

THE STRATIGRAPHIC AND FAUNAL RELATIONS  
OF THE WALDRON FAUNA IN SOUTHERN  
INDIANA.

BY

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# The Stratigraphic and Faunal Relations of the Waldron Fauna in Southern Indiana.<sup>a</sup>

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## INTRODUCTION.

The rich Silurian fauna occurring at Waldron, Indiana, became known to paleontologists through Prof. James Hall<sup>c</sup> more than 40 years ago. The very complete collections which Hall had made and the excellent descriptions and illustrations which he published<sup>d</sup> left but little for later workers to add to our knowledge of the composition of the fauna at Waldron. Concerning the stratigraphic relations of this interesting fauna and its distribution beyond the original locality, Prof. Hall's valuable paper contributed nothing, however. The principal additions to our knowledge of the distribution of the fauna since Hall's work comprise various notes in the papers of Prof. Foerste<sup>e</sup> incidental to the discussion of other parts of the Silurian in Indiana and a list of the fauna at Tarr Hole by Prof. Cummings.<sup>f</sup> The latter paper confines itself to a single locality twelve miles south of the original locality of the Waldron fauna.

The writers have, while occupied in part with other problems, given considerable attention to the distribution of the Waldron shale and its fauna in southern Indiana during two field seasons. These observations have brought out most of the essential facts regarding the distribution and stratigraphic relations of this fauna in southern Indiana. The direct studies of the fauna have been supplemented by the field work of the senior author on the eastern side of the Cincinnati geanticline in Ohio and Kentucky.

<sup>a</sup>Published by permission of the Director of the U. S. Geological Survey.

<sup>b</sup>The collections on which the paper is based were made by both authors; the stratigraphic section is based upon the notes of the senior author.

<sup>c</sup>Notice of some new species of fossils from a locality of the Niagara group in Indiana with a list of identified species from the same place.—*Trans. Albany Inst.*, Vol. IV, 1862.

<sup>d</sup>The fauna of the Niagara group in central Indiana, 28th Ann. Rept. N. Y. State Mus., 1879, pp. 99-199, plates III-XXXIV.

<sup>e</sup>21st Ann. Rept. Ind. Dept. Geol. and Nat. Res. 1897, pp. 213-288; 22d Ann. Rept. Ind. Dept. Geol. and Nat. Res. 1898, pp. 195-255; 24th Ann. Rept. Ind. Dept. Geol. and Nat. Res. 1900, pp. 41-80.

<sup>f</sup>On the Waldron fauna at Tarr Hole, Indiana. *Proc. Ind. Acad. Sci.*, pp. 174-176, 1900.

It will be the purpose of this paper to indicate the stratigraphic relationship of the Waldron shale to the other subdivisions of the Silurian and to present the available data regarding the composition and distribution of its fauna. The relationship of the Waldron fauna to the faunas of the Laurel and the Louisville limestones which were respectively its predecessor and successor in this region will also be considered.

### STRATIGRAPHY.

The Silurian rocks of southern Indiana comprise three distinct limestone formations, which are separated by two shale horizons. The higher of the two argillaceous beds is called the Waldron shale and separates the Laurel limestone from the Louisville limestone, which is the highest division of the Silurian series in this area. The general relationship of the several formations of the Silurian in southern Indiana is expressed in the following table showing their order of superposition:

Silurian	{	Niagaran group	{	Louisville limestone. .
				Waldron shale.
				Laurel limestone.
				Osgood beds.
				Clinton limestone.

The so-called Clinton rests directly upon the Richmond formation, the uppermost beds of the Ordovician. The Guelph dolomite, which terminates the Niagaran group in New York, is absent in southern Indiana, the Devonian limestone resting unconformably on the Louisville limestone.

Dr. M. N. Elrod<sup>a</sup> first introduced the name Waldron shale for the beds from which Prof. James Hall<sup>b</sup> had previously described the rich fauna at Waldron.

The Waldron shale is composed mainly of fine textured blue to greenish clay shale. Thin bands of impure limestone and calcareous nodules sometimes occur in the shale but represent a comparatively insignificant proportion of the formation. The Waldron shale has a thickness ranging generally from four to ten feet. So far as observed by the writers the Waldron beds are conformable with the Niagara limestone beds above and below it. Elrod<sup>c</sup> reports that the shale is unconformable with the Laurel limestone at the Tarr

<sup>a</sup> Geology of Decatur County, 12th Ann. Rept. Ind. Dept. Geol. and Nat. Hist., 1882, pp. 109-111.

<sup>b</sup> 28th Rept. N. Y. State Mus., 1879, pp. 100-199, pls. 3-34.

<sup>c</sup> Niagara group unconformities in Indiana. Proc. Ind. Acad. Sci. 1901, p. 212.

Hole near Hartsville. The evidence which he presents, however, is not conclusive and may be equally well accounted for by local warping of the beds. Under the influence of a gentle westerly dip, averaging probably about 30' to the mile, the Waldron shale passes under the later formations to the westward. The westerly dip and slight thickness of the formation combined with the absence of very strong topographic relief confines the outcrop of the Waldron shale to a rather narrow north and south belt. Although a very thin formation the Waldron is very persistent and extends southward from southern Shelby and Rush counties to the Ohio River, a distance of about 85 miles. The Waldron shale is not known north of the central part of the State. The heavy mantle of drift to the north of its northernmost exposures in Rush and Shelby counties conceals a large area in which important stratigraphic changes take place, the precise nature of which is unknown. All that we know certainly about them is that they result in a Silurian section in the Wabash Valley in which neither the Waldron shale nor its two accompanying limestone formations have been identified. It may be that the Cincinnati geanticline which is believed to have been in existence during the Waldron shale interval, as pointed out elsewhere in this paper, swung to the westward across north central Indiana making distinct marine basins in northern and southern Indiana. Certain differences in the faunas as well as the stratigraphy of the Silurian of the northern and southern Indiana sections could be cited in support of this hypothesis.

From the Shelby county localities southward the Waldron shale can be seen in numerous sections. In the northern part of its area of outcrop the approximate position of the Waldron shale is indicated when it does not outcrop by the junction of the Louisville limestone lying above it and the Geneva limestone. The latter, which is the lowest division of the Devonian, is a chocolate or buff colored saccharoidal magnesian limestone presenting a marked contrast with the lighter colored Louisville limestone. These two formations as previously shown by one of the writers<sup>a</sup> and others<sup>b</sup> are unconformable.

The Louisville limestone decreases from a thickness of 50 feet or more at the Ohio River to less than ten in many places in the northern part of the Waldron shale area.

<sup>a</sup> Kindle. 25th Ann. Rept. Ind. Dept. Geol. and Nat. Res. 1901, p. 557, pl. 16.

<sup>b</sup> Foerste. 22d Ann. Rept. Ind. Dept. Geol. and Nat. Res., 1898, pp 233-234; Price, 24th Ann. Rept. Ind. Dept. Geol. and Nat. Res., 1900, pp. 99, 121; Elrod, Proc. Ind. Acad. Sci., 1901 (1902), p. 210.

The Waldron shale and its relations to the above named formations is well shown in the following section which occurs on the east bank of Flat Rock Creek  $1\frac{1}{2}$  miles above Geneva near the original locality of the Waldron fauna:

*Section on East Bank of Flat Rock Creek  $1\frac{1}{2}$  Miles Above Geneva.*

	Feet.
Chocolate colored dolomitic saccharoidal limestone (Geneva).....	3
Hard light gray limestone (Louisville).....	$5\frac{1}{2}$
Waldron clay with irregular masses of limestone.....	5
Hard gray limestone.....	$1\frac{1}{4}$

The Waldron shale outcrops in the vicinity of Hartsville along the three forks of Clifty Creek. It generally has a thickness of about four feet and is richly fossiliferous, particularly at the Tarr Hole, Anderson Falls and a small ravine  $\frac{3}{4}$  of a mile southwest of Hartsville. The overlying Louisville limestone is in places very thin in this vicinity, measuring less than 5 feet at some points.

At Harris City, which is 9 miles east of Hartsville, the Waldron shale and the Louisville limestone are both absent—the Devonian resting upon the Laurel limestone as shown by the following section of the rocks in the quarry at Harris City:

*Section in Quarry at Harris City.*

	Feet.
c. Buff magnesian limestone of saccharoidal texture (Geneva limestone) .....	3 to 4
b. Hard light gray crystalline limestone with numerous crinoid stems; small brachiopods not uncommon.....	5
a. Hard bluish gray limestone; fossils scarce except an occasional Cephalopod .....	15

The fossils collected from the 5 feet of limestone underlying the Geneva, b of the section, includes the following species:

*Pisocrinus gemmiformis*

*P. baccula*

*Stephanocrinus* n. sp.

*Camarotechia indianensis* var.

*Atrypa reticularis*

*Uncinulus stricklandi*

*Spirifer* cf. *radiatus*

*S. crista* var. *simplex*

*Coelospira* sp.

*Clorinda* sp.

*Dalmanites verrucosus*.

The genus *Pisocrinus* is unknown both in the Waldron and the Louisville limestone and the presence of the two species *P. gemmiformis* and *P. baccula* clearly indicates that this fauna represents the Laurel limestone. The Devonian limestone which follows unconformably the bed containing this fauna does not contain fossils at the Harris City quarry, but its lithologic peculiarities are so striking as to leave no doubt of its identity with the same beds elsewhere in which Devonian fossils are known to occur. The evidence seems therefore conclusive that the Waldron shale and the Louisville limestone are both absent from the Harris City section.

At Milroy, which is 13 miles north of Harris City, the Waldron shale according to Mr. Price<sup>a</sup>, is absent in the more northerly sections, the Devonian resting unconformably on the Laurel limestone as at Harris City. A more southerly exposure in the town of Milroy shows the shale to be present. It is probable that in the drift covered region to the north of Waldron the Devonian generally rests unconformably on the Laurel limestone, as at the locality just noted, and terminates the extension of the Waldron shale to the northward.

The Louisville limestone separating the Waldron shale from the Devonian thickens to the south until at Vernon, 16 miles south of Hartsville, it has about twice the thickness shown at the Hartsville localities. The outcrop at the old tunnel near Vernon shows the following section:

*Section at Old Tunnel Near Vernon, Ind.*

	Feet.
Massive dark chocolate colored magnesian limestone with saccharoidal texture (Geneva limestone).....	12
Hard, gray, heavy bedded limestone (Louisville limestone).....	10 to 11
Blue calcareous sandstone .....	3
Blue clay shale (Waldron).....	4 to 5
Hard, bluish, arenaceous limestone.....	2
Hard, gray, thin bedded limestone.....	10

The Waldron shale here contains a fauna almost if not quite as rich as the one at Waldron. Other richly fossiliferous localities occur to the south and southeast of Vernon along Big Creek, near Paris and Dupont. East of Dupont about two miles the Waldron shale reaches perhaps its maximum thickness—about 14 feet. At Hanover on the Ohio River, which is located south and east of the above-mentioned localities, the Waldron shale is much reduced in

<sup>a</sup> 24th Ann. Rept. Ind. Dept. Geol. and Nat. Res., 1900, p. 138.

thickness, while the Louisville limestone is greatly attenuated, if not entirely absent. The explanation of this fact is to be found in the greater comparative proximity of this locality to the broad crest of the Cincinnati geanticline, the limestone thinning in that direction as well as toward the north. The following section is exposed along the ravine crossing the village just west of the school house:

*Section at Hanover West of Schoolhouse.*

	Feet.
Light gray limestone with an abundance of Devonian fossils.....	3½
Dark buff saccharoidal magnesian limestone, massive or heavy bedded, usually rather soft (Geneva limestone).....	8
Bluish gray calcareous and argillaceous shale and covered (Waldron)	3
Thin bedded, hard, drab limestone.....	35
Bluish arenaceous magnesian, thin bedded, shaly limestone and shale.	6
Brownish buff limestone, weathering in thin layers (Clinton).....	2½

The above section shows the Laurel limestone and Osgood beds to have together a thickness of 41 feet at Hanover, while the Louisville limestone, if present, is represented by but a small fraction of the three feet which includes the Waldron shale horizon.

The only locality at Hanover where the Waldron shale is known to be both fossiliferous and so exposed as to permit its fossils to be separated from the shale by weathering is on the schoolhouse grounds. The fossils collected here are the following: *Mariacrinus carleyi* (Hall), *Eucalyptocrinus* sp., *Atrypa reticularis*, *Spirifer radiatus*, and *Dalmanites verrucosus*. This fauna, though small, represents a combination that might be expected anywhere in the Waldron shale, but is such as would not be found in the limestone above or below it. *Mariacrinus carleyi* is known only in the Waldron shale. The meager character of those found is no doubt due in part to the accessibility of the locality in the center of the village where its weathered fossils have long been collected.

The Fourteen Mile Creek drainage basin includes the southernmost outcrops of the Waldron shale. Northwest of New Washington, near the Sulphur Springs, the shale shows a thickness of about 6 feet, overlaid by 9 feet of the Louisville limestone. The southernmost appearance of the Waldron shale in Indiana is at Charleston Landing, on the Ohio, a short distance below the mouth of Fourteen Mile Creek, where Foerste reports<sup>a</sup> it to be 6 feet in thickness. In the lower Fourteen Mile Creek basin the Laurel limestone has considerably changed in composition and color, and become an argil-

<sup>a</sup> 21st Ann. Rept. Ind. Dept. Geol. and Nat. Res., 1897, p. 234.

laceous and shaley limestone, often brownish in color. The Louisville limestone shows its maximum thickness in this region. At the Utica lime quarry 30 feet of it are exposed without showing the total thickness. It probably has a total thickness of 50 feet or more at this point.

Two significant facts appear in connection with the distribution of the Waldron shale. Its outcrops occupy a narrow belt parallel to the axis of the Cincinnati geanticline. This belt is about 90 miles in length in Indiana and reappears again in west Tennessee<sup>a</sup> flanking the western slope of the southern extension of the same general uplift. Correlative with this considerable north and south extension amounting to about 280 miles, is the notable fact that the formation is entirely unknown in Ohio and Kentucky on the eastern side of the uplift. Professor Foerste<sup>b</sup> has shown that the Clinton is represented by a similar fauna and lithology on both sides of the geanticline and that the only evidence which we have of land masses at that time relates to one or more small islands in southeastern Indiana.

The evidence furnished by the distribution of the Clinton and its similarity in Ohio and Indiana, even to the salmon brown color, is opposed to the existence of any considerable land area in the region of the present Cincinnati geanticline during the deposition of the Clinton. The distribution of the Waldron shale, however, furnishes equally strong evidence of the existence of such a land mass separating the Silurian basin of southwestern Ohio and north-eastern Kentucky from that of southeastern Indiana and northern Kentucky during the latter part of the Niagaran epoch. The Ripley island and probably other undetermined small land masses were doubtless the early Silurian forerunners of the later and more extended uplift, of which the Waldron shale is believed to be an off shore deposit. In harmony with the evidence furnished by the absence of the Waldron shale in Ohio is the lithologic unlikeness of the upper Silurian section on the two sides of the Cincinnati geanticline.

The Ohio section contains no formations which can be considered identical with the Louisville limestone and the Waldron shale. On the Ohio side the Silurian limestones above the Clinton are almost invariably dolomites or highly magnesian limestones,

<sup>a</sup> Bull. Geol. Soc. of Am., Vol. 12, 1901, p. 407.

<sup>b</sup> The Ordovician-Silurian contact in the Ripley Island area of southern Indiana, with notes on the age of the Cincinnati geanticline. Am. Jour. of Sci., Vol. XVIII, 1904, pp. 321-342.



while in southeastern Indiana they are non-magnesian limestones or limestones with a very small percentage of magnesia. All of the available evidence appears to indicate that there was a succession of periods of gradual and areally progressive development of the Cincinnati geanticline from Clinton time to the close of the Louisville epoch. The last of these intervals of uplift terminated Silurian deposition in this area and extended the land conditions to the westward of most of the present outcrops of the Silurian in southern Indiana. The evidence of the last phase of the uplift is found in the unconformity which has been shown to exist between the Silurian and Devonian both in northern and southern Indiana." At Harris City the Geneva limestone, which is the basal Devonian formation, rests directly on the Laurel limestone; the Waldron shale and the Louisville limestone both being absent. Nine miles west of this point both the Louisville limestone and the Waldron shale are present, the latter having about its maximum faunal development. The absence of the two upper formations of the Silurian at Harris City is the result either of erosion during the interval represented by the Siluro-Devonian unconformity or of non-deposition resulting from a retreating shore line at the end of the Laurel limestone epoch. The extension of the latter formation 20 miles eastward of Harris City, without any known outliers of the Louisville limestone or Waldron shale, favors the latter hypothesis.

A map and report by Mr. J. A. Price<sup>b</sup> affords important evidence in this connection. Mr. Price's map attempts to show the eastern limit of the Waldron shale across Decatur County, a north-south distance of about 30 miles. The field work was evidently done with considerable care, but the line which purports to be the eastern limit of the Waldron shale marks in reality the parting between the Geneva limestone (Devonian) and the Laurel limestone (Silurian). The map, which shows all of the Waldron shale outcrops observed by Mr. Price, indicates that these are to be seen frequently three to ten miles west of his assumed eastern limit of the shale, but not a single outcrop is shown on or near the line supposed to represent its eastern border. It appears clear from the report<sup>c</sup> that wherever the uppermost Silurian beds were observed near this line they represent the Laurel limestone and are followed directly by

<sup>a</sup> Kindie, E. M. The Devonian fossils and stratigraphy of Indiana. 25th Ann. Rept. Dept. Geol. and Nat. Res. of Ind., 1901, pp. 557, 562, 566, pl. 16.

<sup>b</sup> "A report upon the Waldron shale and its horizon." 24th Ann. Rept. Ind. Dept. Geol. and Nat. Res., 1900, pp. 81-143.

<sup>c</sup> Ibid., pp. 85-92.

the Devonian. Mr. Price evidently held this opinion with reference to the immediate vicinity of Greensburg, since he states:<sup>a</sup> "The Waldron shale is absent and was probably never deposited in this locality." The important fact for our present purpose, which this map shows, is that for a distance of about 30 miles along its eastern border the Waldron shale and the Louisville limestone are overlapped by the Devonian limestone. It appears highly improbable that erosion during the Devono-Silurian unconformity intervals would have completely removed both formations to the east of the Devono-Silurian parting and left them both with rather slight evidences of erosion a short distance to the west of that boundary.

#### COMPOSITION AND DISTRIBUTION OF THE WALDRON FAUNA.

The luxuriant fauna which characterizes the Waldron shale at Waldron retains a considerable number of the 160 odd species known at Waldron for fifty miles south of this place. Paris Crossing and Dupont are the most southerly localities at which the fauna retains its characteristic richness in the number of species and individuals. South of the Big Creek locality, near Dupont, the fauna is still represented, but in a depauperate condition. At Hanover, on the Ohio River, less than half a dozen species have been found to represent the rich fauna at Hartsville and Waldron. At many localities near the Ohio, it appears to be almost if not quite barren of fossils. While all the outcrops of the Waldron within 25 miles of the Ohio are but very slightly fossiliferous it should be observed that numerous nearly barren outcrops occur also in the same general region as the richly fossiliferous exposures. These semi-barren localities so far as noted seem to lie to the east of the highly fossiliferous ones. It may be that the faunal poverty of these outcrops, together with those near the Ohio River, is due to the fact that they represent an in-shore zone lying slightly to the east of the belt most favorable to the growth of a luxuriant fauna. Shallower water, a slightly different temperature, or difference in salinity may have made the extreme in-shore zone unfavorable to the rich fauna living just outside it. That all of the Waldron outcrops near the Ohio would belong to this more easterly belt follows from the fact that the greater westerly dip near the river reduces the width of the outcropping belt of the Silurian rocks from 30 miles or more near Waldron to 10 miles or less from Jef-

<sup>a</sup> Ibid., 3, p. 89.

ferson County southward. If we may judge from the rich fauna which characterizes the Waldron shale in western Tennessee,<sup>a</sup> the sparse fauna of the shale in the southern part of Indiana is not connected with any conditions unfavorable to life which were associated with the southern part of the Waldron shale basin of deposition. It seems probable that the Waldron shale a few miles to the west of its outcrops in Clark and southern Jefferson counties contains a fauna similar in richness to the Waldron localities. The distribution of the Waldron fauna, as we know it from the outcrops of the Waldron formation, is shown in the following list. The names of the several localities are arranged from left to right in the same order as their relative geographic position from north to south. Hartsville lies 12, Vernon 30, Dupont 38, Paris Crossing 42, and Hanover 50 miles south or southeast of Waldron.

LIST OF THE WALDRON FAUNA IN SOUTHERN INDIANA.<sup>b</sup>

	Waldron.	Hartsville.	Vernon.	Dupont. <sup>c</sup>	Paris. <sup>d</sup>	Hanover.
PLANTAE.						
<i>Buthotrephis gracilis</i> var. <i>crassa</i> , Hall.....	×					
SPONGIAE.						
<i>Receptaculites subtrubatus</i> Hall.....	×					
<i>Receptaculites sacculus</i> Hall.....	×					
<i>Astylospongia praemorsa</i> Goldf.....	×	×				
<i>Astylospongia praemorsa</i> var. <i>nuxmoschata</i> , Hall.....	×					
<i>Astylospongia imbricato-articulate</i> F. Roem.....	×					
<i>Astylospongia</i> ( <i>Palaeomanon</i> ) <i>bursa</i> Hall.....	×					
HYDROZOA.						
<i>Chaunograptus novellus</i> (Hall).....	×					
<i>Inocaulis divaricata</i> Hall.....	×					
ANTHOZOA.						
<i>Streptelasma radicans</i> Hall.....	×			×		
<i>Duncanella borealis</i> Nicholson.....	×	×		×		
<i>Zaphrentis celator</i> Hall.....	×	×				
<i>Aulopora praecus</i> Hall.....	×					
<i>Favosites spinigerus</i> Hall.....	×			×		
<i>Favosites forbesi</i> , var. <i>occidentalis</i> , Hall.....	×	×				
<i>Cladopora sarmentosa</i> Hall.....	×					

<sup>a</sup> Foerste, Aug. F. "Silurian and Devonian limestones of western Tennessee." Jour. of Geol., Vol. XI. 1903, p. 707.

<sup>b</sup> This list includes all of the species recorded by Hall from Waldron and by Cummings from Hartsville. The 12 species added to Cummings' list of the fauna at Tarr Hole are mainly from two localities near Hartsville not represented in the Cummings collection, viz.: Clifty Falls and a ravine southwest of Hartsville,  $\frac{1}{2}$  of a mile.

<sup>c</sup> The fossils from Dupont are given on the authority of Foerste, 21st. Ann. Rept. Ind. Geol. Surv. p. 257.

<sup>d</sup> A very small collection was made at Paris and the few species here listed from this locality are not representative of the richness of the fauna.

## WALDRON FAUNA—Continued.

	Waldron.	Hartsville.	Vernon.	Dupont.	Paris.	Hanover.
BRYOZOA. <sup>1</sup>						
<i>Berenicea elegans</i> (Hall).....	×	×				
<i>Ceramopora</i> ? <i>confuens</i> Hall.....	×	×				
<i>Ceramopora</i> ? <i>rariopora</i> Hall.....	×					
<i>Ceramopora</i> ? <i>nothus</i> Hall.....	×					
<i>Ceramopora</i> ? <i>explanata</i> Hall.....	×					
<i>Chilotrypa varia</i> (Hall).....	×	×				
<i>Chilotrypa varia</i> (Hall).....	×	×				
<i>Fistulipora halli</i> Rominger.....	×	×				
<i>Fistulipora neglecta</i> Rominger.....	×	×	×			
<i>Fistulipora neglecta-maculata</i> (Hall).....	×	×				
<i>Monotrypella</i> ? <i>consimilis</i> (Hall).....	×	×				
<i>Leptotrypa</i> ? <i>sphaerion</i> (Hall).....	×	×				
<i>Lioclema</i> ? <i>exsul</i> (Hall).....	×	×				
<i>Eridotrypa echinata</i> (Hall).....	×	×				
<i>Batostomella granulifera</i> (Hall).....	×	×				
<i>Trematopora</i> ? <i>spiculata</i> Miller.....	×	×				
<i>Trematopora</i> (Chaetetes) <i>crebripora</i> Hall.....	×	×				
<i>Trematopora</i> ? <i>singularis</i> (Hall).....	×	×				
<i>Callopora elegantula</i> Hall.....	×	×		×		
<i>Callopora</i> ? <i>cervicornis</i> Hall.....	×	×				
<i>Callopora</i> ? <i>diversa</i> Hall.....	×	×				
<i>Drymotrypa niagarensis</i> (Hall).....	×	×				
<i>Loculipora ambiguus</i> (Hall).....	×	×				
<i>Semicoecinium acmeum</i> (Hall).....	×	×				
<i>Polypora punctostriata</i> (Hall).....	×	×				
<i>Fenestella pertenuis</i> Hall.....	×	×				
<i>Fenestella bellistriata</i> Hall.....	×	×				
<i>Fenestella proluxa</i> Hall.....	×	×				
<i>Fenestella parvulipora</i> Hall.....	×	×				
<i>Polypora conferta</i> (Hall).....	×	×				
<i>Polypora tentulas</i> (Hall).....	×	×				
<i>Nematopora macropora</i> (Hall).....	×	×				
<i>Nematopora minuta</i> (Hall).....	×	×				
<i>Ptilodictya angusta</i> (Hall).....	×	×				
<i>Stictotrypa orbipora</i> (Hall).....	×	×				
<i>Stictotrypa similis</i> Hall.....	×	×				
<i>Diamesopora osculum</i> (Hall).....	×	×				
<i>Diamesopora infrequens</i> (Hall).....	×	×				
<i>Diamesopora subimbricata</i> (Hall).....	×	×				
<i>Faleschara</i> ? <i>offula</i> Hall.....	×	×				
<i>Faleschara maculata</i> Hall.....	×	×				
<i>Faleschara</i> ? <i>incrassata</i> Hall.....	×	×				
PELMATOZOA.						
<i>Periechocrinus whitfieldi</i> (Hall).....	×	×	×			
<i>Platyerinus siluricus</i> Hall.....	×	×				
<i>Macrostylocrinus striatus</i> Hall.....	×	×				
<i>Macrostylocrinus granulosus</i> (Hall).....	×	×				
<i>Macrostylocrinus fasciatus</i> Hall.....	×	×				
<i>Mariacrinus carleyi</i> (Hall).....	×	×				×
<i>Acacocrinus elrodi</i> W. & Sp.....	×	×				
<i>Thysanocrinus occidentalis</i> , (Hall).....	×	×				
<i>Thysanocrinus occidentalis</i> , var. <i>erebescens</i> , (Hall).....	×	×				
<i>Thysanocrinus inornatus</i> , (Hall).....	×	×				
<i>Botryoerinus polyxo</i> , (Hall).....	×	×				
<i>Botryoerinus nucleus</i> , Hall.....	×	×				
<i>Botryoerinus</i> (Poterioerinus) <i>aemulus</i> , (Hall).....	×	×				
<i>Poterioerinus</i> ? <i>calyx</i> , Hall.....	×	×				
<i>Lecanocrinus pusillus</i> , Hall.....	×	×	×	×		
<i>Ichthyocrinus subangularis</i> , Hall.....	×	×				
<i>Melocrinus oboeonicus</i> , Hall.....	×	×				
<i>Lyriocrinus melissa</i> , Hall.....	×	×				
<i>Dendroerinus ancilla</i> , Hall.....	×	×				
<i>Eucalyptocrinus</i> sp.....	×	×				×
<i>Eucalyptocrinus crassus</i> .....	×	×	×	×		
<i>Eucalyptocrinus ventricosus</i> W. & Sp.....	×	×	×			
<i>Eucalyptocrinus ovalis</i> , (Troost) Hall.....	×	×				
<i>Eucalyptocrinus tuberculatus</i> Miller & Dyer.....	×	×				

<sup>1</sup>The Bryozoa in this list are with but few exceptions quoted on the authority of Hall and Cummings. Their absence from the last four columns indicates only that they were not studied from these localities.

## WALDRON FAUNA—Continued.

	Waldron.	Hartsville.	Vernon.	Dupont.	Paris.	Hanover.
PELMATOZOA—Continued.						
Ampheristocrinus typus, Hall.	×					
Stephanocrinus gemmiformis, Hall.	×					
Codaster (Stephanocrinus ?) pulchellus, Miller & Dyer.	×	×				
Codaster pentalobus Hall.	×					
Calceocrinus stigmatus Hall.	×					
BRACHIOPODA.						
Lingula gibbosa Hall.	×					
Pholidops ovalis Hall.	×	×				
Crania siluriana Hall.						
Crania setifera Hall.		×				
Crania spinigera Hall.		×				
Dictyonella reticulata Hall.		×				
Leptaena rhomboidalis (Wilckens).	×	×		×		
Plectambonites sp.				×		
Stropheodonta profunda Hall.	×		×			
Strophonella striata Hall.	×	×				
Strophonella semifasciata Hall.	×					
Schuchertella tenuis Hall.		×				
Schuchertella subplanus (Conrad).	×	×	×	×		
Mimulus waldronensis (Miller & Dyer).	×					
Chonetes novascotius Hall.	×	×	×			
Chonetes undulatus Hall.	×	×				
Rhipidomella hybrida (Sowerby).	×	×	×	×		
Dalmanella elegantula (Dalman).	×	×	×	×		
Orthis (?) subnodosa Hall.	×					
Bilobites bilobus (Linnaeus).	×					
Anastrophia internascens Hall.		×	×	×		
Clorinda fornicata (Hall).		×				
Rhynchotrete cuneata var. americana Hall.	×	×	×			
Uncinulus stricklandi (Sowerby).	×					×
Camarotoechia (?) neglecta Hall.	×			×		
Camarotoechia (?) acinus Hall.	×			×		
Camarotoechia (?) indianensis (Hall).	×			×		
Camarotoechia whitei Hall.	×			×		
Zygospira (?) minima Hall.	×					
Atrypina disparilis (Hall).		×				
Atrypa reticularis (Linnaeus).		×	×	×	×	×
Spirifer eudora Hall.			×			
Spirifer crispus (Hisinger).			×	×		
Spirifer crispus var. simplex, Hall.			×	×		
Spirifer radiatus Sowerby.			×			×
Spirifer cf. niagarensis (Hall).				×		
Reticularia bicostata petila (Hall).	×	×				
Meristina maria Hall.			×			
Whitfieldella nitida Hall.			×	×		
Meristina rectirostris Hall.						
Nucleospira pisiformis Hall.	×	×				
Homoeospira evax Hall.			×			
Homoeospira sobrina (Beecher & Clarke).	×	×	×			
LAMELLIBRANCHIATA.						
Amphieoelia leidy Hall.	×					
Ambonychia acutirostra Hall.	×					
Modiolopsis perlatus Hall.		×				
Modiolopsis subalatus Hall.						
Mytilarca sigilla, Hall.		×				
Pterinea brisa, Hall.						
Goniophora speciosa, Hall.	×					
Cypricardina arata, Hall.	×	×				
GASTEROPODA.						
Platystoma niagarensis, Hall.	×	×		×		
Platystoma plebeium, Hall.	×					
Strophostylus cyclostomus, Hall.	×	×	×			
Strophostylus cyclostomus, var. disjunctus, Hall.	×					
Lixonea ——— ?	×					
Bellerophon tuber, Hall.	×					
Cyrtolites sinuosus, Hall.	×					

## WALDRON FAUNA—Continued.

	Waldron.	Hartsville.	Vernon.	Dupont.	Paris.	Hanover.
CONULARIA.						
<i>Conularia infrequens</i> , Hall.	×					
<i>Coleolus spinulus</i> , Hall.	×					
<i>Enehostoma</i> n. sp.			×			
CEPHALOPODA.						
<i>Orthoceras simulator</i> , Hall.	×					
<i>Orthoceras medullare</i> , Hall.	×					
<i>Orthoceras subeancellatum</i> , Hall.	×					
<i>Orthoceras undulatum</i> , His.	×					
<i>Orthoceras amyus</i> , Hall.	×					
<i>Nautilus oceanus</i> , Hall.	×					
<i>Gyroceras abruptum</i> , Hall.	×					
<i>Trochoceras waldronense</i> , Hall.	×					
ANNELIDA.						
<i>Spirorbis inornatus</i> , Hall.	×					
<i>Cornulites proprius</i> , Hall.	×	×	×	×		
CRUSTACEA						
<i>Leperditia faba</i> , Hall.	×	×				
<i>Beyrichia granulosa</i> , Hall.	×					
<i>Beyrichia</i> sp.			×			
<i>Calymene niagarensis</i> , Hall.	×	×				
<i>Homalonotus delphinocephalus</i> , Green.	×					
<i>Cyphaspis chrystyi</i> , Hall.	×	×				
<i>Acidaspis fimbriata</i> , Hall.	×					
<i>Illaenus armatus</i> , Hall.	×					
<i>Illaenus (Bumastus) toxus</i> , Hall.	×					
<i>Ceraurus niagarensis</i> , Hall.	×					
<i>Dalmanites vigilans</i> , Hall.	×					
<i>Dalmanites verrucosus</i> , Hall.	×	×				×
<i>Dalmanites bicornis</i> , Hall.	×					
<i>Lichas breviceps</i> , Hall.	×	×				
<i>Lichas boltoni</i> , var. <i>occidentalis</i> , Hall.	×	×				

## RELATION OF THE WALDRON TO PRECEDING AND SUCCEEDING FAUNAS.

The amount and kind of difference which distinguishes the Waldron fauna from that of the Laurel limestone which was its immediate predecessor in this region is a matter of much importance in connection with any adequate interpretation of the history of the fauna. Comparison of the Waldron fauna with the fauna which preceded it is necessary in order to ascertain what elements if any are of foreign and what of indigenous origin. For the purpose of such comparison a list of the fauna of the Laurel limestone which preceded the Waldron is introduced here. In order to make the list as complete as possible all of the species which have been recorded from this fauna are included in it.

FAUNA OF THE LAUREL LIMESTONE.<sup>1</sup>

Unless otherwise stated, the fossils are from St. Paul.

*Anthozoa.*

*Amplexus cinctutus* Miller.  
*Favosites spongilla* Rominger.  
*Streptelasma spongiaxis* Rominger.  
*Striatopora gorbyi* Miller.  
*Plasmopora follis* Milne-Edwards.  
*Plasmopora scita* Milne-Edwards.

*Pelmatozoa.*

*Aethocystites sculptus* Miller.  
*Allocrinus benedicti* Miller.  
*Calceocrinus indianensis* Miller.  
*Callierinus beachleri* Wachsmuth and Springer.  
*Caryocrinus ellipticus* Miller and Gurley.  
*Cyclicocrinus canaliculatus* Miller.  
*Callierinus corrugatus* Weller<sup>a</sup>.  
*Cyclicocrinus* ? *indianensis* Miller and Gurley.  
*Emperocrinus indianensis* Miller and Gurley.  
*Holocystites pustulosus* Miller, a few miles from Waldron.  
*Hyptiocrinus typus* Wachsmuth and Springer.  
*Idiocrinus elongatus* Wachsmuth and Springer.  
*Idiocrinus ventricosus* Wachsmuth and Springer.  
*Indianocrinus punctatus* Miller and Gurley.  
*Macrostylocrinus indianensis* Miller and Gurley.  
*Mariaocrinus aureatus* Miller.  
*Mariaocrinus granulosus* Miller.  
*Melocrinus equalis* Miller.  
*Melocrinus oblongus* Wachsmuth and Springer.  
*Melocrinus parvus* Wachsmuth and Springer.  
*Pisocrinus baccula* Miller and Gurley<sup>a</sup>. H. and St. Paul.  
*Pisocrinus globosus* Ringueberg.  
*Pisocrinus gemmiformis* Miller<sup>a</sup>. H.  
*Periechocrinus* ? *ornatus*.  
*Periechocrinus howardi* Miller.

<sup>1</sup> Species marked with an *a* are included upon the evidence of specimens collected and determined by the senior author. Other species are included on the authority of S. A. Miller (18th Ann. Rept. Ind. Geol. Surv.); Wachsmuth and Springer (Mem. Mus. Comp. Zool. Harvard Coll., vols. XX-XXI, pp. 1-837, pls. 1-83, 1897) and Foerste (Am. Jour. Sci., Vol. XVIII, 1904, pp. 341-342).

*Saccocrinus umbrosus* Miller and Gurley.  
*Stribalocystites gorbii* Miller.  
*Stribalocystites tumidus* Miller.  
*Stribalocystites spheroidalis* Miller and Gurley.  
*Zophocrinus howardi* Miller.

*Brachiopoda.*

*Stropheodonta* cf. *striata*<sup>a</sup>.  
*Schuchertella* cf. *subplana*<sup>a</sup>. O.  
*Dalmanella elegantula*<sup>a</sup> Dalman. O.  
*Platystrophia dentata* (Pander)<sup>a</sup>. O. H.  
*Anastrophia internascens*<sup>a</sup> Hall. G.  
*Clorinda* sp.<sup>a</sup> H.  
*Camarotoechia indianensis* Hall var.<sup>a</sup> H.  
*Uncinulus stricklandi* (Sow.)<sup>a</sup>. H.  
*Atrypa reticularis*<sup>a</sup> Linn. H.  
*Atrypa nodostriata* Hall<sup>a</sup>. G.  
*Spirifer radiatus* Sowerby. Madison and Harris City.  
*Spirifer crista* var. *simplex*<sup>a</sup>. H.  
*Coelospira* sp.<sup>a</sup> H.

*Cephalopoda.*

*Cyrtoceras howardi* Miller.  
*Cyrtoceras indianense* Miller.  
*Orthoceras undulatum* His.<sup>a</sup>  
*Orthoceras imbricatum*.  
*Orthoceras subcancellatum* Hall.  
*Orthoceras crebescens* Hall<sup>a</sup>. Hartsville.  
*Cyrtoceras elrodi* White.

*Crustacea.*

*Lichas byrnesanus* Miller and Gurley. From neighborhood of Madison.  
*Lichas hanoverensis* Miller and Gurley. Hanover.  
*Calymena niagarensis* Hall. Hanover.<sup>a</sup>  
*Dalmanites verrucosus* Hall. H.<sup>a</sup>

Exceptional conditions of preservation have made possible a very complete knowledge of the Waldron shale fauna. The much less perfect conditions of fossilization and collecting, conditioning

Note.—The capital letters after the name of the species indicate the following localities: H = Harris City; G = Greensburg; O = Osgood.



the study of a limestone fauna as well as the comparatively limited amount of study outside the *Pelmatozoa* which it has received, make the fauna of the Laurel limestone, as here listed, less complete and representative of the formation than that of the Waldron shale. Too little is known of the *Anthozoa* of the Laurel limestone to make profitable the comparison of the representatives of that group in the two faunas. The entire absence from this list of the *Bryozoa* and their abundance in the Waldron fauna is without significance except as indicating that the conditions of preservation are incomparably better in the Waldron shale than in the Laurel limestone, and that no attempt has been made to study the material which is preserved in the limestone.

In the case of the *Pelmatozoa*, however, the faunas are probably equally well known and consequently invite comparison. The crinoids described from St. Paul were obtained largely by local collectors, who secured very complete collections of these fossils, so that it is safe to assume that this part of the Laurel limestone fauna is known with a fair degree of completeness. Comparison of the representatives of the groups in the two faunas shows 26 species in the Waldron and 28 in the Laurel limestone fauna. Not a single one of these, however, is common to the two faunas. A complete change in the crinoidal life of the time seems to have been introduced in this province with the initiation of Waldron shale sedimentation. This element of the Waldron fauna evidently came into this region from some outside area at the close of the Laurel limestone interval. It does not appear to have been present in the region at any earlier period in the Silurian and cannot be considered in any degree a recurrent element of the fauna. If it had been present at all during any earlier period in this region the *Pelmatozoa* of the Waldron fauna might be expected to appear in the Osgood beds, which represent sedimentary conditions very similar to those which produced the Waldron shale. Comparison of the listed *Pelmatozoa*<sup>1</sup> of this fauna, which numbers 56 species, shows, however, that none of the Waldron species are present in it.

Comparison of the *Brachiopoda* of the Waldron and Laurel limestone faunas shows a marked contrast with the results noted for the *Pelmatozoa*. A comparatively small number of brachiopods is known from the Laurel limestone, altogether, but of these all but three occur in the Waldron fauna. One of the three is *Platystrophia dentata*; the other two have not been determined specifically. Of the *Brachiopoda* in the two faunas the comparison

<sup>1</sup> Am. Jour. Sci., Vol. XVIII, 1904, p. 341.

shows that 76 per cent. of the Laurel brachiopods are present in the Waldron.

The list affords no information regarding the groups *Pelecypoda*, *Gasteropoda*, and *Conularia*, each of which will probably eventually be found to be represented in the Laurel fauna.

In the *Cephalopod* group the Waldron and Laurel faunas are represented by about equal numbers of species according to the lists, the former having 8 and the latter 6 species. Two are common to the two faunas; thus showing a percentage of 33 1-3, which survived the Waldron shale conditions of sedimentation.

The *Crustacea* at present known in the Laurel fauna numbers but four species. Two of these or 50 per cent are present in the Waldron fauna.

These comparisons show that while the Waldron fauna is rather closely allied to its predecessor through the *Brachiopoda* and the *Cephalopoda*, it introduced in the *Pelmatozoa* a faunal element entirely new to the region.

Very few fossils have ever been found in the Louisville limestone in the region where the Waldron fauna is best developed. But at Louisville the formation contains an abundant fauna, which has been made known through the work of Nettleroth, Hall and others. In order to compare the Waldron fauna with its successor, the Louisville fauna, and to note the general effect on the composition of the fauna of a change from shale to limestone conditions of sedimentation, a list of the latter, which follows, has been compiled:

#### FAUNA OF THE LOUISVILLE LIMESTONE AT LOUISVILLE.<sup>a</sup>

##### *Spongia.*

*Cyathospongia excrescens* H. & W.

##### *Hydrozoa.*

*Dictyonema pergracilis* H. & W. (H. & W.)

##### *Anthozoa.*

*Heliolites megastoma* McCoy. (Davis.)<sup>b</sup>

*Heliolites interstinctus* Linnaeus. (Davis.)

*Heliolites pyriformis* Guettard. (Davis.)

<sup>a</sup> This list is compiled mainly from the papers of Hall (24th and 25th Ann. Repts. N. Y. State Mus. Nat. Hist.) ; Nettleroth (Ky. Fossil Shells, Ky. Geol. Surv.), and Davis (Ky. Fossil Corals, Ky. Geol. Surv.).

<sup>b</sup> The authority for each species is given in parenthesis after it.

- Heliolites subtubulatus* McCoy. (Davis.)  
*Plasmopora follis* Edwards and Haime. (Davis.)  
*Plasmopora elegans* Whiteaves. (Davis.)  
*Lyellia glabra* Owen. (Davis.)  
*Lyellia papillate* Rominger. (Davis.)  
*Lyellia americana* Edwards and Haime. (Davis.)  
*Coenites laminata* Hall. (Davis.)  
*Coenites crassa* Rominger. (Davis.)  
*Favosites favosus* Goldfuss. (Davis.)  
*Favosites niagarensis* Hall. (Davis.)  
*Favosites forbesi* Edwards and Haime. (Davis.)  
*Favosites spongilla* Rominger. (Davis.)  
*Favosites cristatus* Edwards and Haime. (Davis.)  
*Favosites venustus* Hall. (Davis.)  
*Thecia major* Rominger. Davis.)  
*Thecia minor* Rominger. (Davis.)  
*Thecia swindernana* Goldfuss. (Davis.)  
*Coenites verticillata*. (Davis.)  
*Alveolites niagarensis* Nicholson. (Davis.)  
*Cladopora reticulata* Hall. (Davis.)  
*Cladopora laqueata* Rominger. (Davis.)  
*Striatopora huronensis* Rominger. (Davis.)  
*Halysites catenulatus* Linnaeus. (Davis.)  
*Aulopora precius* Hall. (Davis.)  
*Hallia scitula* Hall. (H.)  
*Hallia devisa* Hall. (H.)  
*Omphyma verrucosa* Rafinesque and Clifford. (Davis.)  
*Anisophyllum mulargum* Hall. (H.)  
*Anisophyllum trifurcatum* Hall. (H.)  
*Anisophyllum ? bilamelatum* Hall. (H.)  
*Ptychophyllum stokesi* Edwards and Haime. (Davis.)  
*Ptychophyllum fulcratum* Hall. (H.)  
*Diphyphyllum huronicum* Rominger. (Davis.)  
*Diphyphyllum rugosum* Edwards and Haime. (Davis.)  
*Strombodes pentagonus* Goldfuss. (Davis.)  
*Strombodes striatus* D'Orbigny. (Davis.)  
*Heliophyllum gemmiferum* Hall. (H. & W.)  
*Heliophyllum parvum* Hall. (H. & W.)  
*Heliophyllum dentilineatum* Hall. (H. & W.)  
*Heliophyllum mitellum* Hall. (H. & W.)  
*Heliophyllum puteatum* Hall. (Hall.)  
*Cyathophyllum intertrium* Hall. (H.)

*Cyathophyllum bullulatum* Hall. (H.)  
*Cyathophyllum granilinum* Hall. (H.)  
*Cyathoxonia herzeri* Hall. (H.)  
*Strombodes pygmaeus* Rominger. (Davis.)  
*Strombodes mamillaris* Owen. (Davis.)  
*Cystiphyllum niagarensis* Hall. (Davis.)  
*Zaphrentis spongiaxis*. (Davis.)  
*Zaphrentis radicans*. (Davis.)  
*Amplexus shumardi* Edwards and Haime. (Davis.)  
*Zaphrentis patula*. (Davis.)  
*Zaphrentis conulus*. (Davis.)  
*Calceola pusilla* Hall. (H.)  
*Chonophyllum vadum* Hall. (H.)  
*Chomophyllum capax* Hall. (H.)

*Pelmatozoa.*

*Macrostylocrinus meekii* Lyon. (H. & W.)  
*Periechoerinus infelix* Winch and Marc (*Saccoerinus christii* Hall). (H. & W.)  
*Eucalyptocrinus elrodi* Miller (*Eucalyptocrinus coelatus* Hall). (H. & W.)  
*Eucalyptocrinus crassus* Hall. (H. & W.)  
*Melocrinus obconicus* Troost. (Hall.) (H. & N.)  
*Haplocrinus maximus* Troost. (H. & W.)  
*Caryocrinus ornatus* Say. (H. & W.)  
*Pentremites reinwardtii* Troost. (H. & W.)

*Brachiopoda.*

*Stropheodonta profunda* Hall. (Nettleroth.)  
*Strophonella striata* Hall. (Nettleroth.)  
*Leptaena rhomboidalis* Wilckens. (Nettleroth.)  
*Schuchertella tenuis* Hall. (Nettleroth.)  
*Schuchertella subplanus* Conrad. (Nettleroth.)  
*Orthis flabellites* Foerste. (Nettleroth.)  
*Orthis* (?) *nisis* Hall and Whitfield. (Nettleroth.)  
*Orthis* (?) *rugiplicata* Hall and Whitfield. (Nettleroth.)  
*Orthis* (?) *subnodoso* Hall. (Nettleroth.)  
*Rhipidomella hybrida* Sowerby. (Nettleroth.)  
*Dalmanella elegantula* Dalman. (Nettleroth.)  
*Platystrophia biforata* Schlotheim. (Nettleroth.)  
*Anastrophia interplicata* Hall. (Hall.)

- Anastrophia internascens* Hall. (Nettleroth.)  
*Stricklandinia louisvillensis* Nettleroth. (Nettleroth.)  
*Hyattella congesta* Conrad. (Nettleroth.)  
*Gypidula globulosa*. (Nettleroth.)  
*Gypidula knotti* Nettleroth. (Nettleroth.)  
*Gypidula nucleus* Hall and Whitfield. (Nettleroth.)  
*Gypidula uniplicata* Nettleroth. (Nettleroth.)  
*Conchidium tennicostatum* Hall and Whitfield. (Nettleroth.)  
*Conchidium knappi* Hall and Whitfield. (Nettleroth.)  
*Conchidium littoni* Hall. (Nettleroth.)  
*Conchidium nysius* Hall and Whitfield. (Nettleroth.)  
*Pentamerus oblongus* Sowerby. (Nettleroth.)  
*Pentamerus oblongus*, var. *cylindricus* Hall and Whitfield (Nettleroth.)  
*Pentamerus pergibbosus* Hall and Whitfield. (Nettleroth.)  
*Clorinda ventricosa* Hall.  
*Rhynchotreta cuneata* var. *americana* Hall. (Nettleroth.)  
*Camarotoechia* (?) *acinus* Hall. (Nettleroth.)  
*Camarotoechia* (?) *indianensis* Hall. (Nettleroth.)  
*Rhynchonella belliformis* Nettleroth. (Nettleroth.)  
*Rhynchonella louisvillensis* Nettleroth. (Nettleroth.)  
*Rhynchonella pisa* Hall and Whitfield. (Nettleroth.)  
*Rhynchonella rugicosta* Nettleroth. (Nettleroth.)  
*Rhynchonella tennesseensis* Roemer. (H.) (H. & W.)  
*Wilsonia saffordi* Hall. (Nettleroth.)  
*Wilsonia saffordi* var. *depressa* Nettleroth. (Nettleroth.)  
*Uncinulus stricklandi* Sowerby. (Nettleroth.)  
*Atrypa rugosa* Hall. (H. & W.)  
*Atrypa nodostriata* Hall. (H. & W.)  
*Atrypa marginalis* Dalman. (H.) (H. & W.)  
*Atrypa reticularis* var. *niagarensis* Nettleroth. (Nettleroth.)  
*Cyrtia myrtia* Billings. (Nettleroth.)  
*Spirifer crispus* var. *simplex*. Hall. (Nettleroth.)  
*Spirifer foggi* Nettleroth. (Nettleroth.)  
*Spirifer eudora* Hall. (H. & W.)  
*Spirifer rostellum* Hall. (Nettleroth.)  
*Spirifer radiatus* Sowerby.  
*Spirifer niagarensis* (?) Conrad. (H.)  
*Reticularia bicostata* Vanuxem. (H.)  
*Rhynchospira helena* Nettleroth. (Nettleroth.)  
*Anoplothea hemispherica* Sowerby. (Nettleroth.)  
*Meristina maria* Hall. (Nettleroth.)

- Whitfieldella nitida Hall. (Nettleroth.)  
Whitfieldella nitida var. oblata Hall. (H. & W.)  
Nucleospira elegans Hall. (Nettleroth.)  
Nucleospira pisiformis Hall. (Nettleroth.)

*Lamellibranchiata.*

- Orthonota curta Conrad. (H.)

*Gasteropoda.*

- Pleurotomaria casii Meek and Worthen.  
Euomphalus (Cyclonema) rugaelineata Hall and Whitfield.  
(H. & W.)  
Platystoma niagarense Hall.  
Murchisonia petila Hall and Whitfield. (H. & W.)  
Cyclonema cancellata Hall.  
Trochonema fatua Hall.

*Cephalopoda.*

- Lituites marshi Hall.

*Crustacea.*

- Iliaenus barriensis Murchison. (H.)  
Iliaenus cornigerus Hall and Whitfield. (H. & W.)

One of the most striking contrasts between the two faunas appears in the corals. But one of the Waldron species is recorded from the Louisville fauna, while a second is represented in the latter by a variety. Instead of the half dozen species of the Waldron fauna we have in the Louisville limestone according to Davis and Hall, 57 species. Too little is known of the Bryozoa of the Louisville limestone to permit profitable comparison. In the *Pelmatozoa* we find but two of the Waldron species recorded from the Louisville limestone by Hall. The other 24 species known in the Waldron fauna have not been recorded from the Louisville fauna.

In the case of the Brachiopoda both lists represent fairly complete and accurate knowledge and are probably about equally exhaustive as regards this group in both faunas. Comparison of the species listed in the two faunas shows that 21 of the Waldron brachiopods fail to appear in the Louisville limestone. Some of the Waldron species which are not found in the later fauna and which may be considered characteristic Waldron species are *Mimulus waldronensis*, *Meristina rectirostris*, *Homeospira evax*, *Camero-*

*toechia whitei*, and *Dictyonella reticulata*. In the Louisville limestone fauna 39 brachiopods appear which are unknown in the Waldron shale. These represent 65 per cent of the total brachiopod fauna of the Louisville formation and include several large species of the pentameroid group of which *Pentamerus oblongus* and *Conchidium knappi* are examples. The two lists show that 47 per cent of the Waldron brachiopods continue into the Louisville limestone. Nettleroth's observations on some of these show that many of them are represented in the later fauna by dwarfed specimens.

In the groups not yet discussed it is believed that the list of the Louisville fauna is too incomplete to justify close comparison.