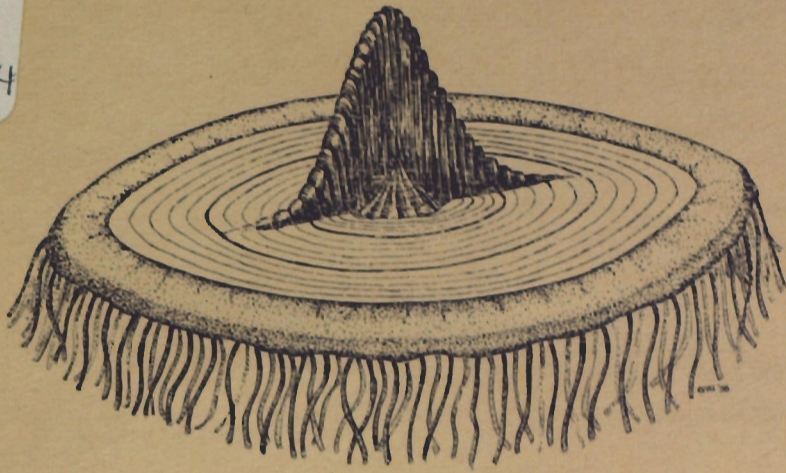


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Lithology, Paleocology and Paleontology of the Vernon Shale (Late Silurian) in the Type Area

By

DONALD W. FISHER

State Paleontologist

New York State Museum and Science Service



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The University of the State of New York

The State Education Department

Albany, N. Y.

November 1957

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COVER ILLUSTRATION: Restoration of the oldest known "by-the-wind sailor" type of jellyfish, *Silurovelella casteri* from the late Silurian Vernon shale near Vernon, N. Y. ($\times\frac{1}{2}$)

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LITHOLOGY, PALEOECOLOGY AND PALEONTOLOGY OF THE VERNON SHALE (LATE SILURIAN) IN THE TYPE AREA¹

By

DONALD W. FISHER

State Paleontologist

New York State Geological Survey

ABSTRACT

A detailed analysis of the physical and organic factors contributory to the formation of the Vernon shale at the type locality in Vernon Township, Oneida County, New York, is presented. The resultant synthesis permits an evaluation of the paleoecological aspects. Five fundamental rock types (lithofacies)—red shale, green shale, gray shale, dolomite, greenish-black shale—are described in detail. Reconstruction of the sedimentary environment, in existence when the Vernon sediments accumulated, reveals that the Vernon was a deltaic river deposit infringing on a large multiple restricted lagoon or series of small restricted lagoons. Temporary encroachment by more normal seas brought accompanying marine life of which the fauna found in the type area of the Vernon shale represents one invasion. The fossils occur within a two-foot faunizone along three streams in southwestern Oneida County. One of these streams, Downing Brook, is designated as a reference section and is described in detail. The fauna is principally molluscan and, with the eurypterids, it is typical of a mixed "hyper-saline-marine" association. Of especial significance is the occurrence within this assemblage of the oldest known veleid siphonophore, *Silurovelella casteri*, n. gen., n. sp. In addition, four other new species are described: *Lingula allingi*, *Poleumita vernonensis*, *Modiolopsis orthoconcavus* and *Pterinea wayland-smithi*. The last named, the most abundant member of the fauna, occurs in three distinct varieties worthy of separate recognition.

¹ Manuscript submitted for publication, December 16, 1955.

INTRODUCTORY REMARKS

Purpose of This Work and Acknowledgments

Over a period of years several hundred specimens of fossil invertebrates and fishes were collected by Mr. Robert Wayland-Smith of Kenwood, N. Y., from within the type area of the Vernon shale in southern Oneida County. This, in itself, is noteworthy for the Vernon had come to be regarded as practically barren of fossils. Mr. Wayland-Smith graciously donated his extensive collection to the New York State Museum and, together with Dr. Rousseau Flower, former Assistant State Paleontologist, reported the existence of this fauna in abstract (Flower and Wayland-Smith, 1947, p. 1180). Subsequently, the cyathaspid fishes were described (Flower and Wayland-Smith, 1952) and a paper dealing with the eurypterids by Erik Kjellesvig-Waering and Kenneth Caster (1955) described two new pterygotids different from those in the basal Vernon and the younger Bertie formation. A discussion of the remainder of the fauna, with associated paleoecological impact, and additional lithologic details are included in this article.

Mr. Wayland-Smith, the donor of the Vernon collection, accompanied the writer in the field, pointing out the exact sites where the fossil-bearing zone occurs. For his graciousness in turning over to the State Museum his fine collection and for his cooperation, the writer offers his appreciation. Photographs were prepared by Mr. John Heller, staff photographer of the State Museum. Dr. Gordon Rittenhouse critically read the manuscript.

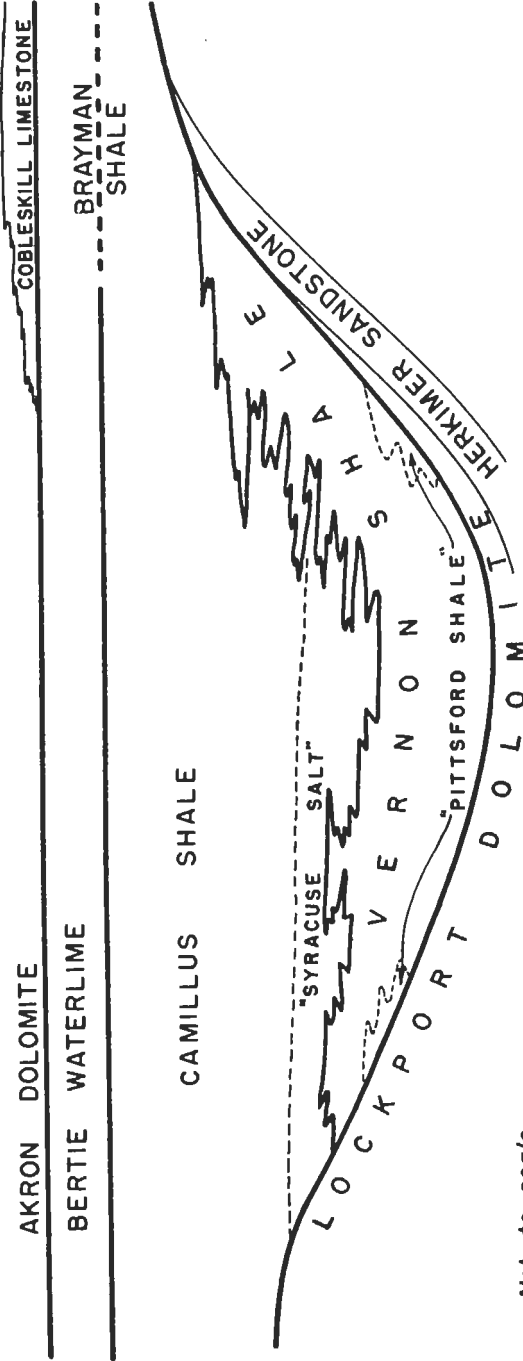
Geologic Setting

Sarle (1903) and Ruedemann (1920) reported Late Silurian (Cayugan) fossils from the basal Vernon (Pittsford shale) in west-central New York, thereby establishing the age. Similarly, Chadwick (1919, p. 152) found ostracodes, *Emmelzoe decora* and *Ceratiocaris salina*, in the Pittsford black shale. In addition, Eaton (1924) reported a small faunule from a drab buff-colored rock "13 feet below the base of the Camillus" a few miles west of Syracuse. The writer has examined Eaton's types. They are very poorly preserved and useless for comparative purposes.

The thickness of the typical Vernon ranges considerably. It is absent in extreme western New York, disappearing somewhere between Batavia and Lockport in Genesee County, and is similarly absent in the subsurface at Castile, Humphrey and Randolph. The Vernon is 174 feet in the Cuylerville core in Livingston County, 245 feet in the Geneva

WESTERN
NEW YORK

EAST-CENTRAL
NEW YORK



Not to scale

Figure 1. Generalized stratigraphic profile denoting plausible relationships of the Late Silurian deposits in central and western New York

quadrangle, 343 feet at King Ferry in Cayuga County, 519 feet at Morrisville in Madison County, 400 feet at Vernon and 335 feet at Clinton. In west-central New York, the Vernon rests on the Guelph-Lockport dolomites and this situation persists to the western edge of the Oriskany (Rome) quadrangle. Across the Oriskany (Rome) and Utica quadrangles, a gray-black shale facies equivalent of the Lockport underlies the Vernon. Eastward the Vernon disappears, for at Deck in the north-central part of the Richfield Springs quadrangle in Herkimer County the overlapping Camillus rests directly on the Silurian (Clintonian) Herkimer sandstone (figure 1). The outcrop belt ranges up to 10 miles in width. Whereas the dip is 20 to 50 feet per mile to the south in western and central New York, it changes to 100-200 feet per mile ($1-2^{\circ}$) southwest in east-central New York.

Nomenclatorial Status

J. M. Clarke (1903, p. 18-19 and chart) was the nomenclator of the term Vernon, applying the name to the red and green shales, gray gypsiferous shales, and thin platten dolomites within the Salina formation and lying above the Pittsford black shale and below the Syracuse salt. Subsequent authors have variously treated the Vernon as a distinct formation or as a member of the Salina formation and have allotted 150 feet to the Vernon in the type area.

Though at least five distinct rock types are represented in the strata classed as Vernon, they are so interrelated that further differentiation into smaller units is not warranted from the cartographic standpoint. The writer prefers, therefore, to regard the Vernon as a phase of sedimentation (magnafacies) capable of geologic mapping, so that thereby it can properly be termed a formation. Within New York, the Vernon shale is considered the correlative of the High Falls shale of Orange and Ulster Counties in southeastern New York.

The name "Pittsford shale," widely used but almost never exposed, is suppressed as it is not a widespread, clearly-recognizable mapping unit. This discontinuous occurrence of greenish-black shale above the Lockport dolomite is included within the Vernon formation.

Type Section

Although a type area (Vernon Township) was designated at the time that the name was proposed, no specific type locality was selected. It seems judicious that a reference locality be chosen so that future workers may afford themselves an opportunity to examine a typical section and thus better familiarize themselves with the characteristics

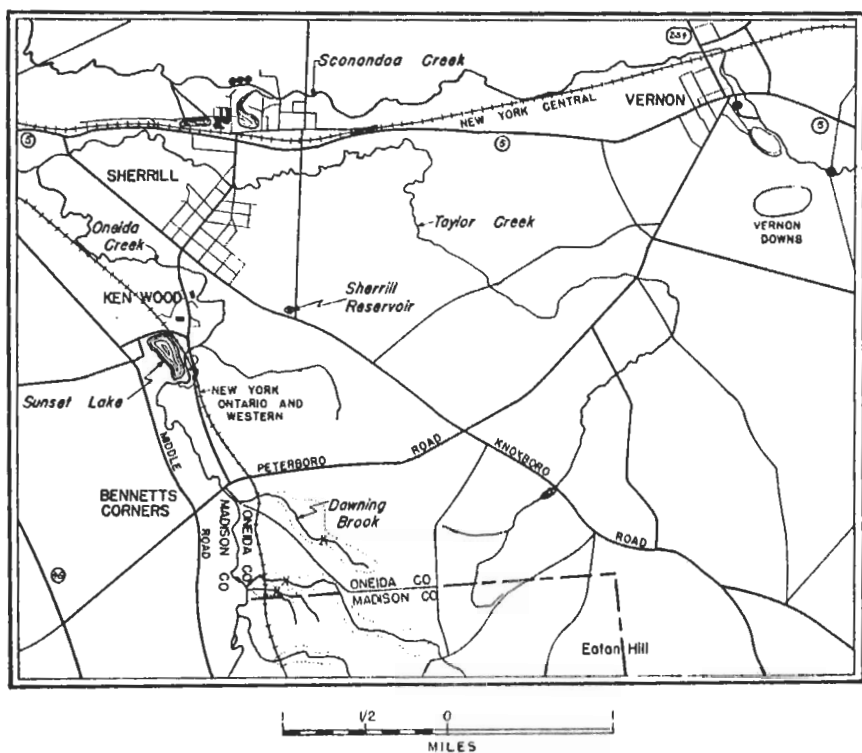


Figure 2. Map showing location of fossil localities in the Vernon shale within the type area. Fossil localities indicated by x's; Lockport dolomite exposures indicated by *s; dotted areas indicate Vernon sections.

of the Vernon shale. Downing Brook, which enters Oneida Creek from the east 1.3 miles south of the portion of Sherrill known as Kenwood and 0.6 miles north of the southern boundary of Oneida County, is selected as a reference locality (see figure 2). This is 2.3 miles south of the intersection of New York Highway 5 and the Kenwood-Sherrill Road. Downing Brook affords the most complete section of the Vernon shale known; and together with a fine exposure of the fossil-bearing zone herein discussed, it provides the interested worker an opportunity to study the lithologic variants. The section is reproduced below through the courtesy of Mr. Wayland-Smith.

Description

Feet	Inches	
6	0	Red shale (top concealed)
1	8	Green shale
2	4	Red shale

<i>Feet</i>	<i>Inches</i>	
0	6	Mottled red-green shale
1	6	Green shale, fine-grained and platy
2	6	Red shale
1	3	Green shale
5	8	Red shale
5	6	Green shale, thinly laminated and very fine-grained in lower part, somewhat coarser and thicker-bedded above
1	10	Thin-bedded blue-gray shales, enclosing three separate layers of gray dolomite 1 to 4 inches thick
6	6	Irregularly stratified green shale
55	0	Red shale, irregularly stratified in lower 2 or 3 feet, unstratified above. Between 10 and 20 feet from the bottom of this layer there are several thin (2 to 3 inches) lenses of pale green sandstone. In the red shale above these lenses, small (0.5 mm.) rounded, frosted, quartz grains are fairly common and at certain levels very abundant. Large (25 to 75 mm.) circular green spots are frequent at certain levels. In the upper 10 feet there are numerous irregular, blotchy spots of green and abundant small (3 to 10 mm.) rounded cavities.
3	1	Mottled red and green shale; broken up (by mud cracks?) into polygonal sections about 6 inches in diameter, with raised edges on upper surfaces. Thinly laminated sections of identical shape lie one above another to a height of 6 to 8 inches, like stacks of dinner plates.
1	3	Green shale
1	9	Calcareous shale, grading from greenish-drab in lower 2 inches, through 4 inches of dark gray to 15 inches of gray-green. ABUNDANT FOSSILS
0	7	Drab calcareous shale; in upper 2 inches, numerous small (2-5 mm. diameter) perpendicular tubular cavities, lined with calcite crystals
0	4	Very thinly laminated gray and drab shale
3	5	Green shale, hard and chunky, with abundant sand grains in lower part; more thin-bedded and shaly, with much less sand in upper part
0	5	Pale green sandstone, very thinly laminated, loosely bound and friable, weathering to loose sand
0	10	Mottled red and green sandstone, rather hard and compact
0	5	Red shale with abundant sand grains
0	9	Green sandstone—small, rounded quartz grains in a green shaly matrix
1	2	Dark purplish-red shale, fine-grained and compact
0	3	Green shale, somewhat mottled with red
0	3	Dark purplish-red shale, very fine-grained, hard and compact
0	9	Green shale, with tiny flakes of mica
0	3	Soft, brownish-drab shale, weathering to clay
2	5	Mottled red and green shale with very abundant sand grains

<i>Feet</i>	<i>Inches</i>	
1	0	Green sandstone. Middle 4 inches consist almost entirely of loosely bound, small, rounded quartz grains. Upper and lower parts are darker green and contain a little more of the shaly matrix
0	5	Red shale with very abundant quartz grains
1	0	Mottled red and green shale with thin ($\frac{1}{2}$ ") lenses of soft, drab shale
0	11	Greenish-drab shale
0	6	Mottled red-green shale
10	4	Red shale, with numerous sand grains and occasional small cavities lined with calcite crystals
1	9	Green shale, showing well-marked sun cracks in lower 15 inches
3	0	Hard, dark gray dolomite
1	6	Gray-green shale with very abundant quartz grains
24	3	Green shale
1	6	Blue-gray shale
0	10	Greenish-drab shale
1	8	Mottled drab and black shale, rather hard and compact
0	7	Gray-green shale
0	11	Light gray, calcareous shale
1	6	Hard, dark gray dolomite
7	6	Dark gray to black shales; thinly laminated and very black in upper 2 feet
2	5	Gray, calcareous shale
0	2	Soft, black shale weathering to clay
0	6	Hard, black dolomite
3	3	Gray-green to yellow-green shale; fine-grained and somewhat harder and more compact than the typical red shale
6	6	Thinly laminated green shale
90	0	Unstratified red shale, weathering into crumbling, irregular fragments. Throughout the whole thickness of this layer, but especially in the lower part, there are numerous bright green spots. These are irregularly arranged, usually circular, from 5 to 50 mm. in diameter, with sharp, well-defined boundaries. At the center of the green area there is usually, but not always, a small, black spot, 1 to 3 mm. in diameter, surrounded by a narrow margin of yellowish brown. The mass is traversed by many irregular joint planes, and small areas of slickensided surfaces are frequent.
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270	2	Total thickness

Note. The contact between the Vernon and the underlying Lockport is not exposed here. The bottom of the Downing section is at the point where the Downing Brook flows into Oneida Creek at 500 feet on the topographic map. Two and one-half miles almost due north of this point there is an exposure of the Lockport in the banks of Sconodoc Creek at 490 feet on the topographic map. Allowing for the regional southwest dip of the strata, the thickness of Vernon shale underlying the Downing section cannot be much over 100 feet and is probably less.

The Downing section does not extend up to the contact between the Vernon and the overlying Camillus, but, judging from measurements

made of exposures in ravines just south of the Downing gulf, there is probably less than 50 feet of Vernon above the top of the Downing section.

Total estimated thickness of the Vernon shale in this area—about 400 feet.

LITHOLOGY

There are essentially five different rock types within the Vernon formation representing five different basic depositional environments (lithotopes). Each possesses characteristic megascopic and microscopic criteria which enable their simple identification. In order of decreasing abundance, the five lithofacies are: red shale, grayish-green shale, medium dark gray shale, dolomite and "black" shale. All gradations exist between these five fundamental lithologies but these transition phases are of only minor importance. The relatively small percentage of green sandstone precludes its consideration as an important physical constituent.

Red (5R 3/6) Shale Lithofacies.¹ This is an argillaceous rock with subordinate quartz of silt size. Minor amounts of gypsum, anhydrite, euhedral dolomite, secondary calcite, and black organic matter also occur. Hopper casts, pseudomorphous after halite, may be found by diligent searching. This is the lithofacies which so characteristically typifies the area of Vernon exposure as well as the area underlain by it, but concealed, for it imparts a noticeably dark red color to the superjacent soils. There is an almost total absence of good stratification in this facies but intraformational slumping and penecontemporaneous folding are common. The angular quartz silt is unabraded, averages 0.01 mm. in diameter and makes up 10-15 percent of the rock. Rarely, thin beds with almost 35 percent quartz are encountered. The red Vernon is frequently changed to green along joints where percolating ground water, high in organic acids, has reduced the iron from the ferric to the ferrous state. The red lithofacies decreases in prominence from east to west across the State.

Grayish Green (10 GY 5/2) Shale Lithofacies. This is an argillaceous rock with green ferrous oxide coating the groundmass. It is slightly calcareous and angular quartz silt averages 10-15 percent of the volume, though rarely beds with a much higher percentage (about 50 percent) of quartz silt occur. Locally, extensive mud cracks give the appearance of many dinner plates stacked atop one another. The beds are commonly laminated. Horizontally oriented selenite and secondary calcite occur occasionally. Rarely, along joints, the coloration

¹ Rock Color Chart, E. N. Goddard et. al., 1951, distributed by the Geological Society of America.

has been changed to red due to recent oxidation, which is exactly the reverse process of that which is found in the red lithofacies. Transitional mottled red and green beds are locally common and represent an integradation of the two conditions.

Medium Dark Gray (N5) Shale Lithofacies. There is a total absence of red staining in this rock. It is, however, perfectly gradational with the grayish-green shale lithofacies and it is within this transitional phase that the fossils reported in this paper have been found. The gray shale is essentially a clay paste with variable amounts of recrystallized calcite, rare angular quartz silt and rare pyrite. The medium dark gray lithofacies is far less common than the aforementioned two lithofacies.

Dolomite Lithofacies. This is a conchoidal fracturing medium gray (N6) fine-grained dolomite (dolomilitite) with some interstitial silica, infrequent grains of pyrite and opaque black specks. Red and green staining is completely lacking. Secondary pink dolomite rhombs and siderite rhombs are rare. This lithofacies occurs as rare thin beds of platten dolomite usually associated with the gray shale where it is transitional into the green shale. Dolomite is likewise commonly present at, or near, the base of the Vernon where it is in contact with the Lockport dolomite when the "black" shale lithofacies is missing.

Greenish-black (5G 3/1) Shale Lithofacies (Pittsford facies). As the Pittsford "black" shale is not a continuous unit, is not currently exposed and is only occasionally encountered in the subsurface, it is recommended that the name be abandoned as a stratigraphic unit. The type locality is likewise concealed by the Barge Canal waters and therefore not available for reference. Though the Pittsford has been referred to as a black shale in the literature, in reality it has a markedly greenish cast and is appropriately classed as greenish-black, or more popularly "verde green." This lithofacies is composed of argillaceous, carbonaceous and dolomitic material with much disseminated pyrite and some angular quartz. Some exposures of the Pittsford facies (now concealed) produced remarkable eurypterid remains which were described by Sarle (1903) and Ruedemann (1920). Were it not for the peculiar eurypterid-bearing environment in which this sediment accumulated, this lithofacies would undoubtedly go unrecognized. Retention of the name in future stratigraphic discussions of the Upper Silurian is not advocated.

PALEOECOLOGY

The Vernon is regarded as representing the initial shoreward phase of deltaic deposition in Late Silurian (Cayugan) time. This is in

accordance with the view of Alling (1928) who made a splendid detailed contribution to the petrology of the Late Silurian rocks of New York State. Opposing views were held by Grabau (1913, p. 569) who considered the Vernon to be a windblown loess deposit whereas Newland (1928) hypothesized that the Vernon was a residual soil. Previously, the absence of fossils was regarded as a strong criterion favoring a continental origin for the formation. However, the presence of marine fossils, mud cracks, stratification and angular quartz discredits the loess and residual soil hypotheses. Yet the nature of the Vernon's makeup discloses that it was not deposited in a "normal" marine environment (*sensu stricto*) but rather in a hypersaline one.

Mud cracks suggest deposition in a littoral zone or one in which the floor of the sedimentary environment (lithotopé) is alternately exposed and flooded. This could imply a tidal zone of a relatively large body of water or a restricted lagoonal type of environment. The writer prefers the latter supposition because of coexistence of evaporites, such as gypsum and halite, within the Late Silurian environments.

Color is not a reliable criterion for assuming a terrestrial origin for the red Vernon shale as it cannot be adequately demonstrated that the red coloration is original. The mere fact that a greater percentage of iron oxide is present does not necessarily mean that the sediment was deposited on land. Agencies producing ferric oxide are to be found wherever erosion is taking place, and rapid accumulation near the strand line may very well supply sufficient quantities of ferric oxide to the sedimentary basin to produce an *apparent* terrestrial deposit.

Dorsey (1926, p. 131) lucidly showed that the color of red beds is not due to a larger iron content nor to the mere presence of ferric oxide. Instead, it is the presence of red ferric hydrate and ferric anhydrate which colors the rocks red. Nevertheless, it can be shown that there is an excess of ferric oxide in red and purple shales and an excess of ferrous oxide in green and black shales. Miller (1919, p. 151) reported the ferric oxide content of the Vernon as averaging 2.25 percent, whereas the ferrous oxide averaged 0.75 per cent.

Treating the red Vernon shale with hot hydrochloric acid results in the disappearance of the red color, and the addition of ammonia to the solution produces a precipitate of brown hydrous ferric oxide. Considering that the water content is directly responsible for the variation in color, it is difficult to ascertain precisely which mineral or minerals constitutes the bulk of the red Vernon lithofacies. Conceivably, it could be any one or any combination of limonite ($2\text{Fe}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$), xanthosiderite ($\text{Fe}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$), goethite ($\text{Fe}_2\text{O}_3 \cdot \text{H}_2\text{O}$), turgite ($2\text{Fe}_2\text{O}_3 \cdot \text{H}_2\text{O}$) or hematite (Fe_2O_3). At any rate, it can be stated with some confidence

PLATES I, II and III

PLATE I

- Figure 1. *Silurovellella casteri* Fisher, n. gen., n. sp. (x1). Oldest known vellelid "by-the-wind sailor" siphonophore from the Late Silurian (Cayugan) Vernon shale 3.5 miles southwest of Vernon, N. Y. Use of compass directions in orientation of siphonophores is a conventional one for locating features on the pneumatophore disc. Note particularly the centrally located trigonal shaped pneumatophoral keel with southerly directed concentric ridges (carinae). N.Y.S.M. 10777.



PLATE II

Vernon Fossils from the Type Locality
(all magnifications $\times 2$)

- Figure 1. *Lingula allingi* Fisher, n. sp. Holotype, N.Y.S.M. 10761. Note the foramen, the completely enclosed slitlike opening for passage of the pedicle, slightly apical of the center of the pedicle valve. The prominence of the radially arranged costellae along the valve margin is also striking.
- Figure 2. Paratype of pedicle valve of same species, N.Y.S.M. 10762. Foramen more pronounced and foramenal trench less marked than in holotype.
- Figure 3. *Poleumita vernonensis* Fisher, n. sp. Paratype, N.Y.S.M. 10763. Apical view of an immature specimen showing four whorls.
- Figure 4. Holotype of same species, N.Y.S.M. 10764. Mature specimen.
- Figure 5. Counterpart of holotype, N.Y.S.M. 10765.
- Figure 6. Oblique-lateral view of paratype of same species, N.Y.S.M. 10766, illustrating the relatively flat upper side of whorls.
- Figure 7. *Pterinea wayland-smithi* Fisher, n. sp. Holotype, N.Y.S.M. 10767. Mold of left valve. Typical cancellate pattern of this, the earliest pectinate palecypod genus is well shown.
- Figure 8. *P. wayland-smithi* var. *opisthoclinus* Fisher. Paratype, N.Y.S.M. 10768. Cast of left valve. This represents the most opisthocline form of this species. The valve is also more orbicular in outline.
- Figure 9. *P. wayland-smithi* var. *normalis* Fisher. Paratype, N.Y.S.M. 10769. Cast of left valve. This is the most abundant variety of the species in the Vernon shale. The radial markings are considerably less pronounced while the posterior auricle is less alate.
- Figure 10. *P. wayland-smithi* var. *prosoclinus* Fisher. Paratype, N.Y.S.M. 10770. Cast of left valve. This variety is definitely prosocline, the umbo is $\frac{1}{3}$ the distance along the hinge from the anterior, and the concentric growth lines have a less marked swing toward the posterior auricle.



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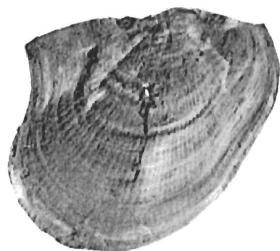
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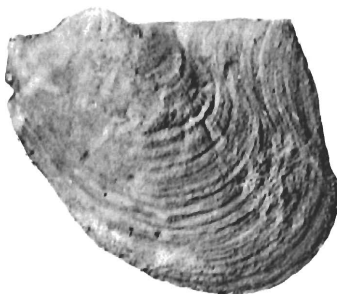
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PLATE III

Vernon Fossils from the Type Locality

- Figure 1. *Modiolopsis orthoconcarus* Fisher, n. sp. (x2). Holotype, N.Y.S.M. 10771. Left valve of a mytilid dysodont with diagnostic straight concavity slightly ventrad of the dorsal side.
- Figure 2. *Kionoceras* sp. (x2). N.Y.S.M. 10772. Portion of conch of orthoconic nautiloid showing kionoceroïd longitudinal ribs.
- Figure 3. *Spyroceras* sp. (x2). N.Y.S.M. 10773. Portion of conch showing narrow camerae and moderately arched septa.
- Figure 4. *Leperditia scalaris* (Jones) (x3). N.Y.S.M. 10774. Mature specimen.
- Figure 5. Immature specimen of same species showing prominent eye spot (x3), N.Y.S.M. 10775.
- Figure 6. Two specimens showing some slight variations in shape and size of this species (x3), N.Y.S.M. 10776.



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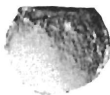
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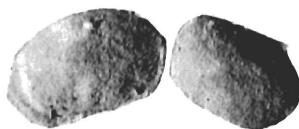
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that the red coloration in the Vernon shale is due to the presence of iron in the form of anhydrous ferric oxide.

Barrell (1908, p. 290-291) thought that the red coloration was due to dehydration subsequent to deposition. This can be disproved, for deep wells reveal the red coloration thereby illustrating that recent or relatively recent oxidation exerted no role in producing the red color.

In some places the red shale lithofacies contains green spots which range from a fraction of an inch to several inches in diameter. At their centers there generally exist black spots 2 to 3 mm. in diameter. As the spots disappear when subjected to the oxidizing flame, they are regarded as carbonaceous and thus remnants of organic life. A light gray residue remains after this treatment. It is therefore obvious that the carbon acted as a reducing agent changing the red coloration to green "aureoles" encircling the black carbonaceous nucleus. Another analogous chemical reaction occurred where, due to the reducing action of percolating ground water high in organic acids, the red shale has been altered to green along joints. In the oxidizing flame, the grayish-green shale turns red.

Alling (1928) has aptly demonstrated that since the quartz grains in the Vernon are angular and clear, they cannot be of aeolian origin, for windblown deposits of quartz grains are well-rounded and considerably abraded (frosted). He further proposed that the Vernon is more properly regarded as a river silt deposit due to the angularity, size (0.01 mm. diameter) and volume (20-30 percent) of the silt.

In summation, the Vernon is a deposit formed in the littoral area of a restricted semimarine environment. The Camillus lithotope, which extends into western New York and Michigan, is considered as a more westerly environment and one consisting of a large but diminishing "Salton Sea"; or one dotted with playa lakes. These lakes were far enough distant from the source of detritus that iron-oxide-rich sediments were deposited closer to the supplying land mass on the east and southeast. Fluctuations in water level produced temporary influx of more typical marine waters, thus accounting for the restriction of marine and hypersaline water faunas to narrow zones within the Salina group. The faunal zone within the type area of the Vernon is regarded as denoting one of these temporary marine invasions.

Westward, the Vernon apparently interfingers with the Camillus shale so that the two formations rise in time to the east; the eastern Vernon is synchronous with the western lower Camillus (see figure 1).¹

¹Leutze (1956) offers a different relationship of the Camillus and Vernon strata, namely, that a recognizable rock unit, the Syracuse formation, occurs between the Vernon and Camillus phases and furthermore that the Syracuse is unconformable upon the Vernon in Onondaga and Madison Counties and is essentially of the same age across the State.

This theory is borne out by the westward thinning of the Vernon to disappearance slightly west of Batavia, whereas the Camillus reaches its maximum thickness in central New York—in the region of thickest salt accumulation. Moreover, if the fossil zone within the type area of the Vernon (middle Vernon) should prove to be the time-equivalent of that found by Eaton (1924) near Jordan (uppermost Vernon), then this biostratigraphic unit furnishes additional corroboration of the time relationships of the Vernon and Camillus formations.

The revised picture reveals that the Salina seas were progressively transgressing eastward and receiving relatively large amounts of fine-grained detritus from the east and southeast in the early stages. The amount of clastics diminished relatively rapidly owing to the probable featureless low land to the east with long meandering rivers carrying the bulk of their load in suspension. Much evidence of slumping (intraformational) and penecontemporaneous folding is observable in the red shale. This suggests that the red shale was deposited at a more rapid rate in an oxidizing environment. The relative absence of organic matter implies that it was transported some distance from the locus of sedimentation and deposited where settling conditions were slower and less turbulent, in the greenish-gray lithotope.

PALEONTOLOGY

General Remarks

The type Vernon fauna occurs in a zone, not exceeding two feet thick, in a dark greenish gray (5GY 4/1) rock which weathers pale yellowish brown (10YR 6/2). The fossils occur where there is a gradation from the grayish-green lithofacies into the medium dark gray lithofacies. Critical ecological factors account for the restriction of the fauna to so narrow a zone. A temporary marine encroachment is theorized to explain this fortuitous discovery.

Three localities exposing the fossil-bearing rock were called to the writer's attention by Mr. Wayland-Smith. These are designated on the map (figure 2) by x's. The most favorable site is that along Downing Brook, designated in this paper as the type locality, where due to the greater resistance of the enclosing rock, the faunizone caps a low waterfall. With the exception of the eurypterids, all the forms occur as molds or casts. The fossils herein reported are infinitely better preserved than those found by Eaton (1924); nonetheless, in some cases, lack of preservation of vital details makes specific identification unwarranted. Aside from the cyathaspid fishes and eurypterids, which have been described by other paleontologists, the fauna consists of the following:

Plantae:

- s* Generically indeterminable seaweeds

Hydrozoa:

- r* *Silurovelella casteri* Fisher, n. gen., n. sp.

Brachiopoda:

- r* *Camarotoechia* sp.
c *Lingula allingi* Fisher, n. sp.

Gastropoda:

- r* *Hormotoma* sp.
c *Poleumita vernonensis* Fisher, n. sp.

Pelecypoda:

- s* *Modiolopsis orthoconcavus* Fisher, n. sp.
r *Nucula* sp.
r *Orthodesma* (?) sp.
a *Pterinea wayland-smithi* var. *normalis* Fisher, n. sp., n. var.
s *P. wayland-smithi* var. *opisthoclinus* Fisher, n. sp., n. var.
s *P. wayland-smithi* var. *prosoclinus* Fisher, n. sp., n. var.

Cephalopoda:

- r* *Hexameroceras* sp.
r *Kionoceras* sp.
r *Spyroceras* sp.

Annelida:

- r* Generically indeterminable worm borings

Ostracoda:

- s* *Leperditia scalaris* (Jones)

It should be emphasized that, considering the Vernon formation in its entirety, all of the species are extremely rare. The frequency abundance designations, *a*—abundant, *c*—common, *s*—scarce, *r*—rare, are relative to the total number of specimens found. For example, approximately three times as many *Pterinea* were found as *Poleumita*; the former is classed as abundant; the latter, as common.

No special techniques were utilized in the photographing of the fossils except that they were coated with ammonium chloride to enhance the details, and low angle incident lighting proved most effective in displaying the true curvature of the specimens.

Systematic Paleontology:**Phylum Coelenterata****Class Hydrozoa** Owen, 1843**Order Siphonophorida** Eschscholtz, 1829**Suborder Chondrophorina** Chamisso & Eysenhardt, 1821**Family Velellidae** Brandt, 1835

Genus *Silurovellella* Fisher, n. gen.**Type species:** *Silurovellella casteri* Fisher, n. gen., n. sp.

(Plate I, figure 1)

Holotype: N.Y.S.M. 10777**Formation and Age:** Vernon shale, Late Silurian (Cayugan)**Locality:** Downing Brook, 3.5 miles southwest of Vernon, N. Y.

Description: This description is based on a single adequate but incomplete natural mold and cast of a pneumatophore disc. The disc is roughly elliptical in outline measuring 145 by 100 mm. Surface of disc has a concentrically arranged corrugated appearance due to many shallow subrounded furrows. These furrows are 4 mm. wide and 0.5 mm. deep. These dimensions are constant regardless of whether the furrows are near the center or near the periphery of the disc. The outer or peripheral edge of each furrow is slightly steeper than the inner edge. Save for very faint radial sulci, no radial ornamentation is visible. In the southwest quadrant are two relatively deeply incised furrows at $\frac{1}{3}$ and $\frac{2}{3}$ the distance from the center of the disc. The regularity of the spacing suggests that this is a morphologic feature and not one due to crushing of the pneumatophore.

In contrast to the few Devonian siphonophores known, the outline of the central trapezohedral area of *Silurovellella* is imperfectly shown. The naturally compressed pneumatocyst ridge or keel, however, is finely displayed. Though the keel is preserved in the recumbent position, in life it was vertical and lenticular in section paralleling the transverse axis of the disc. The length of the keel is 30-32 mm. and, owing to recumbency, the sides are sigmoidally arcuate.

Two prominent concentric ridges (carinae) are visible on the keel with barely visible very fine ridgelets (carinallae) paralleling the two primary carinae. The two primary carinae are 3 mm. apart intercepting the transverse axis at an angle of 45°. Apices of both carinal ridges are directed "southward" toward the flaring end of the pneumatocyst keel.

Discussion and Diagnostic Features. Siphonophores (jellyfish) are polymorphic floating or swimming colonies of specialized medusae or polyps. The medusoid forms include a highly modified pneumatophore or float. This float possesses a chitinous inner lining that may be preserved. *Physalia*, the Portuguese man-of-war, is a modern representative of the siphonophora and not greatly unlike its Paleozoic progenitors. Siphonophores may conveniently be classified into a bipartite division based on their mechanics of locomotion. The porpites are the "drifters" whereas the velellids are the "sailors." The aforementioned *Physalia* is a porpita; *Velevella velevella* (*mutica*) is a common

"sailor" of the Gulf Stream. Possessing a keel, *Silurovellella* is a "by-the-wind sailor" and is of significance because it is the oldest known Velellid siphonophore. It is distinguished from the Devonian velellid siphonophore, *Plectodiscus cortlandensis* Caster, by the regularity of the concentric furrows and the lack of prominent radial markings. The two incised furrows roughly dividing the disc into three parts are extremely reminiscent of the concentric pattern on the modern porpitud siphonophore, *Porpalia prunella* Haeckel, though this is undoubtedly coincidental and not to be construed as having any morphological affinity with the porpituds.

Derivation of the Name. The generic name *Silurovellella* is applied as it indicates the morphologic affinity with velellid siphonophores in addition to the Silurian age. The trivial name *casteri* is given in recognition of the contributions to the knowledge of Paleozoic siphonophores by Dr. Kenneth E. Caster of the University of Cincinnati.

Phylum Brachiopoda

Class Inarticulata

Order Atremata

Superfamily Lingulacea Waagen, 1885

Genus *Lingula* Bruguiere, 1792

Type species: *Patella unguis* Linnaeus

Lingula allingi Fisher, n. sp.

(Plate II, figures 1, 2)

Holotype: N.Y.S.M. 10761

Paratype: N.Y.S.M. 10762

Formation and Age: Vernon shale, Late Silurian (Cayugan)

Locality: Downing Brook, 3.5 miles southwest of Vernon, N. Y.

Description: Moderately large linguloid brachiopod, the holotype measuring 15 mm. in length and 10 mm. in width. Shell spatuloid in outline, the lateral margins gently arcuate; subacute at the beak and truncate at base with scarcely rounded angles; surface displaying faint concentric growth lines most prominent near lateral margins and straight radiating striations very conspicuous along anterior margin.

Foramen pronounced and 8 mm. from beak with foramenal trench, 0.5 mm. wide, extending to beak. Umbonal muscle scar at beak end of foramenal trench; ventral muscle scars 2.5 mm. on either side and slightly ventral from foramen; outside lateral and transmedian muscle scars 2.5 mm. on either side and paralleling foramenal trench; chevron-shaped middle lateral muscle scars 2 mm. ventrad from foramen.

Discussion and Diagnostic Features. This species resembles *Lingula oblonga* Conrad of the Clinton group except that the mature

shell is larger and muscle scars better impressed. In addition, the outline of *L. allingi* differs slightly and lateral margins are more arcuate than in *L. oblonga*. Comparison with *L. vernoni* Eaton is difficult as that species is very poorly preserved and only one specimen of it was found by Eaton. *L. allingi* is based upon some 40 specimens.

Derivation of name. The trivial name *allingi* is applied in honor of Dr. Harold L. Alling, emeritus professor of geology at the University of Rochester, who has made some outstanding contributions to the knowledge of Silurian stratigraphy in New York.

Phylum Mollusca

Class Gastropoda

Subclass Prosobranchia Cuvier

Superfamily Euomphalacea

Family Euomphalidae de Koninck

Genus *Poleumita* Clarke and Ruedemann, 1903

Type species: *Euomphalus discors* Sowerby, 1814

Poleumita vernonensis Fisher, n. sp.

(Plate II, figures 3-6)

Holotype: N.Y.S.M. 10764

Paratypes: N.Y.S.M. 10763, 10765, 10766

Formation and Age: Vernon shale, Late Silurian (Cayugan)

Locality: Downing Brook, 3.5 miles southwest of Vernon, N. Y.

Description: Dextrally coiled, discoidal to low-turbinate advolute gastropod having four to five subovate whorls, slightly overlapped by adjacent volutions; whorl profile less convex on top with peripheral whorl face sloping outward at angle of 35-40° from the subangular shoulder, then curving rather sharply onto a more rounded base. Umbilical region concealed. Transverse revolving ridges or lirae 2-3 mm. apart on outer whorl are particularly pronounced near apertural end of specimen. Faint growth lines visible on some specimens.

Dimensions of holotype; diameter, 16 mm.; diameter of outermost of five whorls at aperture, 4 mm.; apical angle, 55-60°. Height of paratype, N.Y.S.M. 10766, 7 mm.

Discussion and Diagnostic Features. This species differs from *P. scannata* Clarke and Ruedemann of the Guelph dolomite in that the outer whorl is in contact with the preceding whorl throughout its travel. Furthermore, the elevated flat-topped ridges of the whorls are not apparent on *P. vernonensis*. The mature shells of *P. vernonensis* are seemingly about $\frac{1}{3}$ smaller than those of *P. scannata*. The new species is based on some 50 specimens.

Derivation of name. The trivial name denotes both the stratigraphic position and locality of discovery.

Class Pelecypoda
Order Dysodonta
Suborder Pectinacea
Family Pterineidae Dall
Genus *Pterinea* Goldfuss, 1832
Type species: *Pterinea laevis* Goldfuss
Pterinea wayland-smithi Fisher, n. sp.
(Plate II, figures 7-10)

Holotype: N.Y.S.M. 10767

Paratypes:

N.Y.S.M. 10768 (*P. wayland-smithi* var. *opisthoclinus*)

N.Y.S.M. 10769 (*P. wayland-smithi* var. *normalis*)

N.Y.S.M. 10770 (*P. wayland-smithi* var. *prosoclinus*)

Formation and Age: Vernon shale, Late Silurian (Cayugan)

Locality: Downing Brook, 3.5 miles southwest of Vernon, N. Y.

Description: Inequivalve pectinoid with inequilateral valves, the left valve moderately to strongly convex whereas the right valve is plano. Hinge margin constricted into "ears" presenting winglike (alar) appearance to shell. Concentric growth lines visible on almost all specimens examined; radial markings vary in their intensity. Typical cancellate pattern of pectinoid well shown on the slightly crushed mold of the holotype which measures 16.5 mm. along hinge and is 16 mm. high. The umbo is 6 mm. from the anterior end. There is enough diversity within this species to justify the erection of at least three distinct varieties.

P. wayland-smithi var. *normalis* Fisher

The paratype, N.Y.S.M. 10769, possesses a 1:1 ratio of hinge length to height, measuring 15 mm. in each direction. The umbo is $\frac{1}{3}$ of the distance (5 mm.) from the anterior end; the left valve slopes abruptly from the umbonal region toward the anterior though there is a noticeably more gradual slope toward the posterior. Growth lines are prominent; radial markings not visible.

P. wayland-smithi var. *opisthoclinus* Fisher

The paratype, N.Y.S.M. 10768, possesses a 1:1 ratio of hinge line to height, measuring 17.5 mm. in each direction. The valvular outline is distinctly opisthoclinal with the shell having less backward obliquity than the normal form of this species. The umbo is 7 mm. from the anterior end and the left valve is evenly convex anteriorly and posteriorly from the umbonal region. Radial markings are consistently more prominent than in the normal form of this species though they are inferior in prominence to the concentric growth lines. These growth

lines swing sharply toward the posterior wing (auricle) and this feature may be one indicating a gerontic individual.

P. wayland-smithi var. *prosoclinus* Fisher

The paratype, N.Y.S.M. 10770, retains the diagnostic 1:1 ratio of length of hinge line to height, measuring 18.5 mm. in each direction. The umbo is 6 mm. from the anterior end. This variety is markedly prosocline having considerable forward obliquity. Concentric growth lines are stronger than in the normal form of this species.

Discussion and Diagnostic Features: Though the nature of the valvular swing and the degree of prominence of the growth lines and radial markings may conceivably imply features of maturity, and the noticeable curvature of the growth lines in the posterior auricle may be a condition due to geronticity, the absence of these features on numerous other specimens of the same size suggests that these are varietal characteristics. This analysis is based on about 150 specimens. The sedentary mode of living of this species is demonstrated in that the upper (left) valve is convex whereas the lower (right) valve is plano. It is of further note that *Pterinea* is the oldest representative of the pectens (scallops).

Derivation of name: The most abundant representative of this type Vernon fauna is named in honor of its collector and donor, Mr. Robert Wayland-Smith.

Suborder Mytilacea

Family Modiolopsidae Fischer

Genus *Modiopsis* Hall, 1847

Type species: *Cypricardites ovatus* Conrad

Modiopsis orthoconcavus Fisher, n. sp.

(Plate III, figure 1)

Holotype: N.Y.S.M. 10771

Formation and Age: Vernon shale, Late Silurian (Cayugan)

Locality: Downing Brook, 3.5 miles southwest of Vernon, N. Y.

Description: Mytiliform (slipper-shaped) dysodont; exceedingly inequilateral with smaller anterior and larger posterior end. Terminal position of sharp beaks at anterior extremity of hinge line. Marked elongate concavity, 2 mm. from dorsal side, extending backward from dorso-anterior of umbo. Left valve more convex than right. Holotype measures 30 mm. in length and greatest height is 16 mm. Concentric growth lines prominent.

Discussion and Diagnostic Features: The sedentary habitat of this form is proved by the fact that the right valve illustrates much less convexity than the left, indicating that in life this clam laid on its right side. This species is similar to *M. canadensis* Hall but the

concavity, slightly ventrad of the dorsal side, is not found in that species. It is due to this concavity that the name *orthoconcauus* (straight concavity) is applied. About 35 specimens were found.

Class Cephalopoda

Subclass Nautiloidea

Order Michelinoceratida (= Michelinoceroidea)

Family Michelinoceratidae Flower, 1950

Genus *Kionoceras* Hyatt, 1884

Type species: *Orthoceras doricum* Barrande

Kionoceras sp.

(Plate III, figure 2)

Hypotype: N.Y.S.M. 10772

Formation and Age: Vernon shale, Late Silurian (Cayugan)

Locality: Downing Brook, 3.5 miles southwest of Vernon, N. Y.

Description: Only a portion of the conch of a vertically ribbed and fluted orthoceracone is preserved. The conch measures 13-14 mm. in width and the longitudinal flutings are 2-3 mm. apart. Secondary fainter longitudinal ribs, usually three, occur between a pair of flutings. Internal structures not shown.

Discussion: Nature of preservation of this form does not warrant assignment to a definite species. It suggests *Kionoceras cancellatum* (Hall), a well-known kionoceroid from the Clinton and Guelph of New York.

Genus *Spyroceras* Hyatt, 1884

Type species: *Orthoceras crotalum* Hall

Spyroceras sp.

(Plate III, figure 3)

Hypotype: N.Y.S.M. 10773

Formation and Age: Vernon shale, Late Silurian (Cayugan)

Locality: Downing Brook, 3.5 miles southwest of Vernon, N. Y.

Description: Orthoceracone transversed by faint annulations; no vertical striae observed. Apical end of conch preserved, measures 34 mm. in length and 15 mm. in width. Sides of conch are almost parallel, expanding orad only very slightly. The gently curved septa are separated by camerae 2-3 mm. wide. Siphuncle not shown.

Discussion: Faint annulations testify to the spyroceroid affinities though nothing else diagnostic enough for a specific assignment could be found.

Phylum Arthropoda

Subphylum Crustacea

Class Ostracoda

Order Leperditacea

Family Leperditiidae Jones

Genus *Leperditia* Roualt, 1851Type species: *Leperditia brittanica* Roualt*Leperditia scalaris* (Jones)

(Plate III, figures 4-6)

Hypotypes: N.Y.S.M. 10774, 10775, 10776**Formation and Age:** Vernon shale, Late Silurian (Cayugan)**Locality:** Downing Brook, 3.5 miles southwest of Vernon, N. Y.**Description:** Hypotype, N.Y.S.M. 10774, is 7.5 mm. long and 5 mm. high with hinge line 4 mm. long. There is a slightly backward swing to the smooth valve, greatest convexity in ventral anterior portion of valve. A marginal flange, due to overlap of valves, is visible along a position of the margin.

Hypotype, N.Y.S.M. 10775, is 5 mm. long and 3.5 mm. wide with hinge line 3 mm. long. This is undoubtedly an immature specimen. Greatest convexity is in the ventral region of the symmetrical valve. Large "eye spot" $\frac{1}{3}$ of the distance from the anterior end. Marginal flange prominent on anterior and posterior ends but absent on ventral margin.

Hypotype, N.Y.S.M. 10776, is a small slab displaying two valves, the larger measuring 7 mm. in length and 4 mm. in height with a hinge line 4.5 mm. long whereas the smaller specimen measures 6 mm. in length and 4 mm. in height with a hinge line 4 mm. long. There is a pronounced backward swing on both of these valves and the larger valve shows the point of greatest convexity to be $\frac{2}{5}$ of the distance from the anterior end.

Discussion: The affinities of these leperditids with *L. scalaris* (Jones) is somewhat speculative as that species has never been described adequately. These forms resemble *L. alta* Conrad in some respects and therefore may represent an intermediate condition between the two species. For lack of preservation of more critical details and the current inadequate description of *L. scalaris*, these ostracodes are provisionally placed with *L. scalaris* with every reason to believe that when more information is at hand concerning the features of *L. scalaris*, the characteristics of the Vernon forms will prove to lie within those limits. Fifteen specimens were found.

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