternatum (r)	
oweni (c)	Dalmanella meeki (r)

Platystrophia lynx (r)	Orthoceras sp. (r)
Rafinesquina alternata (c)	
Zygospira modesta (r)	Calymene callicephala (r)
	Isotelus maximus (r)
Modiolodon sp. (r)	
	Primitia impressa (r)
Cyclora minuta (c)	

*Fauna of Cut 10, 10-20 Feet Above Railroad, Mt. Auburn-Arnheim.*

Cornulites flexuosus (r)	Homotrypa frondosa (c)
	Peronopora pavonia (r)
Amplexopora ampla (r)	Peronoporella dubia (r)
pustulosa (a)	Stigmatella dychei (r)
robusta (a)	Stomatopora arachnoidea (c)
Arthropora shafferi (r)	
Atactoporella multigranosa (c)	Crania scabiosa (r)
Bernicea primitiva (r)	Plectambonites sericeus (r)
Bytuopora delicatula (r)	Rafinesquina alternata (a)
Ceramoporella ohioensis (r)	alternata fracta (c)
Corynotrypa delicatula (r)	alternata loxorhytis (r)
inflata (r)	Zygospira modesta (c)
Coeloclema cf. alternatum (c)	
oweni (c)	Cyclonema bilix (c)
Dekayia cf. obscura (r)	
Eridotrypa simulatrix (r)	Orthoceras sp. (c)
Hallopora ramosa (a)	Acidaspis sp. (r)
ramosa rugosa (c)	Calymene callicephala (r)
Heterotrypa frondosa (c)	Isotelus maximus (r)

*Fauna of Cut 10, 25-55 Feet Above Railroad, Arnheim.*

Amplexopora cingulata (r)	Mesotrypa orbiculata (c)
pustulosa (a)	Peronopora pavonia (c)
Arthropora shafferi (c)	Peronoporella dubia (c)
Atactoporella mundula (c)	Petigopora asperula (c)
Batostoma varians (r)	petechialis (c)
Bernicea primitiva (r)	Stigmatella catenulata (r)
Ceramoporella ohioensis (c)	
Coeloclema cf. alternatum (c)	Dalmanella meeki (r)
Dekayia aspera (c)	Dinorthis retrorsa (r)
cf. maculata (c)	Platystrophia laticosta (r)
magna (r)	Rafinesquina alternata (a)
cf. obscura (c)	alternata fracta (c)
Hallopora cf. onealli (a)	
ramosa (aa)	Conularia formosa (r)
ramosa rugosa (c)	Cyclonema bilix (a)
cf. subplana (c)	Cyclora minuta (c)
subnodosa (c)	
Homotrypa frondosa (r)	Calymene callicephala (c)
pulchra (c)	

*Fauna of Cut 10, Above P. LYNX Layer, Mt. Auburn or Lower Arnheim.*

Cornulites flexuosus (r)	Byssonychia radiata (r)
Arthropora shafferi (c)	Modiolodon sp. (r)
Bythopora delicatula (a)	Pterinea demissa (r)
Coeloclema cf. alternatum (r)	Conradella dyeri (r)
oweni (r)	Cyclonema bilix (a)
Hallopora cf. onealli (r)	Cyclora minuta (a)
Peronopora pavonia (r)	
Petigopora asperula (r)	Orthoceras sp. (c)
petechialis (r)	
Proboscina frondosa (r)	Acidaspis sp. (c)
	Calymene callicephala (c)
Crania scabiosa (c)	Isotelus maximus (r)
Dalmanella meeki (r)	
Rafinesquina alternata (c)	Primitia impressa (c)
alternata loxorhytis (r)	
Zygospira modesta (aa)	Crinoid segments (a)

*Fauna of Cut 10, All. Coryville-Arnheim.*

Cornulites flexuosus (a)	Petigopora asperula (c)
	petechialis (c)
Amplexopora pustulosa (aa)	Stomatopora arachnoidea (c)
robusta (a)	
Arthropora shafferi (r)	Crania scabiosa (c)
Atactoporella ortonii (c)	Dalmanella meeki (r)
Bernicea primitiva (r)	Platystrophia lynx (r)
Bythopora striata (r)	Rafinesquina alternata (a)
delicatula (r)	alternata fracta (a)
Ceramoporella ohioensis (c)	alternata loxorhytis (c)
Coeloclema oweni (aa)	Zygospira modesta (c)
Corynotrypa inflata (r)	Byssonychia sp. (r)
Dekayia appressa (aa)	Modiolodon sp. (r)
cf. maculata (c)	
multispinosa (c)	Cyclonema bilix (c)
Eridotrypa simulatrix (r)	
Hallopora ramosa (aa)	Orthoceras sp. (c)
ramosa rugosa (c)	
Heterotrypa frondosa (c)	Calymene callicephala (r)
Homotrypa frondosa (r)	Isotelus maximus (r)
pulchra (c)	

*Fauna of Cut 11, 5-30 Feet Above Railroad (South End of Cut).  
Lower Arnheim.*

Crinoid segments (c)	Atactoporella multigranosa (c)
	Bernicea primitiva (r)
Amplexopora cingulata (r)	Ceramoporella distincta (r)
pustulosa (c)	ohioensis (c)
robusta (c)	whitei (r)
Arthropora shafferi (c)	Coeloclema cf. alternatum (c)

Corynetrypa inflata (r)	Dalmanella meeki (c)
Dekayia appressa (c)	Dinorthis retrorsa? (r)
cf. aspera (r)	Rafinesquina alternata (c)
Eridotrypa simulatrix (c)	alternata fracta (a)
Hallopora cf. onealli (c)	alternata loxorhytis (c)
ramosa (a)	Zygospira modesta (a)
ramosa rugosa (c)	
subnodosa (a)	Byssonychia tenuistriata (c)
cf. subplana (c)	Modiolodon sp. (c)
Helopora harrisi (r)	Pterinea demissa (r)
Heterotrypa ulrichi lobata (r)	
Homotrypa flabellaris (r)	Cyclonema bilix (a)
frondosa (r)	Cyclora minuta (a)
pulchra (r)	
Peronopora pavonia (r)	Orthoceras sp. (r)
Peronoporella dubia (c)	
Petigopora asperula (r)	Calymene callicephala (r)
Proboscina autoporoides (r)	Isotelus maximus (r)
Crania scabiosa (r)	Primitia impressa (c)

*Fauna of Cut II, Upper 20 Feet, Upper Anaheim.*

Amplexopora pustulosa (r)	Lingula cincinattiensis (r)
sp. (r)	Rafinesquina alternata (a)
Bythopora delicatula (r)	alternata fracta (c)
Ceramoporella distincta (r)	alternata loxorhytis (a)
ohioensis (a)	Zygospira modesta (aa)
Hallopora ramosa (r)	
subnodosa (c)	Byssonychia radiata (c)
cf. subplana (r)	sp. (c)
Heterotrypa frondosa (r)	
Homotrypa pulchra (r)	Cyclora minuta (c)
Peronopora pavonia (c)	Orthoceras sp. (c)
Proboscina autoporoides (aa)	
Rhopalonaria venosa (c)	Calymene callicephala (r)
Stomatopora arachnoidea (c)	Isotelus maximus (r)
Crania scabiosa (c)	Primitia impressa (r)
Dinorthis retrorsa (c)	

*Fauna of Cut II, All, Anaheim.*

Cornulites richmondensis (r)	robusta (c)
sp. (c)	sp. (c)
	Atactoporella mundula (c)
Glyptocrinus sp. (c)	ortoni (c)
	Batostoma varians (r)
Amplexopora ampla (c)	Bernicea primitiva (r)
cingulata (r)	
pustulosa (a)	

Bythopora delicatula (c)	Peronopora pavonia (c)
gracilis (c)	Peronoporella dubia (a)
Ceramoporella distincta (c)	Petigopora asperula (a)
ohioensis (c)	petechialis (a)
whitei (r)	Proboscina auloporoides (c)
Coeloclema cf. alternatum (a)	Stigmatella catenulata (r)
oweni (r)	
Corynotrypa inflata (c)	Crausia scabiosa (c)
Dekayia appressa (c)	Dalmanella meeki (c)
aspera (c)	Leptaena rhomboidalis (r)
cf. aspera (c)	Platystrophia lynx (r)
magna (r)	Rafinesquina alternata (c)
multispinosa (r)	alternata fracta (aa)
Hallopora cf. onealli (c)	alternata loxorhytis (a)
ramosa (aa)	Zygospira modesta (aa)
romosa rugosa (a)	
Hallopora subnodosa (a)	Cyclonema bilix (a)
cf. subplana (c)	Cyclora minuta (a)
Heterotrypa solitaria (r)	
ulrichi lobata? (r)	Orthoceras sp. (c)
Homotrypa frondosa (c)	
pulchra (a)	Calymene callicephala (c)
Nicholsonella peculiaris (r)	Isotelus maximus (r)

*Fauna of Cut 12, 0-15 Feet Above Railroad. Top of Arnheim.*

Amplexopora filiosa (r)	Strophomena planumbona? (r)
pustulosa (r)	
Ceramoporella ohioensis (r)	Byssonychia grandis (r)
Eridotrypa simulatrix (r)	
Peronopora pavonia (r)	Cyclonema bilix (r)
Petigopora asperula (c)	
Rafinesquina alternata (r)	Primitia impressa (r)

*Fauna of Cut 12, 15-37 Feet Above Railroad. Lower Waynesville.*

Cornulites richmondensis (a)	Stigmatella crenulata (c)
	interporosa (c)
Amplexopora pustulosa (r)	spinosa (c)
Arthropora shafferi (a)	
Bythopora delicatula (c)	Dalmanella meeki (a)
meeki (r)	Rafinesquina alternata (r)
striata (r)	Zygospira modesta (c)
Hallopora cf. onealli (a)	
subnodosa (r)	Byssonychia grandis (r)
Helopora harrisi (c)	Pterinea demissa (c)
Homotrypella hospitalis (r)	
rustica (r)	Conradella dyeri (r)
Peronopora pavonia (c)	Cyclora minuta (a)
Petigopora petechialis (c)	
Proboscina auloporoides (r)	Acidaspis sp. (r)
	Calymene callicephala (c)



Ceraurus pleurexanthemus (r)	Leperditia caecigena (c)
Isotelus maximus (c)	Primitia impressa (aa)
Ctenobolbina ciliata (c)	Lepidocoleus jamesi (r)

*Fauna of Cut 13, Lower 40 Feet. Lower Waynesville.*

Streptelasma rusticum (r)	Crania scabiosa (c)
Cornulites richmondensis (a)	Dalmanella meeki (aa)
Arthropora shafferi (a)	Hebertella sinuata (r)
Batostoma varians (r)	Leptaena rhomboidalis (r)
Bythopora delicatula (r)	Platystrophia laticosta (r)
meeki (a)	Plectambonites sericeus (c)
striata (r)	Rafinesquina alternata (c)
Ceramoporella ohioensis (c)	alternata loxorhytis (c)
whitei (r)	Strophomena planumbona (r)
Dicranopora emacerata (r)	Zygospira modesta (a)
Eridotrypa simulatrix (a)	Byssonychia sp. (c)
Hallopora subnodosa (c)	Pterinea demissa (r)
Heterotrypa prolifica (c)	Cyclonema bilix (c)
Homotrypa austini (c)	Cyclora minuta (r)
Homotrypella hospitalis (c)	Acidaspis sp. (r)
Peronopora pavonia (r)	Calymene callicephala (c)
Petigopora asperula (r)	Isotelus maximus (r)
Proboscina uloporoides (r)	Primitia impressa (a)
Stigmatella crenulata (c)	
spinosa (r)	
Stomatopora arachnoidea (c)	

*Fauna of Cut 13, 40-60 Feet Above Railroad. Middle Waynesville.*

Streptelasma rusticum (c)	Hallopora cf. ramosa (c)
Cornulites richmondensis (c)	ramosa rugosa (r)
Arthropora shafferi (c)	subnodosa (a)
Atactoporella schucherti (r)	Helopora sp. (r)
Batostoma prosseri (r)	Heterotrypa affinis (r)
varians (a)	prolifica (aa)
Bernicea primitiva (c)	singularis (c)
Bythopora delicatula (c)	subramosa (a)
meeki (a)	Homotrypa austini (a)
striata (r)	communis (a)
Ceramoporella distincta (r)	flabellaris (a)
ohioensis (r)	cf. flabellaris spinifera (c)
Constellaria polystomella (r)	Homotrypa nodulosa (c)
Dicranopora emacerata (r)	Homotrypella hospitalis (c)
Eridotrypa simulatrix (a)	Monticulipora parasitica (r)
	Peronopora pavonia (a)
	Proboscina uloporoides (r)

Rhombotrypa quadrata (a)	Zygospira modesta (c)
Stomatopora arachnoidea (a)	
	Byssonychia sp. (r)
Crania laelia (r)	Pterinea demissa (r)
scabiosa (r)	
Dalmanella meeki (c)	Cyclonema bilix (c)
Hebertella sinuata (r)	
Platystrophia acutilirata (a)	Orthoceras sp. (r)
laticosta (c)	
Rafinesquina alternata (a)	Calymene callicephala (r)
Strophomena planumbona (r)	Isotelus maximus (r)

*Fauna of Cut 13, Dump, Waynesville.*

Protarea vetusta (r)	Peronopora pavonia (c)
Streptelasma rusticum (c)	Proboscina auloporoides (c)
	frondosa (r)
Cornulites richmondensis (a)	Rhombotrypa quadrata (a)
sp. (coiled) (c)	Stomatopora arachnoidea (c)
Arthropora shafferi (c)	Crania scabiosa (r)
Atactoporella schucherti (r)	Dalmanella meeki (a)
Batostoma varians (c)	Hebertella sinuata (r)
Bernicea primitiva (c)	Leptaena rhomboidalis (r)
Bythopora delicatula (c)	Platystrophia laticosta (a)
meeki (c)	Rafinesquina alternata (c)
Ceramoporella distincta (r)	Strophomena subtenta (r)
ohioensis (c)	Trematis millepunctata (r)
Dicranopora emacerata (r)	
Eridotrypa simulatrix (r)	Byssonychia obesa (r)
Heterotrypa microstigma (r)	Eridonychia crenata (c)
prolifera (a)	Modiolodon truncatus (r)
singularis (c)	Modiolopsis versaillesensis (c)
subramosa (c)	Opisthoptera casei (c)
Hallopora ramosa rugosa (r)	Pterinea demissa (c)
subnodosa (r)	
Homotrypa austini (c)	Gas'tropoda, unidentified (a)
communis (a)	
flabellaris (c)	Calymene callicephala (c)
frondosa (r)	
Homotrypella hospitalis (a)	Primitia impressa (c)

*Fauna of Cut 14, 0-40 Feet Above Railroad, Middle Waynesville.*

Cornulites richmondensis	Eridotrypa simulatrix (r)
	Heterotrypa prolifera (c)
	subramosa (c)
Arthropora shafferi (c)	Homotrypa austini (r)
Batostoma varians (r)	communis (c)
Bernicea primitiva (r)	Stomatopora arachnoidea (r)
Bythopora delicatula (c)	
meeki (c)	Crania scabiosa (r)
striata (c)	

Dalmanella meeki (a)	Gastropoda, unidentified (r)
Platystrophia laticosta (r)	
Plectambonites sericeus (r)	Orthoceras sp. (c)
Zygospira modesta (r)	
	Acidaspis cincinnatiensis (r)
Byssonychia sp. (c)	Calymene callicephala (c)
Pterinea demissa (c)	Isotelus maximus (c)

*Fauna of Cut 1½, South Side, 70 Feet Above Railroad, Middle Waynesville.*

Streptelasma rusticum (a)	Dalmanella meeki (aa)
	Hebertella sinuata (c)
Cornulites richmondensis (a)	Leptaena rhomboidalis (c)
	Platystrophia acutilirata (c)
	laticosta (a)
Amplexopora pustulosa (r)	Plectambonites sericeus (r)
Arthropora shafferi (c)	Rafinesquina alternata (a)
Batostoma prosseri (r)	alternata loxorhytis (c)
varians (c)	Strophomena planumbona (r)
Bythopora delicatula (c)	Zygospira modesta (c)
meeki (a)	
Ceramoporella distincta (r)	Byssonychia sp. (c)
ohioensis (c)	Modiolopsis versaillesensis (a)
Eridotrypa simulatrix (c)	Opisthoptera casei (r)
Hallopora subnodosa (c)	Pterinea demissa (c)
Heterotrypa prolifica (aa)	
singularis (r)	Cyclonema bilix (r)
subramosa (a)	Lophospira bowdeni (r)
Homotrypa austini (a)	sp. (a)
communis (a)	
flabellaris (a)	Orthoceras sp. (c)
Homotrypella hospitalis (a)	
Nicholsonella vaupeli (c)	Calymene callicephala (r)
Peronopora pavonia (c)	
Rhombotrypa quadrata (c)	
Spatiopora sp. (r)	

*Fauna of Cut 1½, 0-50 Feet Above Railroad, Middle Waynesville.*

Streptelasma rusticum (c)	Dicranopora emacerata (c)
	Eridotrypa simulatrix (c)
Glyptocrinus decadaetylis (r)	Hallopora subnodosa (r)
	Heterotrypa prolifica (a)
	singularis (r)
Cornulites richmondensis (r)	Homotrypa austini (a)
sp. (coiled) (c)	communis (a)
	flabellaris (a)
Amplexopora pustulosa (r)	Homotrypella hospitalis (c)
Arthropora shafferi (r)	Peronopora pavonia (c)
Atactoporella schucherti (r)	Rhombotrypa quadrata (a)
Batostoma varians (c)	
Bernicea primitiva (r)	
Bythopora meeki (c)	Crania scabiosa (c)
Ceramoporella ohioensis (c)	Dalmanella meeki (c)

Hebertella sinuata (c)	Zygospira modesta (c)
Leptaena rhomboidalis (r)	
Platystrophia acutilirata (c)	Byssonychia richmondensis (r)
laticosta (c)	Modiolopsis versaillesensis (r)
Rafinesquina alternata (a)	
alternata loxorhytis (c)	Cyclonema bilix (r)
alternata cf. ponderosa (c)	
Rhynchotrema dentata (c)	Calymene callicephala (r)
Strophomena planumbona (r)	

*Fauna of Cut 1 $\frac{1}{2}$ , 25-50 Feet Above Railroad. Waynesville.*

Streptelasma rusticum (a)	Rhombotrypa quadrata (a)
	subquadrata (r)
Cornulites richmondensis (a)	Crania scabiosa (c)
	Dalmanella meeki (aa)
Arthropora shafferi (aa)	Hebertella sinuata (c)
Batostoma prosseri (r)	Leptaena rhomboidalis (a)
varians (c)	Platystrophia acutilirata (r)
Bernicea primitiva (r)	laticosta (c)
Bythopora delicatula (c)	Plectambonites sericeus (c)
meeki (c)	Rafinesquina alternata (a)
striata (c)	alternata loxorhytis (c)
Ceramoporella distincta (r)	Rhynchotrema capax (c)
ohioensis (c)	dentata (r)
Constellaria limitaris (r)	Strophomena planumbona (c)
polystomella (r)	subtenta (r)
Dicranopora emacerata (c)	Zygospira modesta (aa)
fragilis (c)	
Eridotrypa simulatrix (c)	Byssonychia sp. (r)
Fenestella granulosa (r)	Ischyrodonta ovalis (r)
Hallopora subnodosa (c)	Opisthoptera casei (r)
Heterotrypa prolifica (a)	Pterinea demissa (c)
Homotrypa austini (a)	
cummunis (a)	Conradella dyeri (r)
flabellaris (a)	Cyclonema bilix (c)
nodulosa (c)	Cyclora minuta (r)
Homotrypella hospitalis (a)	
Monticulipora parasitica (r)	Orthoceras sp. (r)
Peronopora pavonia (c)	
Petigopora petechialis (a)	Acidaspis cincinnatiensis (r)
Proboscina frondosa (c)	Calymene callicephala (c)
Ptilodictya plumaria (r)	Ceraurus pleurexanthemus (r)
	Isotelus maximus (c)

*Fauna of Cut 1 $\frac{1}{2}$ , 50-67 Feet Above Railroad. Upper Waynesville (or Lower Liberty).*

Columnaria alveolata (r)	Streptelasma divaricans (a)
Protarea vetusta (a)	rusticum (a)

Amplexopora pumila (a)	Rhombotrypa quadrata (a)
Arthropora shafferi (r)	subquadrata (c)
Batostoma prosseri (c)	Spatiopora aspera (r)
varians (c)	Stomatopora arachnoidea (r)
Bythopora delicatula (a)	
meeki (c)	Dinorthis subquadrata (c)
striata (c)	Hebertella insculpta (aa)
Bernicea primitiva (r)	sinuata (a)
Ceramoporella ohioensis (c)	Leptaena rhomboidalis (a)
Constellaria limitaris (a)	Platystrophia laticosta (c)
polystomella (c)	Plectambonites sericeus (r)
Dicranopora emacerata (r)	Rafinesquina alternata (c)
Eridotrypa simulatrix (aa)	Rhynchotrema capax (aa)
Hallopora subnodosa (aa)	Strophomena planumbona (a)
Heterotrypa prolifica (a)	Zygospira modesta (c)
Homotrypa communis (a)	
flabellaris (r)	Byssonychia sp. (r)
Homotrypella hospitalis (a)	
rustica (r)	Cyclonema bilix (c)
Monticulipora parasitica (r)	
Nicholsonella vaupeli (c)	Orthoceras sp. (c)
Peronopora pavouia (r)	
Proboscina frondosa (r)	Callymene callicephala (a)
	Isotelus maximus (c)

*Fauna of Cut 14, All. Middle and Upper Waynesville.*

Streptelasma rusticum (r)	Homotrypella hospitalis (c)
	Monticulipora parasitica (r)
Cornulites richmondensis (c)	Petigopora petechialis (a)
Arthropora shafferi (r)	Dalmanella meeki (a)
Batostoma varians (r)	Leptaena rhomboidalis (c)
sp. (r)	Platystrophia laticosta (r)
Bythopora delicatula (c)	Rafinesquina alternata (c)
meeki (c)	Zygospira modesta (r)
striata (c)	
Ceramoporella ohioensis (r)	Byssonychia sp. (c)
Dicranopora emacerata (r)	Pterinea demissa (c)
Eridotrypa simulatrix (c)	
Hallopora subnodosa (c)	Calymene callicephala (c)
Heterotrypa prolifica (c)	Isotelus maximus (c)
Homotrypa communis (c)	

*Fauna of Cut 15, 0-30 Feet Above Railroad, Middle Waynesville*

Streptelasma rusticum (a)	Bythopora delicatula (c)
	meeki (c)
Arthropora shafferi (r)	striata (r)
Batostoma prosseri (r)	Ceramoporella granulosa (r)
varians (c)	ohioensis (r)
Bernicea primitiva (r)	Constellaria polystomella (r)

Eridotrypa simulatrix (c)	Stomatopora arachnoidea (a)
Hallopora subnodosa (c)	
Heterotrypa prolifica (a)	Leptaena rhomboidalis (r)
subramosa (c)	
Homotrypa austini (a)	Cyclonema bilix (r)
Homotrypa communis (r)	bilix fluctuatum (r)
flabellaris (r)	
cf. flabellaris spinifera (c)	Orthoceras sp. (r)
Homotrypella hospitalis (c)	
Peronopora pavonia (c)	Calymene callicephala (r)
Rhombotrypa quadrata (a)	

*Fauna of Cut 15, 0-45 Feet Above Railroad. Middle and Upper Waynesville.*

Streptelasma rusticum (a)	Crania laelia (r)
	scabiosa (c)
Cornulites richmondensis (c)	Dalmanella meeki (a)
sp. (a)	Hebertella insculpta (a)
	occidentalis (r)
Arthropora shafferi (a)	sinuata (c)
Batostoma varians (a)	Leptaena rhomboidalis (a)
Bernicea primitiva (c)	Platystrophia laticosta (c)
Bythopora delicatula (a)	Rafinesquina alternata (a)
meeki (a)	alternata loxorhytis (c)
striata (r)	Rhynchotrema capax (c)
Ceramoporella granulosa (c)	Strophomena planumbona (c)
ohioensis (r)	
Constellaria polystomella (r)	Byssonychia obesa (r)
Dicranopora emacerata (c)	radiata (r)
Eridotrypa simulatrix (a)	richmondensis (c)
Fenestella granulosa (r)	sp. (c)
Hallopora subnodosa (c)	Modiolodon truncatus (r)
Heterotrypa prolifica (a)	Opisthoptera casei (r)
subramosa (a)	Pterinea demissa (r)
Homotrypa austini (a)	
communis (c)	Cyclonema bilix (c)
dawsoni (c)	Cyclora minuta (r)
flabellaris (a)	
cf. flabellaris spinifera (a)	Orthoceras sp. (c)
Homotrypella hospitalis (a)	
Nicholsonella vaupeli (c)	Calymene callicephala (c)
Peronopora pavonia (c)	Isotelus maximus (a)
Proboscina frondosa (r)	Ostracoda, unidentified (c)
Rhombotrypa quadrata (a)	
Stomatopora arachnoidea (c)	Lepidocoleus jamesi (r)

*Fauna of Cut 15, 30-45 Feet Above Railroad. Top of Waynesville.*

Streptelasma rusticum (r)	Batostoma prosseri (r)
	Bythopora delicatula (r)
Arthropora shafferi (c)	meeki (r)

Constellaria limitaris (c)	Dinorthis subquadrata (c)
Dicranopora emacerata (r)	Hebertella insculpta (a)
Eridotrypa simulatrix (c)	occidentalis (c)
Fenestella granulosa (r)	sinuata (c)
Hallopora subnodosa (c)	Platystrophia laticosta (r)
Heterotrypa prolifica (r)	Rafinesquina alternata (c)
subramosa (r)	Rhynchotrema capax (c)
Homotrypa austini (r)	Strophomena planumbona (c)
richmondensis (r)	Zygospira modesta (r)
wortheni (r)	
Homotrypella hospitalis (c)	Cyclonema bilix (r)
Nicholsonella vaupeli (c)	
Rhombotrypa quadrata (r)	
subquadrata (r)	

*Fauna of Cut 16, 5-15 Feet Above Railroad (South End of Cut). Top of Waynesville.*

Streptelasma rusticum (c)	Platystrophia laticosta (r)
	Rafinesquina alternata (c)
Arthropora shafferi (c)	Rhynchotrema capax (c)
Bythopora delicatula (a)	Strophomena planumbona (a)
meeki (r)	Zygospira modesta (c)
striata (c)	
Ceramoporella ohioensis (c)	Pterinea demissa (r)
Dicranopora emacerata (r)	
Eridotrypa simulatrix (c)	Cyclonema bilix fluctuatum (r)
Hallopora subnodosa (c)	
Homotrypa nodulosa (r)	Orthoceras sp. (r)
Homotrypella hospitalis (r)	
Rhombotrypa quadrata (r)	Calymene callicephala (c)
	Isotelus maximus (a)
Hebertella occidentalis (r)	
sinuata (c)	Ceratopsis chambersi (r)
Leptaena rhomboidalis (aa)	Leperditia caecigena (r)
Platystrophia acutilirata (r)	

*Fauna of Cut 16, North End, 0-10 Feet Above Railroad. Base of Liberty.*

Protarea vetusta (a)	Homotrypa austini (a)
Streptelasma rusticum (a)	cylindrica (r)
	ramulosa (c)
Amplexopora pumila (c)	richmondensis (r)
Bernicea primitiva (r)	wortheni (r)
Bythopora delicatula (r)	Homotrypella hospitalis (r)
meeki (c)	Proboscina frondosa (r)
Constellaria polystomella (a)	Rhombotrypa quadrata (a)
Hallopora cf. ramosa (a)	Stomatopora arachnoidea (c)
subnodosa (a)	

Dinorthis subquadrata (a)	Rhynchotrema capax (aa)
Hebertella insculpta (c)	Strophomena planumbona (aa)
occidentalis (r)	Zygospira modesta (a)
sinuata (r)	
Plectambonites sericeus (aa)	Calymene callicephala (r)
Rafinesquina alternata (c)	Isotelus maximus (r)

*Fauna of Cut 16, North End, 0-25 Feet Above Railroad. All Above PLECTAMBONITES Layer. Lower Liberty.*

Protarea vetusta (c)	Stomatopora arachnoidea (r)
Streptelasma divaricans (r)	Crania laelia (r)
rusticum (a)	Dinorthis subquadrata (a)
	Hebertella insculpta (c)
Cornulites richmondensis (c)	occidentalis (a)
	sinuata (r)
Amplexopora granulosa (a)	Platystrophia laticosta (r)
Bernicea primitiva (r)	Plectambonites sericeus (c)
Bythopora meeki (a)	Rafinesquina alternata (a)
Hallopora cf. ramosa (c)	Rhynchotrema capax (aaa)
subnodosa (a)	Strophomena planumbona (aa)
Homotrypa austini (aa)	sulcata (r)
richmondensis (r)	vetusta (r)
Homotrypella hospitalis (r)	
rustica (r)	Pterinea demissa (r)
Proboscina anuloporoides (r)	
Rhombotrypa quadrata (a)	Calymene callicephala (r)
subquadrata (r)	Isotelus maximus (r)

*Fauna of Cut 16, PLECTAMBONITES Layer and Above. Liberty.*

Protarea vetusta (r)	wortheni (r)
Streptelasma rusticum (c)	wortheni prominens (r)
	Rhombotrypa quadrata (r)
Cornulites richmondensis (r)	
Amplexopora granulosa (r)	Crania laelia (r)
pumila (r)	Hebertella insculpta (c)
Arthropora shafferi (aa)	occidentalis (r)
Bythopora delicatula (a)	sinuata (c)
meeki (aa)	Dinorthis subquadrata (c)
striata (r)	Platystrophia laticosta (r)
Ceramoporella ohioensis (r)	Plectambonites sericeus (aaa)
Constellaria polystomella (r)	Rafinesquina alternata (c)
Dicranopora emacerata (c)	Rhynchotrema capax (aa)
Hallopora cf. ramosa (a)	Strophomena planumbona (aa)
subnodosa (a)	vetusta (r)
Homotrypa austini (aa)	
nodulosa (r)	Byssonychia richmondensis (r)
ramulosa (r)	sp. (r)
richmondensis (r)	Pterinea demissa (c)



Pelecypoda, unidentified (aa)	Endoceras proteiforme (r)
Conradella dyeri (r)	Primitia cincinnatiensis (r)
Cyclonema sp. (r)	Calymene callicephala (a)
Cyrtoceras amoenum (r)	Isotelus maximus (a)

*Fauna of Cut 16, 15-45 Feet Above Railroad. Liberty.*

Calapoecia cribriformis (r)	Hebertella occidentalis (c)
Columnaria alveolata (r)	sinuata (r)
Streptelasma rusticum (c)	Dinorthis subquadrata (c)
	Plectambonites sericeus (aa)
Arthropora shafferi (aa)	Rafinesquina alternata (c)
Bythopora delicatula (c)	Rhynchotrema capax (a)
striata (c)	Strophomena planumbona (a)
Dicranopora emacerata (c)	vetusta (c)
Hallopora subnodosa (c)	Zygospira modesta (r)
Homotrypa austini (r)	
Homotrypella hospitalis (r)	Cyclora minuta (r)
Mesotrypa patella (r)	
Crania laelia (r)	Calymene callicephala (a)
Hebertella insculpta (r)	Isotelus maximus (r)

*Fauna of Cut 17, Ditch East of Railroad. Lower Liberty.*

Protarea vetusta (c)	Rhombotrypa quadrata (c)
Streptelasma rusticum (c)	Dinorthis subquadrata (c)
Amplexopora granulosa (r)	Hebertella occidentalis (c)
pumila (r)	Rafinesquina alternata (c)
Arthropora shafferi (r)	Rhynchotrema capax (c)
Bythopora delicatula (r)	Strophomena planumbona (a)
meeki (c)	planumbona subtenta (r)
Dicranopora emacerata (r)	vetusta (r)
Hallopora cf. ramosa (c)	Zygospira modesta (r)
subnodosa (c)	
Homotrypa austini (a)	Pterinea demissa (r)
cylindrica (r)	
wortheni (r)	Isotelus maximus (r)
Homotrypella rustica (c)	

*Fauna of Cut 17, South End, Lower 10 Feet. Middle Liberty.*

Calapoecia cribriformis (r)	Hallopora cf. ramosa (r)
Protarea vetusta (c)	subnodosa (c)
Tetradium minus (r)	Homotrypa austini (c)
	communis (c)
Arthropora shafferi (c)	wortheni prominens (r)
Bythopora delicatula (a)	Rhombotrypa quadrata (r)
meeki (a)	Stigmatella incrustans (r)
striata (r)	

Hebertella insculpta (r)	Byssonychia richmondensis (r)
Rafinesquina alternata (c)	
Rhynchotrema capax (c)	Orthoceras sp. (r)
Strophomena planumbona (c)	
Zygospira modesta (c)	Isotelus maximus (c)

*Fauna of Cut 17, North End, 5-29 Feet Above Railroad, Upper Liberty.*

Protarea vetusta (c)	Hebertella occidentalis (r)
Streptelasma rusticum (r)	Platystrophia laticosta (r)
	Plectambonites sericeus (r)
Artthropora shafferi (c)	Rafinesquina alternata (c)
Bythopora delicatula (a)	Rhynchotrema capax (a)
striata (r)	Strophomena planumbona (c)
Dicranopora emacerata (c)	planumbona subtenta (r)
Hallopora cf. ramosa (c)	sulcata (c)
subnodosa (a)	vetusta (c)
Homotrypa austini (c)	Zygospira modesta (a)
richmondensis (r)	
wortheni (r)	Opisthoptera casei (r)
Monticulipora epidermata (r)	Pterinea demissa (c)
Peronopora pavonia (r)	
Rhombotrypa quadrata (r)	Isotelus miximus (c)

*Fauna of Cut 17, Upper 10 Feet, North End, Upper Liberty.*

Protarea vetusta (c)	Hebertella occidentalis (r)
Streptelasma rusticum (c)	Platystrophia laticosta (c)
	Rafinesquina alternata (c)
Bythopora delicatula (r)	Rhynchotrema capax (c)
meeki (a)	Strophomena planumbona (a)
Hallopora cf. ramosa (c)	Zygospira modesta (r)
subnodosa (a)	
Helopora sp. (r)	Byssonychia richmondensis (r)
Homotrypa communis (c)	
cylindrica (r)	Orthoceras bilineatum (r)
wortheni (r)	
wortheni prominens (r)	Isotelus maximus (c)
Monticulipora epidermata (r)	
Rhombotrypa quadrata (r)	Primitia cincinantiensis (r)

*Fauna of Cut 18, Above TETRADIMUM Layer, Whitewater.*

Streptelasma rusticum (r)	Hallopora cf. ramosa (r)
	Homotrypa constellariformis (c)
Lichenocrinus tuberculatus (r)	cylindrica (a)
	nitida (r)
Cornulites sp. (a)	Homotrypa ramulosa (r)
	wortheni (a)
Batostoma variabile (aa)	
Bythopora delicatula (aa)	Monticulipora epidermata (r)
meeki (aa)	Hebertella occidentalis (c)

Platystrophia laticosta (c)	Pterinea demissa (c)
Strophomena sulcata (a)	
	Orthoceras byrnesi (c)
Byssonychia sp. (r)	mohri (r)

*Fauna of Cut 18, Above Heary Limestone, Whitewater.*

Streptelasma divaricans (r)	Monticulipora epidermata (r)
Tetradium minus (r)	
	Hebertella occidentalis (r)
Arthropora shafferi (r)	Platystrophia laticosta (r)
Batostoma variabile (r)	Strophomena sulcata (r)
Bernicea primitiva (r)	
Bythopora delicatula (r)	Pterinea demissa (r)
Dicranopora emacerata (r)	
Halopora subnodosa (r)	Endoceras proteiforme (r)
Helopora sp. (r)	
Homotrypa austini (r)	Primitia cincinnatiensis (c)
Homotrypella hospitalis (r)	

*Fauna of Cut 18, Upper Part, Whitewater.*

Streptelasma divaricans (r)	Hebertella occidentalis (c)
rusticum (r)	Platystrophia laticosta (c)
	Rhynchotrema capax (r)
Batostoma variabile (a)	Strophomena sulcata (a)
Bythopora delicatula (aaa)	
meeki (c)	Byssonychia richmondensis (c)
Homotrypa austini (a)	Ischyrodonta ovalis (r)
cylindrica (a)	
wortheni (c)	Orthoceras bilineatum (r)
Homotrypella hospitalis (r)	byrnesi (r)
Monticulipora epidermata (r)	

*Fauna of Cut 18, Dump, Whitewater.*

Protarea vetusta (r)	Hebertella occidentalis (c)
Streptelasma rusticum (c)	Platystrophia laticosta (r)
Tetradium minus (r)	Strophomena sulcata (r)
Batostoma variabile (aa)	Byssonychia obesa (r)
Bythopora delicatula (r)	richmondensis (c)
meeki (r)	Ortonella hainesi (r)
Homotrypa austini (r)	Pterinea demissa (r)
constellariformis (aa)	
nicklesi (a)	Orthoceras byrnesi (c)
nitida (a)	
ramulosa (a)	Ostracoda, unidentified (c)

*Fauna of Cut 18, All. Whitewater.*

Streptelasma rusticum (r)	Monticulipora epidermata (r)
Atactoporella schucherti (r)	Hebertella occidentalis (c)
Batostoma variable (aa)	Platystrophia laticosta (c)
Bythopora delicatula (r)	Rafinesquina alternata (r)
Homotrypa cylindrica (c)	Strophomena sulcata (c)
nicklesi (r)	
richmondensis (r)	Byssonychia richmondensis (c)
wortheni (c)	Pterinea demissa (r)
Homotrypella hospitalis (r)	
	Leperditia caecigena (aa)

Detailed faunal lists of Section 5.9A, on the Kentucky bank of the Ohio River, opposite the mouth of the Miami River.\*

*Fauna of Section 5.9A, 50 Feet Above River. Lower Southgate.*

Cornulites flexuosus (c)	Zygospira modesta (c)
Aspidopora newberryi (c)	Calymene callicephala (r)
Peronopora vera (r)	Isotelus maximus (c)
Stigmatella clavis (r)	Trinucleus concentricus (a)
Crania albersi (r)	Ceratopsis chambersi (r)
Dalmanella multisecta (a)	
Zygospira cincinnatiensis (c)	Lepidocoleus jamesi (c)

*Fauna of Section 5.9A, 50-55 Feet Above River. Lower Southgate.*

Batostoma implicatum (c)	Plectambonites sericeus (c)
jamesi (a)	Zygospira modesta (c)
Ceramoporella ohioensis (r)	
Hallopora onealli (c)	Calymene callicephala (c)
onealli communis (r)	
onealli sigillarioides (r)	Bythocypris cylindrica (c)
Dalmanella multisecta (a)	

*Fauna of Section 5.9A, 55-60 Feet Above River. Lower Southgate.*

Climacograptus typicalis (a)	Zygospira modesta (r)
	Byssonychia radiata (r)
Bythopora arctipora (r)	
Hallopora onealli (r)	Lophospira sp. (r)
Phylloporina variolata (r)	
Stigmatella clavis (r)	Isotelus maximus (c)
	Trinucleus concentricus (a)
Dalmanella multisecta (c)	
Trematis millepunctata (r)	Lepidocoleus jamesi (r)

\* When the collections were made, upon which the following faunal lists are based, the stage of water of the Ohio was about 15 feet above low water stage at Lawrenceburg.

*Fauna of Section 5.9.A, 60-70 Feet Above River. Lower Southgate.*

Climacograptus typicalis (a)	Zygospira modesta (r)
Cornulites flexuosus (c)	Acidaspis cf. crosotus (c)
Aspidopora eccentrica (a)	Calymene callicephala (c)
Hallopora onealli (r)	Isotelus maximus (a)
Dalmanella multisepta (c)	Bythocypris cylindrica (a)
Lingula covingtonensis (r)	Ctenobolbina ciliata (r)
Zygospira cincinnatiensis (r)	Lepidocoleus jamesi (c)

*Fauna of Section 5.9.A, 70-75 Feet Above River. Southgate.*

Climacograptus typicalis (a)	Byssonychia radiata (r)
Cornulites flexuosus (r)	Pterinea cf. mucronata (r)
Amplexopora petasiformis welchi (r)	Acidaspis sp. (c)
Aspidopora eccentrica (r)	Calymene callicephala (r)
Batostoma jamesi (r)	Dalmanites breviceps (c)
Coeloclema alternatum (r) commune (r)	Isotelus maximus (c)
Hallopora onealli (r)	Proetus spurlocki (r)
Peronopora vera (r)	Bollia pumila (r)
Dalmanella multisepta (c)	Bythocypris cylindrica (aa)
Zygospira cincinnatiensis (c) modesta (c)	Ceratopsis chambersi (c)
	Ctenobolbina ciliata (c)
	Lepidocoleus jamesi (r)

*Fauna of Section 5.9.A, 75-80 Feet Above River. Southgate.*

Climacograptus typicalis (a)	Hallopora onealli (a)
Cornulites flexuosus (r)	onealli communis (r)
Amplexopora petasiformis welchi (r)	onealli sigillarioides (c)
Arthropora cleavelandi (r) shafferi (c)	Heterotrypa ulrichi (c)
Arthrostylus tenuis (a)	Peronopora vera (r)
Batostoma implicatum (c) jamesi (c)	Phylloporina variolata (r)
Bernicea vesiculosa (r)	Rhinidictya parallela (r)
Bythopora arctipora (a)	Dalmanella emacerata (r)
Ceramoporella distincta (r) ohioensis (r)	multisepta (c)
Coeloclema alternatum (c) commune (c)	Lingula modesta (r)
Dicranopora meeki (r)	Plectambonites sericeus (c)
	Rafinesquina alternata (r)
	Zygospira cincinnatiensis (c) modesta (c)
	Byssonychia radiata (r)

Acidaspis sp. (c)	Ceratopsis chambersi (r)
Calymene callicephala (r)	Ctenobolbina ciliata (a)
Isotelus maximus (c)	Leperditia cf. caecigena (c)

Bollia pumila (r)	Lepidocoleus jamesi (c)
Bythocypris cylindrica (aaa)	

*Fauna of Section 5.9A, 70-85 Feet Above River. Southgate.*

Cornulites flexuosus (r)	Stictoporella flexuosa (c)
	Stigmatella clavis (r)
Amplexopora petasiformis welchi (r)	Stomatopora arachnoidea (r)
Arthropora shafferi (r)	Crania albersi (r)
Arthrostylus tenuis (c)	Dalmanella multisecta (a)
Aspidopora eccentrica (c)	Plectambonites sericeus (a)
Batostoma implicatum (c)	Rafinesquina alternata (r)
jamesi (r)	Zygospira modesta (r)
Bythopora arcipora (a)	
parvula (r)	Acidaspis sp. (c)
Ceramoporella distincta (r)	Calymene callicephala (r)
Coeloclema alternatum (r)	Isotelus maximus (c)
commune (r)	Trinucleus concentricus (r)
Dicranopora meeki (r)	
Escharopora acuminata (r)	Bollia persulcata (r)
Hallopora onealli (c)	pumila (r)
onealli communis (r)	Bythocypris cylindrica (c)
onealli sigillarioides (c)	Ctenobolbina ciliata (r)
Peronopora vera (r)	Leperditia caecigena (c)
Proboscina confusa (r)	
Rhinidictya parallela (c)	Lepidocoleus jamesi (c)

*Fauna of Section 5.9A, 110 Feet Above River. Southgate.*

Batostoma jamesi (c)	Zygospira modesta (r)
Bythopora arcipora	
Ceramoporella ohioensis (c)	Cladophorus sp. (r)
Hallopora onealli (c)	Homotoma gracilis (r)
Heterotrypa ulrichi (r)	
Peronopora vera (r)	Trinucleus concentricus (c)
Dalmanella multisecta (r)	Bythocypris cylindrica (c)
Zygospira circumatiensis (r)	

*Fauna of Section 5.9A, 125 Feet Above River. Base of McMicken.*

Cornulites flexuosus (c)	Batostoma implicatum (c)
	jamesi (c)
Amplexopora septosa multispinosa (c)	Bythopora arcipora (c)
	parvula (r)
Arthropora shafferi (c)	Ceramoporella distincta (r)
Aspidopora eccentrica (r)	ohioensis (r)

Coeloclema alternatum (a)	Rafinesquina alternata (r)
commune (a)	Trematis millepunctata (r)
Hallopora nodulosa (c)	Zygospira cincinnatiensis (c)
onealli (a)	modesta (c)
onealli communis (r)	
onealli sigillarioides (c)	Byssonychia radiata (r)
Heterotrypa ulrichi (a)	
Peronopora vera (c)	Acidaspis sp. (c)
Rhinidictya parallela (r)	Calymene callicephala (c)
Stigmatella clavis (r)	Isotelus maximus (c)
Stomatopora arachnoidea (r)	

PART III. COMPLETE REVISED LIST OF SPECIES REPORTED FROM THE CINCINNATI SERIES OF INDIANA, WITH THEIR HORIZONS, SO FAR AS KNOWN.\*

SPONGIÆ AND COELENTERATA.

1. *Beatricea nodulosa* Billings. Saluda.
2. *Beatricea undulata* Billings. Saluda.
3. \**Calapoezia cribriformis* (Nicholson). Liberty.
4. \**Climacograptus typicalis* Hall. Southgate.
5. \**Columnaria alveolata* Goldfuss. Upper Waynesville, Liberty and Saluda.
6. *Dystactospongia madisonensis* Foerste. Saluda.
7. *Labechia montifera* Ulrich. Upper Richmond.
8. \**Protarea vetusta* (Hall). Waynesville, Liberty, Saluda and Whitewater.
9. *Strephochetus richmondensis* (Miller). Whitewater.
10. \**Streptelasma divaricans* (Nicholson). Upper Waynesville, Liberty and Whitewater.
11. \**Streptelasma rusticum* (Billings). Waynesville, Liberty, Saluda and Whitewater.
12. \**Tetradium minus* Safford. Saluda and Whitewater.

ECIPIINODERMATA.

13. *Anomalocrinus incurvus* Meek and Worthen. Richmond (?).
14. *Dendrocrinus casei* Meek. Richmond.
15. *Dendrocrinus polydactylus* (Shumard). Richmond.
16. *Etenocrinus simplex* (Hall). Richmond.
17. \**Glyptocrinus decadactylus* Hall. Waynesville.
18. *Heterocrinus juvenis* Hall. Lower Richmond.
19. *Heterocrinus heterodactylus* Hall. Eden and Maysville.
20. \**Ioecrinus subcrassus* Meek and Worthen. Southgate, Richmond (?).
21. *Lepadocrinus moorei* (Meek). Richmond.
22. *Lepidodiscus faberi* Miller. Richmond.
23. *Lichenocrinus crateriformis* Hall. Eden, Richmond (?).

\* The species marked by an asterisk are found in the Tanner's Creek Section.

Coeloclema alternatum (a)	Rafinesquina alternata (r)
commune (a)	Trematis millepunctata (r)
Hallopora nodulosa (c)	Zygospira cincinnatiensis (c)
onealli (a)	modesta (c)
onealli communis (r)	
onealli sigillarioides (c)	Byssonychia radiata (r)
Heterotrypa ulrichi (a)	
Peronopora vera (c)	Acidaspis sp. (c)
Rhinidictya parallela (r)	Calymene callicephala (c)
Stigmatella clavis (r)	Isotelus maximus (c)
Stomatopora arachnoidea (r)	

PART III. COMPLETE REVISED LIST OF SPECIES REPORTED FROM THE CINCINNATI SERIES OF INDIANA, WITH THEIR HORIZONS, SO FAR AS KNOWN.\*

SPONGIÆ AND COELENTERATA.

1. *Beatricea nodulosa* Billings. Saluda.
2. *Beatricea undulata* Billings. Saluda.
3. \**Calapoezia cribriformis* (Nicholson). Liberty.
4. \**Climacograptus typicalis* Hall. Southgate.
5. \**Columnaria alveolata* Goldfuss. Upper Waynesville, Liberty and Saluda.
6. *Dystactospongia madisonensis* Foerste. Saluda.
7. *Labechia montifera* Ulrich. Upper Richmond.
8. \**Protarea vetusta* (Hall). Waynesville, Liberty, Saluda and Whitewater.
9. *Strephochetus richmondensis* (Miller). Whitewater.
10. \**Streptelasma divaricans* (Nicholson). Upper Waynesville, Liberty and Whitewater.
11. \**Streptelasma rusticum* (Billings). Waynesville, Liberty, Saluda and Whitewater.
12. \**Tetradium minus* Safford. Saluda and Whitewater.

ECIPIINODERMATA.

13. *Anomalocrinus incurvus* Meek and Worthen. Richmond (?).
14. *Dendrocrinus casei* Meek. Richmond.
15. *Dendrocrinus polydactylus* (Shumard). Richmond.
16. *Ectenocrinus simplex* (Hall). Richmond.
17. \**Glyptocrinus decadactylus* Hall. Waynesville.
18. *Heterocrinus juvenis* Hall. Lower Richmond.
19. *Heterocrinus heterodactylus* Hall. Eden and Maysville.
20. \**Iocrinus subcrassus* Meek and Worthen. Southgate, Richmond (?).
21. *Lepadocrinus moorei* (Meek). Richmond.
22. *Lepidodiscus faberi* Miller. Richmond.
23. *Lichenocrinus crateriformis* Hall. Eden, Richmond (?).

\* The species marked by an asterisk are found in the Tanner's Creek Section.



24. *Lichenocrinus dyeri* Hall. Richmond.
25. *Lichenocrinus pattersoni* Miller. Richmond.
26. \**Lichenocrinus tuberculatus* Miller. Whitewater.
27. *Palaester wycoffi* Miller and Gurley. Richmond.
28. *Palaesterina speciosa* Miller and Gurley. Richmond.
29. *Urasterella grandis* (Meek). Richmond.
30. *Xenocrinus baeri* (Meek). Richmond.

## ANNELIDA.

31. \**Cornulites flexuosus* (Hall). Eden and Maysville.
32. *Cornulites minor* (Nicholson). Lower Maysville.
33. \**Cornulites richmondensis* (Miller). Arnheim and Richmond.
34. \**Nereidavus varians* Grimmel. Southgate.
35. \**Œnonites cuneatus* Hinde. McMicken.

## BRYOZOA.

36. \**Amplexopora ampla* Ulrich and Bassler. Maysville.
37. \**Amplexopora cingulata* Ulrich. Arnheim.
38. \**Amplexopora filiosa* (American authors). Middle and upper Maysville.
39. \**Amplexopora granulosa* n. sp. Lower Liberty.
40. *Amplexopora persimilis* Nickles. Southgate.
41. \**Amplexopora petasiformis* (Nicholson). McMicken.
42. *Amplexopora petasiformis welchi* (James). Southgate.
43. \**Amplexopora pumila* n. sp. Upper Waynesville and lower Liberty.
44. \**Amplexopora pustulosa* Ulrich. Upper Maysville and lower Richmond.
45. \**Amplexopora robusta* Ulrich. Maysville.
46. \**Amplexopora septosa* (Ulrich). McMicken, Mt. Hope and Fairmount.
47. \**Amplexopora septosa maculosa* n. var. McMicken and Mt. Hope.
48. \**Amplexopora septosa minima* n. var. McMicken, Mt. Hope and Fairmount.
49. \**Amplexopora septosa multispinosa* Cumings. McMicken, Mt. Hope and Fairmount.
50. \**Arthropora cincinnatiensis* (James). McMicken, Mt. Hope and Fairmount.
51. \**Arthropora cleavelandi* (James). Upper Eden.
52. \**Arthropora shafferi* (Meek). Throughout the Cincinnati.
53. \**Arthrostylus tenuis* (James). McMicken.
54. \**Aspidopora areolata* Ulrich. Southgate.
55. \**Aspidopora eccentrica* (James). Southgate.
56. \**Aspidopora newberryi* (Nicholson). Southgate and McMicken.
57. \**Atactopora hirsuta* Ulrich. Southgate.
58. \**Atactopora intermedia* n. sp. McMicken.
59. \**Atactoporella multigranosa* (Ulrich). Fairmount, Mt. Auburn and Arnheim.
60. \**Atactoporella mundula* (Ulrich). Bellevue, Arnheim.
61. \**Atactoporella newportensis* (Ulrich). Lower Eden.

62. \**Atactoporella ortonii* (Nicholson). Bellevue, Corryville, Mt. Auburn and Arnheim.
63. \**Atactoporella schucherti* Ulrich. Richmond.
64. *Atactoporella typicalis* Ulrich. Lower Eden.
65. \**Batostoma implicatum* (Nicholson). Middle and upper Eden and lower Maysville.
66. \**Batostoma jamesi* (Nicholson). Middle and upper Eden. Lower Maysville (?).
67. \**Batostoma prosseri* Cumings and Galloway. Upper Waynesville.
68. \**Batostoma variabile* Ulrich. Whitewater.
69. \**Batostoma varians* (James). Arnheim, Waynesville and Liberty.
70. \**Bernicea primitiva* Ulrich. Upper Maysville and Richmond.
71. \**Bernicea vesiculosa* Ulrich. Southgate.
72. \**Bythopora arctipora* (Nicholson). Middle and upper Eden, Mt. Hope-Fairmount. (c)
73. \**Bythopora delicatula* (Nicholson). Corryville-Arnheim and Richmond. (c)
74. \**Bythopora gracilis* (Nicholson). Maysville. (c)
75. \**Bythopora meeki* (James). Waynesville, Liberty and Whitewater.
76. \**Bythopora parvula* (James). Southgate, McMicken, Mt. Hope-Fairmount. (r)
77. \**Bythopora striata* Ulrich. Bellevue, Corryville-Arnheim, Richmond. (r)
78. *Callopora circularis* (James). Lower Richmond.
79. \**Ceramoporella distincta* Ulrich. Eden, Maysville and Waynesville. (c)
80. \**Ceramoporella granulosa* Ulrich. Upper Waynesville. (r)
81. \**Ceramoporella granulosa milfordensis* (James). McMicken. (r)
82. \**Ceramoporella ohioensis* (Nicholson). Throughout the Cincinnati. (c)
83. \**Ceramoporella triloba* n. sp. McMicken. (r)
84. \**Ceramoporella tubulosa* n. sp. McMicken. (r)
85. \**Ceramoporella whitei* (James). Arnheim, Waynesville. (r)
86. \**Chiloporella flabellata* (Ulrich). Bellevue, Corryville. (c)
87. \**Coeloclema alternatum* (James). Southgate, McMicken. (a)
88. \**Coeloclema* cf. *alternatum*. Corryville-Arnheim. (c)
89. \**Coeloclema commune* Ulrich. Southgate and McMicken. (a)
90. \**Coeloclema oweni* (James). Mt. Auburn. (a)
91. \**Constellaria constellata* (Van Cleve) Dana. McMicken, Mt. Hope-Fairmount.
92. \**Constellaria constellata prominens* Ulrich. Base of Mt. Hope.
93. \**Constellaria limitaris* (Ulrich). Upper Waynesville. (c)
94. \**Constellaria polystomella* Nicholson. Waynesville and Liberty.
95. \**Corynotrypa delicatula* (James). Fairmount, Corryville-Arnheim.
96. \**Corynotrypa inflata* (Hall). Maysville.
97. *Crepipora simulans* Ulrich. Southgate.
98. \**Crepipora solida* Ulrich. Fairmount.
99. \**Dekayia appressa* Ulrich. Fairmount to middle of Arnheim. (c)
100. \**Dekayia aspera* Edwards and Haine. McMicken, Mt. Hope-Fairmount (a), Arnheim (?).

101. \**Dekayia maculata* James. McMicken, Mt. Hope.
102. \**Dekayia magna* Cumings. Bellevue, Arnheim.
103. \**Dekayia multispinosa* Ulrich. Maysville.
104. \**Dekayia obscura* (Ulrich). McMicken.
105. \**Dicranopora emacerata* (Nicholson). Maysville, Richmond.
106. \**Dicranopora fragilis* (Billings). Waynesville.
107. \**Dicranopora meeki* (James). Southgate, McMicken.
108. \**Eridotrypa simulatrix* (Ulrich). Corryville-Arnheim, Waynesville. (c)
109. \**Escharopora acuminata* (James). Southgate.
110. \**Escharopora falciformis* (Nicholson). McMicken, Mt. Hope-Fairmount.
111. \**Escharopora pavonia* (Edwards and Haime). McMicken, Mt. Hope-Fairmount.
112. \**Fenestella granulosa* Whitfield. Waynesville, Liberty and Whitewater.
113. \**Graptodictya perelegans* (Ulrich). Waynesville.
114. \**Hallopora andrewsi* (Nicholson). Maysville.
115. \**Hallopora dalei* (Edwards and Haime). McMicken, Mt. Hope-Fairmount. (a)
116. *Hallopora frondosa* (Cumings). Whitewater.
117. \**Hallopora nodulosa* (Nicholson). McMicken, Mt. Hope-Fairmount.
118. \**Hallopora onealli* (James). Southgate and McMicken.
119. \**Hallopora onealli communis* (James). Southgate, McMicken. (aa)
120. \**Hallopora onealli sigillarioides* (Nicholson). Southgate and McMicken. (c)
121. \**Hallopora ramosa* (d'Orbigny). Maysville. (aa)
122. \**Hallopora cf. ramosa*. Waynesville and Liberty. (c)
123. \**Hallopora ramosa rugosa* (Edwards and Haime). Middle and upper Maysville. (c)
124. \**Hallopora subnodosa* (Ulrich). Arnheim and Richmond. (c)
125. \**Hallopora subplana* (Ulrich). McMicken, Mt. Hope-Fairmount. (c)
126. \**Helopora elegans* Ulrich. Liberty.
127. \**Helopora harrisi* James. Arnheim and Waynesville.
128. \**Heterotrypa affinis* (Ulrich). Waynesville.
129. \**Heterotrypa frondosa* (d'Orbigny). Maysville, abundant in the Bellevue.
130. \**Heterotrypa inflecta* Ulrich. Fairmount.
131. \**Heterotrypa microstigma* n. sp. Waynesville.
132. \**Heterotrypa paupera* (Ulrich). Maysville.
133. \**Heterotrypa pelliculata* (Ulrich). Fairmount and Bellevue.
134. \**Heterotrypa prolifica* Ulrich. Waynesville, abundant and characteristic.
135. \**Heterotrypa singularis* Ulrich. Waynesville.
136. \**Heterotrypa scitaria* Ulrich. Fairmount and Bellevue.
137. \**Heterotrypa subfrondosa* (Cumings). Mt. Hope-Fairmount.
138. \**Heterotrypa subpulchella* (Nicholson). McMicken, Mt. Hope-Fairmount.
139. \**Heterotrypa subramosa* (Ulrich). Waynesville, Whitewater. (c)

140. \**Heterotrypa ulrichi* Nicholson, McMicken, (a), Mt. Hope-Fairmount. (r)
141. \**Heterotrypa ulrichi lobata* (Cumings), McMicken and lower Maysville.
142. \**Heterotrypa ulrichi robusta* (Foord), McMicken, Mt. Hope-Fairmount.
143. \**Homotrypa alta* n. sp. Mt. Hope-Fairmount.
144. \**Homotrypa austini* Bassler, Waynesville, Liberty and Whitewater.
145. \**Homotrypa cincinnatiensis* Bassler, Mt. Hope-Fairmount.
146. \**Homotrypa communis* Bassler, Waynesville, Liberty. (c)
147. \**Homotrypa constellariformis* Cumings, Whitewater.
148. \**Homotrypa curvata* Ulrich, Fairmount, Bellevue and Corryville.
149. \**Homotrypa curvata praecipua* Bassler, McMicken, Mt. Hope-Fairmount.
150. \**Homotrypa cylindrica* Bassler, Liberty and Whitewater.
151. \**Homotrypa dawsoni* (Nicholson), Waynesville, Whitewater.
152. \**Homotrypa dumosa* Bassler, Mt. Hope-Fairmount.
153. \**Homotrypa flabellaris* Ulrich, Arnheim, Waynesville, Liberty and Whitewater. (c)
154. \**Homotrypa flabellaris spinifera* Bassler, Fairmount, Waynesville and Whitewater (?).
155. \**Homotrypa frondosa* Bassler, Corryville-Arnheim, Waynesville.
156. \**Homotrypa glabra* n. sp. McMicken, Mt. Hope-Fairmount.
157. \**Homotrypa grandis* Bassler, Upper Maysville.
158. \**Homotrypa nicklesi* Bassler, Whitewater.
159. \**Homotrypa nitida* Bassler, Whitewater.
160. \**Homotrypa nodulosa* Bassler, Waynesville and Liberty.
161. \**Homotrypa obliqua* Ulrich, McMicken (?) and Maysville.
162. \**Homotrypa pulchra* Bassler, Corryville-Arnheim.
163. \**Homotrypa ramulosa* Bassler, Liberty and Whitewater.
164. \**Homotrypa richmondensis* Bassler, Upper Waynesville, Liberty and Whitewater.
165. \**Homotrypa spinea* n. sp. Mt. Hope-Fairmount.
166. \**Homotrypa wortheni* (James), Richmond, Whitewater (aa).
167. \**Homotrypa wortheni prominens* Bassler, Liberty, (?) Elkhorn.
168. \**Homotrypella hospitalis* (Nicholson), Waynesville (c), Liberty and Whitewater.
169. \**Homotrypella rustica* Ulrich, Waynesville, Liberty and Whitewater.
170. \**Leptotrypa calceola* (Miller and Dyer), Lower Maysville.
171. \**Leptotrypa clavacoidea* (James), Upper Maysville.
172. \**Leptotrypa discoidea* (Nicholson), Maysville.
173. \**Mesotrypa orbiculata* n. sp. Arnheim.
174. \**Mesotrypa patella* (Ulrich), Liberty.
175. \**Monticulipora epidermata* Ulrich and Bassler, Liberty, Saluda and Whitewater. Characteristic of the Whitewater.
176. \**Monticulipora mammulata* d'Orbigny, Fairmount to Mt. Auburn.
177. \**Monticulipora parasitica* Ulrich, Waynesville, Liberty and Whitewater.
178. \**Nicholsonella vaupeli* (Ulrich), Maysville, Waynesville, Liberty and Whitewater.

179. \**Nicholsonella peculiaris* n. sp. Arnheim.  
 180. \**Peronopora pavonia* (d'Orbigny). Middle and upper Maysville and Richmond.  
 181. \**Peronopora vera* Nickles. Eden, Mt. Hope-Fairmount.  
 182. \**Peronoporella dubia* n. sp. Bellevue to middle of Arnheim.  
 183. \**Petigopora asperula* Ulrich. Upper McMicken to middle Waynesville.  
 184. \**Petigopora gregaria* Ulrich. Upper Maysville.  
 185. \**Petigopora petechialis* (Nicholson). McMicken, Maysville and Waynesville.  
 186. \**Phylloporina variolata* (Ulrich). Southgate and McMicken.  
 187. \**Proboscina autoporoides* (Nicholson). Maysville, Waynesville and Liberty.  
 188. \**Proboscina confusa* (Nicholson). Southgate.  
 189. \**Proboscina frondosa* (Nicholson). Eden, Maysville and Richmond.  
 190. \**Ptilodictya plumaria* James. Waynesville, Whitewater.  
 191. \**Rhinidictya lata* (Ulrich). Waynesville.  
 192. \**Rhinidictya parallela* (James). Southgate.  
 193. *Rhombotrypa crassimuralis* (Ulrich). Whitewater.  
 194. \**Rhombotrypa quadrata* (Rominger). Waynesville, Liberty and Whitewater. (c)  
 195. \**Rhombotrypa subquadrata* (Ulrich). Upper Waynesville and lower Liberty.  
 196. \**Rhopalonaria venosa* Ulrich. Arnheim, Waynesville and Liberty. (r)  
 197. \**Spatiopora aspera* Ulrich. Top of Waynesville.  
 198. *Spatiopora maculosa* Ulrich. Lower Maysville.  
 199. *Spatiopora tuberculata* (Edwards and Haine). Maysville and Richmond.  
 200. \**Stictoporella flexuosa* (James). Southgate.  
 201. \**Stigmatella alaicornis* n. sp. Fairmount.  
 202. \**Stigmatella catenulata* n. sp. Arnheim.  
 203. \**Stigmatella clavis* (Ulrich). Eden and lower Maysville.  
 204. \**Stigmatella crenulata* Ulrich and Bassler. Waynesville.  
 205. \**Stigmatella dychei* (James). Mt. Auburn.  
 206. *Stigmatella irregularis* (Ulrich). Lower Maysville.  
 207. \**Stigmatella incrustans* n. sp. Liberty.  
 208. \**Stigmatella nicklesi* Ulrich and Bassler. Southgate.  
 209. *Stigmatella personata* Ulrich and Bassler. Elkhorn.  
 210. \**Stigmatella spinosa* Ulrich and Bassler. Waynesville.  
 211. \**Stigmatella sessilis* n. sp. Fairmount.  
 212. \**Stomatopora arachnoidea* (Hall). Throughout the Cincinnati.

## BRACHIOPODA.

213. *Catazyga headi* (Billings). Waynesville.  
 214. \**Crania albersi* Miller. Southgate.  
 215. \**Crania laelia* Hall. Liberty.  
 216. \**Crania scabiosa* Hall. Maysville and Richmond.  
 217. \**Dalmanella emacerata* (Hall). Upper Eden.  
 218. \**Dalmanella meeki* (Miller). Corryville-Arnheim (nc) and Waynesville (a).  
 219. \**Dalmanella multisepta* (Meek). Eden (a), Mt. Hope-Fairmount (r).

220. \**Dinorthis retrorsa* (Salter). Top of the Arnheim. (c)
221. \**Dinorthis subquadrata* (Hall). Upper Waynesville, lower Liberty (c), Whitewater (r).
222. \**Hebertella insculpta* (Hall). Top of the Waynesville (aaa), lower Liberty (r).
223. \**Hebertella occidentalis* (Hall). Upper Waynesville, Liberty (a), Saluda and Whitewater (r).
224. \**Hebertella sinuata* (Hall). Fairmount, Bellevue (c), and Richmond.
225. \**Leptaena rhomboidalis* (Wilckens). Arnheim and Waynesville, very common at the top of the Waynesville.
226. \**Leptobolus iepis* Hall. Southgate and Corryville.
227. \**Lingula cincinnatiensis* (Hall and Whitfield). Arnheim.
228. \**Lingula covingtonensis* (Hall and Whitfield). Arnheim.
229. \**Lingula modesta* Ulrich. Southgate.
230. *Orthis fissicosta* Hall. Maysville.
231. \**Platystrophia acutilirata* (Conrad). Waynesville, Liberty and Whitewater.
232. *Platystrophia acutilirata senex* Cumings. Upper Whitewater.
233. \**Platystrophia costata* (Pander). Mt. Hope-Fairmount.
234. *Platystrophia cypha* James. Upper Maysville.
235. \**Platystrophia laticosta* Meek. McMicken, Maysville and Richmond.
236. \**Platystrophia lynx* (Eichwald). Maysville. Characteristic of the Bellevue and Mt. Auburn.
237. *Platystrophia moritura* Cumings. Characteristic of the Elkhorn.
238. \**Plectambonites sericeus* (Sowerby). Southgate (c), Mt. Hope-Fairmount, Mt. Auburn, Waynesville, and lower Liberty (aaa).
239. \**Plectorthis ella* (Hall). Maysville.
240. \**Plectorthis plicatella* (Hall). Top of the McMicken, Mt. Hope-Fairmount. Characteristic of the lower Maysville.
241. \**Plectorthis triplicatella* (Meek). Lower Maysville. (c)
242. \**Rafinesquina alternata* (Emmons). Throughout the Cincinnati.
243. \**Rafinesquina alternata fracta* (Meek). Maysville. Characteristic of the Bellevue, Corryville and Arnheim.
244. \**Rafinesquina alternata loxorhytis* (Meek). Arnheim and Waynesville.
245. \**Rafinesquina nasuta* (Conrad). Middle Maysville.
246. \**Rafinesquina alternata ponderosa* Cumings. Bellevue (c), and Waynesville (?).
247. *Retzia granulifera* Meek. Upper Eden.
248. \**Rhynchotrema capax* (Conrad). Upper Waynesville, lower Liberty (aa), and Whitewater. (c)
249. \**Rhynchotrema dentata* (Hall). Upper Waynesville (rr), and Whitewater (a).
250. *Schizocrania filosa* (Hall). Trenton to Maysville.
251. *Strophomena nutans* Meek. Liberty.
252. \**Strophomena planoconvexa* (Hall). Fairmount.
253. \**Strophomena planumbona* (Hall). Waynesville, Liberty (a), and Whitewater.
254. \**Strophomena sinuata* Meek. Lower Maysville.
255. \**Strophomena subtenta* (Hall). Waynesville and Liberty.

256. \**Strophomena sulcata* (Verneuil). Liberty and Whitewater. (c)  
 257. \**Strophomena vetusta* James. Liberty and Whitewater.  
 258. \**Trematis millepunctata* Hall. Rare throughout the Cincinnati.  
 259. *Trematis reticularis* (Miller). Maysville.  
 260. \**Zygospira cincinnatiensis* Meek. Southgate, McMicken, and Fairmount.  
 261. \**Zygospira modesta* (Hall). Throughout the Cincinnati. (c)

## PELECYPODA.

262. \**Allonychia jamesi* (Meek). Bellevue.  
 263. \**Anomalodonta cestata* (Meek). Middle Maysville.  
 264. \**Anomalodonta gigantea* Miller. Waynesville, Whitewater.  
 265. \**Byssonychia alveolata* Ulrich. Middle and upper Maysville and lower Richmond.  
 266. \**Byssonychia grandis* Ulrich. Arnheim, Waynesville, and Whitewater (?).  
 267. \**Byssonychia obesa* Ulrich. Waynesville (?), Whitewater.  
 268. *Byssonychia praeursora* Ulrich. Upper Maysville.  
 269. \**Byssonychia radiata* (Hall). Eden, Maysville and Richmond.  
 270. \**Byssonychia richmondensis* Ulrich. Waynesville, Liberty and Whitewater.  
 271. \**Byssonychia suberecta* Ulrich. Lower and middle Richmond.  
 272. \**Byssonychia tenuistriata* Ulrich. Arnheim.  
 273. \**Chidophorus fabula* (Hall). Maysville.  
 274. *Chionychia excavata* Ulrich. Richmond.  
 275. *Ctenodonta cingulata* (Ulrich). Waynesville.  
 276. \**Cynatonota typicalis* Ulrich. Waynesville, Whitewater (?).  
 277. *Cyrtodonta cuneata* (Miller). Richmond.  
 278. \**Eridonychia crenata* Ulrich. Whitewater (?), lower Richmond.  
 279. *Ischyrodonta decipiens* Ulrich. Whitewater.  
 280. \**Ischyrodonta elongata* Ulrich. Middle Richmond.  
 281. *Ischyrodonta miseneri* Ulrich. Whitewater.  
 282. *Ischyrodonta modioliformis* Ulrich. Whitewater.  
 283. \**Ischyrodonta ovalis* Ulrich. Waynesville.  
 284. *Ischyrodonta truncata* Ulrich. Whitewater.  
 285. *Ischyrodonta unionoides* (Meek). Lower Maysville.  
 286. \**Modiolodon declivis* Ulrich. Arnheim (?), Waynesville.  
 287. *Modiolopsis concentrica* Hall and Whitfield. Waynesville.  
 288. \**Modiolopsis versaillesensis* Miller. Waynesville.  
 289. \**Opisthoptera casei* (Meek and Worthen). Richmond.  
 290. *Opisthoptera obliqua* Ulrich. Richmond.  
 291. *Orthodesma canaliculatum* Ulrich. Richmond.  
 292. *Orthodesma rectum* Hall and Whitfield. Lower Richmond.  
 293. *Orthodesma subangulatum* Ulrich. Richmond.  
 294. *Orthodontiscus milleri* (Meek). Lower Richmond.  
 295. \**Ortonella hainesi* (Miller). Whitewater.  
 296. *Pterinea corrugata* (James). Waynesville.  
 297. \**Pterinea demissa* (Conrad). McMicken, Maysville and Richmond  
 298. \**Pterinea mucronata* Ulrich. Southgate.  
 299. \**Rhithyma byrnesi* (Miller). Richmond.

300. *Sedgwickia fragilis* Meek. Lower Maysville. May not occur in Indiana.  
 301. *Sphenolium richmondense* Miller. Middle Richmond.  
 302. *Tellinomya hilli* Miller. Saluda.  
 303. *Whiteavesia cincinnatiensis* (Hall and Whitfield). Eden.  
 304. *Whiteavesia pholadiformis* (Hall). Richmond.  
 305. *Whitella obliqua* Ulrich. Lower Richmond  
 306. *Whitella umbonata* Ulrich. Lower Richmond.

## GASTROPODA AND P. EROPODA.

307. \**Bellerophon gorbyi* Miller. Southgate, Maysville (?)  
 308. *Bellerophon mohri* Miller. Middle Richmond.  
 309. *Bellerophon subangularis* Ulrich. Middle Richmond.  
 310. *Bucania crassa* Ulrich. Whitewater.  
 311. *Bucania simulatrix* Ulrich. Whitewater.  
 312. *Clathrospira subconica* (Hall). Maysville and Richmond.  
 313. \**Conradella dyeri* (Hall). Richmond.  
 314. \**Comularia formosa* Miller and Dyer. Arnhem.  
 315. \**Cyclonema bilix* (Conrad). Arnhem and Waynesville.  
 316. \**Cyclonema bilix fluctuatum* James. Waynesville.  
 317. \**Cyclonema bilix humerosum* Ulrich. Upper Maysville and Richmond.  
 318. \**Cyclonema bilix mediale* Ulrich. Lower Maysville.  
 319. \**Cyclora minuta* Hall. Maysville and Richmond.  
 320. *Cyclora parva* (Hall). Richmond.  
 321. *Cyclora pulcella* Miller. Liberty.  
 322. \**Cyrtolites ornatus* Conrad. Upper Fairmount and Bellevue.  
 323. *Helicotoma marginata* Ulrich. Elkhorn.  
 324. *Holopea hubbardi* Miller. Saluda.  
 325. \**Homotoma gracilis* (Hall). Southgate.  
 326. *Hyolithes* (?) *dubius* Miller and Faber. Richmond.  
 327. *Hyolithes versaillesensis* Miller and Faber. Richmond.  
 328. *Liospira vitruvia* (Billings). Throughout the Cincinnatiian.  
 329. *Lophospira acuminata* Ulrich. Middle Richmond.  
 330. *Lophospira ampla* Ulrich. Richmond.  
 331. *Lophospira bicincta* (Hall). Richmond.  
 332. \**Lophospira bowdeni* (Safford). Maysville.  
 333. *Lophospira hammeli* (Miller). Saluda.  
 334. *Lophospira tropidophora* (Meek). Whitewater.  
 335. \**Microceras inornatus* Hall. Maysville and Richmond.  
 336. *Oxydiscus magnus* (Miller). Richmond.  
 337. *Protowartha cancellata* (Hall). Throughout the Cincinnatiian.  
 338. *Protowartha subcompressa* Ulrich. Lower Richmond.  
 339. *Raphistoma richmondensis* Ulrich. Middle Richmond.  
 340. *Salpingostoma richmondensis* Ulrich. Whitewater, upper part.  
 341. *Schizolopha moorei* Ulrich. Whitewater.  
 342. *Trochonema madisonense* Ulrich. Richmond.  
 343. *Tryblidium indianense* Miller. Richmond.  
 344. *Tryblidium madisonense* Miller. Richmond.



## CEPHALOPODA.

345. \**Cyrtoceras amoenum* Miller. Richmond.  
 346. *Cyrtoceras hitzi* Foerste. Saluda.  
 347. *Cyrtoceras tenuiseptum* Faber. Richmond.  
 348. *Cyrtoceras thompsoni* Miller. Upper Richmond (?).  
 349. *Cyrtoceras madisonensis* Miller. Saluda.  
 350. \**Eudoceras proteiforme* Hall. Throughout the Cincinnati.  
 351. \**Gomphoceras indianensis* Miller and Faber. Richmond.  
 352. *Gyroceras baeri* (Meek and Worthen). Middle Richmond.  
 353. \**Orthoceras bilineatum* Hall. Richmond.  
 354. \**Orthoceras byrnesi* Miller. Upper Maysville.  
 355. *Orthoceras carleyi* Hall and Whitfield. Upper Maysville. (?)  
 356. \**Orthoceras duseri* Hall and Whitfield. Lower Richmond.  
 357. *Orthoceras gorbyi* Miller. Horizon unknown.  
 358. *Orthoceras hammeli* Foerste. Saluda.  
 359. *Orthoceras hitzi* Foerste. Saluda.  
 360. *Orthoceras junceum* Hall. Lower Eden. Probably does not occur in Indiana.  
 361. *Orthoceras mohri* Miller. Waynesville.

## TRILOBITA.

362. *Acidaspis ceralepta* (Anthony). Eden.  
 363. \**Acidaspis cincinnatiensis* Meek. Throughout the Cincinnati.  
 364. \**Acidaspis crosotus* (Locke). Southgate.  
 365. \**Calymene callicephala* Green. Common throughout the Cincinnati, especially at the top of the Waynesville.  
 366. *Ceraurus icarus* (Billings). Whitewater.  
 367. \**Ceraurus pleurexanthemus* Green. Lower Maysville and Waynesville.  
 368. \**Dalmanites breviceps* Hall. Southgate (?), Waynesville.  
 369. *Dalmanites callicephalus* (Hall). Probably not found in the Cincinnati.  
 370. \**Isotelus maximus* Locke. Rather common throughout the Cincinnati.  
 371. \**Proetus spurlocki* Meek. Southgate and lower Maysville.  
 372. \**Trinucleus concentricus* (Eaton). Throughout the Eden.

## OSTRACODA.

373. \**Bollia persulcata* Ulrich. Southgate.  
 374. \**Bollia pumila* Ulrich. Southgate (?), middle Richmond.  
 375. \**Bythocypris cylindrica* (Hall). Southgate (aa).  
 376. \**Ceratopsis chambersi* (Miller). Southgate, McMicken, Waynesville.  
 377. *Ceratopsis chambersi robusta* Ulrich. Lower Richmond.  
 378. \**Ceratopsis oculifera* (Hall). Economy, McMicken.  
 379. \**Ctenobolbina ciliata* (Emmons). Eden, Waynesville.  
 380. *Ctenobolbina ciliata hammeli* (Miller and Dyer). Arnheim.  
 381. *Entomis madisonensis* Ulrich. Saluda.  
 382. \**Eurychilina striatomarginata* (Miller). Saluda.  
 383. \**Leperditia caecigena* Miller. Eden (?), Richmond.

384. \**Primitia centralis* Ulrich. Southgate.  
 385. \**Primitia cincinnatiensis* (Miller). Richmond.  
 386. \**Primitia impressa* Ulrich. Arnheim and Waynesville.  
 387. *Tetradella quadrilirata* (Hall and Whitfield). Lower Richmond.  
 388. \**Tetradella quadrilirata simplex* Ulrich. Richmond.

## CIRRIPIEDIA.

389. \**Lepidocoleus jamesi* (Meek). Southgate, Waynesville.

## PART IV. PALEONTOLOGY.

Under this heading we consider the points of special interest of the more important genera and species. The major part of our study has been devoted to the Bryozoa, on account of their abundance, their value as zone markers, and the fascinating interest they lend to paleobiology. The Bryozoa of the Cincinnati exceed all other groups in number of species and individuals.

No attempt has been made in this paper to differentiate the smaller subdivisions of many old species, as has recently been done by Foerste, as it suits our present purpose better to retain the long-used names.

## CORALS.

*Protarea vetusta* (Hall). This coral makes its first appearance, in the Cincinnati, in the middle of the Waynesville. In the upper 17 feet of this division and in the upper Liberty it occurs abundantly, and rarely in the Saluda and Whitewater. Foerste calls this species *Protarea richmondensis*.

## BRACHIOPODA.

*Dalmanella meeki* (Miller) (= *Dalmanella jugosa* (James) ), makes its first appearance in the Fairmount. This is the form recognized by Foerste as *Dalmanella fairmountensis*. *D meeki*, the typical form, comes in in the Corryville and increases in abundance to the base of the Waynesville. In this formation it is the dominant fossil. It disappears at the base of the Liberty.

*Dalmanella multisecta* (Meek). This form ranges throughout the Eden and up into the Fairmount. It is the characteristic brachiopod of the Eden.

*Dinorthis retrorsa* (Salter) (= *D carleyi* (Hall) ), occurs apparently in a single layer near the top of the Arnheim at the top of Cut 11. The variety *D. carleyi insolens* Foerste, which occurs

384. \**Primitia centralis* Ulrich. Southgate.  
 385. \**Primitia cincinnatiensis* (Miller). Richmond.  
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*Dalmanella multisecta* (Meek). This form ranges throughout the Eden and up into the Fairmount. It is the characteristic brachiopod of the Eden.

*Dinorthis retrorsa* (Salter) (= *D carleyi* (Hall) ), occurs apparently in a single layer near the top of the Arnheim at the top of Cut 11. The variety *D. carleyi insolens* Foerste, which occurs

in some places at the top of the Waynesville, was not obtained from our section.

*Hebertella sinuata* (Hall) occurs rather commonly in the Bellevue and rarely in the Fairmount. It also occurs in the Waynesville, increasing in abundance from bottom to top, and in the lower Liberty. The Richmond form is somewhat smaller than the typical Maysville species and does not have the dorsal fold so strongly developed.

*Leptaena rhomboidalis* (Wilckens). This species begins, in the present section, in the Arnheim, where it is very rare, and increases in abundance to the top of the Waynesville, where some of the thin limestone layers are largely made up of fragments of the shells of this species.

*Platystrophia lynx* (Eichwald). The gerontic form is common in a single thick layer at an elevation of 730 feet, in Cut 10, but it is not nearly so abundant as in Ohio, where it ranges through a considerable thickness of rock. This layer corresponds to the Mt. Auburn. We also found a few specimens of the typical form in the Fairmount, but none in the Bellevue. This is rather remarkable in view of the fact that at most localities the Bellevue is replete with specimens of this species.

*Platystrophia acutilirata* (Conrad) is fairly common in the middle and upper Waynesville. It occurs sparingly above and is absent below this horizon in the present section.

*Platystrophia laticosta* (Meek) first appears in the middle of the McMicken, and continues to the top of the section. It is most common at the top of the Waynesville, but is also a common and characteristic fossil of the Fairmount and Bellevue.

*Plectambonites sericeus* (Sowerby) is another long-lived species. It persists with little change throughout the Cincinnati, and reaches its culmination in the base of the Liberty, where several layers are made up almost entirely of this shell.

*Plectorthis plicatella* (Hall), which is characteristic of the Fairmount, first appears in the upper 15 feet of the McMicken. We include under this name all of the commonly recognized varieties of this species.

*Rafinesquina alternata* (Emmons) is one of the most conspicuous and omnipresent species of the Cincinnati, second in this respect only to *Zygospira modesta*. It occurs throughout the section, in several places making up the bulk of the rock. From the base of the Maysville to the top of the Liberty it is very abundant. The

variety *fracta* occurs in immense numbers in the Bellevue, Corryville and Arnheim. The variety *loxorhytis* is common from the Corryville to the top of the Waynesville. The variety *ponderosa* appears abundantly in the Bellevue, and a similar though probably distinct form in the middle Waynesville. It is possible to find all intermediate forms between the species and varieties, and one cannot be certain what variety he is dealing with unless the form is well marked.

*Rhynchotrema capax* (Conrad) is found first at about the middle of the Waynesville and extends up into the Whitewater. It occurs in large numbers in the lower Liberty.

*Rhynchotrema dentatum* (Hall) which is characteristic of the Whitewater at Richmond, appears to be lacking in this division on Tanner's Creek. It occurs rather commonly in the middle Waynesville.

*Strophomena planoconvexa* (Hall) is restricted to the Fairmount. Though occurring in small numbers it is characteristic of the Fairmount, and its first appearance marks the base of that division, as ordinarily defined.

*Strophomena planumbona* (Hall) first appears in the Waynes and reaches its culmination in the Liberty, which it characterizes.

*Zygospira modesta* (Hall) occurs throughout the Cincinnati. It is especially abundant in the Arnheim, Waynesville and Liberty. Our collections from the Saluda and Whitewater do not contain any specimens of this species, but it is found in these beds at Richmond.

#### BRYOZOA.

*Amplexopora cingulata* Ulrich. We found several specimens of this species, which appear to be perfectly typical, in the Arnheim, in Cut 11.

*Amplexopora filiosa* (American authors). This species occurs, in our section, in the Bellevue and at the top of the Arnheim, but it is rare and the zoaria are smaller than the typical form. It seems quite probable that this species is a lineal descendant of *Amplexopora petasiformis* (Nicholson) from the Eden, which it resembles very closely.

*Amplexopora septosa* Ulrich. This species is quite abundant throughout the McMicken and Mt. Hope-Fairmount. The inflexions of the zoecial walls by the acanthopores scarcely ever show at the surface, so that sections are necessary to distinguish the species from the variety *multispinosa*. The variety *minima* is the

simplest form, and the one from which the species and the other varieties were probably derived. In the variety *maculosa* the maculae are quite different from the maculae of *A. septosa*, as pointed out in the description.

Our study of maculae and monticules has shown that they are of considerable importance in classification, and has thrown much light on their probable function. Our studies have also shown that curved diaphragms, which are quite common in species with numerous diaphragms, have little or no classificatory significance. These results, and other studies on morphology, will be brought out in detail in a succeeding paper.

There are three well-marked groups within the genus *Amplexopora*. The simplest type is the *fliosa* group, consisting of *A. filiosa*, *A. petasiformis*, and *A. Welchii*. A second group is the *pustulosa* type, consisting of *A. ampla*, *A. Columbiana*, *A. cylindracea*, *A. granulosa*, *A. pustulosa*, *A. pumila*, and *A. robusta*. A third group is the *cingulata* type, consisting of *A. cingulata*, *A. persimilis*, and *A. septosa* and its varieties. In this third group might appropriately be placed *Batostoma variable*, *Batostoma minnesotense*, and *Batostoma winchelli*. It will probably be found advisable to redistribute most of these species among other genera and reserve *Amplexopora* for the *cingulata* type above.

*Batostoma implicatum* (Nicholson) and *Batostoma jamesi* (Nicholson) are characteristic of the Eden. *B. implicatum* extends up into the Fairmount also.

*Batostoma varians* (James) appears in the Arnheim and fails at the top of the Waynesville. It shows close relationship with *B. implicatum* of the Eden. The acanthopores and wall structure of the three species, *B. implicatum*, *B. jamesi* and *B. varians* (and probably *B. maysvillensis* Nickles, from the Mt. Hope at Maysville, Ky.), belong to a single type which is quite different from the acanthopores and wall structure of all the other species now referred to the genus *Batostoma*. We are of the opinion that it might be advisable to restrict the genus *Batostoma* to the *implicatum* type, and redistribute the other species among *Amplexopora* and other genera. In this way we believe the natural relationships would be better shown.

*Batostoma variable* Ulrich is restricted to the Whitewater. In Cut 18, near Weisburg, it is very abundant, but it is found only rarely at most other localities. At Ballstown, Ind., it is abundant in the Whitewater, and is beautifully preserved. This species was

evidently not derived from any Cincinnati *Batostoma*. It bears a remarkably close resemblance to *Amplexopora cingulata* and was either derived from that species, or more probably, migrated from the northwest and is the descendant of *Batostoma minnesotense* or some of its congeners in the Trenton.

*Batostoma prosseri* Cumings and Galloway, which occurs commonly in the upper Waynesville, has no near relative in the Cincinnati rocks. The similarity between it and *Batostoma varium* Ulrich, from the Black River of Minnesota, would indicate that it may have been derived from that form and came into the Cincinnati area during the Waynesville invasion from the north. It is found also in the Richmond of northern Illinois.

The species of the genus *Bythopora*, which occur in the Cincinnati strata, fall into two groups, the *B. arctipora* group, consisting of *B. arctipora*, *B. dendrina*, *B. parvula* and *B. striata*, characterized by their delicate zoaria, rather large zooecia, and scarcity of diaphragms and acanthopores; and the *B. gracilis* group, consisting of *B. delicatula*, *B. gracilis* and *B. mecki*, characterized by their much larger zoaria and conspicuous acanthopores. There is considerable variation in the latter group, especially in the size and number of acanthopores and number of diaphragms. Some of these variants may later be recognized as distinct varieties, but they will be of little value in stratigraphic determination.

*Bythopora delicatula* (Nicholson) ranges from the Corryville to the Whitewater. In the latter formation it occurs in immense numbers.

*Bythopora gracilis* (Nicholson) is restricted to the Maysville, occurring most abundantly from the Bellevue to the Arnheim.

*Bythopora mecki* (James) occurs throughout the Richmond in considerable numbers.

*Chiloporella flabellata* (Ulrich) occurs commonly in a layer in the Corryville at an elevation of 60 feet above the railroad in Cut 8, and sparingly above and below this horizon. It is of considerable value as a zone marker, being characteristic of the Corryville.

The genus *Dekayia*, as we conceive of it, consists of *Dekayia appressa* Ulrich, *Dekayia aspera* E. and H., *Dekayia maculata* James, *Dekayia magna* Cumings, *Dekayia multispinosa* Ulrich, and *Dekayia obscura* (Ulrich). These species may be distinguished from all other species which have heretofore been placed in the genera *Dekayella* and *Heterotrypa* (which we refer to the single

genus *Heterotrypa*) by fewer diaphragms, fewer mesopores, and by their peculiar type of wall structure, seen typically in *Dekayia aspera*. We have near completion a re-study of all the species of *Dekayia* and *Heterotrypa*, the results of which will be published in the near future. In that paper we shall show the evolution of these genera, and endeavor to demonstrate that they constitute two well-defined natural groups.

*Dekayia aspera* E. and H. occurs abundantly in Cut 5 at the base of the Maysville. A form scarcely distinguishable from it, probably a variety, occurs in the Arnheim. A form of *Dekayia* very similar to *D. obscura* occurs in the Corryville-Arnheim. The *Dekayias* appear in the McMicken and become extinct at the middle of the Arnheim. They are especially characteristic of the Maysville.

*Eridotrypa simulatrix* (Ulrich), the only species of this genus found in the Cincinnati, ranges from the Corryville to the base of the Liberty. It is most abundant in the upper Waynesville.

The genus *Hallopora* (formerly *Callopora*) is represented in the Cincinnati by ten species, all of which are abundant at their respective horizons.

*Hallopora dalei* (E. and H.) characterizes the Mt. Hope-Fairmount. It also occurs sparingly in the McMicken.

*Hallopora oncalli communis* (James) is found sparingly in the Southgate and very abundantly in the McMicken, which formation it characterizes.

*Hallopora ramosa* (d'Orbigny) is very common throughout the Maysville, and is most abundant in the Bellevue and Corryville. A form scarcely distinguishable, perhaps the same species, occurs in the Waynesville and Liberty.

*Hallopora subnodosa* (Ulrich) extends from the Arnheim to the top of the Richmond.

*Hallopora ramosa rugosa* (E. and H.) is found throughout the middle and upper Maysville, and a form probably referable to this species occurs in the Waynesville. It reaches its maximum development in the Arnheim. The rugose phase is not confined to *H. ramosa*. It appears occasionally on all monticulose *Halloporas*.

*Heterotrypa frondosa* (d'Orbigny) occurs commonly throughout the Maysville. It reaches its culmination in the Bellevue. Occasionally specimens show inflected walls, as in *H. singularis*.

*Heterotrypa prolifica* Ulrich occurs only in the Waynesville, where it is very common. All the Waynesville species of *Hetero-*



TABLE I.

TABLE OF SPECIFIC CHARACTERS OF THE GENUS DEKAYIA.

SPECIES.	Zoarium.	Surface.			Zoecia in 2 mm.	Shape of Zoecia.	Tangential Section.				
		Mesopores.	Monticules.	Maculae.			Mesopores.	Acanthopores.		Thickness of Walls.	Cingulum.
								No. in 10 Zoecia	Size.		
<i>Dekayia appressa</i> . . .	Ramose, flattened, 1-3 in. high; 7-10 mm. in diam.	Very few . . . . .	None . . . . .	Of large cells and meso- pores.	10	Polygonal . . . (oval).	Few to none . .	4	2	Thin . . . . .	Very thin or none.
<i>Dekayia aspera</i> . . . . .	Ramose, 6-10 mm. thick; 3-6 cm. long.	None . . . . .	None . . . . .	Of large cells and meso- pores.	10	Polygonal . . . . .	None . . . . .	4	3, 4	Thin. Thicker than in <i>appressa</i> .	Very thin or none.
<i>Dekayia maculata</i> . . .	Ramose, 3-6 mm. thick; 3-6 cm. long.	Few, restricted to maculae.	None . . . . .	Of mesopores..	8	Oval . . . . .	Few, except in maculae.	4-8	1, 2, 3	Thick . . . . .	Very thin . . . .
<i>Dekayia magna</i> . . . . .	Massive, large, ra- mose; 2 or more cm. thick.	None . . . . .	None . . . . .	Of large zoe- cia.	8	Polygonal . . . . .	None . . . . .	1	1	Very thin . . . .	None.
<i>Dekayia multispinosa.</i>	Ramose, flattened; 8-15 mm. in di- ameter.	Few or none . . .	None . . . . .	Of large Zoe- cia and meso- pores.	10	Oval or poly- gonal.	Few, many in maculae.	4-10	2 (1, 3)	Medium . . . . .	None.
<i>Dekayia obscura</i> . . . .	Ramose, slender, 4-6 mm. thick.	Moderate num- ber.	None . . . . .	Of large zoe- cia and meso- pores.	9	Oval . . . . .	Moderate num- ber, angular.	3-6	1, 2, 3	Thick . . . . .	Thin.

TABLE 1—Continued.

TABLE OF SPECIFIC CHARACTERS OF THE GENUS DEKAYIA.—Continued.

SPECIES.	Longitudinal Section.				Range.	Remarks.
	Diaphragms in Axial Region.	Diaphragms in Periphery.	Acanthopores.	Diaphragms in Mesopores.		
<i>Dekayia appressa</i> .....	None.....	5 to 10.....	Not conspicuous.....	Closer than in zoecia.	Upper Maysville.....	Surface sometimes covered with a pellicle.
<i>Dekayia aspera</i> .....	None.....	None (2 to 4).....	From axial region to periphery.	None.....	McMicken to Fairmount.	Walls crinkled. Acanthopores large at surface. Communication pores sometimes present.
<i>Dekayia maculata</i> .....	None.....	2 to 4.....	From axial region to periphery.	None.....	McMicken (Maysville).	Walls crinkled, much thickened at surface. Acanthopores large at surface.
<i>Dekayia magna</i> .....	None.....	None.....	Rarely a large one in axial region.	None.....	Fairmount to Arnheim.	Walls crinkled, not thickened in periphery.
<i>Dekayia multispinosa</i> .....	None.....	None (1 or 2).....	Common in axial region	None.....	Mt. Hope to Fairmount	Walls crinkled, not abruptly thickened in periphery. Sometimes covered with pellicle.
<i>Dekayia obscura</i> .....	None.....	2-4.....	Common from axis to periphery.	Closer than in zoecia	Upper Eden to lower Maysville.	Walls crinkled. Mature region shallow. Surface often with pellicle.

**TABLE 2.**  
TABLE OF SPECIFIC CHARACTERS OF THE GENUS HETEROTRYPA.

SPECIES.	Zoarium.	Surface.			Zooccia in 2 mm.	Shape of Zooccia.	Tangential Section.				
		Mesopores.	Monticules.	Maculae.			Mesopores.	Acanthopores.		Thickness of Walls.	Cingulum.
							No. in 10 Zooccia.	Size.			
<i>Heterotrypa affinis</i> .	Irregularly ramose, 15 mm. thick.	Only in maculae.	Very low.	Of large zooccia and mesopores.	7-8	Polygonal.	Few to none.	20	1	Thin.	None.
<i>Heterotrypa frondosa</i> .	Frondescent, 5-10 mm. thick.	Numerous or few.	Low, round.	Of large zooccia and mesopores.	7-8	Oval or polygonal.	Numerous to few.	3-4	*1, 2	Medium.	None.
<i>Heterotrypa infecta</i> .	Flabellate, 3-5 mm. thick.	Numerous.	None.	Of large zooccia and mesopores.	8	Round.	Numerous.	5-7	†1, 2	Thick.	Thick, perfect.
<i>Heterotrypa paupera</i> .	Ramose or subramose, 4-8 mm. in diameter.	Only in maculae.	None.	Of large zooccia and mesopores.	8	Polygonal.	Very few.	4-5	1	Very thin.	None.
<i>Heterotrypa pelliculata</i> .	Large, subramose, 16-20 mm. thick.	Few to none.	None.	Of large zooccia and mesopores.	7-8	Polygonal.	Few.	4	1, 2	Very thin.	None.
<i>Heterotrypa solitaria</i> .	Frondescent, 2-4 mm. thick.	Very few or none.	None or very low.	Of large zooccia and mesopores.	7-8	Polygonal.	Very few.	6-10	1	Thin.	None.
<i>Heterotrypa subfrondosa</i> .	Frondescent, large, 8-10 mm. thick.	Few to numerous.	Low, round.	Of large zooccia and mesopores.	7-8	Round.	Few to numerous.	10	†1, 2, 3, 4	Thin.	None.
<i>Heterotrypa subpulschella</i> .	Large, subramosa, 10-15 mm. in diameter.	Few, except in the maculae.	Very low.	Of mesopores, surrounded by zooccia.	7-8	Round.	Numerous.	6	1, 2, (3)	Medium.	None.
<i>Heterotrypa ulrichi</i> .	Ramose, 5-10 mm. in diameter.	Abundant.	None (or low).	Of mesopores, surrounded by zooccia.	7-8	Round.	Abundant.	4-10	2, (3)	Medium to thick.	Thick, perfect.
<i>Heterotrypa ulrichi lobata</i> .	Subramose to frondescent, 3-5 mm. thick.	Abundant.	None (or low).	Of large zooccia and mesopores.	7-8	Round.	Numerous.	4	1, 2, 3	Thin.	None.
<i>Heterotrypa ulrichi robusta</i> .	Ramose, 10 mm. in diameter.	Numerous.	Small, conical.	Of large zooccia and mesopores.	7-8	Polygonal (Round).	Numerous.	6	1, 2, 3	Medium.	None or thin.
<i>Heterotrypa microstigma</i> .	Ramose, 10 mm. or more in diameter.	None.	None.	Very small, of small mesopores.	9	Subcircular.	None.	20-25	1	Thick.	Thick, perfect.
<i>Heterotrypa prolifica</i> .	Frondescent, large, 8-15 mm. thick.	Few.	Low, large, round.	Large of large zooccia and mesopores.	8-9	Subcircular.	Few.	20	1	Thick.	Thick, perfect.
<i>Heterotrypa singularis</i> .	Subramose, 7-10 mm. in diameter.	Abundant.	Low, large, round.	Large, of large zooccia and mesopores.	8-9	Subcircular.	Abundant.	20	1	Thick.	Thick, perfect.
<i>Heterotrypa subramosa</i> .	Ramose, 8-10 mm. in diameter.	Few or none. (sometimes numerous).	None or low.	Large, of large zooccia and mesopores.	8-9	Subcircular.	Few to numerous.	10-15	1, 2	Thick.	Thick, perfect.

\*Very regular.

‡Very variable.

†Regular.

TABLE 2—Continued.

TABLE OF SPECIFIC CHARACTERS OF THE GENUS HETEROTRYPA—Continued.

SPECIES.	Longitudinal Section.				Range.	Remarks.
	Diaphragms in axial Region.	Diaphragms in Periphery.	Acanthopores.	Diaphragms in Mesopores.		
<i>Heterotrypa affinis</i> .....	Numerous, 1-3 tube diameters apart.	$\frac{1}{2}$ -1 tube diameters apart.	Small.....	Numerous, close-set (beaded).	Waynesville.....	Acanthopores slightly inflect the walls.
<i>Heterotrypa frondosa</i> ....	None.....	1 tube diameter apart.	Rarely a large one in axial region.	Numerous, close-set (beaded).	Mt. Hope to Arnheim..	Very variable in all characters.
<i>Heterotrypa inflecta</i> ....	None.....	1 tube diameter apart.	Inconspicuous.....	Numerous, close-set (beaded).	Mt. Hope to Corryville.	Acanthopores inflect walls; conspicuous at surface.
<i>Heterotrypa paupera</i> ....	None.....	1-2 tube diameters apart.	Inconspicuous.....	Numerous, close-set (beaded).	Fairmount to Corryville	
<i>Heterotrypa pelliculata</i> ..	None.....	$\frac{1}{2}$ -1 tube diameters apart.	No. 2 common.....	Numerous, close-set (beaded).	Fairmount and Bellevue	Surface sometimes covered with a pellicle.
<i>Heterotrypa solitaria</i> ....	None.....	$\frac{1}{2}$ -1 tube diameters apart.	Inconspicuous.....	Numerous, close-set (beaded).	Fairmount to Arnheim.	
<i>Heterotrypa subfrondosa</i> ..	None.....	$\frac{1}{2}$ -1 tube diameters apart.	Sometimes a large one in axial region.	Numerous, close-set (beaded).	Mt. Hope to Fairmount	
<i>Heterotrypa subpulchella</i>	None.....	1-2 tube diameters apart.	Sizes 2, 3 in submature region.	Numerous, close-set (beaded).	McMicken to Fairmount	
<i>Heterotrypa ulrichi</i> .....	None.....	$\frac{1}{2}$ -2 tube diameters apart.	Sizes 2, 3 in submature region.	Numerous, close-set (beaded).	Southgate to Fairmount	Characteristic of the middle McMicken.
<i>Heterotrypa ulrichi lobata</i> .	None.....	$\frac{1}{2}$ -2 tube diameters apart.	No. 3, rare.....	Numerous, close-set (beaded).	McMicken to Fairmount	
<i>Heterotrypa ulrichi robusta</i> .	None.....	$\frac{1}{2}$ -2 tube diameters apart.	Nos. 2, 3 in submature region.	Numerous, close-set (beaded).	McMicken to Fairmount	
<i>Heterotrypa microstigma</i>	Numerous, 1-3 tube diameters apart.	1 tube diameter apart.	Small.....	Close-set.....	Waynesville.....	Zooecia sometimes inflected.
<i>Heterotrypa prolifica</i> ....	Numerous, 1-3 tube diameters apart.	$\frac{1}{2}$ -1 tube diameters apart.	Small.....	Close-set.....	Waynesville.....	Zooecia sometimes inflected. Communication pores and infundibular diaphragms common.
<i>Heterotrypa singularis</i> ..	Numerous, 1-3 tube diameters apart.	$\frac{1}{2}$ -1 tube diameters apart.	Small.....	Close-set.....	Waynesville.....	Zooecia much inflected.
<i>Heterotrypa subramosa</i> ..	Numerous, 1-3 tube diameters apart.	$\frac{1}{2}$ -1 tube diameters apart.	Small.....	Close-set.....	Waynesville to White-water.	

*trypa* may be easily distinguished from the Maysville species of the genus by the presence of numerous diaphragms in the axial region of the Richmond forms. In the Maysville representatives of this genus diaphragms are almost always entirely lacking in the axial region. Communication pores and infundibular diaphragms are very beautifully developed in most species of *Heterotrypa*, especially in *H. prolifica* and its allies.

*Heterotrypa ulrichi* (Nicholson) ranges throughout the Eden and up into the Fairmount. It reaches its culmination in the middle of the McMicken.

The genus *Homotrypa* is represented in the Cincinnati of Indiana by twenty-five species.

*Homotrypa austini* Bassler and *Homotrypa communis* Bassler, two closely related species, occur commonly in the Waynesville and Liberty, and occasionally in the Whitewater.

*Homotrypa flabellaris* Ulrich occurs rarely in the Arnheim and commonly in the Waynesville. The variety *H. flabellaris spinifera* Bassler occurs in the Fairmount and in the upper Waynesville. It is doubtful, however, if the Waynesville form is identical with the Fairmount form. Bassler does not say from which formation his type comes.

*Homotrypa frondosa* Bassler occurs from within the Corryville to the top of the Waynesville. That this species is not a variety of *H. flabellaris* is shown by the absence of diaphragms in the axial region of *frondosa*, the large round monticules, and other minor differences.

In the Whitewater occurs a group of species, the *Homotrypa ramulosa* group, consisting of *Homotrypa constellariformis* Cumings, *Homotrypa nicklesi* Bassler, *Homotrypa nitida* Bassler and *Homotrypa ramulosa* Bassler, which are very closely related to each other, and distinguished from all other species of *Homotrypa* (except *H. gelasinosa* Ulrich, which probably belongs in the same group) by the peculiar, irregular maculae.

*Homotrypa pulchra* Bassler is characteristic of the Corryville-Arnheim. The ease of identification of this species in the field makes it valuable for stratigraphic determination.

*Homotrypa wortheni* (James) occurs quite abundantly in the Whitewater, which it characterizes. It is not confined to this formation, however, but is found sparingly in the upper Waynesville and Liberty.

*Homotrypella hospitalis* (Nicholson) is characteristic of the Waynesville, increasing in abundance from the bottom to the top of this formation. It also occurs in the Liberty and rarely in the Whitewater.

*Homotrypella rustica* Ulrich occurs rarely in the Waynesville and Liberty. We have no specimens from the Whitewater of the Tanner's Creek section, although it occurs abundantly in that formation at Richmond, Laurel and Versailles.

*Peronopora pavonia* (d'Orbigny) is a common fossil, occurring from the top of the Fairmount to the middle of the Liberty. There is considerable variation in the characters of this species. The acanthopores vary considerably in size and number. There is also much variation in the size of the zoaria, number of mesopores, diaphragms and cystiphragms. Some of these variants may sometime be recognized as varieties or even distinct species. *P. pavonia* may always be distinguished from *Peronopora vera* by the much smaller zoecia of the former.

*Peronopora vera* Nickles occurs in the Southgate and McMicken, and is particularly abundant in the Mt. Hope-Fairmount. There is also considerable variation in the characters of this species, variations which would at once be considered of sufficient importance to cause the erection of new species and varieties if they occurred in some other genera. However, it seems that no useful purpose would be served by recognizing these variants as new species or varieties at the present time.

The genus *Stigmatella* is represented by ten species in the Cincinnati of Tanner's Creek. None of these species occur abundantly and they are consequently of little importance in stratigraphic work.

#### SCALE OF SIZES OF ACANTHOPORES.

We have found in our study of acanthopores that instead of there being two recognizable sizes, heretofore designated as "large" and "small," there are at least seven easily recognizable sizes, ranging from the extremely minute ones like those found in *Homotrypa grandis* Bassler to the extraordinarily large ones of *Lioclema spinicolum* Bassler.

We have taken as the unit of measurement  $1/20$  of a mm., so that when a tangential section is magnified 20 diameters, No. 1 acanthopores will be 1 mm. in diameter, No. 2, 2 mm. in diameter,

etc. This scale makes it possible, and frequently desirable, to recognize half sizes.

The following species exhibit typically the various sizes of acanthopores:

No. 0. *Homotrypa grandis* Bassler and *Homotrypa alta* n. sp. In this size there is no central lumen and the acanthopore presents an indistinct, "fuzzy" appearance.

No. 1. *Heterotrypa prolifica* Ulrich, and *Homotrypa communis* Bassler.

No. 2. *Heterotrypa affinis* (Ulrich), and *Homotrypella hospitalis* (Nicholson).

No. 3. *Homotrypa nodulosa* Bassler, and *Dekayia aspera* Edwards and Haime.

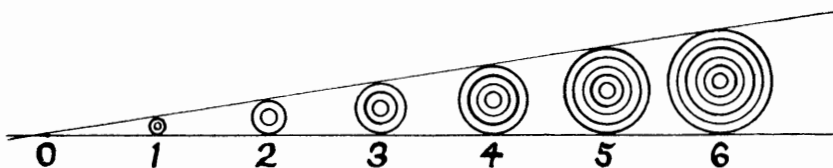
No. 4. *Homotrypa flabellaris spinifera* Bassler, and *Dekayia aspera* Edwards and Haime.

No. 5. This size is not typically developed in any species so far described, but acanthopores of this size are sometimes found in several species of *Dekayia*.

No. 6. *Lioclema spincum* Bassler. We have a specimen of *Dekayia*, probably a new species, which has all seven sizes, and all intermediate sizes.

Most species provided with acanthopores have two or three sizes. The size of most common occurrence is No. 1.

## Scale of Acanthopores, x45



### PART V. DESCRIPTION OF NEW SPECIES.

#### AMPLEXOPORA GRANULOSA n. sp.

Plate I, Figs. 1-1c.

Zoarium ramose or subramose, 8 to 10 mm. in diameter, the branches short and irregular, sometimes anastomosing. Surface nearly smooth, with medium-sized maculae consisting of smaller

etc. This scale makes it possible, and frequently desirable, to recognize half sizes.

The following species exhibit typically the various sizes of acanthopores:

No. 0. *Homotrypa grandis* Bassler and *Homotrypa alta* n. sp. In this size there is no central lumen and the acanthopore presents an indistinct, "fuzzy" appearance.

No. 1. *Heterotrypa prolifica* Ulrich, and *Homotrypa communis* Bassler.

No. 2. *Heterotrypa affinis* (Ulrich), and *Homotrypella hospitalis* (Nicholson).

No. 3. *Homotrypa nodulosa* Bassler, and *Dekayia aspera* Edwards and Haime.

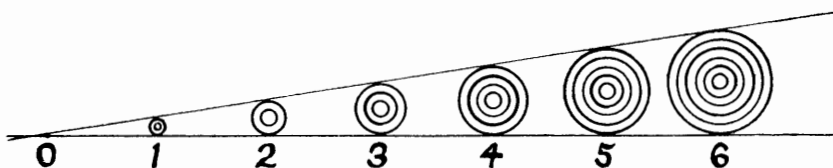
No. 4. *Homotrypa flabellaris spinifera* Bassler, and *Dekayia aspera* Edwards and Haime.

No. 5. This size is not typically developed in any species so far described, but acanthopores of this size are sometimes found in several species of *Dekayia*.

No. 6. *Lioclema spincum* Bassler. We have a specimen of *Dekayia*, probably a new species, which has all seven sizes, and all intermediate sizes.

Most species provided with acanthopores have two or three sizes. The size of most common occurrence is No. 1.

## Scale of Acanthopores, x45



### PART V. DESCRIPTION OF NEW SPECIES.

#### AMPLEXOPORA GRANULOSA n. sp.

Plate I, Figs. 1-1c.

Zoarium ramose or subramose, 8 to 10 mm. in diameter, the branches short and irregular, sometimes anastomosing. Surface nearly smooth, with medium-sized maculae consisting of smaller



zoëcia and mesopores surrounded by zoëcia larger than the average; maculæ very little elevated above the general surface, about 9 in one sq. cm.

Tangential sections show the zoëcia to be subpolygonal to oval, moderately thick walled, each aperture surrounded by a thin, light-colored cingulum; about 8 zoëcia in 2 mm. The zoëcial walls are made up of a light-colored material in which are embedded numerous dark, fuzzy granules. These granules are commonly arranged in transverse rows. Under high magnification each granule shows a light-colored nucleus. In longitudinal sections the granules are seen to be in parallel, vertical rows. Acanthopores are apparently absent, none of our slides showing any. There are occasionally, however, indefinite structures which may be acanthopores. Mesopores are restricted to the Maculæ. The mesopores have the same wall structure as the zoëcia, and may be only young zoëcia.

Longitudinal sections show that the zoëcia in the axial region have thin, crinkled walls, and are crossed by diaphragms from one to two tube diameters apart. In the mature region the zoëcial walls are considerably thickened, and exhibit the usual median, black line. Diaphragms are close-set in the mature region, many of them being curved and infundibuliform.

This species does not sufficiently resemble any described species to require comparison. The only associated species of the genus is *Amplexopora pumila* n. sp., from which it differs in having no acanthopores. It was probably derived from *Amplexopora robusta*, which occurs over 100 feet lower in the section.

*Occurrence:* Rather abundant in the lower 25 feet of the Liberty, in Cuts 16 and 17, on the Big Four Railroad, near Weisburg, Ind.

#### AMPLEXOPORA PUMILA n. sp.

Plate II, Figs. 1-1e.

Zoarium irregularly ramose, consisting of short, knotted branches from 3 to 8 mm. thick, and 3 or 4 cm. long. Surface nearly smooth, with slightly raised maculæ composed of large zoëcia and a few mesopores; about 8 maculæ in 1 sq. cm. Zoëcia polygonal, thin-walled at the surface; mesopores few, scattered among the ordinary zoëcia as well as in the maculæ.

In tangential sections the zoëcia are seen to be subpolygonal in form, with medium thick walls, 7 or 8 in 2 mm. The double zoëcial wall consists of two very light-colored rings of tissue separated by

a dark, granular line. These rings are not cingula, but parts of the true zoöceal walls. The granules in the median line vary in number and size and are not arranged in transverse rows, as in *Amplexopora granulosa*. Mesopores are few in number and have the same wall structure as the zoöcia; they are probably only young zoöcia.

The acanthopores vary much in size and number, there being ordinarily about 3 in 10 zoöcia. In size they range from No. 0 to 2, averaging about size 1. They are indefinite in outline and shape, fading out into the median line. The lumen is not clear and well-defined, but only somewhat lighter in color than the surrounding tissue.

The zoöcia in the axial region have the usual thin, flexuous walls, and are crossed by diaphragms about their own diameter apart. As the mature region is reached the walls become considerably thickened, and the diaphragms about three times as numerous, many of them being curved.

The large, indistinct acanthopores are occasionally seen in longitudinal sections, but are never conspicuous. The dark line between adjacent zoöcia is quite distinct, not straight and uniform, but irregularly crinkled and varied in thickness, and of a granular structure.

This species bears some resemblance to *Amplexopora pustulosa*, but may be distinguished by the small, irregular, smooth zoarium, the granulose intermural line, and larger and fewer acanthopores. The only associated species is *A. granulosa*, which differs from *A. pumila* in the absence of acanthopores, the presence of a cingulum, the wide intermural line with granules in transverse rows, and the absence of mesopores.

*Occurrence*: Rather abundant in the upper 15 feet of the Waynesville and lower 25 feet of the Liberty, in Cuts 14, 16 and 17, on the Big Four Railroad, near Weisburg, Indiana.

#### AMPLEXOPORA SEPTOSA MACULOSA n. var.

Plate III, Figs. 1-1c.

Zoarium robust, ramose, about 10 mm. in diameter and 4 or 5 cm. long, branching every 2 or 3 cm. Surface with elevated, subsolid, flat-topped maculae about 1 mm. in diameter, composed of mesopores or very small zoöcia surrounded by zoöcia considerably larger than the average; 12 maculae in 1 sq. cm. These maculae constitute the main distinguishing characteristic between this va-

riety and *A. septosa* and its other varieties, all of which have maculae on a level with the general surface of the zoarium, and composed of larger zoecia and a few open mesopores.

Tangential sections show that the zoecia are thick-walled, although at the surface the walls are usually thin and the zoecia polygonal, and separated by a definite dark median line; 8 zoecia in 2 mm. There is usually no cingulum present in the zoecia, as is ordinarily the case with the variety *A. septosa multispinosa*. The acanthopores are numerous, 5 or 6 surrounding a zoecium about  $\frac{2}{3}$  the size of No. 1, that is  $\frac{1}{30}$  mm. in diameter, sometimes inflecting the zoecial walls. The outlines of the acanthopores are indistinct; the lumen is extremely small and seldom showing, but sometimes appearing clear and well-defined. The maculae are seen to be composed of mesopores either completely filled with secondary tissue or possessing a thick cingulum. Communication pores are sometimes present in large numbers.

The zoecia in the axial region have thin, irregularly crinkled walls and are usually without diaphragms, although an occasional very thin one is present. In the curve from the immature to the mature region the zoecial walls are considerably thickened and there begins a close-set series of diaphragms which become more and more crowded till a point about half way from the submature region to the surface is reached, at which point the diaphragms suddenly stop and only an occasional one is inserted from there on to the surface. In the type specimen there appears to have been a rejuvenation after maturity was reached and several diaphragms are again inserted. The median dark line is quite distinct, and nearly straight, as ordinarily seen. In good slides under a high power of the microscope (320 diameters) this median line is seen to be composed of curved, transverse rows of granules, and is not a double, or even single, plate separating adjacent zoecia and along which the walls tend to split. This variety agrees in all respects with *A. septosa multispinosa*, except the presence of the prominent, subsolid, elevated maculae.

*Occurrence:* Common in the upper 70 feet of the Eden and lower 50 feet of the Maysville, in Cuts 1, 2, 3, 4 and 5, on the Big Four Railroad, near Guilford, Indiana.

AMPLEXOPORA SEPTOSA MINIMA n. var.

Plate IV, Figs. 1-1d.

Zoarium small, ramose, 2-5 mm. in diameter and 3 or 4 cm. long, branching frequently. Surface smooth, with small, incon-

spicuous maculae composed of large zoecia and a few mesopores, not raised above the general level of the surface.

In tangential sections the zoecia are seen to be thin-walled, with no cingulum, the dark median line showing quite plainly; 8 or 9 zoecia in 2 mm. Acanthopores are numerous, 5 or 6 surrounding a zoecium, about 1/3 the size of No. 1, that is, 1/60 mm. in diameter, with a clear, well-defined lumen. Mesopores few, scarcely more numerous in the macula than elsewhere.

Diaphragms numerous in the submature region, absent in the mature, and absent or few in the axial region; walls crenulated. Walls somewhat thickened in the mature region.

This variety differs from *A. septosa* in having smaller zoaria, thinner walls and smaller acanthopores which do not inflect the zoecial walls.

*Occurrence:* Common in the upper 70 feet of the Eden and lower 50 feet of the Maysville, in Cuts 1, 2, 3, 4 and 5, on the Big Four Railroad, near Guilford, Ind.

#### ATACTOPORA INTERMEDIA n. sp.

Plate IV, Figs. 2, 2a; Plate V, Figs. 1-1d.

Zoarium parasitically attached to *Orthoceras*, no basal epitheca, about 20 sq. cm. in area and 1 mm. thick, and made up of superimposed layers. The surface presents prominently raised subsolid monticules, which are slightly elongated in the direction of the longitudinal axis of the *Orthoceras* and in rows in the same direction, about 15 occupying the space of 1 sq. cm. Zoecia floriform, thin-walled at the surface, indented by the small but conspicuous acanthopores.

Tangential sections show the zoecia to be very irregular in shape, indented by the numerous conspicuous acanthopores, about 9 zoecia in 2 mm. Each zoecium is surrounded by a very thin dark line, the interzoecial tissue consisting of irregular granular material, slightly lighter in color than the zoecial wall. Acanthopores very abundant, 4 or 5 surrounding each zoecium, No. 1 in size. The maculae are made up of irregularly concentric tissue, enclosing a few acanthopores. Mesopores are practically absent.

In the longitudinal section the zoecia are thick-walled, the acanthopores very conspicuous with a clear canal, which is somewhat irregular in size but not increasing in size as the surface is approached. Diaphragms numerous in the lower half of each zoecium, usually absent in the outer half. Cystoid diaphragms are pres-

ent in some of the tubes. The zoœcia are at first prone, but soon turn at right angles, and then proceed direct to the surface. The maculæ are composed of aborted zoœcia and acanthopores, as described by Ulrich.\*

This species presents several very interesting features. It is very similar to *Atactopora hirsuta*, except in possessing numerous diaphragms in the lower portion of the tubes. It resembles *Atactoporella* in possessing cystiphragms in some of the zoœcia. We do not, however, attach even specific importance to the sporadic development of cystiphragms, inasmuch as we have found them in at least nine genera, exclusive of the Monticuliporidae. In a subsequent paper, now in preparation, we shall suggest an explanation of these structures.

This species also resembles very closely several species of *Spatiopora*, but the total absence of a lunarium would indicate that it is not a Ceramoporoid.

*Occurrence:* Rare in the McMicken division of the Eden, in Cut 3, on the Big Four Railroad, near Guilford, Ind.

CERAMOPORELLA TRILOBA n. sp.

Plate VI, Figs. 1-1c.

Zoarium growing parasitically upon other bryozoans (*Heterotrypa ulrichi*), with no epitheca, forming large masses by superimposition of layers. Each layer is less than 1 mm. in thickness. The type specimen is 5 cm. long and about 2 cm. in diameter.

Surface nearly smooth, with maculæ slightly raised or depressed. Maculæ composed of smaller, distorted zoœcia and mesopores. Zoœcia irregularly trilobed, with a strongly arching lunarium. On unweathered surfaces minute acanthopores are discernable. Mesopores are numerous.

In tangential sections the zoœcia are seen to be roughly trilobed, with moderately thin walls; 7 zoœcia in 2 mm. Mesopores rather abundant, oval or irregular in shape. Structures exactly like the acanthopores in some Trepostomata, and which we consider to be true acanthopores, are common, though irregularly distributed among the zoœcia. They are about half the size of No. 1, that is 1/40 mm. in diameter. Lunaria prominent, horseshoe shaped, occupying one-third of the zoœcial circumference, the ends projecting slightly into the zoœcial cavity. Opposite the lunarium is another very small crescent-shaped, light-colored structure very sim-

\*Journ. Cin. Soc. Nat. Hist., VI, p. 246.

ilar to the lunarium but much smaller. These structures occur also in several other *Ceramoporoids*.

In longitudinal sections the walls are seen to be irregular in structure, rather thin, with no mural pores or large granules. Diaphragms thin, one or two in each tube. Acanthopores not conspicuous, but typically developed, with comparatively wide canals and thin walls.

This species is closely related to *Ceramoporella distincta*, but has fewer mesopores, differently shaped zoëcia and more prominent lunaria. It resembles *Crepipora* in the distinct lunaria with projecting ends, but the mesopores are not collected into maculae, and the lunarium overarches more than in that genus. It is distinguished from *Ceramoporella ohioensis* by the prominent, horseshoe-shaped lunarium.

*Occurrence:* Rare in the McMicken member of the Eden, in Cut 3, on the Big Four Railroad, near Guilford, Ind.

#### CERAMPORELLA TUBULOSA n. sp.

Plate VI, Figs. 2, 2a; Plate VII, Figs. 1-1c.

Zoarium parasitically attached to foreign bodies, in the type specimen to a species of *Orthoceras*, covering over 30 sq. cm. and having a thickness of about 1 mm. There is no epitheca.

Surface smooth, with maculae composed largely of irregular mesopores, neither elevated nor depressed and scarcely distinguishable. Zoëcia oval, surrounded completely by irregular mesopores. Lunarium not elevated. Numerous minute acanthopores may be seen on unweathered surfaces.

Tangential sections present a bizarre appearance. The zoëcia are regularly oval in shape, all orientated the same way, 1/4 mm. long and 1/6 mm. wide, about 6 in 2 mm., including mesopores. Walls of medium thickness. Lunarium pronounced, occupying a little less than one-half the zoëcial circumference, the ends not projecting into the zoëcial cavity. Mesopores abundant, very irregular in shape, separating the zoëcia the distance of their shorter diameter and in the same direction; usually also separating the zoëcia in the direction of their longer diameter. The most noticeable thing in tangential sections is the numerous acanthopores. They occupy for the most part the angles between the mesopores. They are sometimes much more abundant than in the section figured (Plate VII, Fig. 1), there being as many as ten or more to a

zoecium. They are about half the size of No. 1, or 1/40 mm. in diameter, though they vary somewhat in size.

Longitudinal sections show very few diaphragms, these structures averaging less than one to a tube. The acanthopores are perfectly typical, with wide canal and thin, laminated walls. Diaphragms occasionally cross the tube of the acanthopore.

This species most closely resembles *Ceramoporella granulosa*, but has fewer diaphragms, more mesopores, and absolutely lacks the large granules which are such a conspicuous feature of longitudinal sections of that species. The two species also occupy different horizons. We do not agree with Ulrich that the "small dark spots, precisely like acanthopores in tangential sections,"\* are simply the cross-sections of granules, but hold that they are cross-sections of true acanthopores. Our specimens of *Ceramoporella granulosa* show these granules as well as acanthopores, from which they are easily distinguished by differences in structure.

*Ceramoporella tubulosa* resembles *Ceramoporella distincta* externally, but tangential sections of the two are quite different.

*Occurrence:* Rare in the upper 25 feet of the Eden in Cut 3, on the Big Four Railroad, near Guilford, Ind.

#### HETEROTRYPA MICROSTIGMA n. sp.

Plate VIII, Figs. 1-1c.

Zoarium ramose or subramose, about 10 mm. thick and 6 cm. long. Surface nearly smooth, with very small, subsolid maculae composed only of mesopores, surrounded by zoecia slightly larger than the average; 15 maculae in 1 sq. cm. Maculae averaging about 1 mm. in diameter, sometimes slightly elongated transversely to the zoarium. Zoecia medium thick walled, subpolygonal. No mesopores show at the surface except in the maculae. Acanthopores not showing at the surface.

Tangential sections show the zoecia to be subcircular, very thick walled, 9 zoecia in 2 mm. Mesopores absent, except in the maculae, where they are usually nearly closed by a secondary deposit of tissue. The zoecial aperture is surrounded by a thick ring of light-colored tissue. To this structure which is found in many species of Trepostomata, we apply the name "cingulum." The cingulum is typically developed in *Amplexopora cingulata* Ulrich. Immediately surrounding the cingulum is a thin dark line, the true zoecial

\* Geol. Surv. Ill., VIII, p. 456.

wall. The intermural tissue is light-colored, and finely granular. Acanthopores small, No. 1 in size, and abundant, from 20 to 25 in 10 zoëcia; sometimes slightly inflecting the zoëcial walls. The zoëcia and acanthopores are quite regular in size and arrangement.

In longitudinal sections the zoëcia in the axial region are seen to be crossed by diaphragms averaging 3 tube diameters apart. In the mature region the zoëcia are very thick walled and provided with diaphragms less than one tube diameter apart. Mesopores are rarely seen in these sections.

The character which distinguishes this species from associated species of *Heterotrypa* is the minute, subsolid maculae. Other differences are indicated on the chart, pages 417, 418.

*Occurrence:* Rather rare in the Waynesville, in Cut 13, on the Big Four Railroad, near Weisburg, Ind.

#### HOMOTRYPA ALTA n. sp.

Plate IX, Figs. 1-1c; Plate X, Figs. 1-1c.

Zoarium robust, ramose, or slightly compressed, 6 to 10 mm. in diameter and 4 or 5 cm. long, branching about every 2 cm. Surface perfectly smooth, with numerous subsolid, stellate maculae, which are neither raised nor depressed, composed of small mesopores surrounded by zoëcia somewhat larger than the average. The maculae have a tendency to be drawn out in the direction of the longitudinal axis of the zoarium; 10 maculae in 1 sq. cm. At the surface the zoëcia are polygonal to oval with medium thick walls, and the acanthopores rarely show.

As seen in tangential sections the zoëcia are polygonal, medium thick walled, with oval apertures; 10 zoëcia in 2 mm. The aperture is surrounded by a ring of dark tissue, succeeded by a lighter ring, and this is in turn surrounded by a second dark ring of granular tissue. Ordinarily there is a median line of light-colored tissue, but occasionally this is absent, in which case the median line is made up of the second, granular zoëcial wall. Mesopores are practically absent, except in the maculae, but there are occasional small zoëcia which might be mistaken for mesopores, but differ from mesopores in having walls exactly like the large zoëcia. The maculae are composed of mesopores which have almost always been filled by a deposit of light-colored schlerenchyma. Acanthopores common, 4 in 10 zoëcia, very minute, number 0 in size, with no central lumen. Communication pores are sometimes present.



In longitudinal sections the zoëcia have wavy walls and no diaphragms in the axial region. The zoëcia turn sharply outward in the submature region and proceed direct to the surface. Mature region deep, 1.5 to 2 mm. from the submature region to the surface. A series of 5 or 6 cystiphragms is developed in the bend of the submature region. A close-set series of diaphragms extends from the immature region to the surface. Cystiphragms are frequently interpolated near the surface, where the diaphragms are variously curved. Rarely in the submature region an acanthopore about number 1 in size appears, but never reaches the surface.

This species is most closely related to *Homotrypa grandis* Basler, from the Lorraine of Tennessee, but differs in having only about a tenth as many acanthopores, and in wall structure. The specimen figured on Plate IX, Fig. 1c seems to be intermediate between these two species; the tangential section, however, is different (Plate X, 1c).

*Occurrence:* Common in the Mt. Hope-Fairmount in Cuts 2 and 4 on the Big Four Railroad, near Guilford, Ind.

#### HOMOTRYPA GLABRA n. sp.

Plate XI, Figs. 1-1d.

Zoarium small, ramose, 2 to 5 mm. in diameter and 2 or 3 cm. long. Surface smooth, with solid, stellate maculæ composed of mespores which have been completely filled with schlerenchyma. Zoëcia thick walled, their apertures oval.

In tangential sections the zoëcia are seen to be thick walled, the zoëcial apertures oval and largely filled with a secondary deposit of schlerenchyma, most of the thickening being on the upper side of the zoëcium. Zoëcial walls granular, much as in *Homotrypa cylindrica*, with a light streak of intermural tissue. Acanthopores rare, minute, number 0 in size, and indistinct. Mesopores absent. About 9 zoëcia in 2 mm.

Longitudinal sections show the zoëcia in the axial region to have thin, crinkled walls, and no diaphragms. Four or five cystiphragms appear in the submature region but there are none in the mature region. Occasionally a diaphragm or two is present in the mature region. Some of the zoëcia are without cystiphragms. The zoëcial walls are greatly thickened in the mature region, most of the thickening being on the upper side. The zoëcia emerge obliquely to the surface. Acanthopores are almost

wanting in longitudinal sections, but occasionally one of about  $\frac{1}{3}$  the size of number 1 is present in the submature region. These acanthopores do not appear to reach the surface.

This species is not sufficiently similar to any described species of *Homotrypa* to require comparison. The most nearly related form seems to be *Homotrypa crillis* Ulrich, from the lower third of the Trenton shales at Minneapolis, Minn.

*Occurrence*: Rare in the McMicken in Cut 2 on the Big Four Railroad, near Guilford, Ind.

#### HOMOTRYPA SPINEA n. sp.

Plate XII, Figs. 1-1c; Plate XIII, Figs. 1-1d.

Zoarium subramose to subfrondescent, about 5 mm. thick, 10 mm. wide and 4 to 6 cm. long. Surface ordinarily smooth, with stellate maculae of mesopores surrounded by zoecia larger than the average. Well-preserved surfaces show the projecting ends of the numerous large acanthopores; but in most of our specimens these are broken off. Zoecia polygonal, medium thick walled. Mesopores are usually absent except in the maculae.

In tangential sections the zoecia are subpolygonal to oval, with thick walls; 9 zoecia in 2 mm. Each zoecial aperture is surrounded by a dark ring of tissue, then a lighter ring and finally by a second dark ring. The median line between adjacent zoecia is dark in some places, but ordinarily there is a line of light-colored tissue between the second set of dark rings. Mesopores are practically absent except in the maculae. Deep sections, or sections from immature zoaria, show a considerable number of small mesopores. The acanthopores are rather large, from number 1 to 2 in size, 4 in 10 zoecia.

The zoecia in the axial region are without diaphragms, their walls thin and crinkled. A considerable number of large acanthopores appear in the axial region and proceed to the surface, bending with the zoecia, though sometimes they cut across the zoecia and maintain a straight course. The zoecia turn with an increasing curvature after they reach the immature region, and emerge at the surface almost at right angles. The walls become considerably thickened in the mature region. A close-set series of cystiphragms and diaphragms is developed from the immature region to the surface.

The internal characters of this species are quite constant. No associated species resembles it very closely in internal characters.

*Homotrypa flabellaris spinifera* Bassler resembles it zoariaally, but *H. spinica* is readily distinguished by the thicker walls, smaller acanthopores and the absence of diaphragms in the axial region.

*Occurrence:* Rather common in the Mt. Hope-Fairmount in Cuts. 2, 4, 5 and 7, on the Big Four Railroad, near Guilford, Ind.

MESOTRYPA ORBICULTATA n. sp.

Plate XIV, Figs. 1-1b.

Zoarium discoidal or hemispherical, 10 to 15 mm. in diameter and 2 to 5 mm. thick, with a concave base, growing parasitically upon brachiopod shells; there is no basal epitheca. The zoarium is made up of two or three superimposed layers or successive rejuvenations with thickening of the walls and maximum development of acanthopores, exactly as found in the genus *Stigmatella*. We do not attach even varietal significance to this feature, which is merely due to rejuvenation and is common to all genera of Trepostomata.

The surface is smooth, with the ordinary maculae of large zoecia and mesopores. The zoecia are subcircular, 7 in 2 mm. and separated from each other by angular mesopores. Conspicuous acanthopores occur between adjacent zoecia. They are regularly of size number 1, 20 in 10 zoecia. Several diaphragms are developed in the young part of each zoecium, some of them being curved, but are practically absent in the mature part of the zoecium. The mesopores are provided with a close-set series of diaphragms throughout their length.

This species most nearly resembles *Mesotrypa patella* (Ulrich), which is also found in the Richmond. It may, however, be distinguished by the larger acanthopores of *M. orbiculata*. *Mesotrypa* (?) *spinosa* Ulrich, from the Black River of Minnesota, is also a closely related form, but has many more cystiphragms and diaphragms, and no mesopores at the surface.

*Occurrence:* Common in the middle of the Arnheim, in Cut 10 on the Big Four Railroad, near Harmon's station, Ind.

NICHOLSONELLA PECULIARIS n. sp.

Plate XIII, Fig. 2; Plate XIV, Fig. 2, 2a.

Zoarium irregularly frondescant, 3 mm. thick, about 2 cm. wide and 4 cm. long. Surface smooth, having maculae which are slightly depressed, composed of 6 or 8 large zoecia separated from each other by large, irregular mesopores. Maculae 2 or 3 mm. in dia-

meter, about 10 in 1 sq. cm. The zoecia are circular, medium thick-walled, the angles between them occupied by mesopores.

Tangential sections present a pretty appearance. The zoecial apertures are nearly circular and surrounded by a cingulum of light-colored tissue; 8 or 9 zoecia in 2 mm. The true zoecial wall is an irregular, dark line, enclosing numerous, very minute acanthopores. These acanthopores are number 0 in size and rarely show the central canal; 8 or 10 surround a zoecium. Communication pores are occasionally present.

Irregular mesopores occupy the angles between the ordinary zoecia. The zoecia of the maculae have no cingula, consequently their apertures are larger than the average. They are more or less completely separated by large, extremely irregular mesopores. The mesopores are not hazy or indefinite, but clear-cut, as if they were merely spaces between the zoecia. The mesopores, rather than the zoecia, are strongly inflected by the acanthopores. The structure of the walls, as well as the arrangement of zoecia, mesopores and acanthopores, is the most irregular of any species we have seen.

The zoecia in the axial region are without diaphragms, their walls thin and wavy. They curve gradually till they reach the submature region, whence they proceed direct to the surface. One or two diaphragms are developed in the mature region. The mesopores have a chain-like appearance, very similar to those of *Stigmatella catenulata* n. sp.

This species, which has all the generic characters of *Nicholsonella*, bears a close resemblance to *Stigmatella*, and raises the question whether *Nicholsonella* should not be replaced in the family Heterotrypidae.

The irregular structure and arrangement of parts makes this species easy to recognize and to distinguish from other species of *Nicholsonella*.

*Occurrence:* Rare in the Arnheim, in Cut 11 on the Big Four Railroad, near Harmon's station, Ind.

#### PERONOPORELLA new genus.

Compressed, flabellate Monticuliporidae, having a much abbreviated axial region but no median lamina. Zoecia oval or petaloid, commonly indented by the abundant, rather large acanthopores, which give to the surface a hirsute appearance. Mesopores numerous, crossed by numerous diaphragms, sometimes

closed at the surface. No monticules, but inconspicuous maculae of larger zoëcia and mesopores are present.

This genus is distinguished from *Homotrypa* by its abundant mesopores, from *Peronopora* by the absence of a median lamina, and from *Atactoporella* by its frondescient form. *Peronoporella* is distinguished from *Homotrypella*, to which it is evidently most closely related, by the narrow axial region and the presence of cystiphragms all the way from the axial region to the surface. The longitudinal section is very similar to that of *Peronopora*, except that there is no median lamina, and there is a longer immature region in *Peronoporella*. The zoarium is also like that of *Peronopora*, with which it has probably been confused, but it can usually be distinguished by the less regular arrangement of zoëcia and mesopores and the conspicuous acanthopores of *Peronoporella*.

*Genotype: Peronoporella dubia* n. sp.

PERONOPORELLA DUBIA n. sp.

Plates XV, XVI and XVII.

Zoarium compressed, frondescient or laminar, 6 or 8 cm. long, 5 or 6 cm. broad and about 2 mm. thick. Surface smooth, no monticules, but about 9 inconspicuous maculae in 1 sq. cm. Maculae only slightly elevated above the general surface, composed of 5 or 6 zoëcia slightly larger than the average and separated by large, irregular mesopores. The maculae are about 2 mm. in diameter and 3 mm. apart.

The zoëcia at the surface are oval or irregularly petaloid, inflected by the numerous acanthopores, and usually separated more or less completely from each other by irregular mesopores. The conspicuous acanthopores give to the surface a granulose appearance. Sometimes the mesopores are closed at the surface, but in ordinary specimens and in weathered specimens they more or less completely surround the zoëcia. The zoëcial walls are thick at the surface.

Tangential sections near the surface show that the zoëcia are oval or irregularly petaloid in shape, thick-walled, about 8 in 2 mm. Mesopores are few on account of their being closed by the thickening of the zoëcial walls and the enlargement of the acanthopores. The zoëcial walls are amalgamated, having no distinct boundary; and the intermural deposit is light-colored, corresponding in position to the mesopores deeper down (Plate XV, Fig. 1 b.)

In the typical tangential section (Plate XV, Figs. 1, 1c) the zoëcia are oval, indented by the acanthopores, and separated from each other at the angles by numerous oval mesopores. The crescentic edges of one or more cystiphragms occupy each zoëcial aperture. The walls are of medium thickness, and consist of a dark ring next to the aperture, surrounded by lighter tissue. Occasionally there is a second, indistinct, interrupted dark line separating two zoëcia, but not comparable to the dark median line of the *Integrata*. Three or four acanthopores having a diameter of about one-fourth the zoëcial aperture, or a little larger than number 1, surround a zoëcium. In deeper sections they are slightly smaller and in shallower sections slightly larger than in ordinary sections. They have a central lucid canal surrounded by a very dark ring, which is in turn surrounded by successively lighter concentric rings. The outer limits of the acanthopores are not clearly defined, where they fade into the mural tissue. Deeper sections show thinner walls, more numerous and larger mesopores and somewhat smaller acanthopores (Plate XV, Fig. 1a). Communication pores, similar to those found in *Homotrypa* and many other genera, are occasionally present in tangential sections.

In longitudinal sections the immature region is seen to be about one-fifth as broad as the whole zoarium. The zoëcia are at first almost parallel to the surface, thin-walled and crossed by a few remote diaphragms. They gradually bend toward the surface till the submature region is reached, where they bend more abruptly outward and proceed in a straight line to the surface and emerge at right angles to the latter.

Numerous cystiphragms are developed in the immature region, on the upper or distal side of the zoëcia, and extend almost to the surface in an increasingly crowded series. They also become smaller as they approach the surface. There are a few diaphragms in the immature region of the zoëcia, but usually none in the mature region. The mesopores are provided with a close-set series of diaphragms from the immature region to the surface.

Acanthopores are numerous in the longitudinal section, of rather large size and with a clear central canal. They are ordinarily straight, beginning in the immature region and increasing slightly in size till they reach the surface. Sometimes, where they have been protected by an overgrowth, the acanthopores extend some distance (one or two zoëcial diameters) above the general level of the surface. In this case they consist only of the central canal and the thin dark tube immediately surrounding it. We have

observed this same feature in many other species, and it throws much light on the structure and function of acanthopores. Ordinarily this tenuous tube is broken off near the surface, and we do not see the complete acanthopore.

A remarkable feature of the acanthopores of *Peronoporella* is their occasional irregularity as seen in longitudinal sections. Very frequently, instead of proceeding in a straight line, they are bent in the shape of a hook, or in other unusual forms (Plate XVI, Fig. 1a). Then they appear to be rejuvenated and proceed toward the surface, sometimes showing several successive dislocations. Almost every longitudinal section shows these hooked acanthopores. They indicate that as the zoarium grew these tubes, which extended above the surface, were sometimes accidentally broken off or bent and were immediately rejuvenated. So far these peculiarly shaped acanthopores have not been detected in any genus except *Peronoporella*. We do not, however, at present, consider this feature as constituting a generic or even a specific character.

This species resembles species of *Peronopora* very closely, both in zoanial habit and in longitudinal sections, but the absence of any median lamina in over 50 longitudinal and cross-sections examined convinces us that it is not a *Peronopora*. Figures of *Peronopora vera* for comparison are given on Plate XVII, Figs. 2, 2a.

*Occurrence:* Common in the Bellevue in the Borrow Cut and abundant in the Arnheim in Cuts 10 and 11, on the Big Four Railroad near Harmon's station, Ind.

#### STIGMATELLA ALCICORNIS n. sp.

Plate XVIII, Figs. 1-1e.

Zoarium compressed, frondescant or subramose, about 2 mm. thick, 2 or 3 cm. high and about the same distance in width. Around the margin there are short, subramose branches, giving to the zoarium the appearance of the antlers of the moose. The surface is nearly smooth, having about 10 slightly raised maculae in 1 sq. cm. The maculae are composed of larger cells and a few mesopores. The zoecia at the surface are thin-walled and polygonal.

The zoecia, in tangential sections, are thin-walled, polygonal and separated in some places by an interrupted dark line; 7 or 8 zoecia in 2 mm. Acanthopores are very small, between num-

ber 0 and 1 in size, about 10 occurring in 10 zoecia. Mesopores are usually absent.

Longitudinal sections show that the zoecia have thin walls throughout, with very little thickening in the mature region. The zoecial walls are more or less crinkled. Diaphragms are absent, except a single one occasionally in the young part of the zoecium. The acanthopores are not conspicuous, but have a clear, sinuous canal; they are numerous in the periphery and rare in the axial region.

The only associated bryozoan with which this species might be confused is the very thin form of *Heterotrypa frondosa*, but the larger zoecia, thinner walls and absence of mesopores will distinguish *S. alcicornis*.

*Occurrence*: Rather common in the Fairmount, in the upper 15 feet of Cut 5 on the Big Four Railroad, near Guilford, Ind.

#### STIGMATELLA CATENULATA n. sp.

Plate XIX, Figs. 1-1c.

Zoarium robust, subramose, 1.5 to 2 cm. in diameter and 5 or 6 cm. long. Surface nearly smooth, with low, round monticules or large maculae, composed of mesopores and large zoecia. Zoecia subcircular, with medium thin walls. Mesopores are usually restricted to the clusters, but sometimes, on immature branches, there may be a small area in which mesopores are numerous.

Tangential sections show the zoecia to be subpolygonal and thin walled, with a light-colored internural line; 9 zoecia in 2 mm. Where there are mesopores the zoecia are smaller, but there is the same number in 2 mm., including mesopores. The acanthopores are small but conspicuous, about half the size of number 1, that is, 1/40 mm. in diameter, about 10 in 10 zoecia. They are situated at the angles of junction of the zoecia and never inflect the zoecial wall. Mesopores are usually few or absent in sections near the surface, but occasionally a section will show a region of numerous mesopores, especially if the section is deep or taken from an immature branch.

Diaphragms are absent in the axial region and there are only one or two in the mature region. The zoecial walls are only slightly thickened in the mature region, which is 2 or 3 mm. in depth. The chain-like mesopores are the noticeable feature of longitudinal sections. They begin in the submature region and ordinarily do not reach the surface. Where the diaphragms cross



the mesopores there is a constriction, giving to the mesopores the appearance of chains or strings of beads. The zoecial walls are nearly straight or only slightly flexuous.

This species is evidently most closely related to *Stigmatella interporosa* Ulrich and Bassler, which it resembles, but it may be distinguished from that species by its more robust habit of growth, thicker mature region and less numerous mesopores and greater development of chain-like mesopores.

*Occurrence:* Rather common in the Arnheim, in Cuts 10 and 11, on the Big Four Railroad near Harmon's station, Ind.

STIGMATELLA INCRUSTANS n. sp.

Plate XIX. Fig. 2; Plate XX. Figs. 1, 1a.

Zoarium incrusting foreign bodies, in the type specimen attached by an epitheca to a cast of *Orthoceras*; irregular in growth, 4 or 5 cm. long and 2 to 3 cm. wide, and from 1 to 5 mm. in thickness, and composed of several superimposed layers. The surface is strongly monticulated, 10 monticules in 1 sq. cm.

In tangential sections the zoecia are very thin-walled, polygonal, 8 in 2 mm. Mesopores are practically absent. Acanthopores are conspicuous, situated at the angles or in the walls between adjacent zoecia, sometimes strongly inflecting the zoecial walls; 10 acanthopores in 10 zoecia and in size ranging from number 0 to 1.

The zoecia are at first prone, but quickly assume an erect position and proceed in undulating curves to the surface. Diaphragms are almost absent, except in the successive mature regions, which makes the whole section appear to have numerous diaphragms.

This species differs from *Stigmatella nicklesi* Ulrich and Bassler, to which it seems to be most closely related, in zoarial habit, in possessing prominent conical monticules, and in having fewer acanthopores which vary considerably in size. It differs from *Stigmatella clavis* (Ulrich) in the same respects. This form also resembles *Cyphotrypa wilmingtonensis* Ulrich and Bassler, but there is no doubt of its being a *Stigmatella* as the latter genus is at present defined.

*Occurrence:* Rare in the lower Liberty, in Cut 17 on the Big Four Railroad, near Weisburg, Ind.

## STIGMATELLA SESSILIS n. sp.

Plate XIX, Fig. 3; Plate XX, Figs. 2-2b.

Zoarium discoidal, about 15 mm. in diameter and 3mm. thick in the center, growing parasitically upon foreign objects. There is no basal epitheca.

The zoecia, as shown by tangential sections, are polygonal, their apertures oval or circular, 10 zoecia in 2 mm. Surrounding the aperture is a ring of very light-colored schlerenchyma, which is in turn surrounded by a very thin dark ring. The median line is usually light in color, but is absent in some places, in which case the two dark rings constitute the median line. Mesopores are practically absent. Acanthopores are numerous, 10 in 10 zoecia, quite constant in size, about  $\frac{2}{3}$  the size of number 1, that is  $\frac{1}{30}$  mm. in diameter. The lumen is clear.

The zoecia at first are crossed by thin diaphragms, their own diameter or less apart. In this region there is also a considerable number of chain-like mesopores. In the remaining portion of the zoecia the diaphragms are twice their diameter apart. At several successive levels, 4 in the type specimen, the acanthopores and walls show the characters of maturity. At these levels there is one diaphragm, occasionally 2, in each tube, at the same height in adjacent zoecia. That these levels represent successive stages of maturity is proven by the specimen, for the growth is interrupted completely in one part of the zoarium at these four levels. This characteristic of rejuvenation and overgrowth is not confined to the genus *Stigmatella*. It is a common feature of a good many species of Trepostomata, and we consider it as an inadequate basis upon which to found a genus. We consider *Stigmatella* as a valid genus; but we rely chiefly upon the thin walls, small acanthopores, few diaphragms and the presence of mesopores for its recognition.

*Stigmatella sessilis* differs from *S. nicklesi* Ulrich and Bassler, which it closely resembles, in internal characters, in zoarial habit, and in having thicker walls and smaller acanthopores.

*Occurrence:* Rare in the Fairmount, in Cut 7, on the Big Four Railroad, near Manchester Station. Ind.